

Oct. 14, 1924.

N. H. HENDERSON

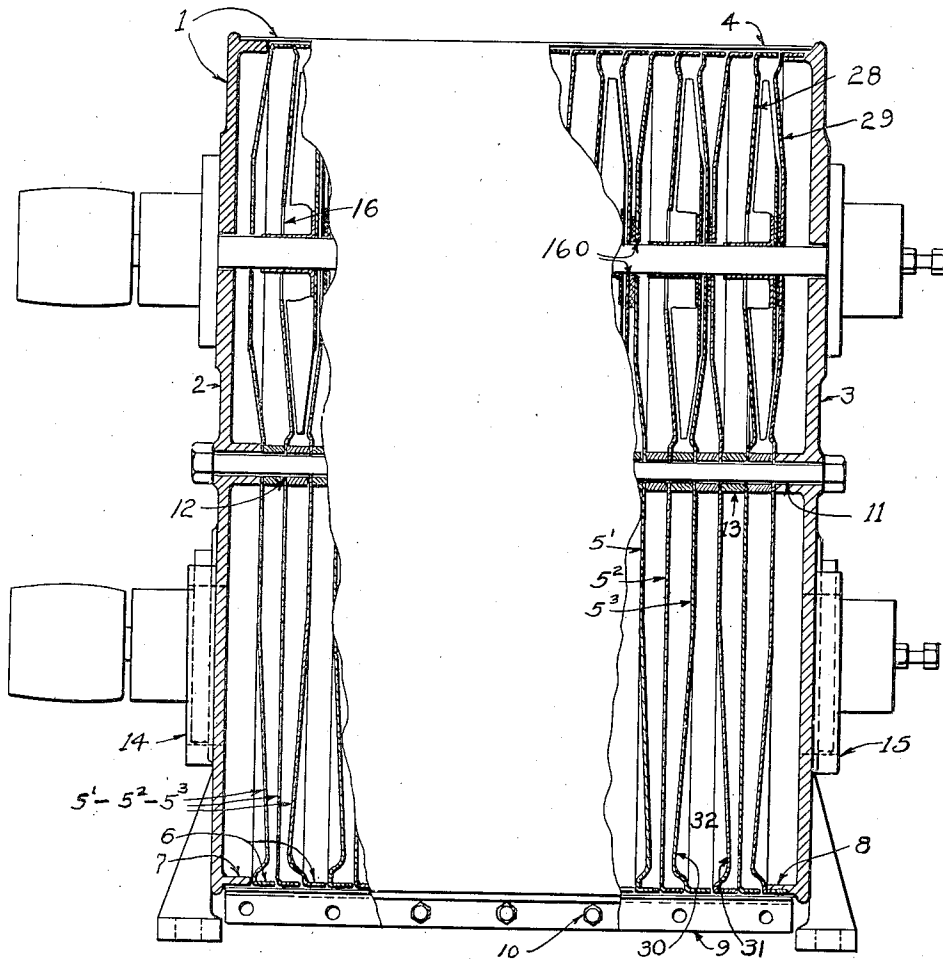
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MULTIPLE FAN

Filed July 15, 1921

7 Sheets-Sheet 1

Fig. 1



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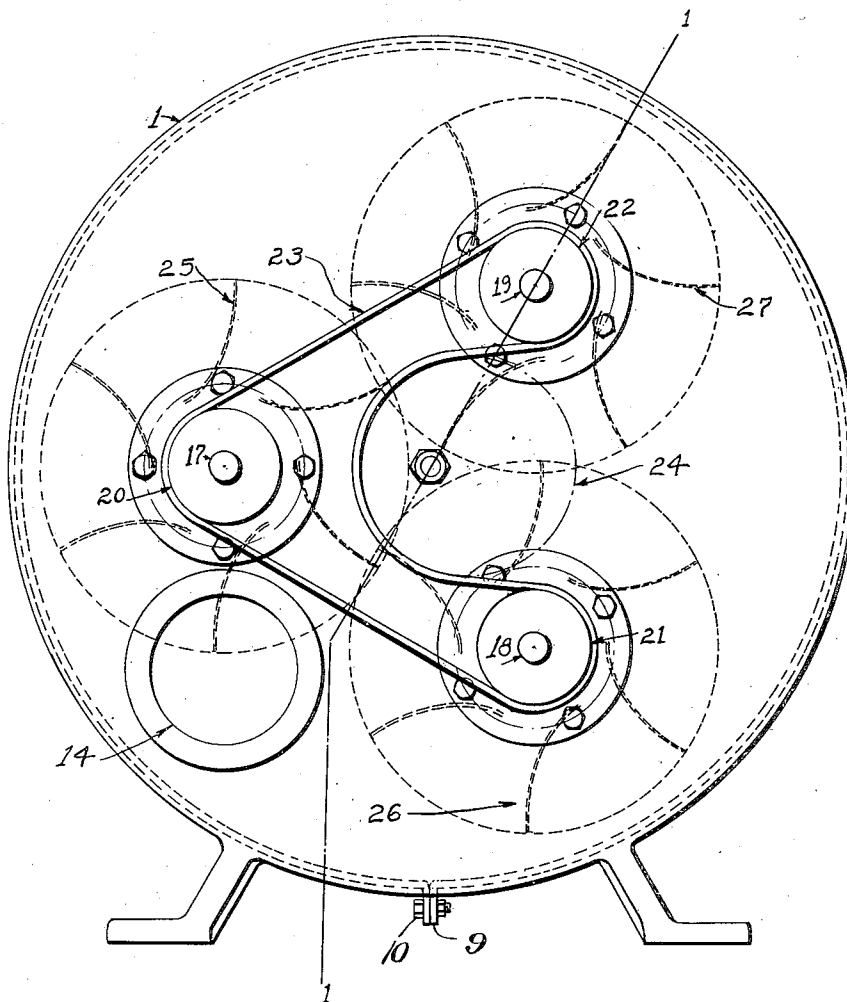
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7 Sheets-Sheet 2

Fig. 2



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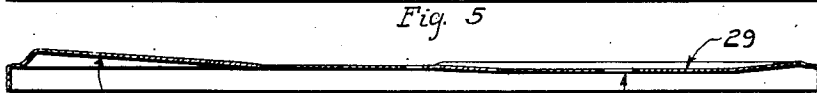
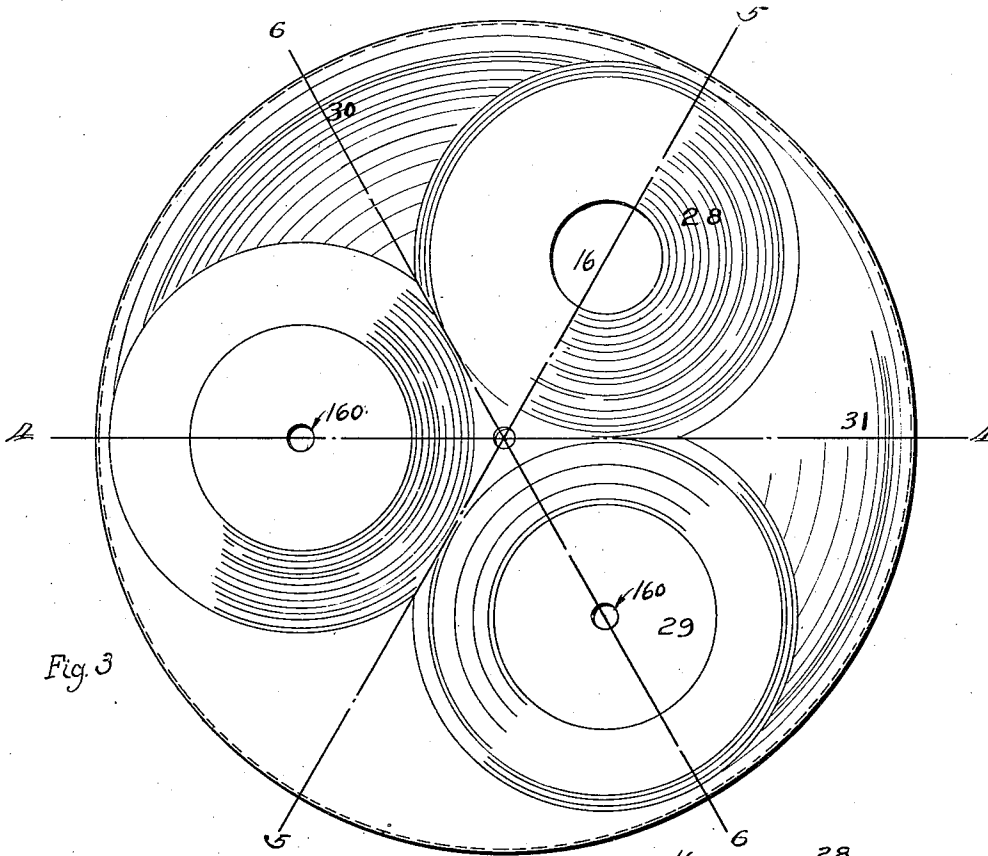
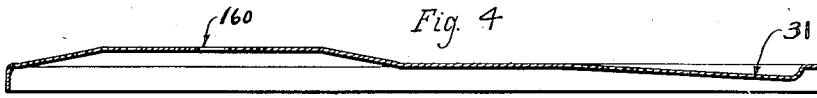
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7 Sheets-Sheet 3



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Fig. 7

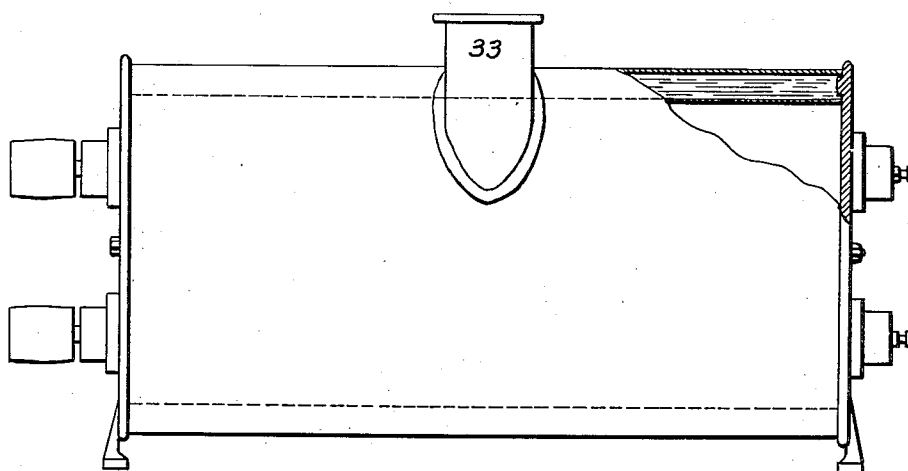


Fig. 8

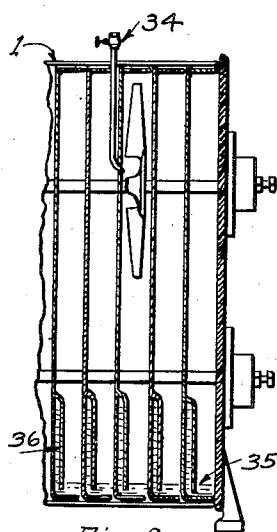
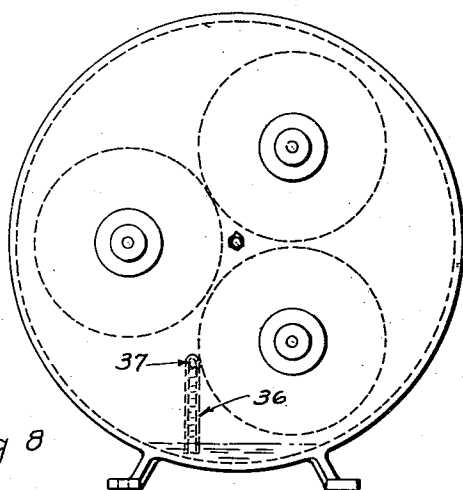


Fig. 9

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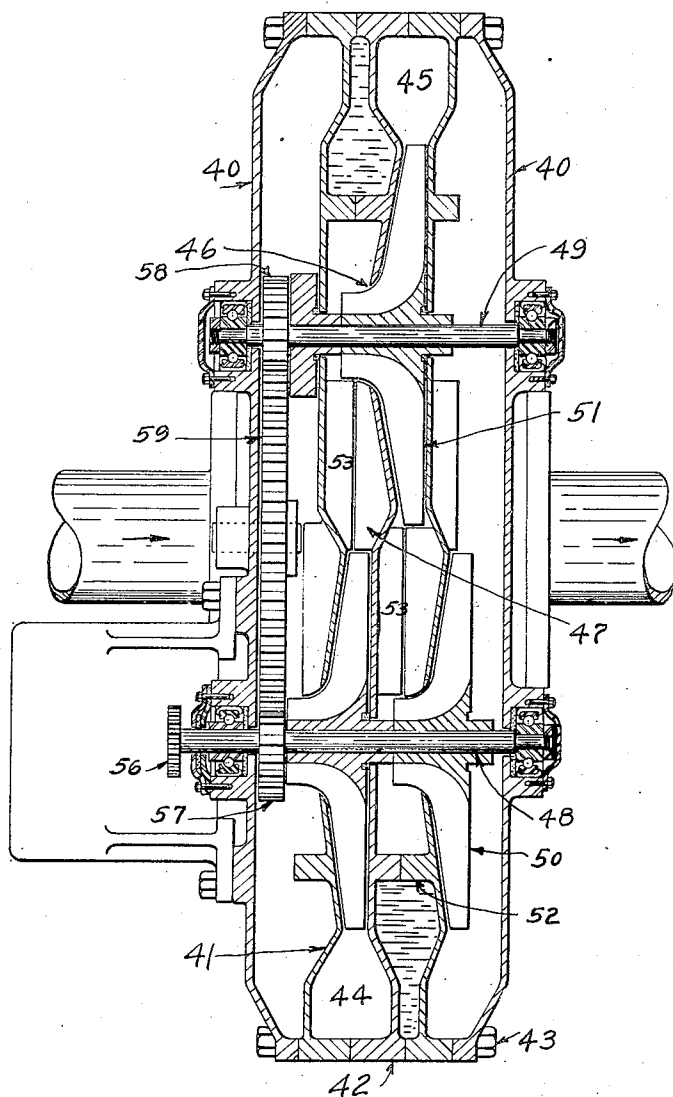
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Fig. 10



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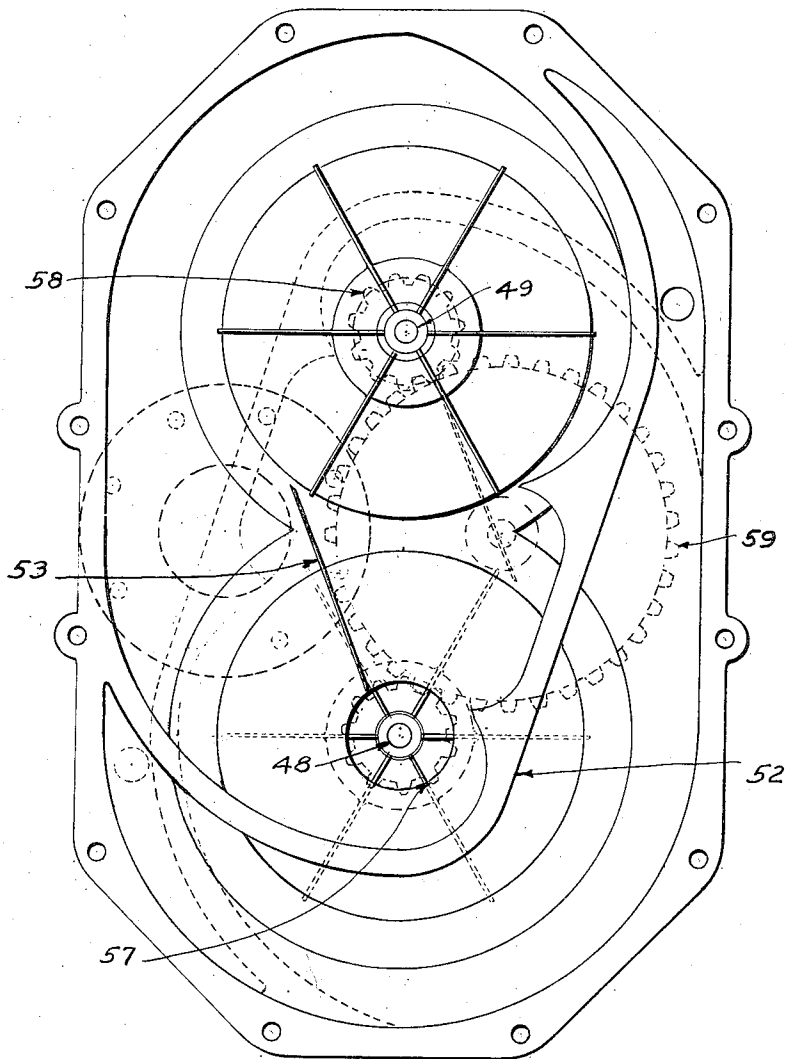
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Fig. 11



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MULTIPLE FAN

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Fig. 12

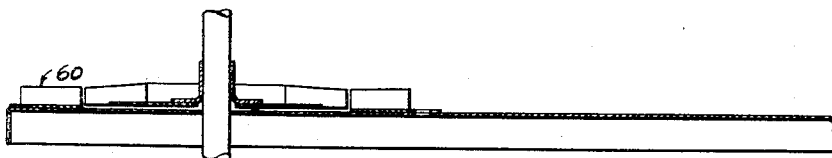
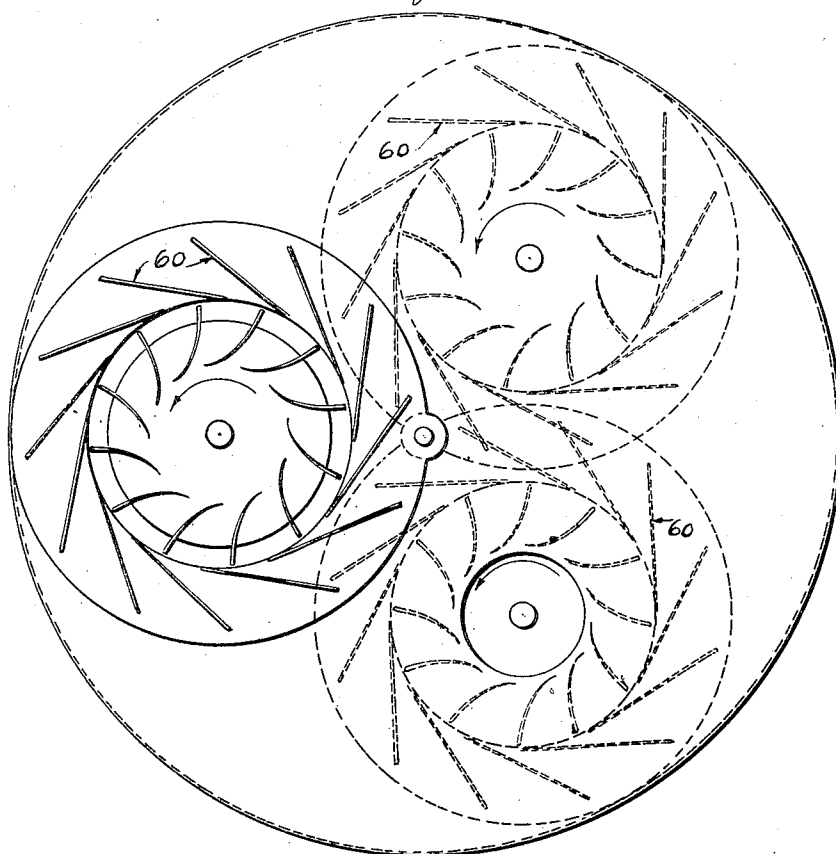


Fig. 13

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UNITED STATES PATENT OFFICE.

NELSON H. HENDERSON, OF SYRACUSE, NEW YORK.

MULTIPLE FAN.

Application filed July 15, 1921. Serial No. 485,126.

To all whom it may concern:

Be it known that I, NELSON H. HENDERSON, a citizen of the United States, and a resident of Syracuse, in the county of Onondaga and State of New York, have invented a certain new and useful Multiple Fan, of which the following is a specification.

This invention has for its object a multiple fan or blower designed for compactness and to give higher pressure than possible with the ordinary fan or blower, which multiple fan is particularly simple in construction, economical in manufacture and highly efficient and durable in use. This invention consists in the novel features and in the combinations and constructions hereinafter set forth and claimed.

In describing this invention, reference is had to the accompanying drawings in which like characters designate corresponding parts in all the views.

Figure 1 is a vertical sectional view, partly in elevation, of a multiple fan embodying my invention, the portions in section being taken on line 1—1, Fig. 2.

Figure 2 is an end view.

Figure 3 is a face view of one of the sections or partitions of the fan.

Figures 4, 5, 6 are sectional views taken respectively on line 4—4, 5—5, 6—6, Fig. 3.

Figure 7 is an elevation, partly in section, of another form of my multiple fan.

Figures 8 and 9 are respectively, an end elevation, and a fragmentary sectional view of my multiple fan showing means for water cooling the same and for scrubbing gas passing therethrough.

Figures 10 and 11 are respectively a sectional view and an end view of another form of fan.

Figure 12 is a diagrammatic elevation of one of the sections and contiguous parts showing the section provided with a ring of stationary vanes around the fans to increase the efficiency of the fan by directing the flow of air or gas as it leaves the tips of the fan blades.

Figure 13 is a horizontal sectional view taken centrally on Fig. 12.

This multiple fan comprises generally, a plurality of fans arranged in chambers which are connected in series whereby the

first fan discharges into the second fan and the second into the third etc. thereby raising the pressure in each case, so that the number of fans in the series determines the resulting pressure.

The fans are preferably arranged in parallel sets, three sets being shown in Figs. 1 and 2, and two sets in Figs. 10 and 11, the fans of one set being arranged out of alignment with or alternately or staggered with respect to those of the other sets whereby the first fan of one set delivers to the first fan of the second or next parallel set and the first fan of such other set delivers to the first fan of the third set etc., and the last fan of each series discharges into the first fan of the next series.

These fans are located on parallel shafts, within the casing of the machine. The fan wheels are located in chambers so formed that each, when arranged in juxtaposition to the next in order, encloses the fan wheel and leaves a receiving or pressure chamber around the wheel for collecting the gas or air as it leaves the fan blades, and this receiving chamber is so shaped that the velocity head is transformed into pressure, or partly so, and is directed into the center of the next fan in the series as shown. The direction of flow of the gas or air, on entering the fan may be such as to aid the rotation of this wheel by whatever velocity energy still remains in the gas or the rate of discharge from the fan wheel may be such as to change the velocity energy to pressure energy as much as possible before the air enters the next wheel in the series. A baffle may be so arranged in this air chamber or passage as shown in Figs. 10 and 11, that it will accomplish the above purposes. A number of stationary vanes may also be arranged around such wheel as shown in Figs. 12 and 13 for the same purpose.

Each section of the machine may be designed with a water chamber in such a way that cooling water will pass from one side of the machine to the other when going through each section as shown in Fig. 10.

In Figs. 1 and 2, the numeral 1 designates the casing, here illustrated as comprising heads 2, 3 and an enclosing wall or shell 4. The interior of the casing is divided into

chambers connected in series, by transverse partitions, each of which has an opening therethrough which constitutes the inlet for the space on one side of the partition and the outlet for the space on the other side, the openings in adjacent partitions being out of alinement, and there are fans in the spaces between the partitions, one in each space, the fans being arranged respectively, in line with the openings with their intake sides adjacent said openings.

In the embodiment of my invention shown in Figs. 1 and 2, there are three sets of fans and a plurality of series of fans and chambers, each series of fans comprising three fans, one from each set. The wall 4 of the casing is cylindrical and hence the partitions 5 are discoidal and fit the cylindrical wall 4 and are spaced from each other by marginal annular flanges 6. The flanges 6 of the partition at the exit end of the machine are here shown as lapping a flange 8 on the inner sides of the head 3, and the margins of the cylindrical wall fit or lap the flange 8 and flange 6 and also the flange 7 on the head 2. The end margins 9 of the strip forming the wall 4 are turned radially outwardly and secured together as by bolts 10. The heads 2, 3 are tied together by a bolt 11 extending axially of the casing and through central holes 12 in the partitions 5, and are spaced apart on the bolt by spacing rings 13. The heads 2, 3 are formed with a suitable inlet 14 and outlet 15 respectively. The partitions 5 are arranged in groups of three, the partitions of each group being designated 5', 5², 5³, and each partition 5', 5², 5³ is formed with an opening 16 serving as an inlet for the space on one side of the partition and an outlet for the space on the other side, and the openings 16 of the partitions 5', 5², 5³ are arranged out of alinement and equidistant apart, or in radial lines at an angle of 120° to each other. However, the openings 16 of the partition 5' of all the groups are in alinement, and likewise the openings 16 of the partitions 5² and the openings 16 of the partitions 5³. Each partition is also formed with two small holes 160 for two of the fan shafts, the third fan shaft passing axially through the openings 16. Suitable packing rings as felt washers are preferably located around the holes 160 and between the partitions. The inlets and outlets 14, 15 of the casing are preferably arranged in alinement.

17, 18, 19 are the fan shafts journaled in the heads 2, 3 of the casing and spaced equidistant apart around the axis of the cylindrical casing of the bolt 11. The shafts 17, 18, 19 are connected to a driver in any suitable manner, and as here shown, pulleys 20, 21, 22 are mounted on the ends of the shafts outside of the head 2, and a single belt 23 passes around the pulleys and around a driv-

ing pulley 24 on a motor shaft not shown. The belt is arranged to rotate all the shafts in the same direction.

25, 26, 27 are the sets of fans mounted on the shafts 17, 18, 19 between the partitions with their intake sides alined with the openings 16. The partitions may be flat but to obtain highest efficiency from the fans, the blades of the fans are tapered and the opposing portions 28, 29 of the partitions are shaped to form fan chambers which conform to the contour of the blades. Also, the portions of the partitions at 30, 31 are shaped to widen the space leading from the fan chamber between the portions 28, 29 to the opening 16 leading to the next fan chamber, to form a pressure or receiving chamber 32 between each two partitions so that the velocity head of the gas or air is transformed into pressure or partly so before it enters the next fan.

By reason of the partitions 5 being duplicates, a multiple fan can be built up to contain any number of fans by providing the shafts 17, 18 and 19 of sufficient length and by bolts 11 of sufficient length. Hence, great economy in manufacture is obtained as the casing of each multiple fan consists of two heads and duplicate partitions and the only additional changes to be made is to provide a cylindrical wall of sufficient length. Also, any pressure may be obtained and the ordinary characteristics of the fan blower retained.

In case where the fans are so numerous in one blower that the end thrust is objectionable, it will be found to advantage to balance the end thrust on the shafts, and in such case the fan or blower may be built as shown in Fig. 7 to have intakes at the opposite ends and the discharge passage 33 in the middle. In such case, the partitions on opposite sides of the discharge passage 33 will be arranged opposite to each other. That is, the spacing flanges of the partitions on the right side of the central discharge opening will point toward the right and the flanges on the partitions on the left side toward the right.

In some instances, it may be desirable to water cool the fans or to scrub the gas passing through the blower, and as shown in Fig. 9 an inlet pipe 34 for water may be arranged to discharge into part or all of the spaces between the partitions and preferably in the fans near their centers, so that the water is thrown by the fans. The lower portions of the partitions may be provided with water seals at 35 provided by forming the partitions with upright hollow portions or conduits 36, open at their lower ends into the casing 1 and having overflow outlets 37 in the spaces on the sides of the partition opposite to that side on which the open lower ends are located. The pressure of the gas on the surface of the water accumulating in

the lower portion of the casing forces the water up through the conduit 36 and through the outlets 37 to the end of the casing, then through a suitable outlet to the outside of the casing. The overflows are arranged so that the flow of water is contrary to the direction of flow of gas so that the cleaner gas comes in contact with the cleaner water.

This arrangement of water seals also, of course, may be used to carry off water removed from the gas by the centrifugal force in such quantities as to necessitate draining off of the water.

In Figs. 10 and 11, is illustrated another form of multiple fan having but two sets of shafts and fans. In Figs. 10 and 11, the casing includes opposing heads 40 intermediate partitions 41 having marginal spacing flanges 42 for spacing the partitions from the heads and from each other, and fastening members as tie bolts 43, extending transversely through the heads 40 and partitions 41. These partitions 41 are also duplicates of each other and each is so constructed that when arranged in one position, it, together with the adjacent partition forms fan chambers 44 and 45, each of which has a central intake 46 and a tangential discharge passage 47 communicating with the intake of the next chamber in the series. 48, 49 are shafts, two in number extending coaxially of the fan chambers and 50, 51 are the fans mounted on the shafts 48, 49 respectively, there being two fans on each series.

In the form shown in Figs. 10 and 11, each side of the partition 41 is formed with a spacing flange 52 on each side which flange 52 on one side is inversely arranged with respect to the flange 52 on the other side, and the edge face of each flange 52 is flush with the edge face of the marginal flange 42. The partitions are shaped to provide the fan chambers 44, 45 to conform to the contour of the fan blades. The fan chambers are separated transversely in order to provide substantially tangential inlet and outlet passages by means of flanges or baffle plates 53.

The fan shafts 48, 49 are shown as actuated by a motor and a gear, not shown, on the shaft thereof meshing with a gear 56 on the outer end of one of the shafts 48, 49 as the shaft 48. The shaft 48 is connected to the shaft 47 by gears 57, 58 mounted on the shafts within the casing, and an idler gear 59 meshing with the gears 57, 58.

The operation of the fan or blower shown in Figs. 10 and 11 is the same as that shown in Figs. 1 and 2, except that the gas or air passed through two sets of fans arranged in groups or series consisting of two fans.

In Figs. 12, 13, each partition is shown as formed with a circular series or ring of stationary blades 60 around the openings 16

in the partition to increase the efficiency of the fan by directing the flow of air or gas as it leaves the tips of the fan blades.

In all constructions, the pressure is raised by the successive fans.

What I claim is:

1. A multiple fan comprising a casing, parallel shafts extending lengthwise of the casing, the casing being formed with fan chambers, fans mounted respectively on the shafts within the chambers, one fan in each chamber, the fans in adjacent chambers being mounted on different shafts and the fan on one shaft communicating with the next fan chamber through an opening concentric with the shaft on which the fan is mounted, whereby the fans of the series on one shaft are arranged alternately with the fans on the other shaft and means for actuating the shafts.

2. A multiple fan comprising a plurality of fans arranged in parallel sets, the fans of the sets being arranged alternately with those of the others, a casing having fan chambers connected in series, and each chamber of one set communicating with the alternate chamber of the next set, each chamber having an intake concentric with the fan therein and an outlet passage communicating with the intake of the next chamber in the series, and means for actuating the fans, substantially as and for the purpose described.

3. A multiple fan having a casing comprising opposing heads and intermediate partitions having marginal flanges for spacing the partitions apart from the heads and from each other, the flanges forming the outer walls of the fan chambers, the flange of one partition abutting against the next partition, and fastening members extending through the heads and the partitions, substantially as and for the purpose specified.

4. A multiple fan or blower comprising a casing having an inlet and an outlet and transverse partitions, each partition having an opening therethrough constituting the inlet for the space on one side of the partition and the outlet for the space on the opposite side of the partition, and fans between the partitions, and openings in adjacent partitions being arranged out of alinement, substantially as and for the purpose described.

5. A multiple fan or blower comprising a casing having an inlet and an outlet and transverse partitions, each partition having an opening therethrough constituting the inlet for the space on one side of the partition and the outlet on the opposite side of the partition, the openings of adjacent partitions being arranged out of alinement, and fans arranged in the spaces between the partitions, one in each, the fans being arranged coaxially with said openings and

with their intake sides adjacent said openings, substantially as and for the purpose specified.

6. A multiple fan or blower comprising a casing having an inlet and an outlet and transverse partitions, each partition having an opening therethrough constituting the inlet for the space on one side of the partition and the outlet for the space on the opposite side of the partition, the openings of adjacent partitions being arranged out of alinement, shafts journaled in the casing and extending coaxially through said openings respectively, and fans mounted on the shafts respectively in the spaces between the partitions one in each space, the fans being arranged with their intake sides adjacent said openings, and means for actuating the shafts, substantially as and for the purpose set forth.

7. A multiple fan or blower comprising a casing having an inlet and an outlet, and transverse partitions forming a fan chamber, and a receiving chamber between any two partitions, each partition being formed with an opening therethrough constituting the inlet for the space on one side of the partition and the outlet for the space on the opposite side of the partition, said openings leading into the fan chamber on one side of the partition and from the receiving chamber on the opposite side, shafts extending through such openings and the partitions, fans mounted on one or another of the shafts in the spaces between the partitions, one fan in each fan chamber of such spaces, and means for actuating the shafts, substantially as and for the purpose described.

8. A multiple fan or blower comprising a casing having transverse partitions therein forming a fan chamber, and a receiving chamber between any two partitions, each partition being formed with an opening therethrough constituting the inlet for the space on one side of the partition and the outlet for the space on the opposite side of the partition, said opening leading into the fan chamber on one side of the partition and from the receiving chamber on the opposite side, shafts extending through such openings and the partitions, the portions of the partitions confining the receiving chamber being spaced farther apart than the portions confining the fan chambers, fans mounted on one or another of the shafts in the spaces between the partitions, one fan in each fan chamber of such spaces, and means for actuating the shafts, substantially as and for the purpose set forth.

9. A multiple fan or blower comprising a casing having transverse partitions, the partitions being duplicates of each other and having marginal flanges arranged at an angle to the body of the partition to abut

against the next partition to space the partitions apart, each partition having an opening therethrough constituting the inlet for the space on one side of said partition and the outlet for the space on the opposite side thereof, the openings of adjacent partitions being arranged out of alinement, shafts journaled in the casing and extending coaxially through the openings, fans mounted on the shafts in the spaces between the partitions, one fan in each space, the fans being arranged coaxially with said openings and with their intake sides adjacent said openings, and means for actuating the shafts, substantially as and for the purpose specified.

10. A multiple fan or blower comprising a cylindrical casing having transverse partitions, each partition having a single opening therethrough constituting the inlet for the space on one side of the partition and the outlet for the space on the opposite side thereof, a series of fans in the casing, one fan in each of said spaces, the fans of the series being arranged with their axes spaced apart about the axis of the cylindrical casing, and means for actuating the fans, substantially as and for the purpose set forth.

11. A multiple fan or blower comprising a cylindrical casing and discoidal transverse partitions, the partitions being arranged in groups or series, each partition having an opening therethrough at one side of the center of the partition, such opening constituting the inlet for the space on one side of the partition and the outlet for the space on the opposite side, the openings of the partitions of each group being arranged out of alinement, and like openings of corresponding partitions of the different groups being in alinement, shafts journaled in the casing and extending coaxially through said openings, fans mounted respectively on the shafts, one in each space between the partitions, said fans being arranged with their intake sides adjacent the openings, and means for actuating the shafts, substantially as and for the purpose described.

12. A multiple fan or blower comprising a casing, and a plurality of series or groups of partitions in the casing, each series or group including a plurality of partitions and each partition having an opening therethrough constituting the inlet for the space on one side of the partition and the outlet for the space on the opposite side of the partition, the openings of the partitions of each series being arranged out of alinement and the openings of the corresponding partitions of all the series being arranged in alinement, shafts journaled in the casing and extending through the aligned openings, a fan mounted in each space between the partitions on one or another of the shafts, with its intake side adjacent the opening in

one of the partitions, and means for actuating the shafts, substantially as and for the purpose specified.

13. A multiple fan or blower comprising a casing including opposing heads and a cylindrical wall, transverse partitions in the casing, each partition having a spacing flange abutting against the next partition, a tie bolt extending lengthwise of the casing and the partitions centrally thereof, passages connecting the spaces on opposite sides of each partition, each passage constituting the inlet for the space on one side of the partition and the outlet for the space on the opposite side of the partition, fans in such spaces, one in each space arranged with their intake side adjacent the inlet opening for such space, a plurality of shafts journaled in the heads on which shafts the fans are mounted, there being one fan in each chamber and a plurality of fans on each shaft, the shafts extending through the partitions, and means for actuating the shaft, substantially as and for the purpose set forth.

14. A multiple fan or blower comprising a casing having inlets at opposite ends thereof, and an outlet intermediate of its ends, transverse partitions in the casing having passages connecting the spaces between the partition, each passage constituting the inlet for the space on one side of the partition, and an outlet on the opposite side of the partition, a plurality of shafts extending lengthwise of the casing through the partitions, fans arranged on the shafts in such spaces, one fan in each space, the fans in adjacent spaces being arranged on different shafts and the fans located in the spaces on one side of the outlet opening being arranged opposite to those on the opposite side of the outlet opening, substantially as and for the purpose described.

15. A multiple fan comprising a casing having fan chambers arranged in a series lengthwise of the casing, three shafts mounted in the casing and extending lengthwise thereof transversely through the fan chambers and being spaced equidistant apart, fans mounted on the shafts in series, one fan in each chamber and a passage connecting the adjacent fan chambers, such passage being arranged concentric with the fan in such chamber.

16. A multiple fan comprising a cylindrical casing having transverse partitions, three shafts journaled in the casing and spaced equidistant apart about the axis of the casing, fans mounted on the shafts one in each space between the partitions, each partition having an opening therethrough concentric with one of the shafts and serv-

ing as an outlet for the space on one side of the partition, and an inlet for the fan on the other side of the partition, substantially as and for the purpose specified.

17. A multiple fan comprising heads, a spaced apart transverse partition between the heads, and having marginal flanges for spacing the partition apart, a centrally located fastening member extending through the heads and the partitions, and shafts spaced apart about the fastening member, and journaled in the heads, fans mounted on the shafts one in each space between the partitions, each space being connected in series with the next space, substantially as and for the purpose set forth.

18. A multiple fan comprising a cylindrical casing having an inlet and an outlet in opposite ends thereof, fan chambers extending transversely of the casing and connected in a series extending from one end of the casing to the other, a plurality of shafts extending lengthwise of the casing transversely through the fan chambers, fans mounted on the shafts, the fans located in adjacent chambers being mounted on different shafts, passages connecting adjacent chambers, such passages being arranged concentric with the shaft on which the fan in one of such chambers is located.

19. A multiple fan comprising a casing having fan chambers therein connected in series, shafts journaled in the casing and extending lengthwise thereof transversely through the fan chambers, said shafts being spaced equidistant apart about a common center, fans mounted in series on the shafts, one fan in each chamber, a pulley mounted on the shaft, a driving wheel mounted approximately concentric with said common center, and a belt extending around the pulleys and having the run between two of the pulleys looped inwardly around the driving wheel, substantially as and for the purpose specified.

20. A multiple fan comprising a cylindrical casing comprising opposing heads having an inlet and an outlet respectively, the heads having annular flanges on their opposing faces, discoidal partitions spaced apart between the heads, a shell comprising a strip wrapped around the flanges of the heads and the peripheries of the partitions, and means for clamping the ends of the strip together, substantially as and for the purpose set forth.

In testimony whereof, I have hereunto signed my name, at Syracuse, in the county of Onondaga, and State of New York, this 20th day of April, 1921.

NELSON H. HENDERSON.