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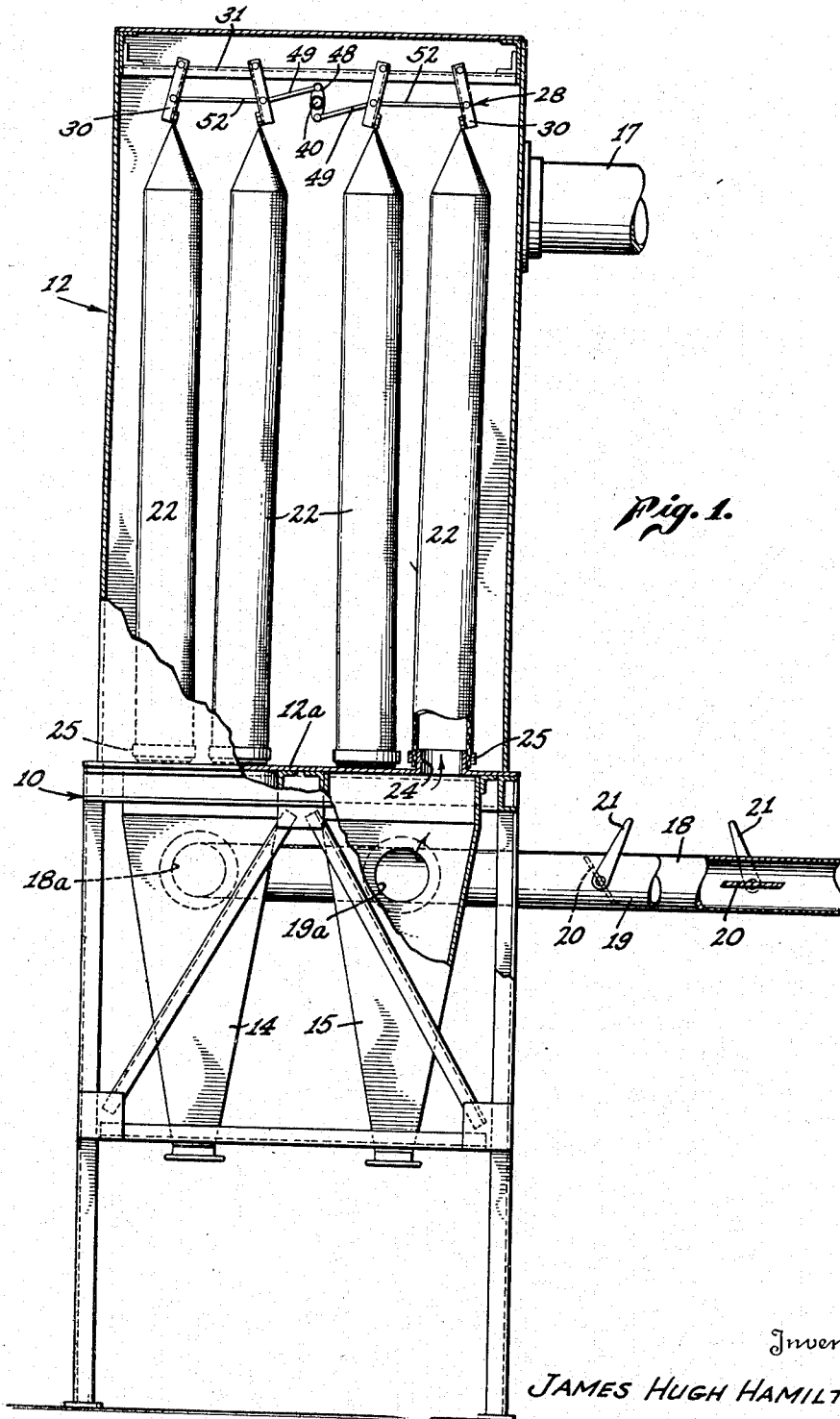
J. H. HAMILTON

2,204,590

DUST COLLECTOR

Filed July 9, 1938

2 Sheets-Sheet 1



By *Arthur P. Knight and*
Alfred W. Knight
Attorneys

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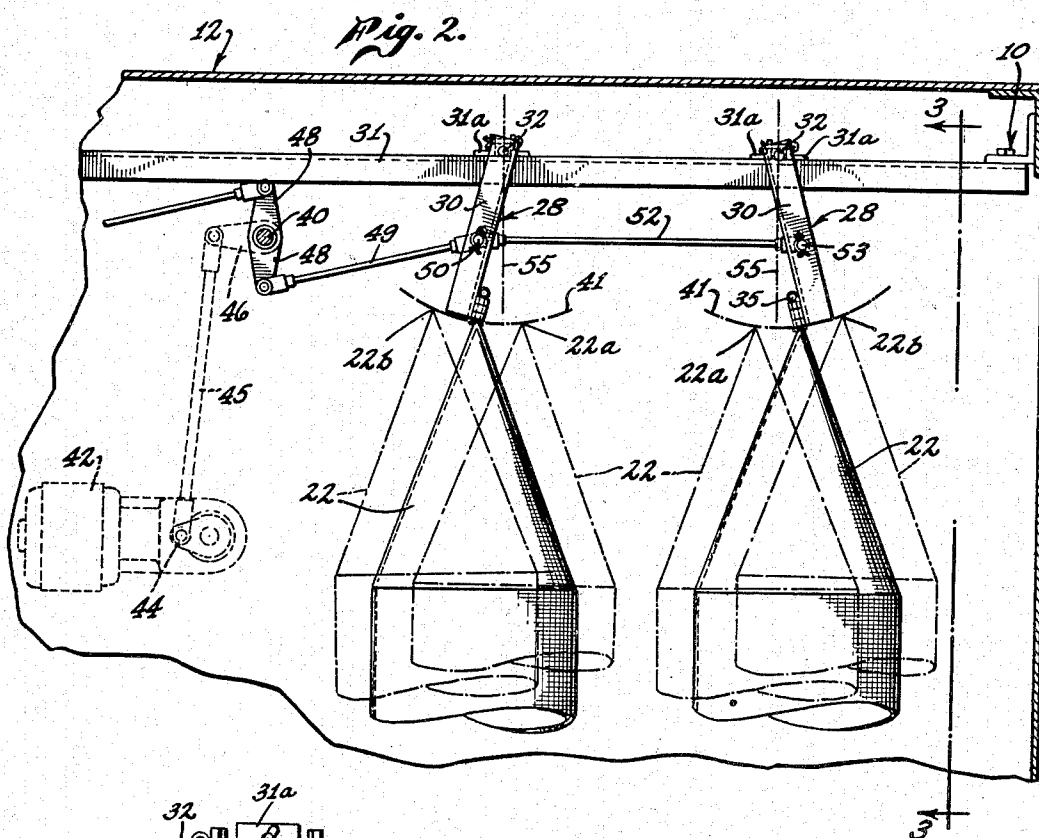
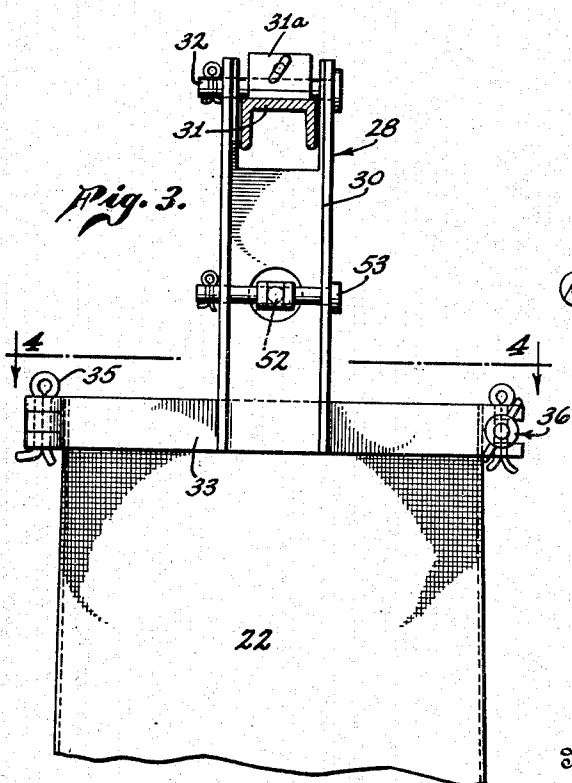
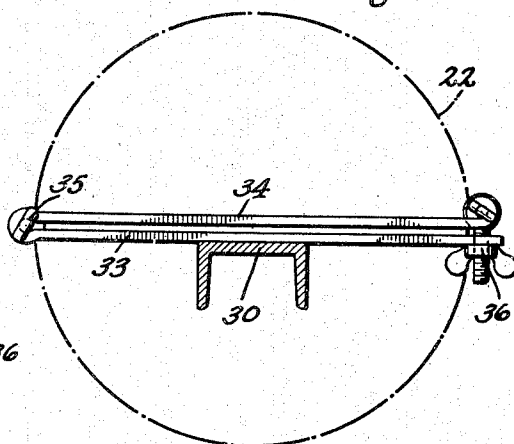
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2 Sheets-Sheet 2



Inventor

JAMES HUGH HAMILTON

By *Arthur P. Knight and*
Alfred W. Knight Attorneys

UNITED STATES PATENT OFFICE

2,204,590

DUST COLLECTOR

James Hugh Hamilton, Burbank, Calif., assignor
to Western Precipitation Corporation, Los
Angeles, Calif., a corporation of California

Application July 9, 1938, Serial No. 218,483

10 Claims. (Cl. 183—58)

The present invention relates generally to dust collectors employing cloth or fabric filters to arrest the dust, and more particularly to means for supporting and shaking the filter elements of the collector. It also includes a novel method of shaking a filter element.

It is a well known practice to pass a stream of gas, such as air, carrying suspended particles through one or more filter elements in order to clean the gas and collect the solid particles. While various materials may be used as filters, the present invention is concerned particularly with filters made of cloth, either in the form of flat sheets or of cylindrical bags comprising one or more thicknesses of cloth fabric. As the dust collects on the filter cloth, the accumulations become so great that it is necessary periodically to remove the accumulated dust particles, at least partially. This is commonly done by shaking or vibrating the flexible filter elements to loosen the adhering dust particles which then fall down into a hopper or other receptacle for holding the dust.

It has always been a problem to secure effective cleaning of the filter elements without undue wear of the filter elements. For example, good cleaning action is ordinarily obtained by using beaters that strike the cloth filters with a sharp blow, because a very high percentage of the accumulated dust is jarred loose from the filter. But beaters have the disadvantage that they break the fibers of the cloth and consequently not only destroy the ability of the filter to retain very fine particles but rapidly wear out the filter elements. For these reasons it has been preferred to resort to shaking the bags or sheets, and various types of motion have been devised in an attempt to secure an effective shaking motion and a simple mechanism that is inexpensive to build and operate.

Most designs have heretofore been open to various objections, usually that they are not capable of satisfactorily cleaning the filters, especially in the case of the long bag filters which range in length from ten to twenty feet or more. In so long a bag it is very difficult to shake the upper end and have the motion effectively transmitted the full length of the bag; and if not, only the upper end of the bag continues to function as a filter. The problem is not solved merely by placing a larger power unit on the shaking mechanism, for some designs that are satisfactory for short filters are not at all suited to long filters; and heavier power units simply cause excessive vibration of the entire structure, par-

ticularly in constructions in which the reciprocated weight is relatively great, as when a number of filters are attached to a frame that is reciprocated horizontally. Larger power units merely increase the loads on pins and bearings and increase the already high rate of wear of these parts which are frequently exposed to dust from the collector. The relatively short life of these wearing parts can be materially increased by reducing the loads and hence the rate of wear.

Hence, it becomes a primary object of my invention to provide means for supporting and shaking cloth filter elements to effect a quick and satisfactory cleaning, even of filters of relatively great length.

Another object of the invention is to provide an advantageous and effective method of cleaning the filter elements by shaking them.

It is another object to provide a shaking mechanism for filter elements that is simple, inexpensive, relatively free of vibration, and requires a minimum of power to operate.

An additional object is to provide a simple support for the upper end of filter elements, that is inexpensive and reduces to a minimum the time and effort involved in replacing a filter element.

A further object is to provide a shaking mechanism in which the loads are reduced to lowest possible values and are relatively uniform.

These objects are attained in a dust collector constructed according to my invention by providing a plurality of filter element supporting members each adapted to be pivotally mounted on the frame of the dust collector and attached to the top of a filter element. In a preferred embodiment of my invention the supporting member includes a pair of horizontal members hinged together at one end and adapted to grip between them the upper end of the cloth filter element, fastening means being provided at the unhinged ends of these members to hold them in gripping position. As the pivotally mounted support is actuated by suitable driving means, the support reciprocates the top of the attached filter element in a vertical arc through a path having both vertical and horizontal components of motion that impart an undulatory movement to the filter element while at the same time alternately stretching and slackening the filter element to remove accumulated dust from the filter. In a preferred form of construction, the filters are located in pairs on opposite sides of a driving member, as in this construction the horizontal components of forces set up during shaking

can be neutralized and excessive vibration from these horizontal components reduced or entirely eliminated. The supports for the two filters at one side of the drive member are interconnected by means that holds the supports in mutually counterbalanced positions such that one of the bags is being raised while the other one is lowered. Since only half of the bags are being lifted at one time, the power requirements for the shaking operation and wear on moving parts are kept at a minimum; and this power is further reduced because a portion of the energy stored up by lifting a bag is available to lift the other bag of that pair as the first bag is lowered.

How the above objects and advantages of my invention, as well as others not specifically mentioned, are attained will be more readily understood by reference to the following description and the annexed drawings, in which:

Fig. 1 is a vertical section, partially in elevation, through a dust collector constructed according to my invention;

Fig. 2 is an enlarged fragmentary vertical section showing the supporting and shaking mechanism for one pair of counterbalanced filter elements;

Fig. 3 is an enlarged fragmentary section on line 3—3 in Fig. 2, with the bag support in vertical position.

Fig. 4 is a horizontal section through a filter bag support on line 4—4 of Fig. 3.

As shown in Fig. 1, the dust collector comprises a structural framework indicated generally at 10 upon which is mounted a gas-tight housing 12 of rectangular outline. Beneath the bottom wall 12a of housing 12 are two hoppers 14 and 15 which receive the accumulated dust deposit shaken loose from the filter elements. Hoppers 14 and 15 have sloping side walls and terminate at their lower ends in a suitable type of valve structure, not shown adapted to discharge the dust from the hopper in any desired manner.

The hoppers are separated at their upper ends which are fastened to bottom wall 12 of the housing, so that each hopper extends under one-half of the housing and is separated from the other hopper in a gas-tight manner.

An outlet for the cleaned gas is provided by pipe 17. The gas inlet to the dust collector is divided into two branch pipes 18 and 19 which communicate with hoppers 14 and 15 respectively at inlets 18a and 19a to introduce gas into the dust collector at these points. Each inlet pipe 18 and 19 is provided with a damper 20 adapted to control gas flow through the individual pipe. Dampers 20 may be controlled by any suitable operating mechanism adapted to actuate the dampers either automatically or at the will of an operator, but for the sake of simplicity in the description and drawings, each damper 20 is here shown as being operated manually by a lever handle 21. Housing 12 is provided with an outlet pipe 17.

The bottom wall 12a of the housing serves not only as a bottom header plate which distributes the incoming gas to the open lower end of each filter bag 22, but it also serves as an anchor means for holding the lower ends of the filter bags in a fixed position. Plate 12a is provided with a plurality of circular openings each surrounded by a short cylindrical nipple 24 having an external diameter substantially the same as the diameter of a filter bag 22. The lower open end of a filter bag is slid over a nipple 24 and fastened tightly in place by means of a suitable

clamp, one typical means being a metal band 25 passed around the filter bag to press it into gas-tight fit with the exterior of nipple 24, the ends of the band being drawn together by any suitable fastening means such as a screw or toggle.

The stream of gas carrying suspended particles is introduced into the upper portions of the hoppers 14 and 15, from which it flows upwardly through nipples 24 on plate 12a into the interiors of the individual filter bags 22. For purposes of this description, the dust collector may be considered as comprising only four filter bags 22, arranged as shown in Fig. 1. However, it will be understood that in commercial practice a dust collector may contain any desired multiple of four bags, depending upon the capacity desired, and that the additional bags may be arranged in the same manner as the bags shown in Fig. 1 to form rows extending perpendicular to the plane of the drawings. There is, of course, a separate opening through plate 12a for each of the bags, and one-half of the total number of bags is placed above and in communication with each of hoppers 14 and 15.

Filter elements 22 are referred to as cloth bags, because filter elements of this type are well known in the art and are made of a variety of cloth fabrics as best may be suited to the particular conditions under which the dust collector operates. There also may be included within the scope of this term, bags made of special materials, such as asbestos, or cloth bags which have been specially treated. Although bags 22 are indicated as having a circular cross-section, bags of other cross-sections may be used.

Each filter bag 22 is individually connected at its upper end to a support, indicated generally at 28, one possible form of which is shown in greater detail in Figs. 2, 3 and 4. Each filter bag support 28 comprises a vertical channel member 30 adapted to be pivotally mounted on horizontal channel 31, which is a portion of framework 10, by pivot pin 32 resting on channel 31. A pair of lugs 31a hold the pin against lateral movement. Horizontally extending clamp member or strap 33 is rigidly attached to the lower end of vertical member 30. A second horizontal clamp member or strap 34 is hinged at one end by pin 35 to the end of horizontal strap 33, while the unhinged ends of members 33 and 34 are held together, as shown in Fig. 4, by a screw and wing nut arrangement 36, or other suitable fastening means. Filter bags 22 are each formed at their upper ends with a flat fold which is placed between the support members 33 and 34 and gripped by them when wing nut 36 is tightened. Two large triangular darts are taken out of opposite sides of the bag so that the bag may be given the peaked shape shown in the drawings, and the upper end is closed by a narrow horizontal fold which is sewn, and preferably reinforced, to form a flat section that can be securely gripped between clamping members 33 and 34 of the bag support and held in a fixed position relative to the support.

Replacement of individual bags is quickly and easily accomplished. Loosening wing nut 36 and clamp 25 is all that is required to free a bag to permit removal. The new one is placed over the nipple 24, and clamp 25 replaced, then the upper end is placed between gripping members 33 and 34 of the support and wing nut 36 tightened to install the new bag. The bags are preferably cut accurately to length, though minor differ-

improved results are obtained appreciably as long as the movement at one side is about three or more times that on the other, that is, as long as at least approximately three-fourths of the total arc is at one side of the vertical centerline 55.

It will be seen that a point at the extreme top of each bag moves repeatedly through an arcuate path that has both vertical and horizontal components of motion, the arcuate movements of all bags being equal. The horizontal components of the two bag supports shown in the figure are always in the same direction, that is, either toward the right or left; but the vertical components of the motions of the bag tops are preferably substantially always in opposite directions. Thus one bag is moving downwardly in general while the other bag is moving upwardly when the end point 22a of the swing is at, or substantially at, the lowest point on arc 41. The lowest point on each arc is therefore at or near opposite ends of the swing. This is a consequence of the initial inclination of the supports 28 that swings the supports out of phase, with one at the high end of its arc while the other is at the low end of its arc. Since the top of one bag is rising as the other is falling, link 52 maintains the bag tops and their supports one-half cycle out of phase with each other at all times, considering a complete cycle of movement as being the swing outwardly from point 22a and return. During at least about three-fourths, if not all, of each one-half cycle one bag of the pair is being raised while the other bag is being lowered, the second bag being raised during the second half of the cycle.

By virtue of the interconnection of the supports of a pair of bags through link 52, the vertical components of motion of the bag tops counterbalance each other throughout the major portion of the cycle of movement. Since only one-half of the bags are being lifted at any one time, the power unit 42 has imposed upon it a maximum load only one-half as great as if all bags were being lifted simultaneously; and the load is much more uniform since throughout each cycle some bags are being lifted. Also, a portion of the energy stored in the system by lifting a bag to the end of its arc is recovered on the downward swing and helps lift the other bag of the pair. This construction consequently produces a very even, smooth action with the work done distributed over the entire operation cycle, and permits the use of a smaller power unit, with attendant economy of operation.

The relatively small loads on the various pin connections and bearings greatly reduce the wear at these points compared with wear in former known types of shaking mechanism, and permit an economical construction using oilless bearings.

As a result of placing equal number of bags at opposite sides of rock shaft 40, the horizontal forces set up by the two connecting rods 49 are always equal and opposite to each other and are substantially neutralized. Substantially all vibration resulting from unbalanced horizontal forces is eliminated, and shaft 40 may be oscillated at any desired speed without any danger of encountering excessive vibration.

As the top of the bag is moved through the arcuate path described, the horizontal component of the motion creates an undulatory movement which travels longitudinally of the bag and shakes loose accumulated deposits of dust on the bag's interior. Simultaneously with this movement, the bag is alternately stretched and slack-

ened by the alternate rise and fall of the top of the bag to help loosen the accumulated dust. It has been found that a particularly advantageous and efficient shaking action is derived from this method of shaking the bags, usually reaching a maximum when the motion of the bag top is entirely to one side of its vertical center line 55. This shaking action is greatly improved by the firm grip of the straps 33 and 34 on the bag top, the shaking motion travelling much farther along the bag than when the top is held loosely as by a rod passing through a loop in the fabric at the top of the bag. As a result, for a given angular movement of support 28, maximum amplitude is given to the horizontal motion which creates the undulatory shaking movement, and also maximum stretching action is secured. It will be clear that placing point 22a at or near center line 55 has the marked advantage that the effective vertical components of the motion at the bag top are approximately twice what they would be if the bag top were swung equally on both sides of centerline 55.

The cleaning operation is carried out for one half the bags at a time, though all the bags are shaken. When it is desired to clean the bags of accumulated dust, the gas flow to one half the bags is cut off, as by closing damper 20 in pipe 19 (see Fig. 1). The power to motor 42 is then turned on and all the bags are shaken, the bags at the right hand half of the collector, as viewed in Fig. 1, being cleaned while the bags of the other half continue to filter. After the dust has fallen down into hopper 15, the damper in conduit 19 is opened and that in conduit 18 is closed, allowing the other half of the bags to be cleaned. Finally, both dampers are opened and motor 42 shut off. One half the bags filter at all times allowing continuous operation of the collector, the capacity being sufficient to permit the short periods of overloading.

Having shown and described one form of my invention, it will be clear that many changes in construction and arrangement of parts may be made within the scope of my invention; and it is therefore to be understood that the foregoing description is to be construed as illustrative of rather than limitative upon the appended claims.

I claim:

1. Apparatus for supporting and shaking a pair of spaced, substantially vertically extending cloth filter elements of the character used to filter suspended dust particles from a stream of air, comprising a pair of spaced rigid supports each mounted pivotally to swing about a substantially horizontal axis and attached to the top of one filter element at a position spaced from and below the axis to support the filter element; a source of motive power for shaking both filter elements; and an actuating linkage operatively connecting the power source to both supports and oscillating the supports and the tops of the filter elements about their associated axes through equal arcs of which the lowest point on each arc is near one end of the arc.

2. Apparatus for supporting and shaking a pair of spaced, substantially vertically extending cloth filter elements of the character used to filter suspended dust particles from a stream of air, comprising a pair of spaced rigid supports each mounted pivotally to swing about a substantially horizontal axis and attached to the top of one filter element at a position spaced from and below the axis to support the filter element; a source of motive power for shaking both filter

ences in length are of little consequence. Some vertical adjustment can be made, if desired, by moving the folded seam up or down in the clamp members 33 and 34; and the range of adjustment can be increased by increasing the vertical width of the straps. The replacement of a single bag takes but a few minutes; and by shutting off only the one half of the bags, including the bag to be replaced, by closing a damper 20, operation of the entire dust collector need not cease.

Filter bags 22 are arranged in pairs, with one pair at each side of the centrally located rock shaft 40, each bag being individually supported by a pivotally mounted support 28 which is adapted to reciprocate the top of the bag along a vertical arc 41. The driving mechanism for swinging the bag supports and imparting the desired movement to the bags to shake them includes electric motor 42 which has a reduction gear head, or other suitable source of power. Motor 42 is placed at the side of the housing or other convenient location. The power take-off shaft of motor 42 carries an eccentric crank pin 44 to which is attached one end of connecting rod 45, the other end of connecting rod 45 being attached to arm 46 fastened on horizontally extending rock shaft 40. For each set of four bags 22, there is secured to rock shaft 40 a pair of opposed arms 48 which oscillate through an arcuate path as rock shaft 40 is oscillated. Each arm 48 is drivingly connected to the nearest bag support 28 by connecting rod 49, which is pivotally connected to the bag support by pin 50. The two spaced bags constituting a pair at the same side of the rock shaft, as shown in Fig. 2, are interconnected by a rigid link 52 attached at one end to pin 50 and at the other end to a similar pin 53 on the support for the second bag of the pair. Openings are cut in the backs of channel members 30 for link 52 to pass through and connect to pins 50 and 53. Though link 52 may be considered as a part of the system comprising a pair of bags and their supports driven by connecting rod 49, yet link 52 may also be considered to be a part of the driving means for actuating two separately supported bags.

Interconnecting link 52 is placed between the bags and pivots 32, and is longer than the spacing between the two pivots 32, as may be seen in Fig. 2. Consequently, bag supports 28 are oppositely inclined by being spread apart at their lower ends, and when the pair of bags are free of any external forces, as would be the case if connecting rod 49 were disconnected from pin 50, the bags and their supports will assume the full-line position of Fig. 2, which position, for convenience of reference, is termed the neutral position. In this neutral position the tops of bags 22 are held eccentric to and at opposite sides of vertical center lines 55 passing through pivots 32 and the centers of nipples 24 at the base of the bags. Also, the oppositely inclined bag supports 28 are equally inclined to, and converge upwardly from opposite sides of, center lines 55. Since the tendency of each support 28 to assume a truly vertical position is counterbalanced by the equal and opposite tendency of the other support to do likewise, the system comprising a pair of bags and their supports 28 interconnected by a link 52 would normally tend to come to rest in the neutral position illustrated if the system were free of any external forces applied by connecting rod 49. The construction is preferably such that the bags are

substantially vertical at all times, though it is not necessary that the vertical 55 through pivot 32 pass also through the center of nipple 24.

The construction shown may be modified in various ways, as by extending members 30 upwardly beyond pivot pins 32, in which case link 52 can be placed above pipe 31 if desired. The link 52 should then be shorter than the distance between pivots 32 to secure the same positions of the bags. If link 52 were longer, as now, and above pipe 31, or shorter and below pipe 31, then supports 28 would diverge upwardly and the bags would still be eccentric to, but disposed on the adjacent sides of, center lines 55. The arrangement shown is preferred because a smaller spacing between center lines 55 is required.

When the shaking operation takes place, the circular movement of crank pin 44 driven by motor 42 causes an oscillation of arm 46 and rock shaft 40. The oscillatory motion of the rock shaft and arms 48 is communicated by connecting rods 49 to the pair of bags at either side of the rock shaft, and the bag supports are swung to and fro about the pivots 32 and move the extreme top of each bag along vertical arc 41 from the position at 22a to 22b. The lengths and relationships of the several parts are such that each support 28 occupies at one end of its swing a substantially vertical position in which its longitudinal axis is aligned with the associated center line 55, and in this position the bag top is at 22a, which is the lowest point, or substantially so, on the arc 41. During the swing, each support moves the same distance from the vertical position at one end of the swing, upwardly past the neutral position to move the bag top to the extreme upper position 22b. Both end positions are indicated by dotted lines in Fig. 2.

Because of the construction of the particular bag support 28 illustrated, the top of the attached bag is not exactly on the longitudinal axis of the support; and, consequently, when the support is vertical at the end of its swing, point 22a is slightly offset from centerline 55 toward the other bag of the pair. In practice the amount of the offset is of the order of $\frac{1}{2}$ inch to $\frac{3}{4}$ inch. Of course, the offset could be made on the other side of centerline 55 by reversing the two supports of the pair; or the offset could be reduced or made zero by changing support 28 to place the bag top on the support axis. The effect of the offset may be eliminated by increasing the length of link 52 sufficiently that point 22a falls at the end of the swing on centerline 55. With the offset shown, the vertical rise of the bag top at point 22a over the actual lowest point on the arc is of the order of .02-.04 inch, and may be ignored, since it is so small and the rise of the bag at 22b is many times this amount.

The construction illustrated places a small part of the arcuate path, and also of the horizontal movement, of the bag top on the inner side of centerline 55 toward 22a; but it may also be that all of the movement is at the outer side of the centerline, and point 22a is at or beyond the intersection of centerline 55 and arc 41. When point 22a is on centerline 55, the advantages of my novel arrangement as pointed out below, are at a maximum, and they decrease somewhat as the proportion of the total arc at the inner side of the centerline increases. As long as the portion of the arc on one side of the centerline is materially greater than that on the other side, the advantages of my invention are secured, at least to some degree, and it has been found that

elements; and an actuating linkage, including a member interconnecting the two supports, operatively connecting the power source to both supports and oscillating the supports and the top of the filter elements about their associated axes through equal arcs of which at least substantially three-fourths of the arcuate movement of each bag top is at one side of a vertical line passing through the pivotal mounting of the associated support.

3. Apparatus for supporting and shaking a pair of spaced, substantially vertically extending cloth filter elements of the character used to filter suspended dust particles from a stream of air, comprising a pair of spaced rigid supports each mounted pivotally to swing about a substantially horizontal axis and attached to the top of one filter element at a position spaced from and below the axis to support the filter element; a source of motive power for shaking both filter elements; and an actuating linkage operatively connecting the power source to both supports and oscillating the supports and the tops of the filter elements about their associated axes through equal arcs of which substantially all of each arc is at one side of a vertical line passing through the associated axis, said linkage including a rigid member interconnecting the two supports and adapted to position the supports inclined oppositely to the vertical when at the mid-point of the arcs.

4. Apparatus for supporting and shaking a pair of spaced, substantially vertically extending cloth filter elements of the character used to filter suspended dust particles from a stream of air, comprising a pair of spaced rigid supports each mounted pivotally to swing about a substantially horizontal axis and attached to the top of one filter element at a position spaced from and below the axis to support the filter element; a rigid member attached to both supports positioning the supports, when in neutral positions, inclined to the vertical and upwardly converging from opposite sides of vertical lines through said axes; a source of motive power for shaking both filter elements; and an actuating linkage operatively connecting the power source to the supports and simultaneously oscillating the supports, each about its associated horizontal axis, between substantially vertical positions at the end of the down swing and inclined positions at the upper end of the swing.

5. Apparatus for supporting and shaking a pair of spaced, substantially vertically extending cloth filter elements of the character used to filter suspended dust particles from a stream of air, comprising a pair of spaced rigid supports each mounted pivotally to swing about a substantially horizontal axis and attached to the top of one filter element at a position spaced from and below the axis to support the filter element; a rigid member attached to both supports maintaining the supports in mutually counterbalancing relation with each other and positioning the supports oppositely inclined to the vertical when in neutral positions; a source of motive power for shaking both filter elements; and an actuating linkage operatively connecting the power source to the supports and oscillating the supports and the tops of the filter elements about their associated axes through equal arcs.

6. Apparatus for supporting and shaking a pair of spaced, substantially vertically extending cloth filter elements of the character used to filter suspended dust particles from a stream of air, comprising a pair of spaced rigid supports each

mounted pivotally to swing about a substantially horizontal axis and attached to the top of one filter element at a position spaced from and below the axis to support the filter element; a source of motive power for shaking both filter elements; an actuating linkage operatively connecting the power source to the supports and oscillating the supports and the tops of the filter elements about their associated axes through arcuate paths having horizontal and vertical components of motion; and a rigid member interconnecting the two supports to secure equal movement and maintain the supports one-half cycle out of phase with each other, whereby the vertical components of the movement of the supports tend to counterbalance each other.

7. Apparatus for supporting and shaking a plurality of spaced substantially vertically extending cloth filter elements of the character used to filter suspended dust particles from a stream of air, comprising an oscillating member; a plurality of rigid filter element supports disposed in equal numbers at opposite sides of the member, each support being pivotally mounted to swing about a horizontal axis and attached to the top of one filter element at a point spaced from and below the axis to support the filter element; a source of motive power operatively connected to the oscillating member for shaking the plurality of filter elements; and an actuating linkage operatively connecting the oscillating member to all the supports to swing the supports and shake the filter elements, said linkage swinging the supports at one side of the oscillating member equally and oppositely to the supports at the other side of the member to neutralize horizontal forces created by the swinging movements.

8. Apparatus for supporting and shaking a plurality of spaced substantially vertically extending cloth filter elements of the character used to filter suspended dust particles from a stream of air, comprising an oscillating member; a pair of rigid filter element supports at each of two opposite sides of the oscillating member, each support being pivotally mounted to swing about a horizontal axis and attached to the top of one filter element at a point spaced from and below the axis to support the filter element; a rigid member attached to both supports of each pair maintaining the supports of each pair inclined oppositely to the vertical when in neutral rest positions and in mutually counterbalancing relation when in motion; a source of motive power operatively connected to the oscillating member for shaking the filter elements; and an actuating linkage operatively connecting the oscillating member to the pairs of supports at either side to swing the supports through equal arcs of which the lowest point on each arc is near one end of the arc, said linkage swinging the pair of supports at one side of the oscillating member equally and oppositely to the pair of supports at the other side of the member to neutralize horizontal forces created by the swinging movements.

9. Apparatus as set forth in claim 1 in which the actuating linkage is adapted to position the supports inclined oppositely to the vertical when at the mid-points of the arcs.

10. Apparatus as set forth in claim 1 in which the actuating linkage maintains the supports one half cycle out of phase with each other, whereby the vertical components of the movement of the supports tend to counterbalance each other.

JAMES HUGH HAMILTON.