No. 871,209. PATENTED NOV. 19, 1907.

A. COTTON.

JET BLOWING APPARATUS.

APPLICATION FILED JAN. 16, 1907.

4 SHEETS—SHEET 1.

Fig. 1

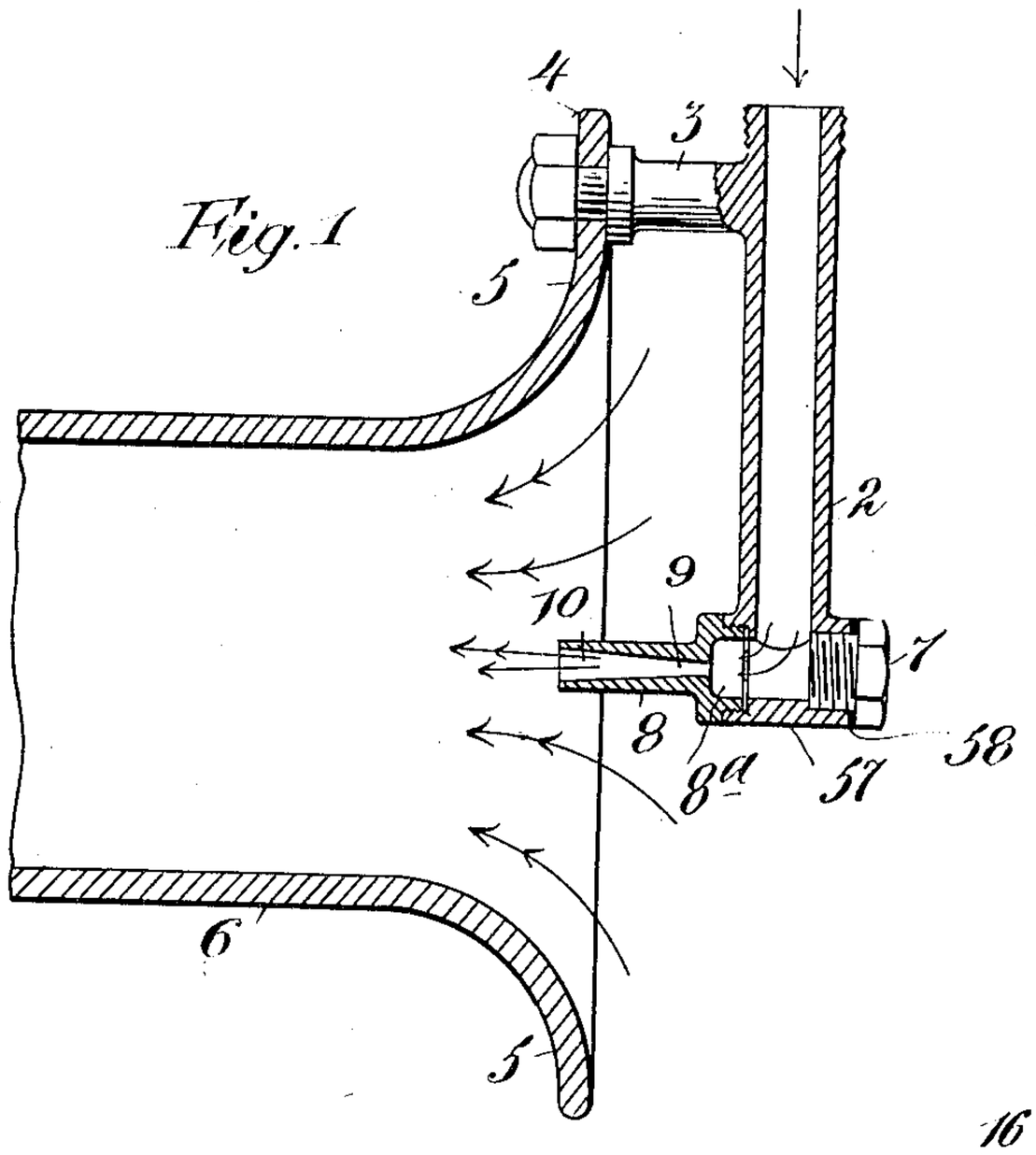


Fig. 2.

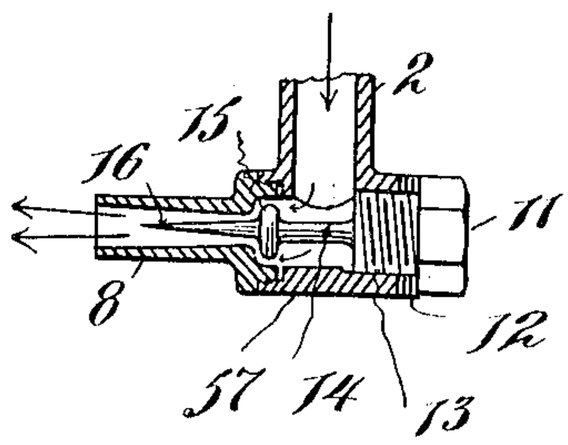


Fig. 3.

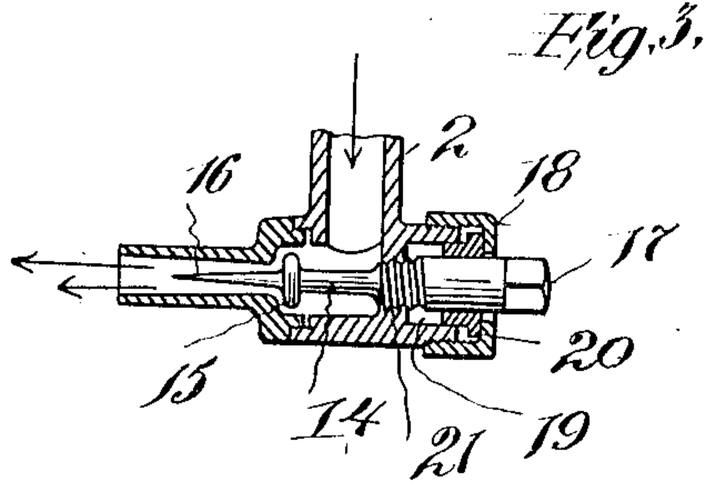


Fig. 7.

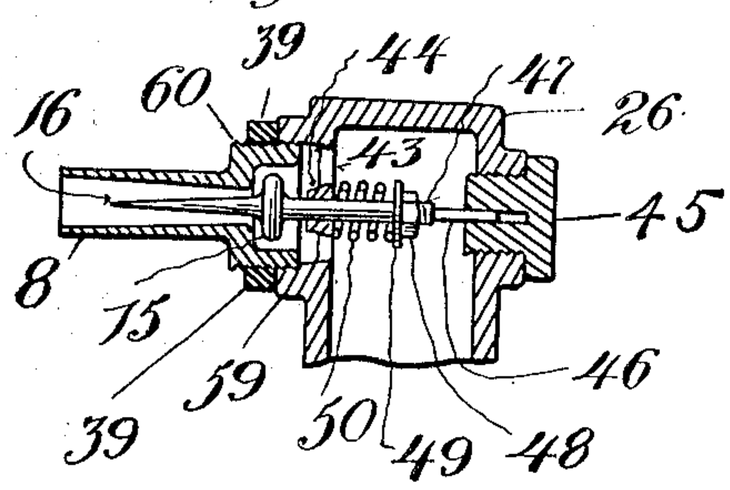
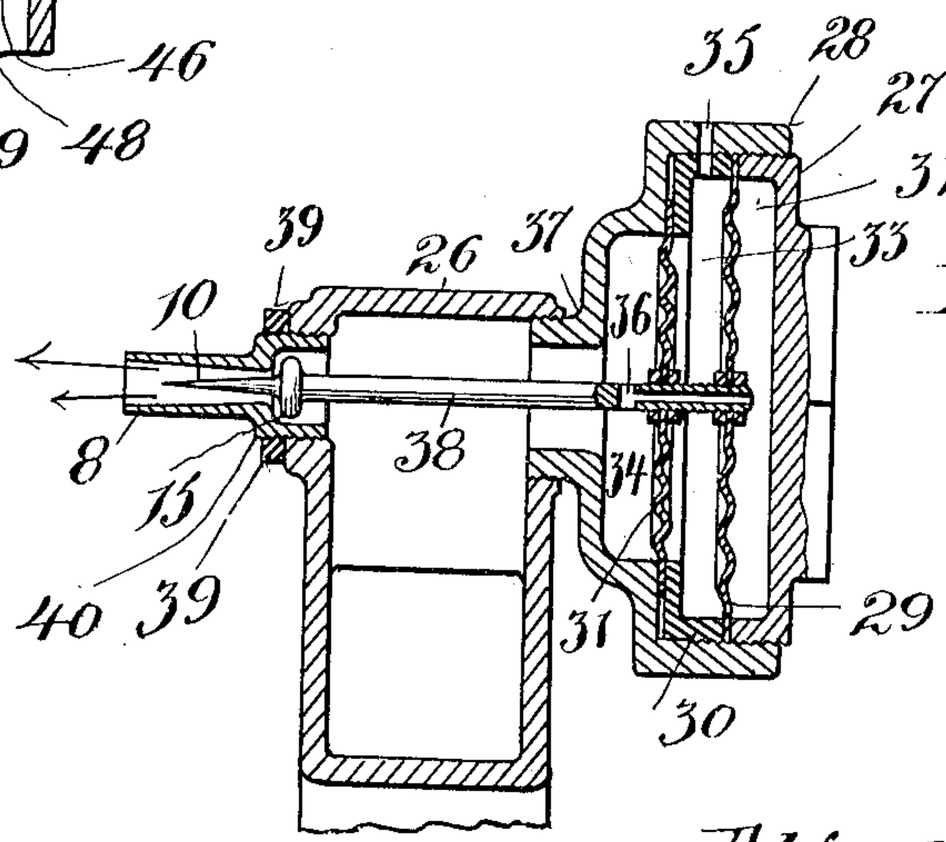


Fig. 6.



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4 SHEETS—SHEET 2.

Fig. 5.

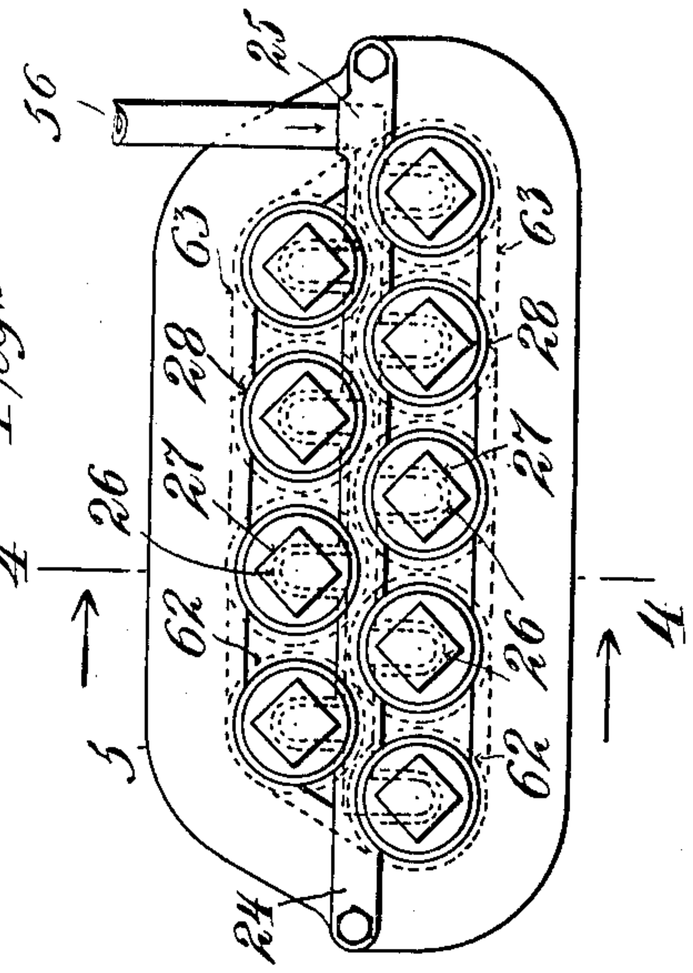

Fig. 9.

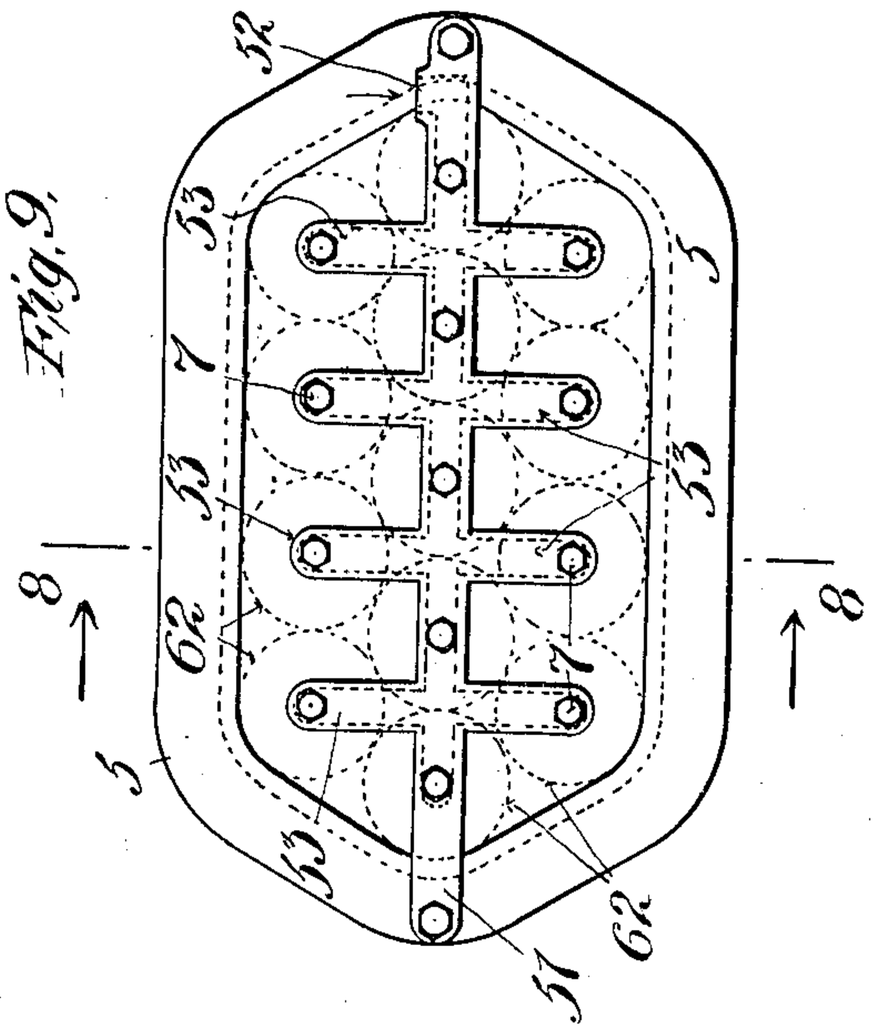

Fig. 4.

Fig. 8.

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4 SHEETS—SHEET 3.

Fig. 10.

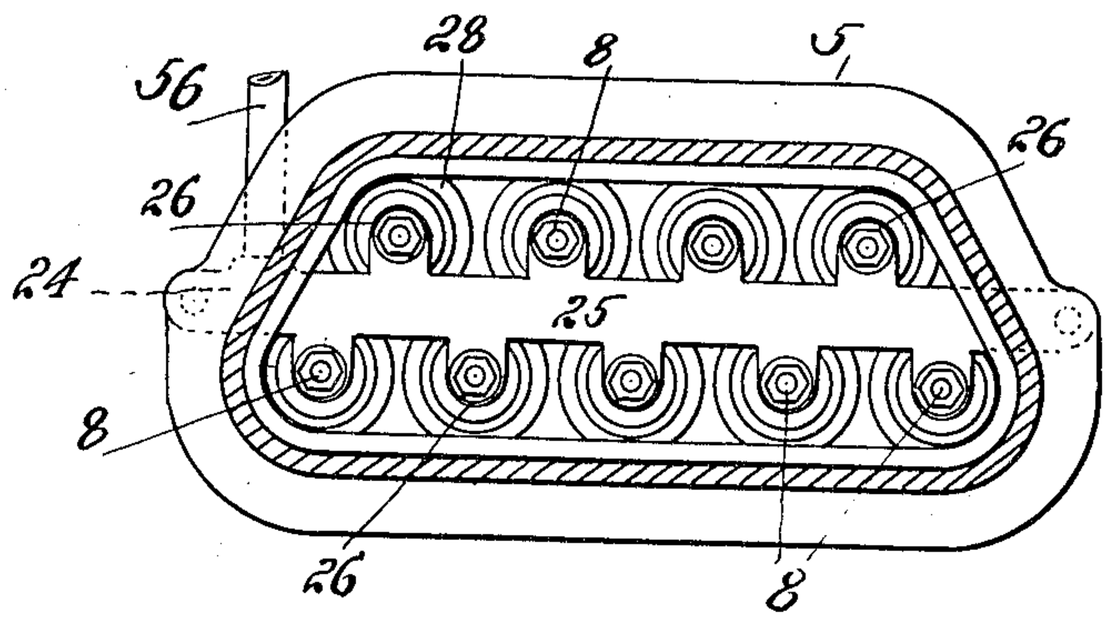
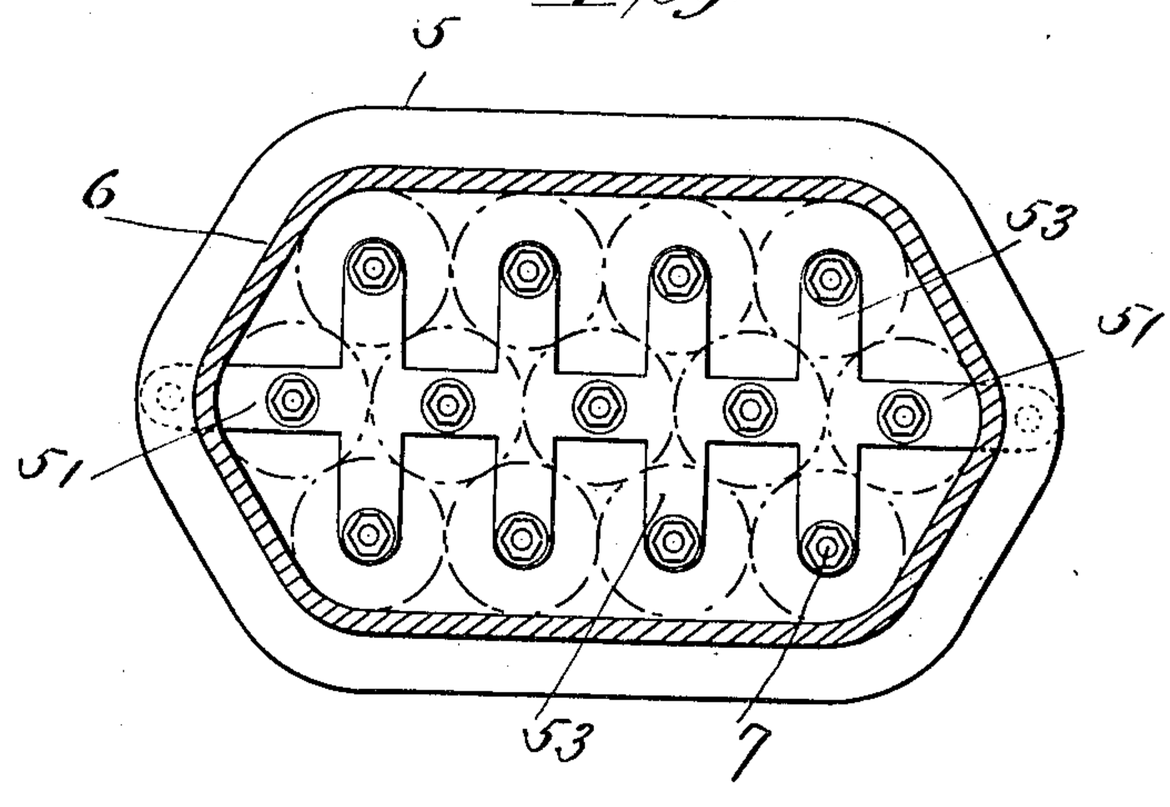


Fig. 11.



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4 SHEETS—SHEET 4.

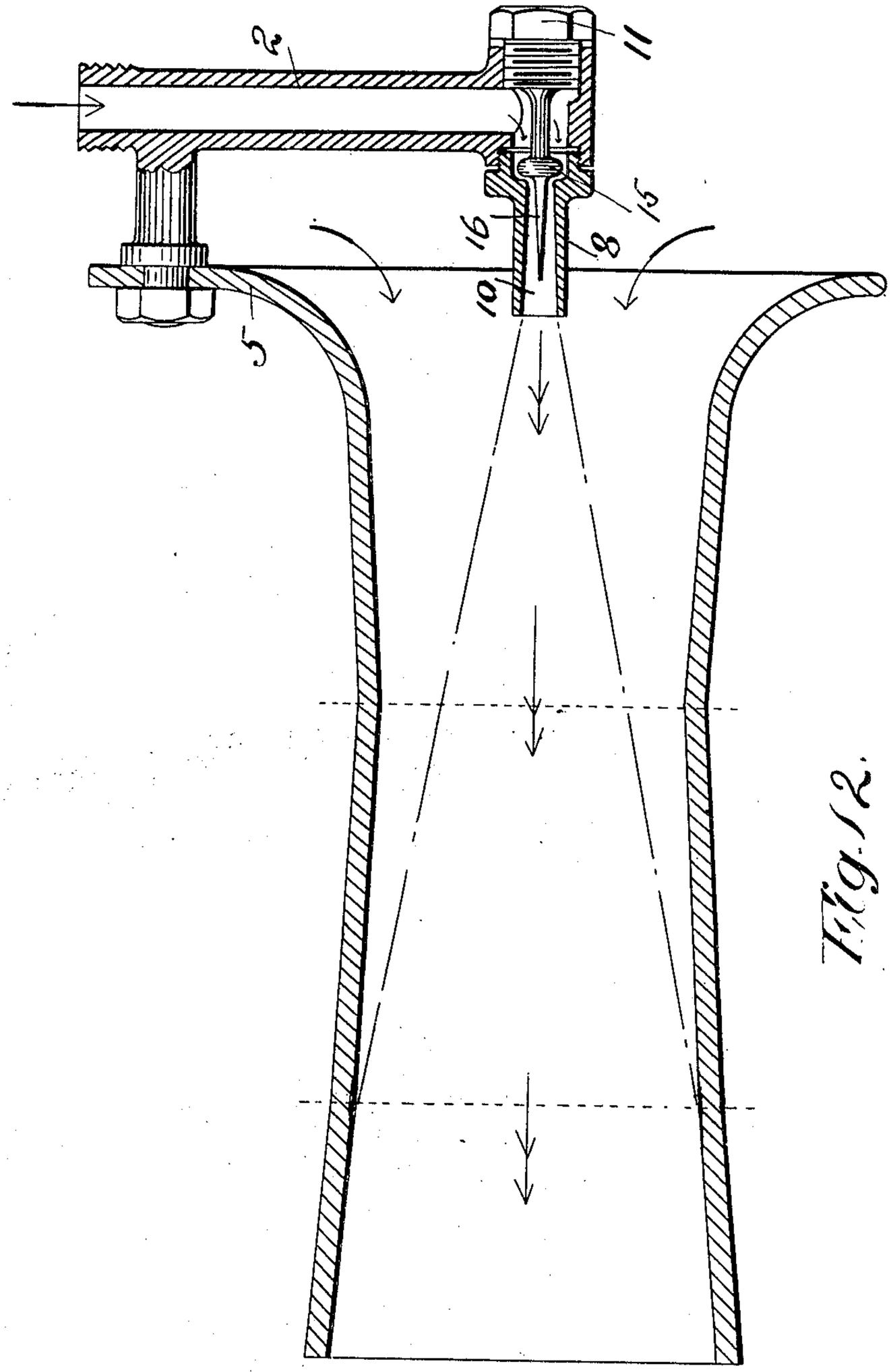

Fig. 12.

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UNITED STATES PATENT OFFICE.

ALFRED COTTON, OF NEWARK, NEW JERSEY.

JET BLOWING APPARATUS.

No. 871,209. Specification of Letters Patent. Patented Nov. 19, 1907.

Application filed January 16, 1907. Serial No. 352,541.

To all whom it may concern:

Be it known that I, ALFRED COTTON, a subject of the King of Great Britain, residing at Newark, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Jet Blowing Apparatus, of which the following is a specification, reference being had therein to the accompanying drawings, in which—

Figure 1 is a vertical, longitudinal sectional view of a portion of an air conveyer equipped with one jet nozzle of my invention. Fig. 2 a vertical central sectional view of a nozzle provided with a regulating needle valve; Fig. 3 a similar sectional view of a nozzle provided with a slightly different form of adjustable needle valve; Fig. 4 a longitudinal sectional view of an air conveyer provided with a series of automatically controlled nozzles, said section being taken on the line IV—IV of Fig. 5; Fig. 5 a front elevation of the apparatus shown in Fig. 4; Fig. 6 an enlarged vertical sectional view of one of the automatically controlled nozzles shown in Figs. 4 and 5; Fig. 7 a similar sectional view showing a slightly different form of self regulating nozzle; Fig. 8 a longitudinal vertical sectional view showing a conveyer having parallel sides and a slightly different form of a jet nozzle, said section being taken on the line VIII—VIII of Fig. 9; Fig. 9 a front view of the apparatus showing a group of jet nozzles arranged according to my invention in combination with a single conveyer of a peculiar form. Fig. 10 a transverse sectional view on the line *b*—*b* of Fig. 4; and Fig. 11 a similar view on the line *b*—*b* of Fig. 8. Fig. 12 a detail vertical sectional view of a conveyer and nozzle.

My invention relates to blowing apparatus in which a jet of steam, or other equivalent motive fluid, is employed to induce the desired flow of air or similar fluid which is to be moved by the blower.

The special embodiment of my invention which is illustrated in the accompanying drawings and which is hereinafter particularly described, relates to air blowers for feeding furnaces, and may be briefly designated as a "furnace blower".

Broadly stated the objects of my invention are simplicity, compactness and economy of construction and efficiency, economy and reliability of operation.

More particularly the object of my invention is to provide a nozzle of peculiar form whereby the steam will escape therefrom with the least possible friction and loss of energy, and with the greatest speed and least tendency to lateral expansion when it issues from the nozzle.

A further object of the invention is to combine my peculiar form of nozzle with a conveyer having its inlet end of proper form to insure the entry therein of the induced currents of air with the least possible friction and without any tendency of the inflowing air currents to cross the steam jet, whereby there will be no cross currents at the mouth of the conveyer.

A further object of my invention is to arrange a plurality of nozzles in such relation to one another, and to so shape a single conveyer to be used in combination with such plurality of jets, that the motive jets and the induced air currents will flow through said conveyer with the least possible friction and without causing cross-currents of air or steam within the casing, whereby the greatest efficiency of the plurality of jets is obtained.

Still another object of the invention is to provide automatically-operating pressure-controlled valves for varying the capacity of the inlet to the nozzles, whereby the relative areas of the inlet end of the nozzle and the outlet therefrom may be varied.

I have discovered that the greatest efficiency in jet blowers is to be obtained by the employment of a nozzle of such form that the expansive energy of the steam will be converted into speed energy, or to kinetic energy, within the nozzle so that when the jet issues therefrom it will have the least possible tendency to lateral expansion, the jet moving forward in lines substantially parallel with the longitudinal line of the conveyer into which said jet is projected. Where the motive jet expands laterally to any considerable degree as it issues from the nozzle, it obstructs the mouth of the conveyer and retards the inflowing air currents. It is necessary therefore, to provide a nozzle whose bore is divergent from a point very near its inlet to its outlet, and whose outlet is so proportioned with respect to the inlet that the steam will have expanded to almost atmospheric pressure before it leaves the nozzle, so that its expansive energy will have been converted into speed energy. What-

ever expansive force remains in the steam after it leaves the nozzle seems to obstruct the inflowing air currents within the conveyer, and is, therefore, undesirable. I accomplish this preferably by the apparatus herein described.

Referring to the various parts by numerals, 2 in Figs. 1, 2 and 3 designates a nozzle support and steam inlet pipe. This pipe is provided with a stud 3 near its upper end which is bolted to an upward extending lip or projection 4 formed on the upper edge of the mouth of the air conveyer 6. The mouth of this conveyer flares or is inwardly contracted, as at 5. The curve of the flaring part being as nearly as possible the curve which currents of moving gas would take upon entering an orifice, when said currents are induced or forced through said orifice.

The lower end of the nozzle support 2 is provided with a T-head 57, shown as axially in line with the central line of the conveyer, the rear end of this head being closed by a screw plug 7, as arranged in Fig. 1. To the forward end of this T-head is attached, preferably by screw threads, nozzle 8, the central longitudinal line of said nozzle being axially in line with the central longitudinal line of the conveyer. This nozzle is formed with an enlarged chamber 8^a at its inner end which is in open communication with the interior of the pipe 2. The nozzle proper is formed with a divergent bore, the inlet end 9 of said bore being quite small and the outlet end 10 being considerably larger than the inlet end thereof. The relative size of the two ends of the divergent part of the nozzle must be such that the amount of steam admitted to said nozzle may expand to almost atmospheric pressure before it leaves said nozzle. The result of this is that the expansive force of the steam is converted into speed energy so that the jet of steam upon issuing from said nozzle will move forward in substantially parallel lines, until its speed is considerably reduced. The enlargement of the jet, due to deceleration, and not to expansion, must take place a considerable distance within the conveyer so as not to retard the inflowing induced air currents, and further it must not take place within the conveyer until the steam and air currents have reached the same velocity and are of the same temperature. Any considerable lateral expansion of the steam prior to this condition having been obtained is detrimental to the successful operation of the blower. It will be readily seen that when the steam expands laterally after leaving the nozzle the air currents are retarded and, therefore, a greater amount of steam must be used in the blower to induce the desired amount of air currents.

At the inlet end of the nozzle the bore is enlarged or flared, the curve of the wall of said flared part being as nearly as possible the curve assumed by a jet of steam passing through the orifice so that there will be no loss of energy at the inlet end of the nozzle. I have found that where the inlet end of the nozzle terminates in a sharp corner a tremendous amount of energy is lost because of the eddies formed at that point by the outrushing steam jet. By flaring the inlet end of the nozzle so that the steam jet will flow smoothly into the nozzle without any back pressure, a greater speed can be obtained in the jet with less pressure than is possible where the inlet end of the nozzle terminates in a sharp corner. This I consider extremely important; and it is one of the features of my invention. It is important that the proportion of the inlet of the nozzle to the exit thereof be varied according to the pressure of steam in the pipe 2 in order that the amount of steam admitted to the nozzle shall expand to substantially atmospheric pressure before it leaves the nozzle. It is apparent that if the inlet of the nozzle were not varied in size the pressure of the jet and its tendency to lateral expansion as it issues from the nozzle would vary somewhat as the pressure of steam in the pipe 2 varied. Therefore, to secure the most efficient operation of the nozzle I provide a longitudinally adjustable needle valve 16 which projects into the nozzle and terminates at its forward end in an extremely fine point. The rear end of this valve part 16 is joined centrally to a head 15 which is carried by a stem 14. This stem is joined at its rear end to a screw plug 13, as arranged in Fig. 2, said plug being provided with a squared head 11 by which it may be rotated and the valve thereby advanced or withdrawn from the nozzle. A series of washers 12 are provided so that the valve may be secured in the proper position. The purpose of this needle valve is to vary the capacity of the inlet to the nozzle so that the steam entering said nozzle will be permitted to expand as herein before described, within the nozzle. It will be noted that the valve is very long as compared with the length of the nozzle, the purpose of this being to avoid any sudden enlargement of the capacity of the nozzle at any point therein. It will be apparent that if the end of the valve were blunt or squared, eddies of steam would be formed at that particular point and that said eddies or cross-currents would obstruct the forward movement of the jet and result in a loss of efficiency.

As shown in Fig. 3 the stem of the valve is threaded as at 21 and is formed with a cylindrical portion 20 which passes through a stuffing box 18, a chamber 19 being formed for packing material. The end of this stem is squared, as at 17, to receive an adjusting wrench or other suitable tool.

It is desirable to provide means whereby the regulating valve 16 may be automatically

operated by pressure-controlled means connected thereto. One form of device for accomplishing this is shown in Fig. 6. As illustrated therein the stem 38 of the valve is connected to two flexible diaphragms 29 and 31, diaphragm 29 being considerably larger than 31. These diaphragms are secured within a casing 28, 31 being secured by a threaded ring 30 and 29 being secured in position by a closure plug 27. The chamber 33 is formed between the two diaphragms, said chamber being in communication with the atmosphere through the port 35. The chamber 32 formed between the diaphragm 29 and the closure plug 27 is in communication with the steam space of the chamber 26 by means of a port 36 formed in the valve stem. The diaphragm chamber 28 is connected to the steam chamber 26 through the tubular neck 37 which is screwed into said chamber. As shown in this figure the nozzle is screwed into the steam chamber 26 by means of its threaded forward end 40 and a locknut 39 is screwed thereon out-side of the casing 26 to lock the nozzle in place. The operation of this self-regulating valve is obvious. Under normal working pressure the valve will remain stationary. When the steam pressure exceeds the desired normal working pressure the diaphragm 29 will be forced inward and the inlet to the nozzle 8 will be correspondingly restricted, that is its capacity will be reduced so that the amount of steam entering therein at the increased pressure will be permitted to expand, and thereby reduce any pressure to the desired point before it leaves the nozzle.

In Fig. 7 is illustrated a slightly different form of self-regulating pressure-controlled valve. As shown in this figure the valve stem 60 is provided with an extension 46 which reciprocates in a recess formed in a closure plug 45. This stem 60 is guided near its forward end by a bracket 44. Surrounding the stem and bearing against the inner side of said bracket is a coil spring 50, said spring at its inner end bearing against the plate 49 which is adjustably secured at the valve stem by means of a nut 48 screwed on a threaded part 47 of said stem. As shown in this figure the casing 26 is formed with an enlargement 59 within which the enlarged inner end of the nozzle is screwed. When the steam pressure within the chamber 26 increases beyond the desired pressure the valve will be forced toward the inlet end of the nozzle thereby varying the capacity of said inlet end in proportion to the steam pressure.

In Figs. 4 and 5 a plurality of nozzles are ranged in a peculiar manner and are to be used in combination with a conveyer of peculiar shape in cross-section. The nozzle support and steam chamber 25 is secured to the forward end of the conveyer and extends horizontally across the same midway the height thereof. This chamber is provided on its upper edge with upwardly extending nozzle supports 26 which are short extensions of the main steam chamber 25; and on the lower edge of the chamber 25 are formed corresponding down-ward extending enlargements of said chamber. These enlargements are so arranged that those on the upper side of the chamber are directly above a point midway between the centers of those formed on the lower side of said chamber. The nozzles are secured to these enlargements of the main chamber at points which are equally distant on each side of a line passing longitudinal the center of the chamber 25 and the distance between the centers of the nozzles in the upper row are equal to the distance between the nozzles of said upper rows and the centers of the adjoining nozzles in the lower row so that all of said nozzles are equal distances apart from the adjoining nozzles. The purpose of this peculiar arrangement of the nozzles is to avoid as far as possible what may be termed dead spaces between the jets. Eddies of air are apt to be formed in these spaces by the steam jets, and, of course, in so far as these eddies are formed they result in cross-currents and impair the efficiency of the blower. The interior of the conveyer adapted for use with this grouping of the nozzles is somewhat elongated horizontally having substantially flat lower and upper surfaces, outward and downward inclined sides and rounded corners connecting the end of the sides with the ends of the upper and lower walls. The upper and lower walls are tangent to the circumference of the jets at the point where said jets will impinge upon said walls. The side walls are tangent to the circumference to the two outer jets and the rounded corners are on the same areas as the circumference of said jets, the arcs of said corners being struck from the centers of the outer jets.

As shown in Fig. 4 the form of nozzle illustrated is of the self-regulating pressure-controlled construction illustrated in Fig. 6. As shown in this figure the conveyer is formed with a flared inlet end and from the inner end of the flared portion the inner walls of said conveyer converge to a point marked *a*—*a* said point being the smallest internal diameter of the conveyer. From this point *a*—*a* the internal diameter of the conveyer enlarges to its exit end, 22. It is important where conveyers of this form are used that the jet be given a speed sufficient to carry it beyond the point of smallest diameter before it has enlarged sufficiently to impinge upon the walls of the conveyer. This can only be accomplished by the use of such form of nozzle that the jet issuing therefrom will travel forward in substantially parallel lines for a

considerable distance. To this end the jet must have very little tendency to expand laterally; and its expansive force must have been converted into speed energy within the nozzle. As illustrated in this figure the group of jets will have enlarged because of their deceleration at the point marked *b*—*b* to such an extent as to impinge upon the walls of the conveyer. Steam is supplied to the chamber 25 through pipe 56.

In Fig. 9 is shown another arrangement of the nozzles wherein however, each nozzle is an equal distance from all the adjoining nozzles in the group. In this grouping there are three horizontal rows of nozzles, each nozzle in the upper row is in a direct vertical line with the corresponding nozzle in the lower row. The nozzles in the intermediate row are arranged midway between the nozzles of the upper and lower rows, and an equal distance from the adjoining nozzles in said upper and lower rows. In cross section the interior of the single conveyer adapted to be used with this group of numerals is an irregular diamond shape, the corners formed by the meeting of the walls of the conveyer being rounded. The upper and lower interior walls of the conveyer are tangent to the surfaces of the jets in said rows, and the side walls of said conveyer are tangent to the circumference of the jets forming the ends of the rows. The corners of the said conveyer are on the same arcs as the circumference of the end jets and are struck from centers axially in line with the centers of the end jets. By this grouping and by the peculiar shape of the conveyer, dead spaces between the jets are reduced to minimum and the nozzles are arranged in the best possible position for eliminating said dead spaces. This is an important feature of my invention and produces a most efficient blower.

As shown in Fig. 8 the conveyer is formed with parallel upper and lower longitudinal walls and the jets will be enlarged laterally because of their deceleration sufficiently to impinge upon the walls of the conveyer along the line marked *b*—*b*.

As shown in Fig. 12 the conveyer is formed with a contracted throat or entrance, an inwardly tapered part extending inward from said throat and then a rearwardly enlarging part extending from the inner end of said converging part to the end of the conveyer. The nozzle 8 is so arranged that the jet issuing therefrom will flow inward beyond the smallest diameter of the conveyer before it has enlarged, by the loss of speed, sufficiently to impinge upon the walls of the conveyer. By this arrangement there will be no checking of the inflowing jets in the conveyer. This is important as it contributes materially to the success of my particular form of nozzle and blower.

Having fully described my invention what I claim as new and desire to secure by Letters Patent is:—

1. A jet blowing apparatus comprising a nozzle whose internal diameter gradually increases from its inlet to its outlet, the smallest diameter of said nozzle being so proportioned with respect to the largest diameter thereof that fluid under a certain pressure entering said nozzle will expand to approximately atmospheric pressure before it leaves said nozzle, in combination with a conveyer open at its ends and formed with an inwardly contracted entrance throat and whose interior gradually converges for a short distance from its throat and then gradually enlarges toward its outlet, the smallest diameter of said conveyer being located at such a point in the length of the conveyer that the jet from the nozzle will travel beyond said point of smallest diameter before it has enlarged sufficiently to impinge upon the inner surface of the conveyer, said conveyer being arranged axially in line with the longitudinal center line of the nozzle, and the nozzle being outside of said conveyer adjacent to its inlet, whereby the air currents will move inward and entirely surround the nozzle, and means for changing the proportional areas of the inlet and outlet of said nozzle by varying the capacity of the inlet thereof, for the purpose set forth.

2. A jet blowing apparatus comprising a nozzle whose internal diameter gradually increases from its inlet to its outlet, the smallest diameter of said nozzle being so proportioned with respect to the largest diameter thereof that fluid under a certain pressure entering said nozzle will expand to approximately atmospheric pressure before it leaves said nozzle, in combination with a conveyer open at its ends and formed with an inwardly contracted entrance throat and whose interior gradually converges for a short distance from its throat and then gradually enlarges toward its outlet, the smallest diameter of said conveyer being located at such a point in the length of the conveyer that the jet from the nozzle will travel beyond said point of smallest diameter before it has enlarged sufficiently to impinge upon the inner surface of the conveyer, said conveyer being arranged axially in line with the longitudinal center line of the nozzle, and the nozzle being outside of said conveyer adjacent to its inlet, whereby the air currents will move inward and entirely surround the nozzle, automatically operating pressure controlled means for changing the proportional areas of the inlet and outlet of said nozzle by varying the capacity of the inlet thereof, for the purpose set forth.

3. A jet blowing apparatus comprising a plurality of nozzles arranged in rows, each nozzle in each row being an equal distance from the adjoining nozzles of all the rows,

the nozzles at the periphery of the group being half the distance in transverse direction from the walls of the conveyer that the nozzles are from each other, means of supplying fluid under pressure to said nozzles and a conveyer having upper and lower internal walls arranged in transverse section at a tangent to the surfaces of the jets from the upper and lower rows of nozzles, the side walls of said conveyer in transverse section being tangent to the surfaces of the jets from the end nozzles, the corners of said conveyer in transverse section being rounded on arcs struck from points axially in line with the centers of said end nozzles, whereby the jets from the nozzle will impinge upon the walls of the conveyer and upon each other in the same transverse plane.

4. A jet blowing apparatus comprising a plurality of nozzles arranged in rows, each nozzle in each row being an equal distance from the adjoining nozzles of all the rows the nozzles at the periphery of the group being half the distance in transverse direction from the walls of the conveyer that the nozzles are from each other, means for supplying fluid under pressure to said nozzles, and a conveyer having upper and lower internal walls arranged in transverse section at a tangent to the surfaces of the jets from the upper and lower rows of nozzles, the side walls of said conveyer being in transverse section tangent to the surfaces of the jets from the end nozzles, the corners of said conveyer being rounded in transverse section on arcs struck from points axially in line with the centers of said end nozzles, the inlet end of said conveyer flaring outwardly from a point near its inlet end, said conveyer from the inner end of said flaring part gradually converging for a portion of its length and then gradually enlarging towards its outlet end, whereby the jets from all the nozzles will impinge upon the walls of the conveyer and upon each other in the same transverse plane.

5. A jet blowing apparatus comprising a nozzle whose internal diameter gradually increases from its inlet to its outlet, the smallest diameter of said nozzle being so proportioned with respect to the largest diameter thereof that fluid under a certain pressure entering said nozzle will expand to approximately atmospheric pressure before it leaves said nozzle, in combination with a conveyer open at its ends and formed with an inwardly contracted entrance throat and whose interior gradually converges for a short distance from its throat and then gradually enlarges towards its outlet, the smallest diameter of said conveyer being located at such a point in the length of the conveyer that the jet from the nozzle will travel beyond said point of smallest diameter before it has enlarged sufficiently to impinge upon the inner surface of the conveyer, said conveyer being arranged axially in line with the longitudinal center line of the nozzle, and the nozzle being outside of said conveyer adjacent to its inlet, whereby the air currents will move inward and entirely surround the nozzle.

In testimony whereof I hereunto affix my signature in the presence of two witnesses this 10 day of January 1907.

ALFRED COTTON.

Witnesses:
GEO. O. TOTTEN,
GEO. R. FORD.