(Model.) 2 Sheets—Sheet 1.

F. MURPHY.

COMBINED FAN BLOWER AND INDUCTION APPARATUS.

No. 387,177. Patented July 31, 1888.

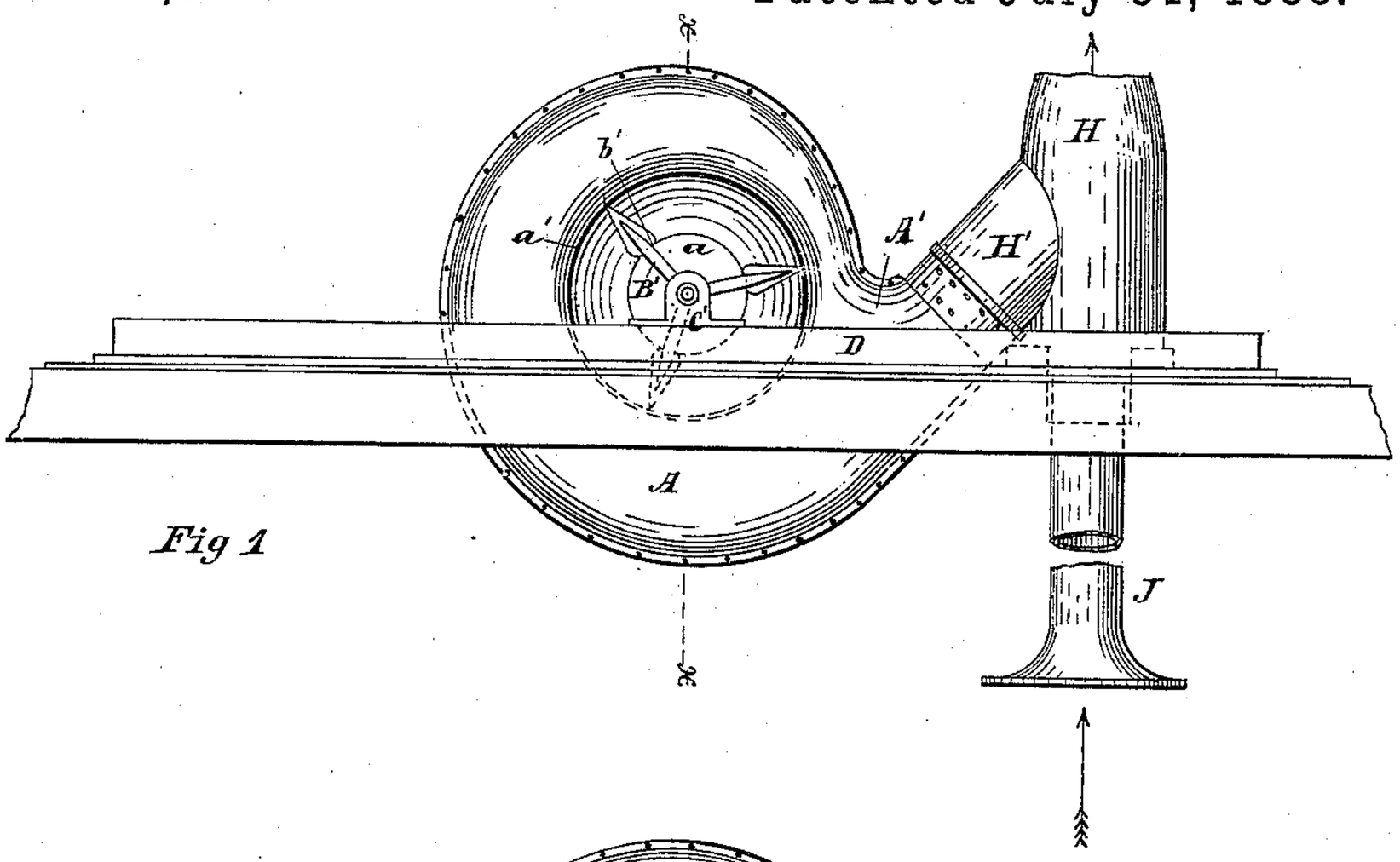

Fig 1

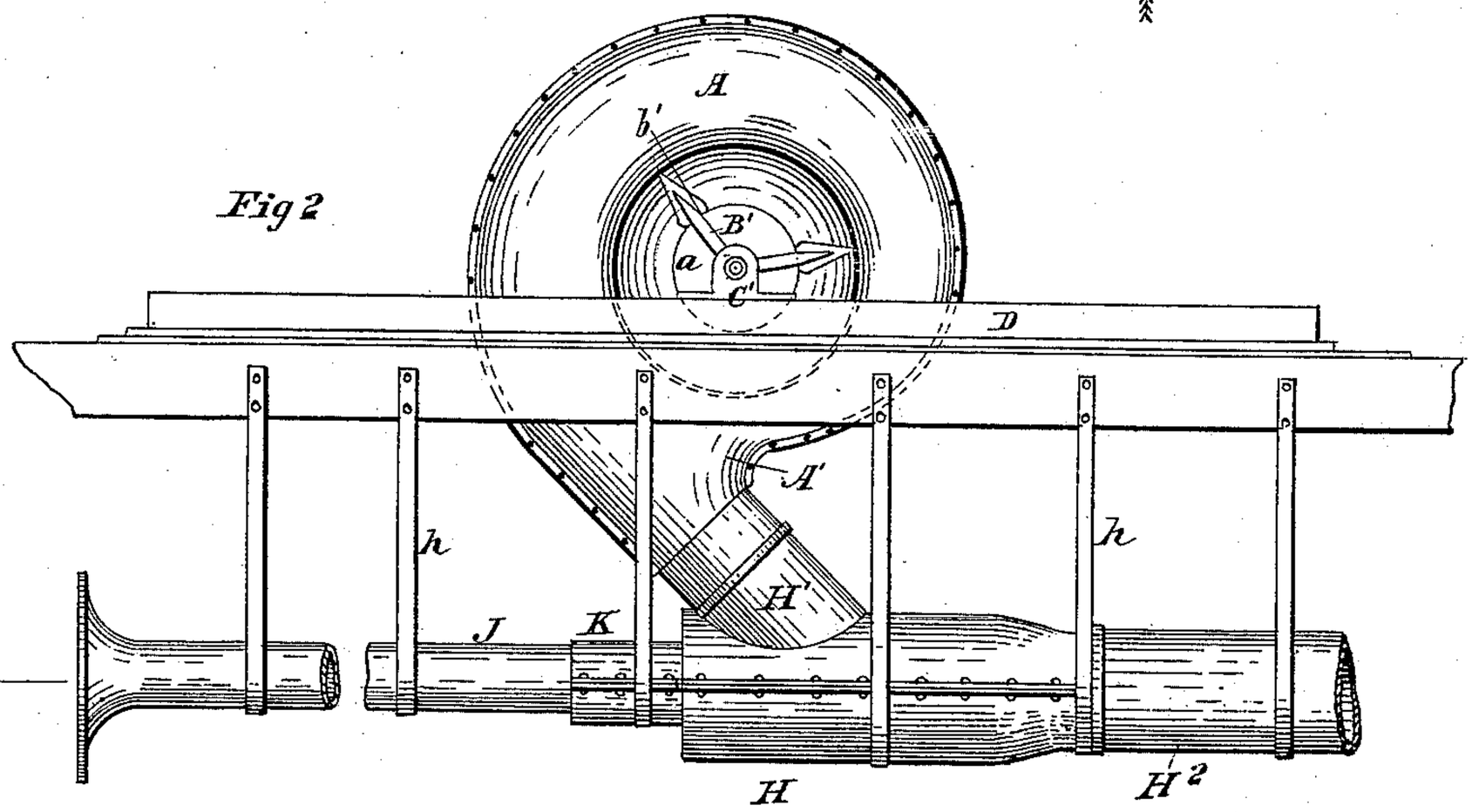

Fig 2

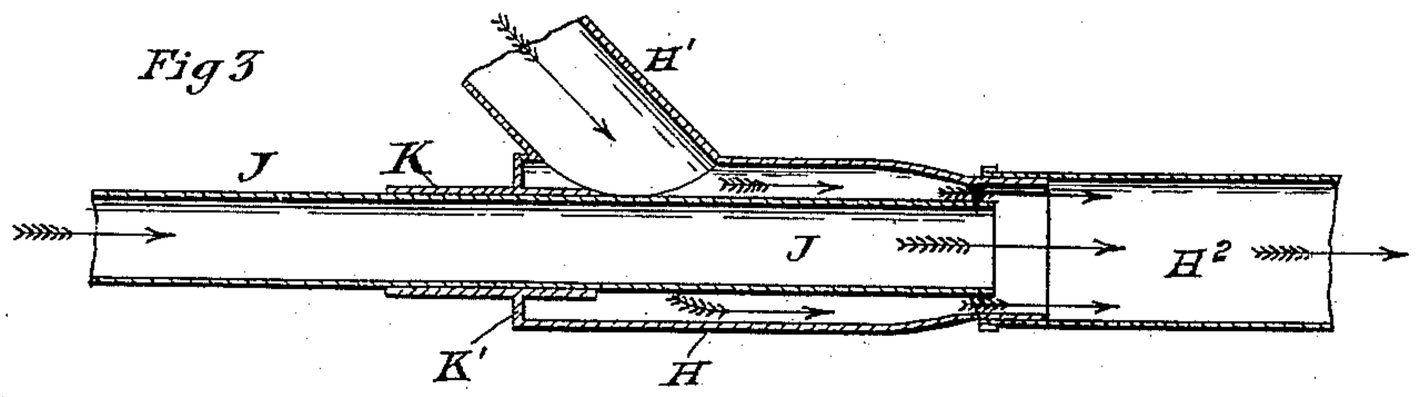

Fig 3

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(Model.) 2 Sheets—Sheet 2.

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COMBINED FAN BLOWER AND INDUCTION APPARATUS.

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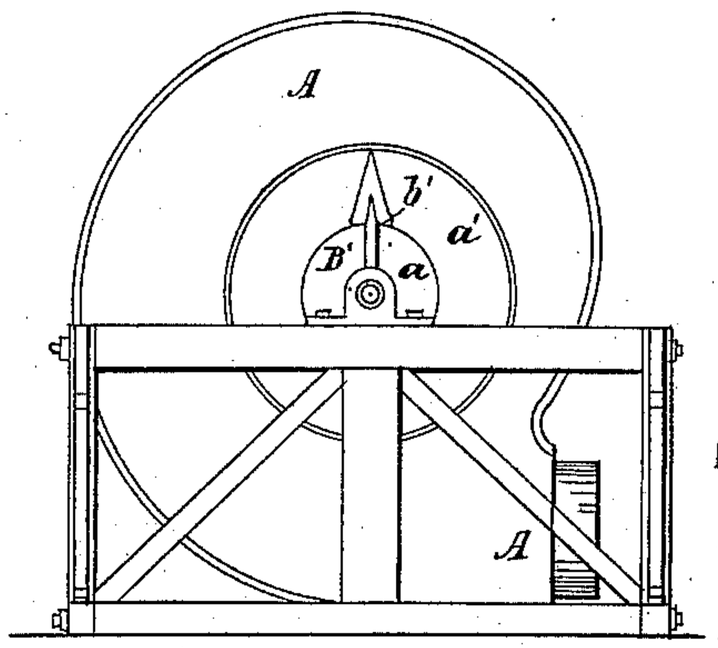

Fig 4

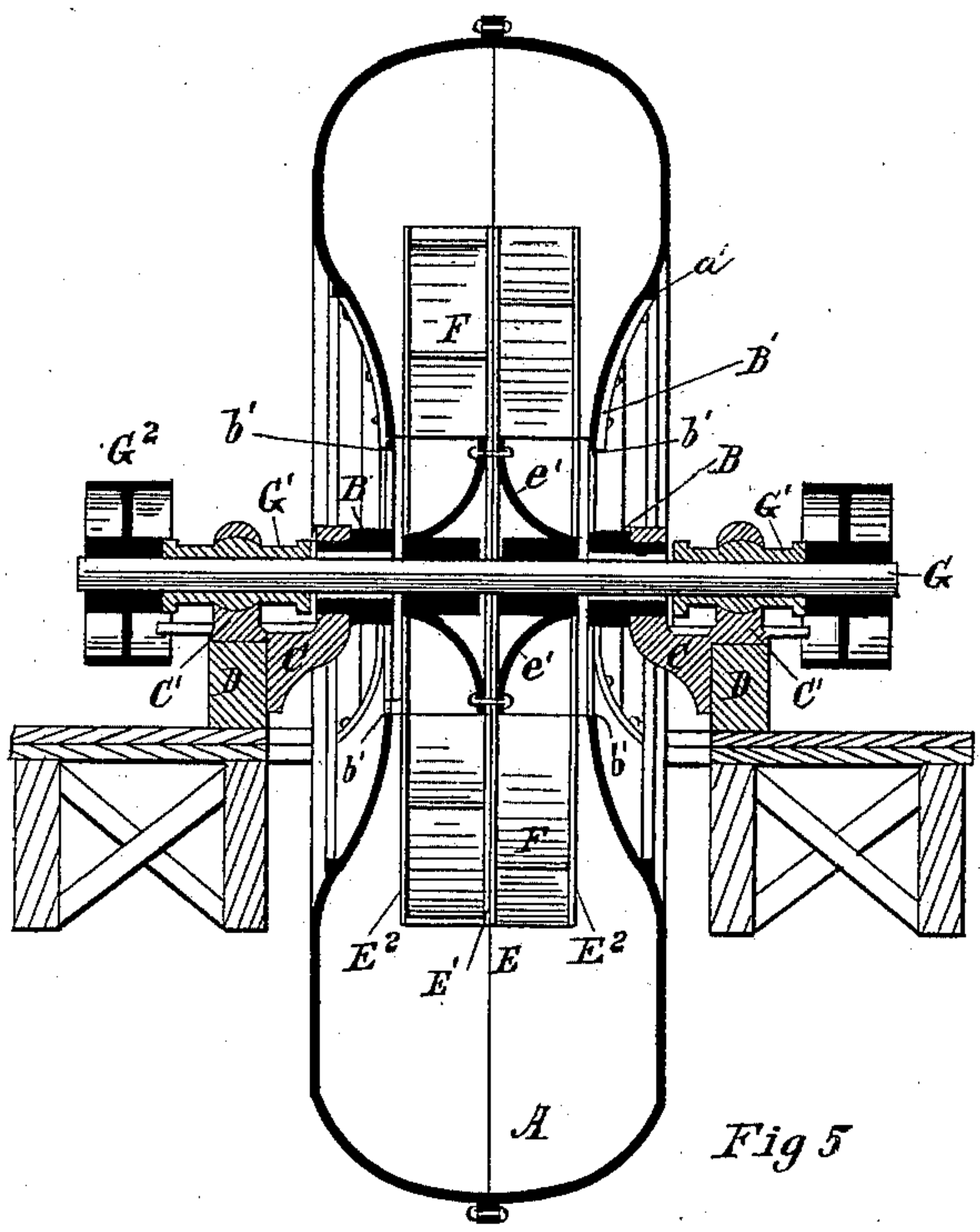

Fig 5

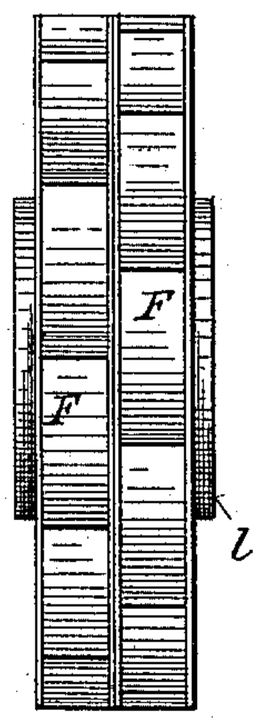

Fig. 7.

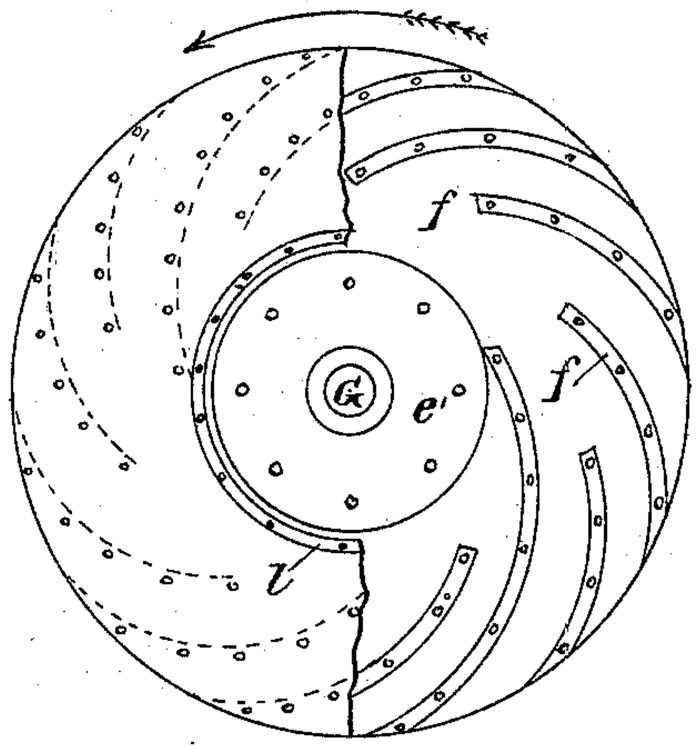

Fig. 6.

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UNITED STATES PATENT OFFICE.

FRANCIS MURPHY, OF CHICAGO, ILLINOIS.

COMBINED FAN-BLOWER AND INDUCTION APPARATUS.

SPECIFICATION forming part of Letters Patent No. 387,177, dated July 31, 1888.

Application filed February 18, 1881. Serial No. 26,464. (Model.)

To all whom it may concern:

Be it known that I, FRANCIS MURPHY, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Air-Blast Apparatus, of which the following is a specification.

An object of my invention is to utilize the full force of a blast of air from a rotary fan-blower as a means for conveying along a tube or passage a variety of light articles—such as dust, shavings, cotton, wool, chips, grain, and the like—without permitting any of the matters thus conveyed to enter the fan-wheel chamber and clog up the fan-wheel, and to utilize the blast from the rotary fan-blower, not only as a means for inducing along a separately-arranged induction passage a current of air substantially equal in velocity to the strongest current a rotary fan-blower is capable of producing, and hence sufficient for drawing into and carrying along the passage various light matters from a remote point, but also as a means for causing the rapid and efficient discharge of such matters from the induction-passage into and through a discharge-passage without necessitating the passage of any of the conducted matters or materials through the fan-wheel chamber of the blower; also, to provide certain novel and improved details, as will hereinafter appear.

To the attainment of the foregoing and other useful results, my invention consists in matters hereinafter described, and particularly pointed out in the claims.

In the accompanying drawings, Figure 1 is a side elevation of an apparatus embodying the principles of my invention, the apparatus in this view being shown set in a floor and arranged for direct upward draft, with a portion of the length of the induction-tube broken away. Fig. 2 is a view in elevation, similar to Fig. 1, representing, however, the apparatus arranged for a horizontal draft. Fig. 3 is a central longitudinal section on a vertical plane through the induction and discharge tube, which latter is in the preceding figure connected with the mouth A′ of the blower by the hollow arm H′ in Fig. 3, said arm being broken away at its end that is to connect with the mouth of the blower. Fig. 4 is an end elevation of the blower mounted within a frame. Fig. 5 is a vertical transverse section of the blower and its bearings on a plane indicated by dotted line *x x*, Fig. 1. Fig. 6 is an end elevation of the fan-wheel, with about half of the outer end plate of the wheel broken away. Fig. 7 is a side or face view of the fan-wheel, representing so much of its periphery as would be visible in such illustration.

In said drawings, A indicates the blower-casing adapted to provide a chamber wherein the fan-wheel E is arranged for operation. Air is admitted to the fan-wheel through one or both ends of the casing, which, for such purpose, is provided at one or both ends with a centrally-arranged circular inlet-opening, *a*. The current or blast created by the rotation of the fan is discharged from the fan-wheel chamber desirably at the perimeter of the casing. To such end the blower-casing is provided at a point along its perimeter with a tubular neck or mouth, A′, set substantially tangential to the blower-casing, and united thereto, so as to somewhat modify the generally-cylindric form of the fan-wheel chamber by enlarging or expanding such chamber at the point where it opens into the passage through its mouth A′, thus providing for a free discharge of air into and through such outlet.

H^2 indicates the discharge pipe or tube, and J denotes the induction pipe or tube of what may be termed an "induction device." This induction device is connected with the blower, so that the blast from the latter will enter the discharge-tube in a manner to induce a current through the passage of the induction-tube and effect a continuance of such current onward through the "discharge-tube" or "discharge-passage," as it may be indifferently termed.

In the arrangement herein shown the induction tube, which is somewhat smaller in diameter than the discharge-tube, opens at its discharge end into the passage of said discharge-tube H^2, and is held in alignment with the longitudinal center of the same. The tube H^2 extends to some extent back of the discharge end of the induction-tube, as at H, so as to provide between the two tubes a concentrically-arranged space or passage.

The discharge opening or mouth of the

blower is in communication with the annular passage that is formed between the discharge and induction tubes, (considering hereinafter, for convenience, the tube H^2 and its rear extension, H, as a whole to be the discharge-tube,) the point of connection between the blower and such annular passage being back of the discharge end of the induction-tube. It is desirable that the blast from the blower should enter the annular passage between the discharge and induction tubes as nearly parallel with the direction of such passage as circumstances will permit, and to such end the rear end portion, H, of the discharge-tube is connected with the mouth A′ of the blower by a short pipe or hollow arm, H′, arranged obliquely to the discharge-tube. The discharge-tube is closed around the induction-tube at a point back of the connection between the discharge-tube and the hollow blower-arm H′, for example, by a flange, K′, herein formed at the point where the induction-tube passes centrally through the rear extremity of the discharge-tube, and, as a convenient means for steadying and centering the induction-tube, it can be fitted for a portion of its length within a tubular holder, K, which is in turn connected with the discharge-tube by the flange K′.

The annular passage between the induction and discharge tubes is contracted at or about the point where the induction-tube discharges into the discharge-tube; or, conversely, the rear extension, H, of the discharge-tube is internally expanded back from such point. In this way the blast from the blower enters an annular chamber or passage closed at its rear end, but at its forward end formed with a somewhat contracted annular discharge-orifice at the point where the induction-tube J discharges into the discharge-tube. The effect of thus contracting the passage around the induction-tube at a point adjacent to the discharge end of the induction-tube serves to attain greater force in the current entering the main discharge portion H^2 of the discharge-tube, and at the same time an annular passage or chamber of ample capacity for receiving air from the blower is provided.

As a result of the foregoing arrangement the blast from the rotary blower enters the discharge-passage at a point where the discharge end of an induction-tube opens into the latter. During the operation of the fan-blower the blast therefrom will, upon entering the discharge-passage at the point where the induction and discharge passages merge or open into one another, drive the air forward from the discharge end of the induction-passage of tube J and overcome all atmospheric pressure at the discharging end of the discharge-passage through the discharge-tube, whereby atmospheric pressure at the inlet or receiving end of the induction-passage will force the air into and along such passage so long as the fan continues in operation. Light matters within the vicinity of the receiving end of tube J will hence be drawn into such tube, and by the induced current therein be carried along until discharged into the discharge-tube, and from thence carried onward by the blast to the ultimate point of discharge, as indicated by the several arrows in Fig. 3. The velocity of the current thus induced through the induction-tube will be substantially equal to the strongest current the blower can produce; and hence all desired matters can be efficiently carried from the receiving end of the induction-passage to the discharging end of the discharge-passage without entering the blower.

In Figs. 1 and 2 the inlet end of the induction-tube J is made trumpet-shaped or bell-mouthed to facilitate both the entrance of air and such matters as are to be conveyed through the tube.

The blower can be set so as to place the passage through the induction and discharge tubes at any desired angle—as, for example, such passage can be arranged vertically, as in Fig. 1, or horizontally, as in Fig. 2. When the apparatus is arranged to place such passage horizontally and the blower is set in the flooring of a building, the induction and discharge tubes can be steadied and supported by hangers or hoops *h*, as in Fig. 2, thus relieving the neck A′ of the blower from undue strain.

In Fig. 1 the blower is shown supported similar to the blower in Fig. 2, the induction device being, however, held in a vertical position and arranged to pass up through the floor.

It will be obvious that any comparatively light matter entering the induction-tube will be carried to the point of discharge without entering the blower and hence without coming in contact with the fan.

It is also evident that the operation of this apparatus will serve to constantly change the air in such space as may surround the inlet end of the induction-tube J, and hence that the apparatus can be used successfully for the ventilation of mines, sewers, ships' holds, and the like; also, that since the tube J provides a draft-flue such flue can be employed as the flue leading from a stove or furnace, so as to increase the draft of a chimney.

With regard to my invention thus far described, I do not limit myself to any particular construction of fan-blower, since I may, in connection with the induction and discharge tubes or passages, such as set forth, employ any construction of rotary fan-blower adapted for creating a suitable blast. Certain features, however, herein involved in the construction of the blower and in the manner of mounting the same constitute matters of improvement, and while applicable to fan-blowers for other purposes are also highly efficient and serviceable in the present connection.

The fan-casing A is herein capable of rotary adjustment about the axis of the rotary fan-wheel, whereby the casing can be adjusted so

as to direct the blast therefrom either up or down or from any point about the plane of its rotation, in which way the direction of the current can be changed without shifting the supporting media of the apparatus.

The fan-wheel casing is also capable of rotary adjustment about and independently of the axle of the fan-wheel and is provided with hollow journals, while the fan-wheel has its axle extended through the hollow journals of the fan-wheel casing, the journals of the fan-wheel casing being supported upon bearings independently of the separately-mounted fan-wheel axle.

The hollow journals B of the fan-wheel casing are supported in suitable bearings, C, whereby the fan-wheel casing, or "blower casing," as it may be indifferently termed, can be turned freely about the axle of the fan-wheel, which will in nowise be affected by any rotary adjustment on the part of the fan-wheel casing. The rotary shaft or axle G, upon which the fan-wheel is secured, extends through the hollow journals of the fan-wheel casing without contact with such journals, and is supported beyond such journals in its own bearings G′. In this way the rotary adjustable fan-wheel casing is supported in bearings independent of the fan-wheel, which has the supports for its axle separate from the supports for the journals of the casing. The fan-wheel casing is therefore capable of rotary adjustment about the axis of the fan-wheel independently of such axle, with the fan-wheel casing and the fan-wheel axle separately journaled. With such arrangement there is no frictional contact between the fan-wheel axle and the journals of the fan-wheel casing, and the latter is relieved from all strain incident to belting the fan-wheel axle.

Both the fan-wheel and its inclosing-casing can be ultimately supported from a support common to both—such, for example, as a floor frame or the like—but each may have upon such common foundation separate supporting media. Hence while the journals of the casing can be set in comparatively light bearings, such as the brackets herein shown, the axle of the fan-wheel can be journaled in bearings suitable for resisting lateral pull of the belting; and, furthermore, it can be mounted in bearings, which will avoid the necessity for belting the shaft at both ends as a means for equalizing the strain. While, therefore, I have shown belt-pulleys G^2, one at each of the fan-wheel shaft or axle, it is understood that but one pulley can be advantageously employed; also, that good results, but to a modified extent, can be attained by supporting the casing and fan-wheel shaft independently of each other at one end only.

It will be observed that the foregoing arrangement serves to insure the steady and easy running of the fan-wheel under all circumstances.

To provide for greater freedom of action on the part of the fan-wheel and to guard against binding or cramping in case the supports or foundations for the supports should sag to any extent at either end of the apparatus, the fan-wheel axle is journaled in rocking bearings G′, which are provided with rounded enlargements between their ends, substantially as in Fig. 5, and arranged with their rounded or partly-spherical enlarged portions seated in correspondingly-shaped stationary seats or bearings C′, sustained in Fig. 5, for example, on supports or beams D. As a result of such arrangement, a simple form of bearing can be provided by casting each bracket C integral with the next adjacent bearing C′, although of course such bearings can be made separate where found more convenient and supported in any suitable way.

The fan-wheel comprises three disks arranged in parallel planes and all set at right angles to the axis about which the wheel revolves. The two end or outer disks, E^2, are each provided with a central opening, which said openings correspond and register with the openings *a* in the fan-wheel casing, whereby air is freely admitted to the fan.

The end disks, E^2, of the fan-wheel are connected with its middle disk, E′, by the vanes F. Each vane is provided with a flange, *f*, along each of its two longitudinal edges, one of said flanges of each vane being secured to one of the end disks, E^2, with the remaining flange of each riveted to the middle disk, E′. The middle disk, E′, is clamped between the larger ends of two hollow conical plates or hub-sections, *e*′, which at their outer smaller ends are rigidly secured upon the fan-wheel shaft or axle in any suitable way, Fig. 5 representing each hollow conical plate *e*′ having a central collar which is fitted upon the shaft of the fan-wheel.

Each vane is of uniform width from its inner to its outer end, and is equal in width to the space between the middle disk and the end disk between which the vane is secured. The vanes are all curved longitudinally, substantially as in Letters Patent No. 176,756, granted to me May, 1876—that is to say, each vane is curved and set so that it shall lie tangential or substantially tangential to the periphery of the wheel and to the circumference of the circular inlet-opening in that one of the disks E^2 to which the vane is secured, thereby providing an outline which involves the least friction of and resistance to the air. The vanes are also desirably arranged about the axis of the wheel at equal distances apart. These vanes vary in length, some extending inwardly to the central openings in the disks, while others terminate short of such central openings. All of the vanes, however, have their outer ends arranged to terminate at a common periphery. The distinguishing feature involved in the arrangement of these vanes consists in subdividing each of the two sets of vanes into sets of vanes whereof the vanes of each sub-

set are successively and regularly shortened in length with the longest vane placed first or ahead relatively to the direction of rotation of the wheel. This will be understood by reference to Fig. 7, which indicates the flanges of the vanes secured to the middle disk, it being observed that where the outer or end disk is not broken away in such figure the flanges are indicated by dotted lines. In said figure the direction of rotation of the wheel is indicated by the arrow. The dotted line 1 denotes the position of a vane extending from the opening in the outer disk to the periphery of the wheel. This vane may be said to be ahead of the vanes denoted by the numerals 2 3 4, and so on. The vane 2 in this figure will be seen to terminate short of the central opening in the end disk, E^2, but to be somewhat longer than the next vane 3, which is still shorter and which has its inner end more remote from such central opening. This successive reduction in the length of the vanes continues up to vane 6, which is the shortest of this sub-set, after which the next sub-set involves, first, a long vane, 1^a, extending from the periphery of the wheel to the central opening of the disk; then a vane, 2^a, terminating a little short of such opening; next a still shorter vane, 3^a, terminating still farther from the central opening, and so on up to the shortest vane, 6^a, of this sub-set.

The foregoing variation in length and arrangement of vanes affords a free space for air in the wheel and avoids undue compression and friction. During the rotation of the wheel there is a tendency to create a partial vacuum or attenuation of the air back of its vanes; and, by arranging the vanes as hereinbefore set forth, free space for the entrance of air to relieve such condition is attained in the most effective way.

Preferably, the vanes of one set—that is to say, the vanes at one side of the middle disk—alternate in point of position with the vanes of the other set, whereby further effective results are attained.

In order to provide a blower with a noiselessly-operating fan-wheel it is necessary that there should be considerable free space within the casing on each side of the tops of the vanes. This in some instances has been attained by narrowing the vanes toward their tips, which arrangement has resulted not only in an undesirable degree of compression of air within the fan-wheel, and consequent friction and loss of power, but also in giving the currents of air a tendency to take an indirect course through the fan, so as to compel them in passing through the wheel to encounter unnecessary friction by passing through passages, the cross-area of which in place of gradually expanding will have a gradual contraction throughout the length of passage.

In order to avoid noise during the operation of the fan-wheel and at the same time to provide not only a most efficient construction of fan-wheel, I construct the fan-wheel casing with a peripheral bulge or enlargement laterally in both directions from a plane taken centrally through the fan-wheel at right angles to the axis of the latter, as shown in Fig. 5. From its enlarged or widened peripheral portion both ends of the casing gradually converge toward the center of the wheel, so as to approach sufficiently close to the central openings of the end disks of the wheel. This arrangement brings the edges of the circular openings in the casing in register with and in close proximity to the edges of the circular openings in the end disks of the fan-wheel, but from such points causes the end walls of the casing to diverge outwardly from the fan-wheel, such divergence continuing to the periphery of the casing. No modification of the fan-wheel is therefore necessary, and hence while each blade or vane of the fan-wheel is of equal width from end to end the dish shape of the ends of the casing affords air-spaces opposite both ends of the wheel without setting the edges of the circular opening or openings in the casing at an undesirable distance away from the opening or openings in the fan-wheel.

As a means for accurately centering the casing relatively to the axis of the fan-wheel, each end of the casing is turned, so as to provide it with an annular shoulder, a', concentric with its circular opening a at such end.

The journals B of the casing are provided with radial arms b', which are gaged in length, so that when the casing is in place their tips shall bear against the annular shoulders a' of the casing, to which latter said arms are then secured by bolts, rivets, or other suitable fastening devices.

Claims relating to the manner of mounting the fan-wheel casing independently of the casing, as hereinbefore set forth, have been transferred from this application to my application No. 237,401. Claims relating to the construction of the fan-wheel, the construction of the casing, and certain minor details hereinbefore set forth have been transferred from this application to my application No. 83,592, while the claims in the present application are confined to the air-blast apparatus involving a rotary blower combined with an induction device.

What I claim as my invention is—

1. An air-blast apparatus for conveying light materials by the force of the blast, consisting of the induction-tube J and discharge-tube H^2, which together provide a passage adapted for the direct and free conveyance of materials, such as set forth, and a rotary fan-blower connected with the passage of the discharge-tube by an air-blast passage having an annular outlet around the end of the induction-tube which opens into the discharge-tube, substantially as described.

2. In an air blast apparatus for conveying light materials, such as set forth, the combination of the discharge-tube H H^2, closed at one end, the induction-tube J, entering the

closed end of the discharge-tube, and the rotary fan-blower having a hollow arm, H′, extended from its casing and connected with the rear portion, H, of the discharge-tube, substantially as described.

3. The combination, substantially as herein described, of a rotary fan-wheel blower having its casing capable of rotary adjustment about the axis of the fan-wheel, and a discharge-tube containing in a portion of its length an induction-tube, said tubes being supported from the fan-wheel casing by a hollow arm, through which a blast from the blower is utilized as a means for forcing a current through the discharge-tube and inducing a current through the induction-tube, for the purpose set forth.

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