Oct. 14, 1941. G. W. SAATHOFF 2,258,961

EJECTOR DRAFT CONTROL

Filed July 26, 1939 4 Sheets-Sheet 1

Fig. 1.

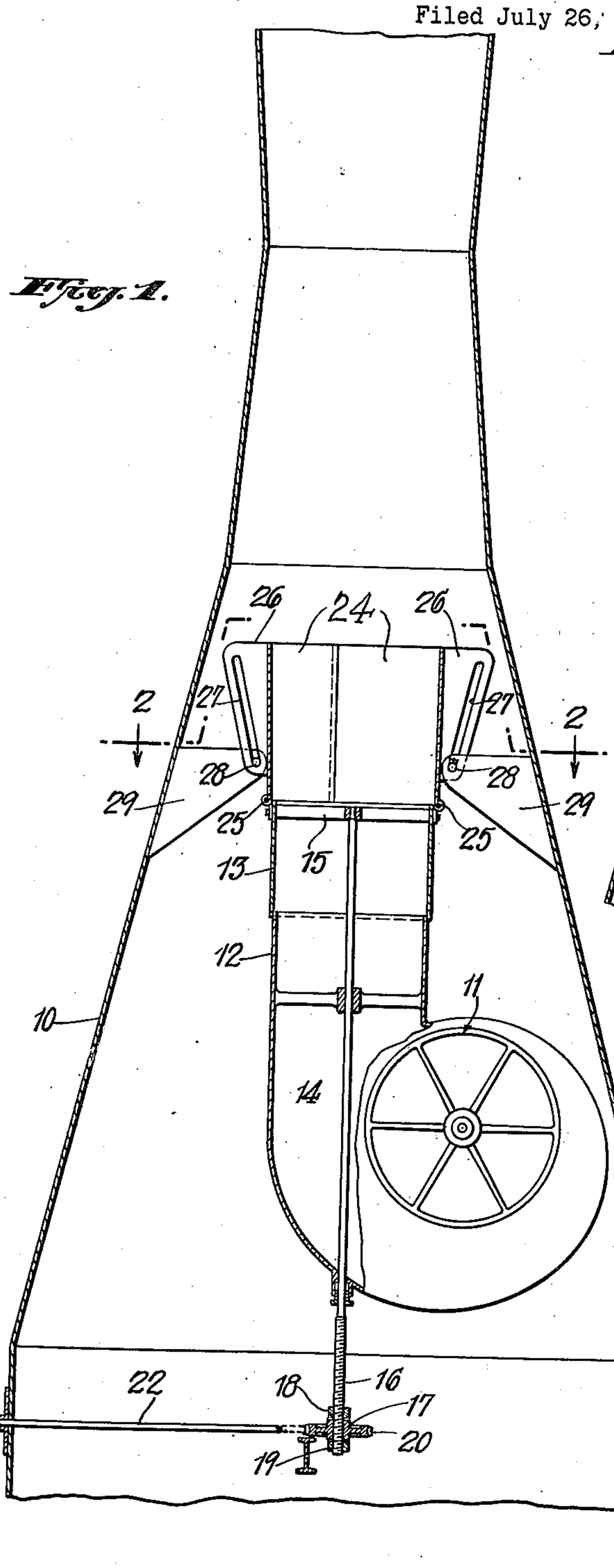



Fig. 2.

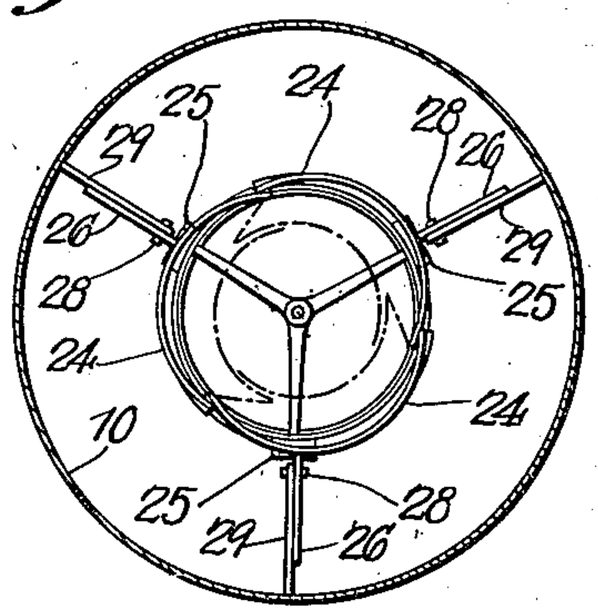
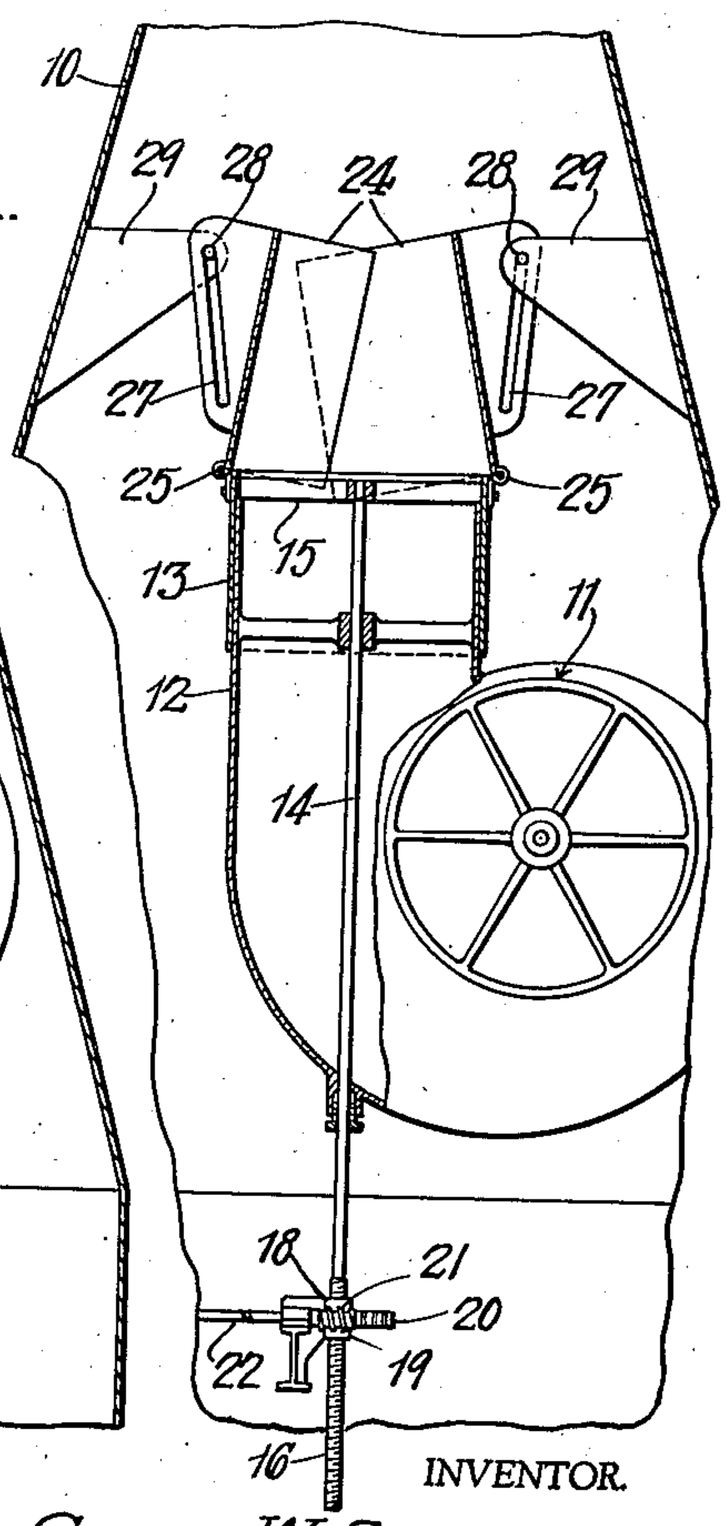



Fig. 3.




INVENTOR.
GEORGE W. SAATHOFF.

BY Benj. T. Rauber ATTORNEY.

Oct. 14, 1941. G. W. SAATHOFF 2,258,961

EJECTOR DRAFT CONTROL

Filed July 26, 1939 4 Sheets-Sheet 2

Fig. 4.

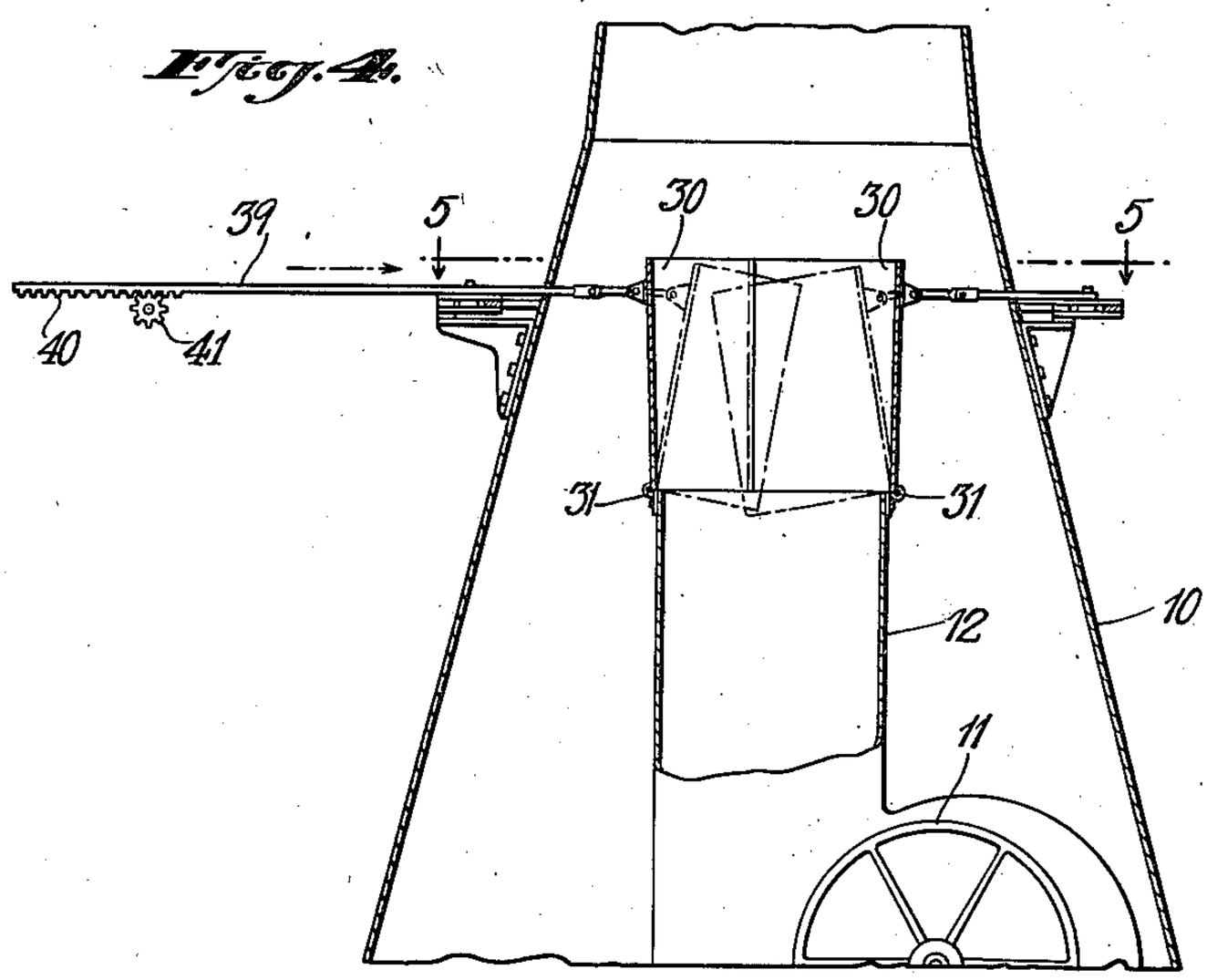



Fig. 5.

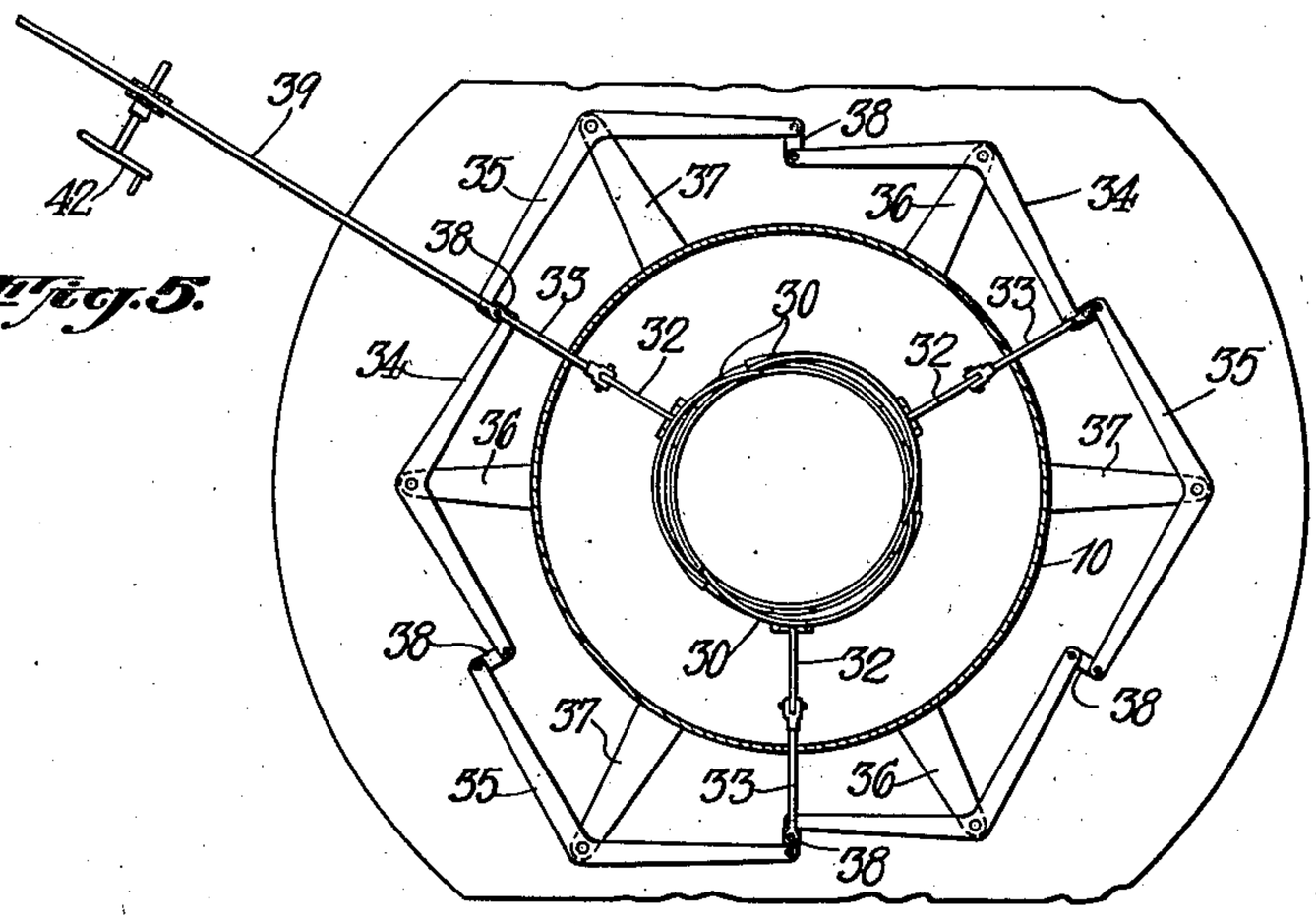
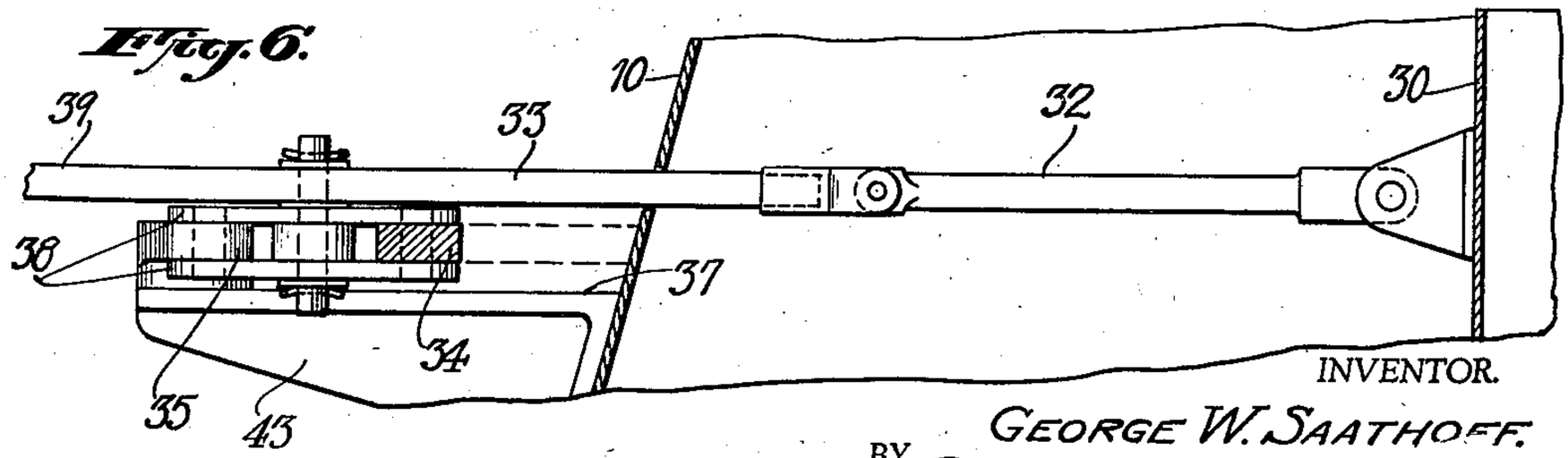



Fig. 6.




INVENTOR.

GEORGE W. SAATHOFF.

BY Benj. T. Rauber ATTORNEY.

Oct. 14, 1941. G. W. SAATHOFF 2,258,961

EJECTOR DRAFT CONTROL

Filed July 26, 1939 4 Sheets-Sheet 3

Fig. 7.

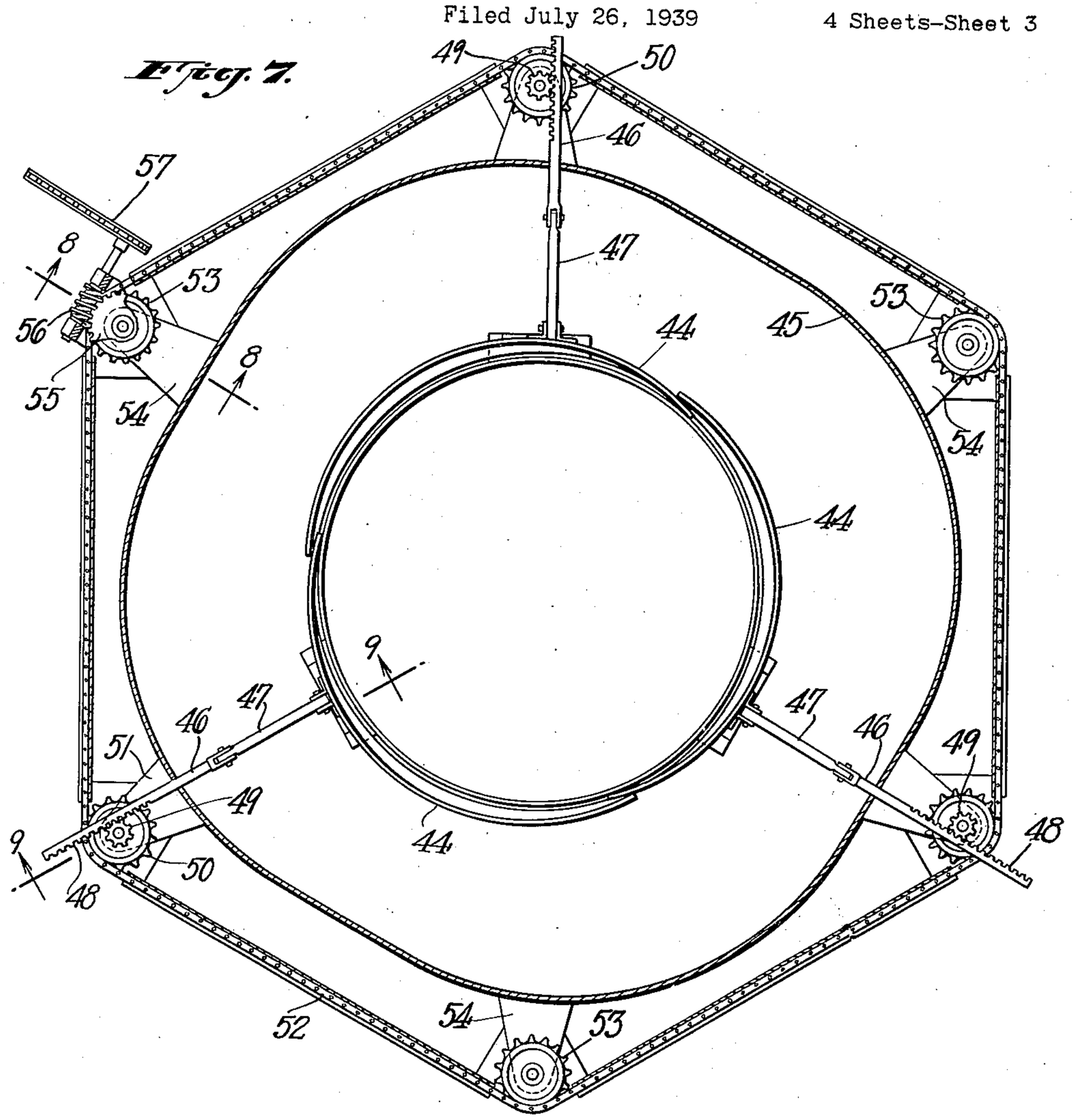



Fig. 8.

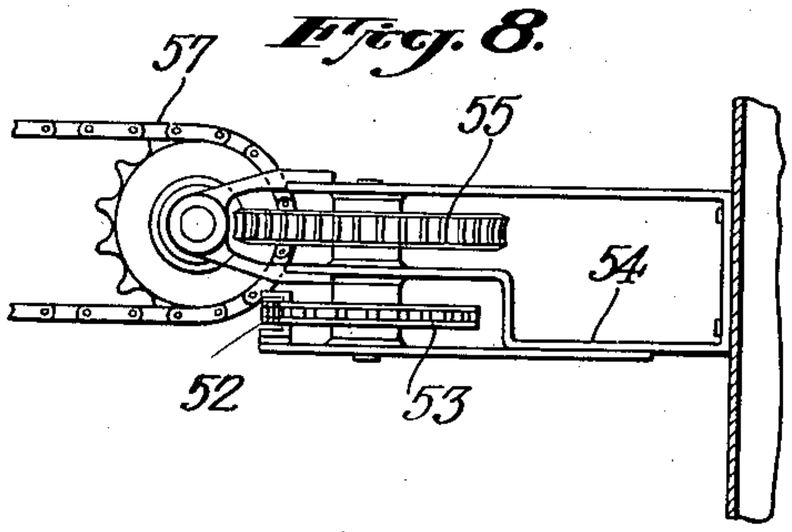
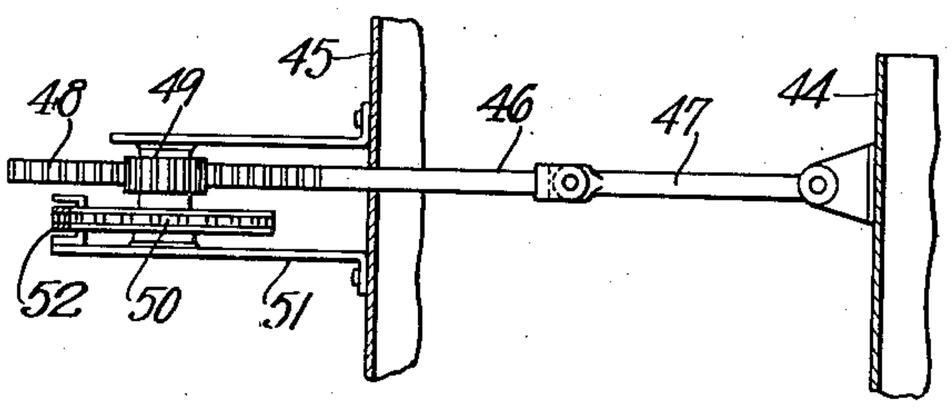



Fig. 9.




INVENTOR.
GEORGE W. SAATHOFF.
BY
Benj. T. Tauber ATTORNEY.

Oct. 14, 1941. G. W. SAATHOFF 2,258,961

EJECTOR DRAFT CONTROL

Filed July 26, 1939 4 Sheets-Sheet 4

Fig. 10.

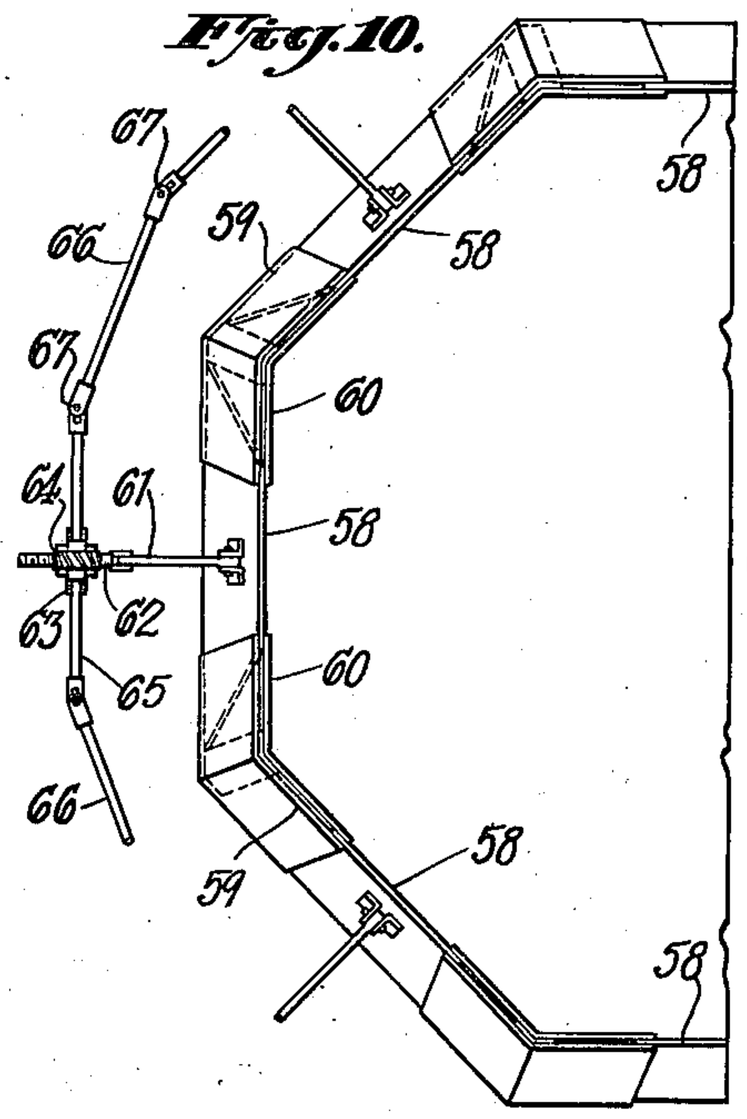



Fig. 11.

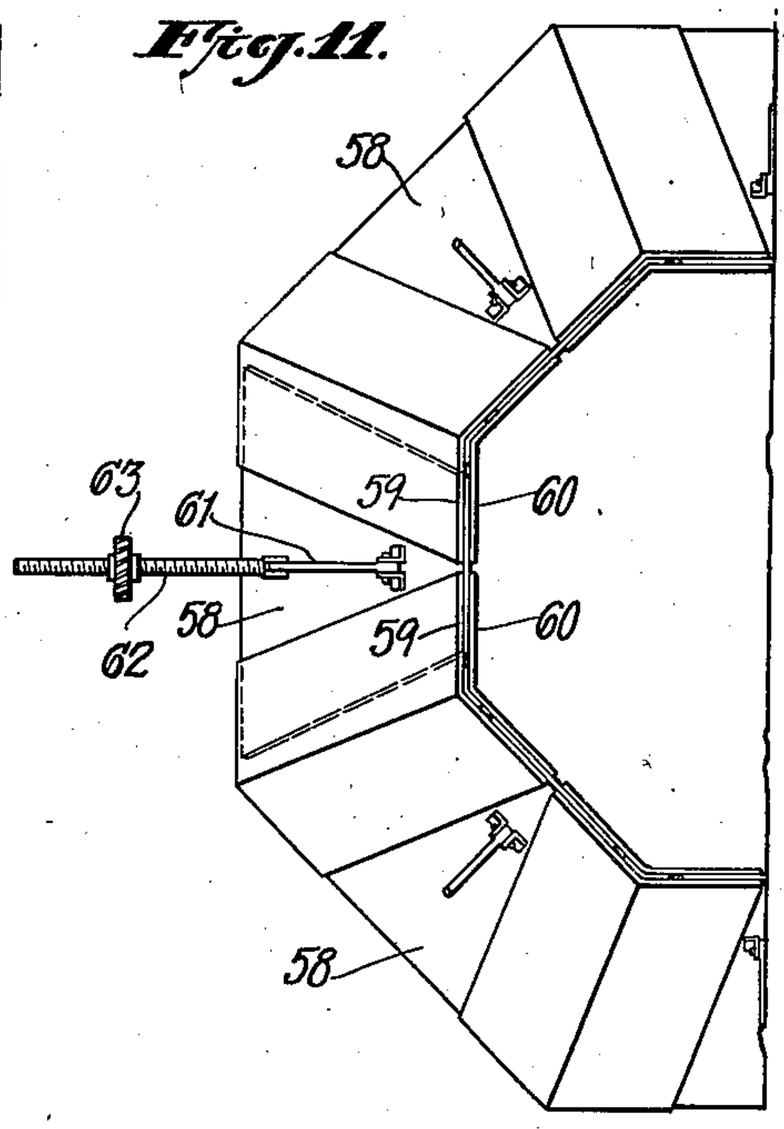



Fig. 12.

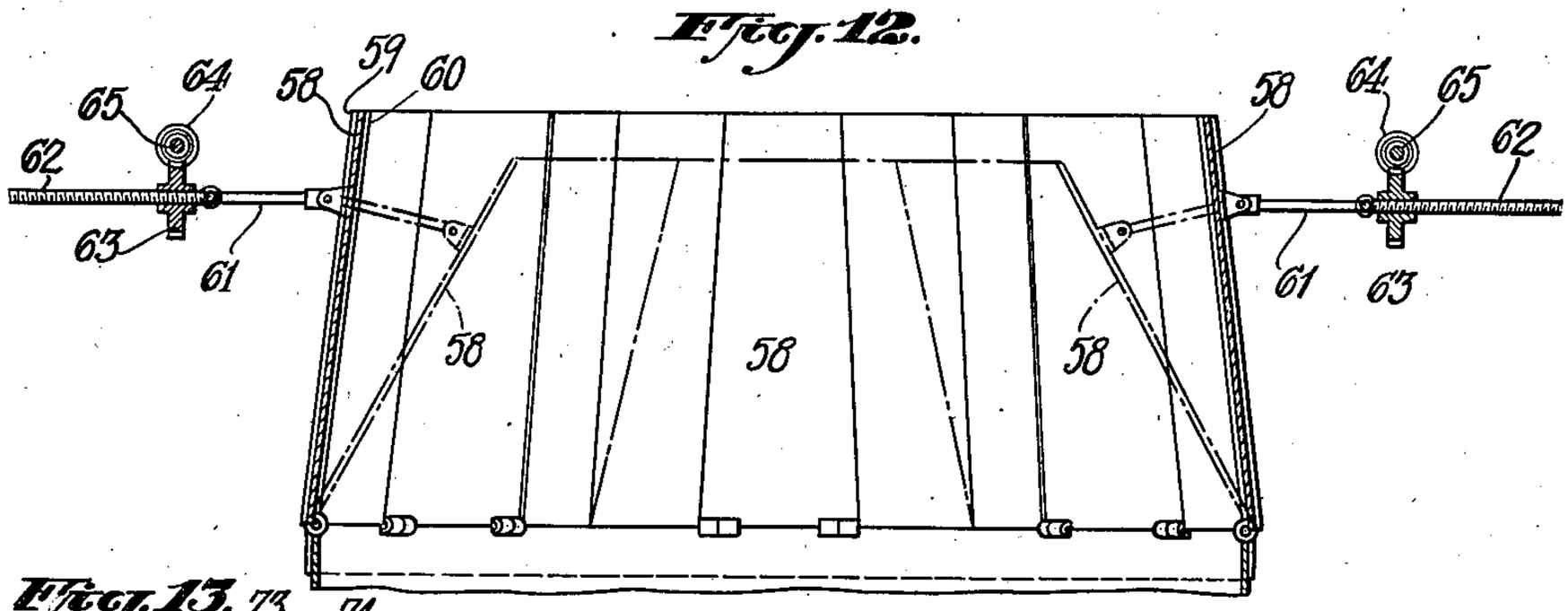



Fig. 13.

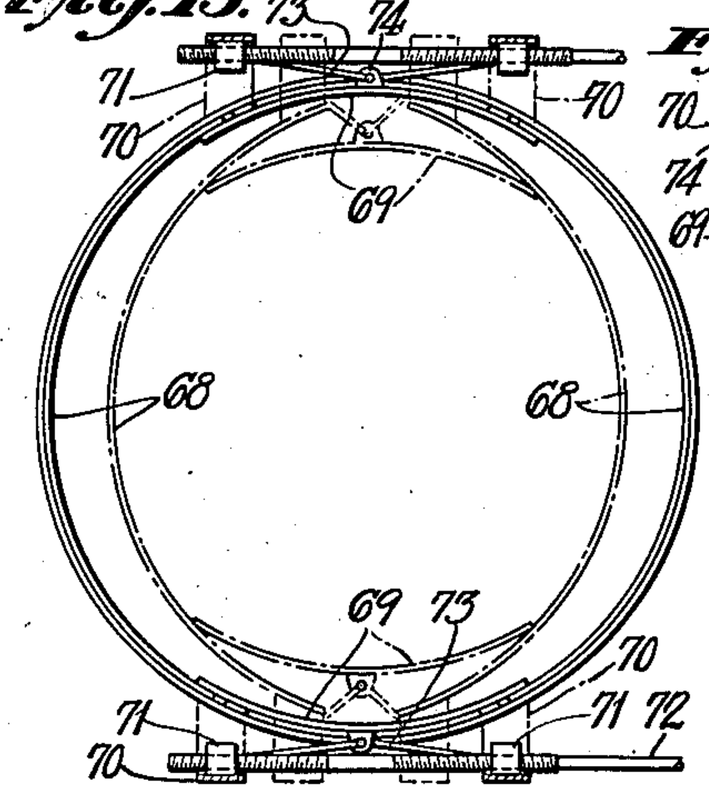



Fig. 15.

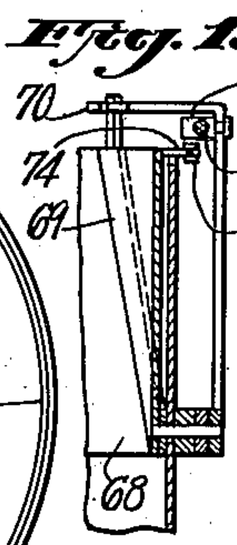
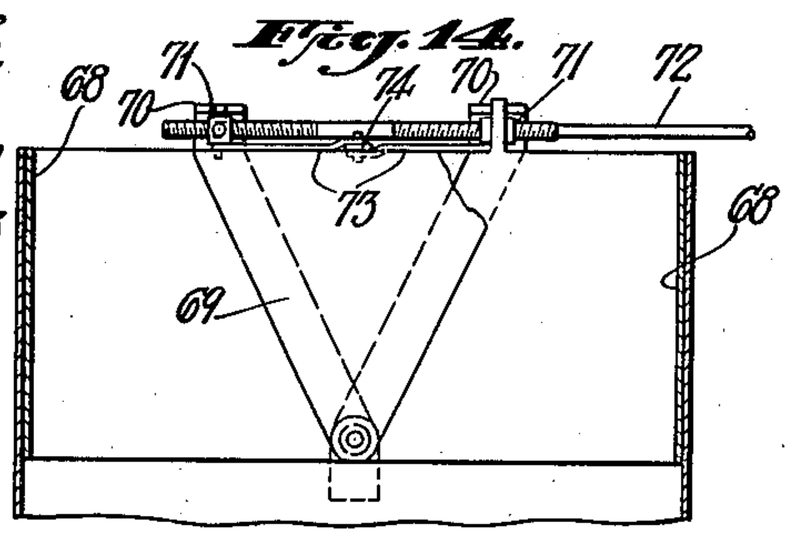



Fig. 14.




INVENTOR.
GEORGE W. SAATHOFF.
BY Benj. T. Tauber ATTORNEY.

Patented Oct. 14, 1941

2,258,961

# UNITED STATES PATENT OFFICE

2,258,961

## EJECTOR DRAFT CONTROL

George W. Saathoff, South Orange, N. J., assignor to Prat-Daniel Corporation, Port Chester, N. Y., a corporation of New York

Application July 26, 1939, Serial No. 286,521

7 Claims. (Cl. 230—99)

My invention relates to ejector type of draft apparatus such as is used in creating a draft for industrial boilers and furnaces, and more particularly to apparatus adjustable with the variation in the quantity of exhaust gases.

In ejector type of draft apparatus a fan or blower is arranged to withdraw products of combustion from a stack and to return said gases to the stack under an increased velocity or pressure, and at a later point in the path of travel of the gases, so as to create an ejector effect and thus to create a draft or to aid or increase the natural draft of the stack.

The fan or pressure creating apparatus and the ejector nozzle are of such size and proportion relative to the stack as to obtain the maximum efficiency when a maximum volume of gases is to be handled. When this volume is less than the maximum, the efficiency decreases with a constant speed motor and fan so that more power is required for the movement of a given volume of gases and, under some circumstances, there may be a re-circulation of gases within the stack with consequent loss of energy.

With some types of installation also, the position of the ejector nozzle relative to the interior of the stack is one giving a high efficiency in the handling of large amounts of gases, but much less efficiencies when the amount of gases passing through the stack decreases.

These various disadvantages are obviated by my present invention which provides draft ejector apparatus in which the size of the outlet area of the ejector may be adjusted or varied in accordance with variations in the amount of gases passing through the stack so as to maintain the efficiency of the ejector with a constant speed of fan to minimize the decreasing efficiency when smaller quantities of exhaust gases pass through the stack. The invention, therefore, may provide means whereby the position of the nozzle may be adjusted longitudinally of the stack to provide a position better adapted for small volumes of gases when the outlet at the end of the nozzle is contracted for this purpose.

The various features of the invention are illustrated, by way of example, in the accompanying drawings, in which—

Fig. 1 is a vertical section through a stack and ejector apparatus embodying a preferred form of the invention, and showing the ejector nozzle in position for maximum duty or the passage of a maximum amount of exhaust gases.

Fig. 2 is a horizontal section on the line 2—2 of Fig. 1 showing the ejector nozzle with its maximum cross sectional area shown in full lines, and shown in contracted position with broken lines.

Fig. 3 is a fragmentary vertical section similar to that of Fig. 1, but showing the ejector nozzle contracted.

Fig. 4 is a vertical section, similar to that of Fig. 3, of a modified form of embodiment of the invention.

Fig. 5 is a horizontal section of this embodiment taken on the line 5—5 of Fig. 4.

Fig. 6 is a detail vertical view of a detail of the invention.

Fig. 7 is a view, similar to that of Fig. 5, showing a modified form of apparatus for varying the outlet area of the ejector nozzle.

Figs. 8 and 9 are, respectively, vertical and plan views of details of the operating mechanism shown in Fig. 7.

Fig. 10 is a plan view of a modified form of ejector nozzle in maximum or expanded position.

Fig. 11 is a similar view of the ejector nozzle of Fig. 10 in contracted position.

Fig. 12 is a vertical section through the nozzle of Figs. 10 and 11 showing the nozzle expanded in full lines, and contracted in broken lines.

Fig. 13 is a plan view of a modified form of nozzle.

Fig. 14 is a vertical section of the nozzle of Fig. 13, and

Fig. 15 is a vertical section of a detail of the nozzle of Figs. 13 and 14.

In the apparatus to which my invention is directed, a part of the exhaust gases passing through a stack are withdrawn therefrom by a fan and forced at an increased velocity through a nozzle within the stack and pointing in the direction of the passage of the gases so as to create an ejector effect. The nozzle is placed with respect to the walls of the stack or exhaust passage so as to obtain the most effective and efficient ejecting action on the gases passing between the nozzle and the stack.

In accordance with my invention the nozzle will have a maximum cross sectional area or outlet area when the full or maximum amount of exhaust gases is passing through the stack. The volume of gases passing through the stack is decreased as, for example, when the boiler or furnace supplying the stack is operating at less than its full capacity, the outlet area or cross sectional area of the ejector nozzle may be decreased proportionately. This contraction and expansion of the outlet area of the ejector nozzle are obtained by forming the nozzle of a number of leaves hinged at their lower ends so that they

may be tilted inwardly from maximum position and thus form a contracted opening. In their expanded position these leaves form a substantially complete enclosure or nozzle. When they are tilted inwardly the edges overlap so that they still form a complete nozzle, but of smaller area. The leaves may be hinged at their bottom in a fixed relation to the stack, or may be so arranged that they slide downwardly in collapsed position. The leaves may be of any shape so as to form a circular nozzle, or one of approximately circular or round shape, or one of polygonal outline.

Referring more particularly to the embodiment shown in Figs. 1, 2 and 3 of the drawings, the exhaust gases passing upwardly through a stack 10 are drawn into a fan casing 11 and delivered by a motor driven fan therein to a delivery or outlet pipe 12 extending vertically upwardly and symmetrically within the stack 10. A pipe 13 telescoping over the upper end of the pipe 12 forms an extension thereof that may be varied by means of adjusting rod 14 supporting the pipe or ring 13 at its upper end through a spider 15 and, in turn, supported at its lower threaded end 16 by a nut 17 between a pair of supports 18 and 19 so that by rotating the nut 17 for preventing rotation of the rod 14, the latter and with it the telescoping extension 13 is raised or lowered. The nut 17 forms the hub of a gear 20 which may be driven by means of a worm 21 on a shaft 22 rotatable by a hand wheel 23. At the upper edge of the adjustable extension or collar 13 a number of leaves 24 are hinged, three being shown by way of example, although any number may be employed. Each of the leaves 24 is hinged at its lower end by a single hinge 25 to the upper rim or edge of the collar 13, so that it may swing from the position shown in full lines in Figs. 1 and 2 to the position shown in broken lines in Fig. 2, and in full lines in Fig. 3. The swinging of the leaves is accomplished simultaneously with, and proportionately to, the raising or lowering of the collar 13 by means of radially projecting vanes 26, one for each leaf, and having upwardly and outwardly inclined slots 27 through which extend pins 28 mounted in fixed position on wings 29 extending radially inwardly from the walls of the stack 10.

It will be apparent that as the end wheel 23 is rotated in position to lower the collar 13 and the slots 27 slide downwardly, the vanes 26 and leaves 24 must swing inwardly as shown in Fig. 3. Reversely, when the wheel 23 is rotated into the opposite position, the collar 13 rises and the pins 28 will pull or swing the vanes 26 and leaves 24 outwardly, providing a larger outlet area for the nozzle. In the above way, the area of the nozzle may be adjusted with variations in the amount of gases to be handled to provide not only the optimum ejector opening, but the optimum position for this opening in the nozzle. It will also be obvious that with the same inclination of the slots 27 of each vane, and the same size of, and relative position for, the wings or plates, each leaf will have the same angular swing or movement as the other leaves.

In the embodiment of the invention shown in Figs. 4, 5 and 6, a number of leaves 30, of generally cylindric curvature are mounted, each by a single hinge 31, at its lower edge to the upper edge of the delivery pipe 12 of the fan 11, each element being positioned within the stack 10 in substantially the same manner as the embodiment in Figs. 2 and 3. In the specific example, three leaves 30 are shown by way of example, but it will be obvious that any desired or suitable number may be employed. Each leaf is, therefore in fixed position vertically relative to the stack at all positions of opening. The leaves 30 are moved or swung inwardly and outwardly on their respective hinges 31 in simultaneous and equal movements by means of a lever mechanism operated from a common operating source.

For this purpose each leaf is connected near its upper end by a link 32 to a pull rod 33 which is secured outside of the stack 10 to an operating linkage through which the pull rods 33 of all the leaves are operated simultaneously and through the same distance. This linkage comprises for each pull rod a pair of levers 34 and 35, one lever being on one side of the rod and the other lever on the opposite side, and being pivotally supported by fulcrum brackets 36 and 37 projecting radially outwardly from the stack 10. These levers 34 and 35 are connected at their ends by links 38 so that the successive links move alternately outwardly and inwardly and, consequently the pull rods being connected to alternate links, move simultaneously inwardly and outwardly. By making the levers 34 and 35 equal, the movements of the pull rods and of the leaves will be equal as well as simultaneous. Consequently the inward or outward movement imparted to one of the pull rods 33 will be transmitted to all of the others. To give the pull rods and their respective leaves the desired movement, one of the rods is extended as at 39 and provided with rack teeth 40 meshing with, and driven by, a pinion 41 and hand wheel 42, Figs. 4 and 5. In order to support the links 38 and guide them in their movements, brackets 43 are provided on the sides of the stack 10, said brackets having suitable grooves in which the links slide, and the levers 34 and 35 may be bent as shown in Fig. 5 to conform to the shape of the stack.

It will be apparent that when the hand wheel 42 is rotated to push the rod 39 inwardly, all of the leaves 30 will swing inwardly to contract the ejector nozzle opening and, conversely, when the hand wheel 42 is rotated in the opposite direction.

In the modification shown in Figs. 7, 8 and 9 each of the leaves 44 may be mounted as in the modification shown in Figs. 4, 5 and 6, being hinged at their lower ends so as to swing inwardly and outwardly within the stack 45. The leaves 44 are moved or swung from one position to another by means of sliding rods 46 to which the leaves are connected by links 47, and which are provided outside of the stack with rack teeth 48 and each engaging an individual pinion 49. Each of the pinions 49 is mounted on a common shaft and rotatable by a cog wheel 50 supported on a bracket 51 projecting from the outside of the stack. An endless chain 52 is trained about the respective cog wheels of the leaves 44, there being three such cog wheels and pull rods in the embodiment shown, and about certain idler sprockets 53 also mounted on brackets 54 on the stack 45. Above one of the idler sprockets 53 is provided a gear wheel 55 secured to a common shaft with the sprocket wheel 53 and driven by a worm 56 which may be driven by any suitable means as, for example, the sprocket chain 57. It will be apparent that when the worm 56 is rotated in one direction, all of the sprockets 50 and pinions 49 will be rotated in one direction to push the rods 46 inwardly or outwardly to tilt their respective leaves 44 and thus contract or enlarge the ejector nozzle opening.

In the example shown in the drawings, the stack is illustrated as not being circular, but one of rounded and flattened area. The stack, however, may be of any suitable shape, and it will be understood that in this case also, any number of leaves may be employed to provide the nozzle outlet.

In the modification shown in Figs. 10, 11 and 12 the nozzle outlet is made up of a number of plane or flat plates **58** hinged at their lower edges to swing inwardly and outwardly and with their lower edges mounted to form a polygon. In the example given, a hexagon is shown to form a hexagonal nozzle outlet, but it will be understood that a polygon of any number of edges may be employed. The plates **58** swing, for example, from the position shown in Fig. 10 to that shown in Fig. 11 and, in thus swinging, the upper edges of the plates approach, there being a wider space when the plates are in the position of Fig. 10. The spaces between these plates are closed by means of spaced angle plates **59** and **60**, a pair extending between the adjacnt edges of the successive plates **58** so as to form a complete and continuous nozzle. Thus, when the plates **58** are pushed or tilted inwardly, the angle plates **59** and **60** also move inwardly, there being a relative sidewise sliding of the surfaces of the plates **58** between the plates **59** and **60**.

The plates **58** are all moved or tilted simultaneously by links **61** connected to threaded rods **62** held from turning and passing through rotatable nuts **63**, the outer peripheries of which are formed into gears engaged by worms **64** on rods **65**. Each of the plates **58** is thus provided with a link **61**, rod **62**, nut **63**, worm **64** and rod **65**. The rods **65** are all inter-connected by means of connecting rods **66** extending between the adjacent ends of the rods **65** and connected thereto by universal joints **67**. Therefore, by turning one of the rods **65**, all of them turn simultaneously, and all of the plates **58** are tilted simultaneously and to the same amount.

In the modification shown in Figs. 13, 14 and 15, a pair of tilting leaves **68** are shown, the opposite edges of which are spaced apart or diverge upwardly. The spaces between the opposite edges of the leaves **68** are closed by plates **69**. When the plates **68** are tilted inwardly, the plates **69** also move inwardly to form a smaller nozzle, as indicated by broken lines in Fig. 13. Mechanisms are provided for moving the plates **69** inwardly with the movement of the plates **68**. For this purpose each of the plates **68** is provided near each side edge with outwardly or sidewise projecting brackets **70** to which are attached fixed nuts **71**. Rotatable rods or shafts **72** extend through the nuts **71** and have right hand and left hand screw threads for each respective pair of nuts so that, upon turning in one direction, these nuts are drawn together and, in the opposite direction, are pushed apart, thereby swinging the plates **68**.

Also secured to the nuts **71** are links **73** which extend to and are secured to ears **74** on the plates **69** so that as the nuts **71** are drawn toward each other, they push the links **73** inwardly and thus move the plates **69** from the position shown in full lines toward the position shown in broken lines in Fig. 13.

From the above examples it will be apparent that through the above invention the outlet area of the ejector nozzle may be adjusted to suit any condition of operation. Thus when but a small quantity of gases is passing through the stack, the nozzle may be contracted and thus the amount of gases sent through the nozzle may be reduced together with a reduction in the power required to drive the fan. The power required at low loads may, therefore, be reduced without decreasing the speed of the fan or of the motor driving it. The apparatus does not interfere with the natural draft of the stack, and if the fan is stopped, the full natural draft will be obtained. Where it is desirable to use steam jets to aid in the draft, the above arrangement does not interfere with such jets.

It will be understood that the various modifications are shown by way of example, and that the invention may be embodied in various other forms.

What I claim is:

1. Apparatus of the type described which comprises an exhaust stack having an inner surface contracting toward the outlet, an ejector nozzle within the contracting part of said stack and spaced from the wall of the stack to form an annular passage, a blower to withdraw gases from said stack and force them at an increased velocity through said nozzle, and means to vary the cross sectional area at the outlet of said nozzle and the longitudinal position of said nozzle in the contracted part of said stack.

2. The apparatus of claim 1 in which the means to vary the cross sectional area at the outlet of the nozzle and the longitudinal position of the nozzle comprises a ring, means for moving the ring toward and from the contracted area of said stack, leaves hinged to said ring and extending toward said contracted area of said stack and tiltable inwardly from fully open position and forming a continuous nozzle in various positions of opening, slotted wings, one for each leaf, extending radially outwardly therefrom, and brackets extending inwardly from said stack, one for each said wing, and having pins extending into the slots of said wings, said slots being inclined so that said leaves swing outwardly when said ring is moved toward said contracted part of said stack and swing inwardly when said ring moves away from said contracted part of said stack.

3. Apparatus of the type described which comprises an exhaust stack, an ejector nozzle within said stack and spaced from the wall of the stack to form an annular passage, a blower to withdraw gases from said stack and force them at an increased velocity through said nozzle and means to vary the cross-sectional area of said nozzle opening and inversely the cross-sectional area of said annular passage which comprises leaves hinged at their lower ends to said nozzle and tiltable inwardly from a position of maximum opening, said leaves forming a substantially continuous wall in various positions of opening.

4. Apparatus of the type described which comprises an exhaust stack, an ejector nozzle within said stack and spaced from the wall of the stack to form an annular passage, a blower to withdraw gases from said stack and force them at an increased velocity through said nozzle and means to vary the cross-sectional area of said nozzle opening and inversely the cross-sectional area of said annular passage which comprises leaves hinged to said nozzle at their lower ends and tiltable inwardly from a position of maximum opening and forming a substantially continuous wall in various positions of opening and means to swing said leaves simultaneously inwardly and outwardly.

5. Apparatus of the type described which comprises an exhaust stack, an ejector nozzle within said stack and spaced from the wall of the stack to form an annular passage, a blower to withdraw gases from said stack and force them at an increased velocity through said nozzle and means to vary the cross-sectional area of said nozzle opening and inversely the cross-sectional area of said annular passage and comprising leaves hinged at their lower ends to said nozzle and tiltable inwardly from a position of maximum opening, said leaves forming a substantially continuous wall in various positions of opening, means to swing said leaves simultaneously inwardly and outwardly and comprising push rods, links connecting said push rods to said leaves and means to move said push rods simultaneously inwardly and outwardly.

6. Apparatus of the type described which comprises an exhaust stack, an ejector nozzle within said stack and spaced from the wall of the stack to form an annular passage, a blower to withdraw gases from said stack and force them at an increased velocity through said nozzle and means to vary the cross-sectional area of said nozzle opening and inversely the cross-sectional area of said annular passage and comprising leaves hinged at their lower ends and tiltable inwardly from a position of maximum opening, said leaves forming a substantially continuous wall in various positions of opening and means to swing said leaves simultaneously inwardly and outwardly, said means comprising racks and pinions, one for each leaf, an endless chain drive to drive said pinions, and means to connect individual racks to its respective leaf.

7. Apparatus of the type described which comprises an exhaust stack, an ejector nozzle within said stack and spaced from the wall of the stack to form an annular passage, a blower to withdraw gases from said stack and force them at an increased velocity through said nozzle and means to vary the cross-sectional area of said nozzle opening and inversely the cross-sectional area of said annular passage, said means comprising leaves hinged at their lower ends to said nozzle and tiltable inwardly from a position of maximum opening, said leaves forming a substantially continuous wall in various position of opening and means to swing said leaves simultaneously inwardly and outwardly, said means comprising lever arms connected at their ends to form a continuous endless circuit about said stack and means to connect said lever arms to said leaves.

GEORGE W. SAATHOFF.