W. H. CARRIER.

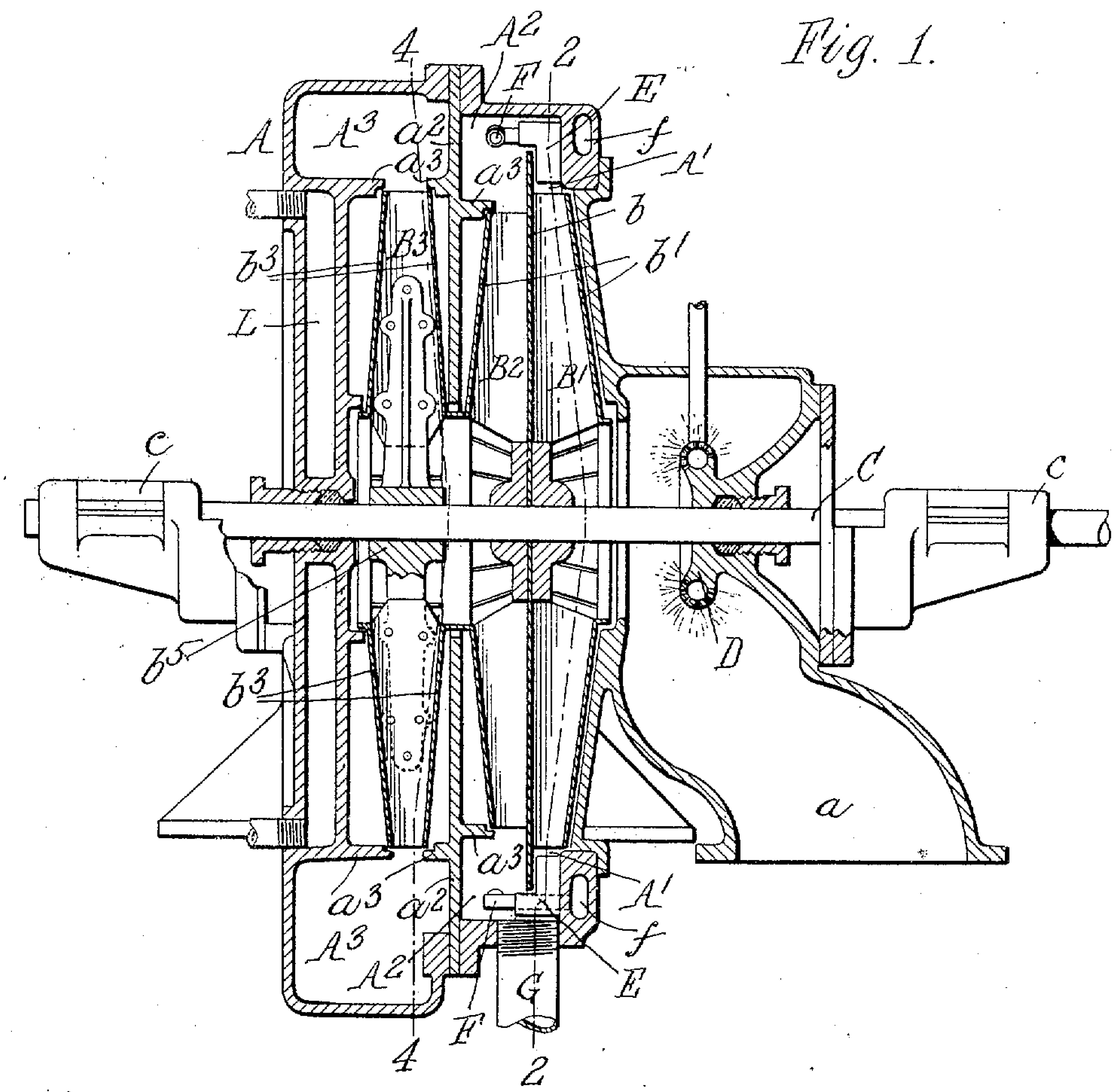
GAS WASHING MACHINE.

APPLICATION FILED DEC. 7, 1907.

973,626. Patented Oct. 25, 1910.

3 SHEETS—SHEET 1.

Fig. 1.



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3 SHEETS—SHEET 2.

Fig. 2.

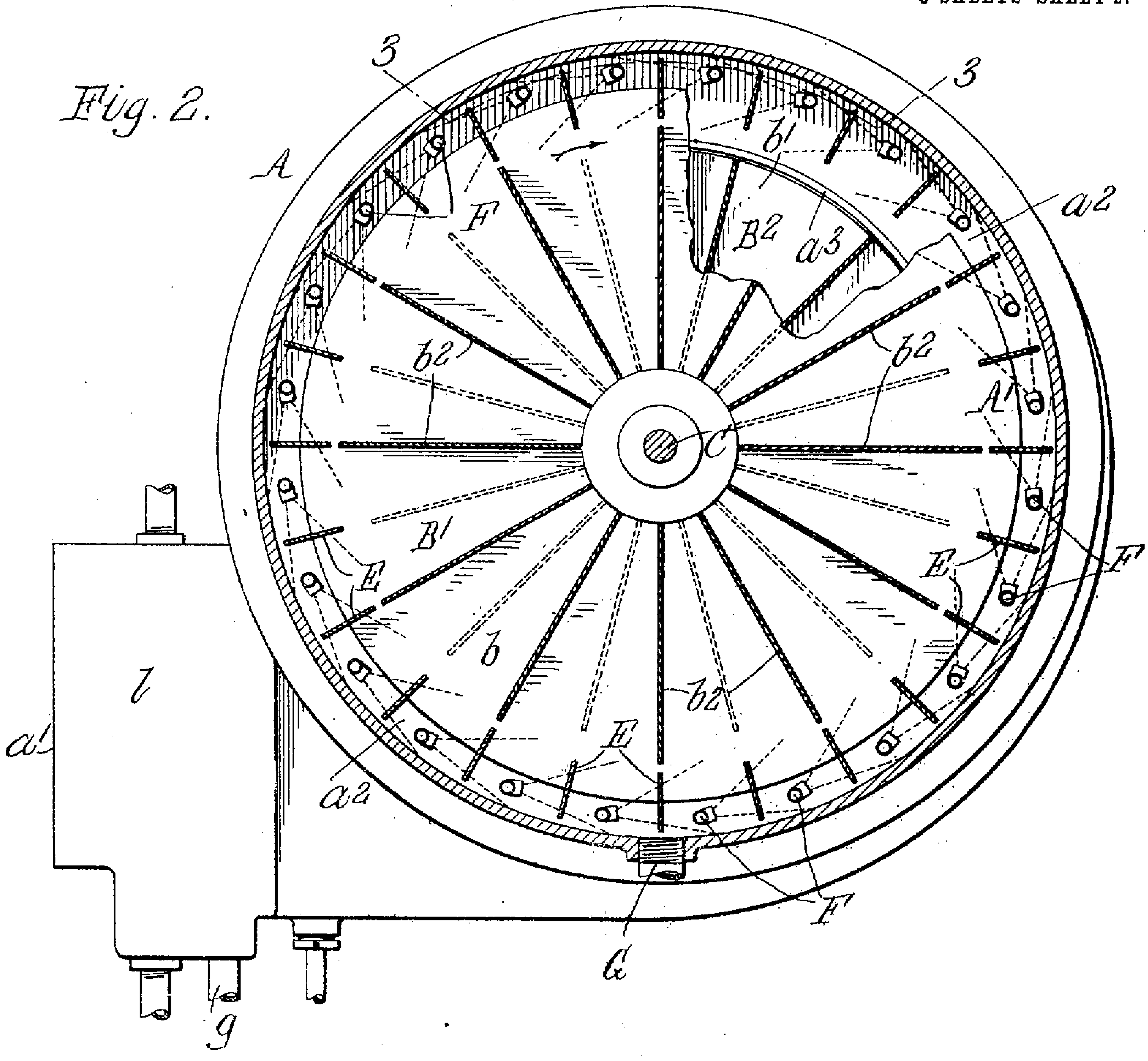
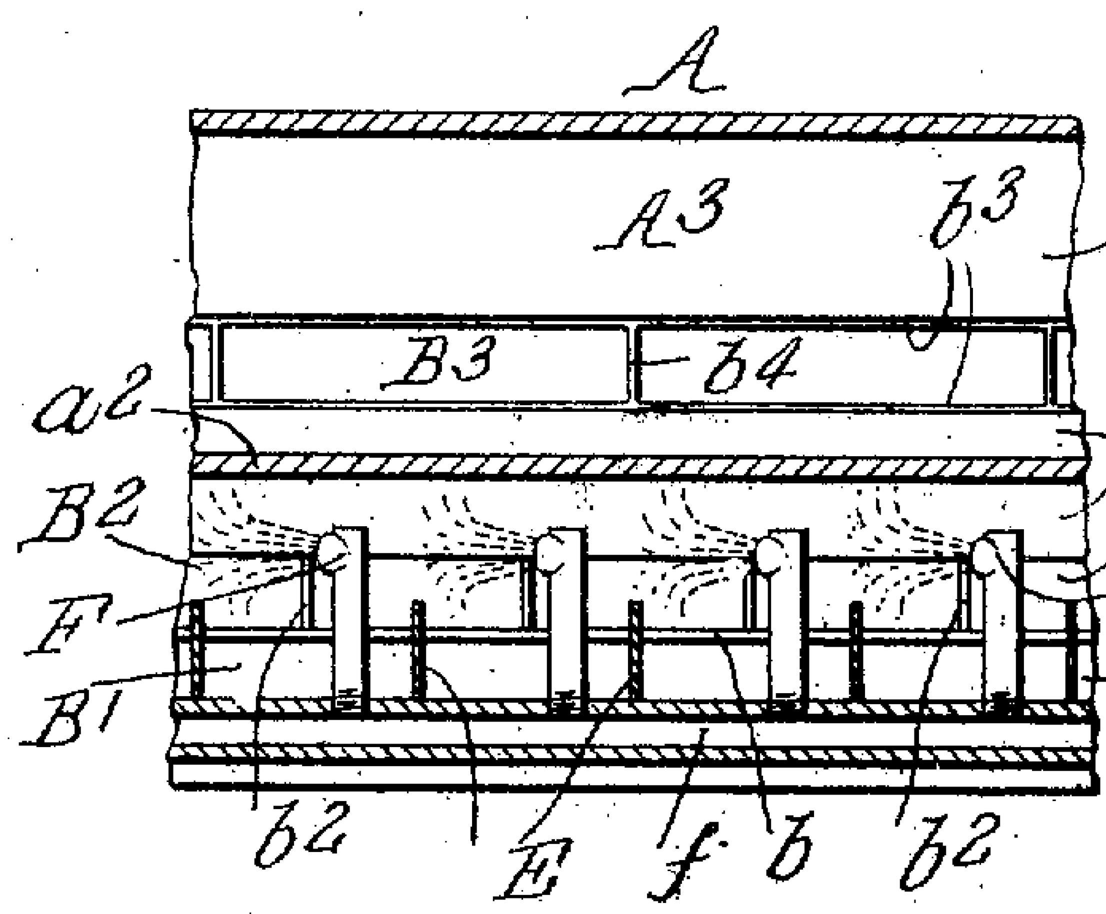


Fig. 3.



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3 SHEETS—SHEET 3.

Fig. 4.

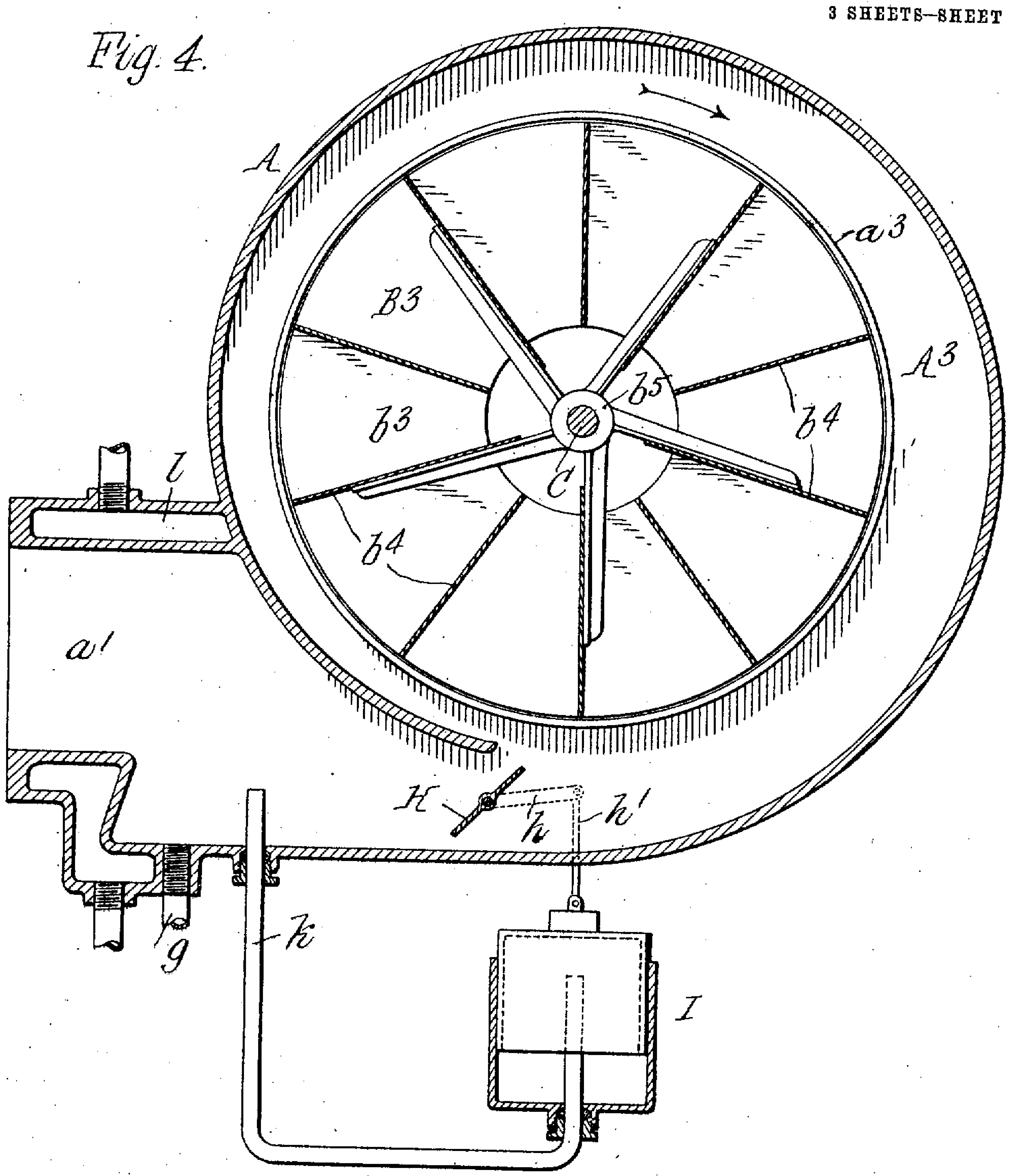
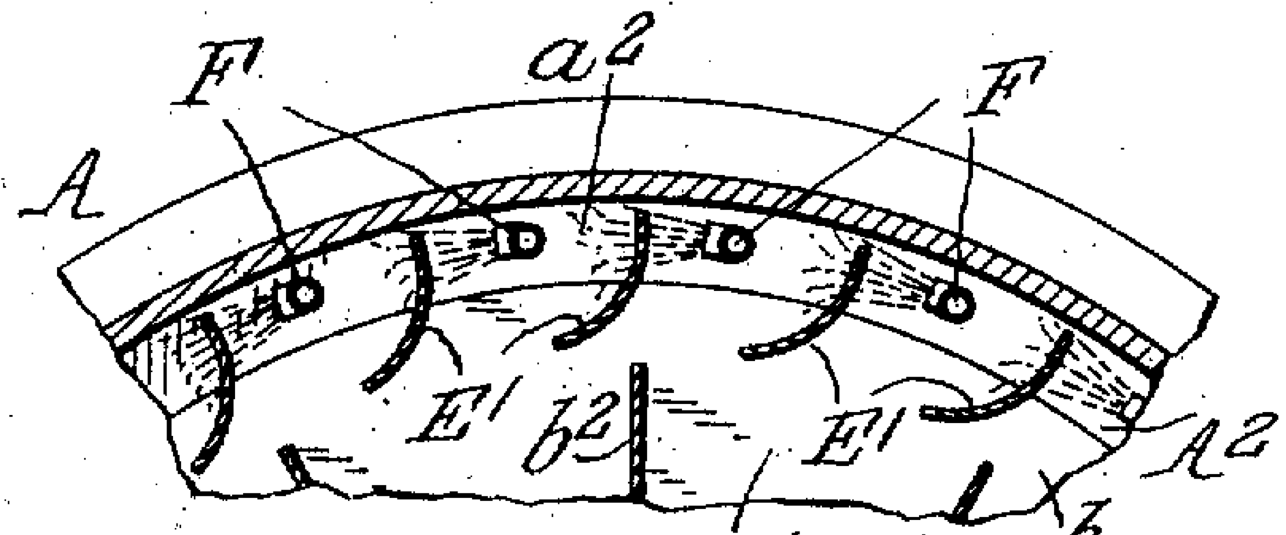


Fig. 5.



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UNITED STATES PATENT OFFICE.

WILLIS H. CARRIER, OF BUFFALO, NEW YORK, ASSIGNOR TO BUFFALO FORGE COMPANY, OF BUFFALO, NEW YORK.

GAS-WASHING MACHINE.

973,626. Specification of Letters Patent. **Patented Oct. 25, 1910.**

Application filed December 7, 1907. Serial No. 405,514.

To all whom it may concern:

Be it known that I, WILLIS H. CARRIER, a citizen of the United States, residing at Buffalo, in the county of Erie and State of New York, have invented a new and useful Improvement in Gas-Washing Machines, of which the following is a specification.

This invention relates to machines for washing or cleaning producer, blast furnace and other manufactured gases to remove the tar, dust and other impurities therefrom, and more particularly to gas washing machines of that sort comprising a stationary casing and fans or impellers which are rapidly rotated therein to cause the rotation of the gas and separate the impurities therefrom by centrifugal action.

The objects of the invention are to produce a combined centrifugal gas washer or purifier and blower which will thoroughly cleanse the gas of all tar and other impurities and at the same time create a sufficient difference of pressure between the gas entering and leaving the machine to overcome the resistance of the piping of the producer system as well as the back pressure in the gas holder or delivery piping to the engines or other consumers; also to construct the machine so that the tar and other impurities will be extracted from the gas through the combined and successive action of impact of the gas against wetted surfaces and centrifugal action through the rotation of the gas; also the provision of means for preventing the leakage and discharge of impure or partially cleansed gas without necessitating closely fitted and machined joints between the rotary and stationary parts of the machine; also to construct the machine so that it will be self-cleansing and will not become clogged or fouled by the condensed tar and other impurities extracted from the gas; also to provide the machine with automatic means for maintaining a constant gas pressure in the delivery mains regardless of the variations in pressure in the producer system and in the amount of gas consumed; and to provide means for preventing the condensation of the tar vapor in the gas after leaving the purifier.

In the accompanying drawings, consisting of three sheets: Figure 1 is a longitudinal sectional elevation of a gas washing and purifying machine embodying the invention. Fig. 2 is a transverse sectional elevation thereof, in line 2—2, Fig. 1. Fig. 3 is a fragmentary sectional plan thereof, in line 3—3, Fig. 2. Fig. 4 is a transverse sectional elevation thereof, in line 4—4, Fig. 1, but showing the machine provided with means for regulating the discharge pressure. Fig. 5 is a fragmentary section showing a modified construction of the baffle plates.

Like letters of reference refer to like parts in the several figures.

A represents a shell or casing provided at one end with a central gas intake connection *a* which is coupled to a supply pipe from the gas producer or other source of supply, and at the opposite end with a tangential discharge connection *a'* which is coupled to a delivery main. The shell has a transverse partition a^2 dividing it into two impeller chambers, and laterally-extending circular flanges a^3 on said partition and on one end-wall of the shell form annular chambers at the periphery of the casing, one of which is divided by the impellers, as hereinafter explained, thus providing three annular chambers A' A^2 A^3 in the peripheral portion of the shell.

B' B^2 B^3 represent three circular impellers or fans which are secured on a central drive shaft C journaled in suitable bearings *c* on the end of the shell, or the impellers can be mounted in any other suitable way to rotate together in the shell or casing A. In the construction shown, the first and second impellers B' B^2 are composed of a central circular disk *b* having a hub secured on the drive shaft, annular side disks *b'* at opposite sides thereof, and numerous radial blades b^2 (see Fig. 2) arranged between and connecting the central and side disks. The central holes in the side disks form respectively intake and discharge openings for the first and second impellers B' and B^2. The third impeller B^3, shown, consists of two annular side disks b^3 and radial blades b^4 (see Fig. 4) which connect said side disks and a portion of which are connected by spokes to a hub b^5 secured on the drive shaft C. The adjacent side disks of the second and third impellers B^2 B^3 are connected around their central openings so that the spaces between the blades of these impellers form continuous or uninterrupted gas passages through said impellers from the periphery of one to the periphery of the other. The three impellers are thus comnected and turn together as a unit and they can be properly considered as parts or sections of a single compound impeller, but for the sake of clearness they will be hereinafter referred to as though they were separate or distinct parts. The impellers could be constructed in any other suitable way. The disk b separating the first and second impellers B′ B² extends beyond the outer ends of their blades and side disks to divide the surrounding space in the shell into the two annular chambers A′ A² before mentioned. The first and third impellers are of somewhat larger diameter than the middle one, to produce the proper movement of the gas through the machine and create a pressure in the last annular chamber A³ which shall be equal to or slightly greater than the pressure in the second chamber A².

D represents a circular spray head which is located in the intake connection a of the shell and which may be of any suitable construction adapted to thoroughly wet the gas entering the machine.

E represents baffle plates in and crossing the first annular chamber A′, or impact chamber, of the shell around the first impeller B′. These baffles are preferably secured to the adjacent end wall of the shell and extend comparatively close to the periphery of the first impeller B′, and have lateral extensions projecting between the outer edge of the central disk b of the first and second impellers and the circular wall of the shell, but they do not join the circular wall of the shell, so that spaces are left between their outer edges and said circular wall of the shell through which water can circulate in the impact chamber. These baffle plates can be arranged radially, as shown in Fig. 2, or curved, as shown at E′ in Fig. 5, to provide concaved faces for the gas to impinge against.

F represents spray or atomizer nozzles arranged in the second annular chamber, or spray chamber A², of the shell around the periphery of the second impeller B². These nozzles are preferably of that sort which produce a hollow cone-like film of water and are arranged (see Fig. 2) to discharge the water in a direction opposite to the direction of rotation of the gas in the spray chamber produced by the impellers. The spray nozzles can connect with an annular water passage f in the end wall of the shell, as shown, or they can be supplied with water by any other suitable means.

G and g represent respectively water discharge or drain pipes for the shell arranged at opposite sides of the partition a^2.

The operation of the machine is as follows: The impellers being rapidly rotated draw the impure gas through the intake a, where it is thoroughly and uniformly wetted by the water from the spray head D, into the central intake of the first impeller B′. This first impeller sets the wet gas in rapid rotation, and the heavier particles of tar and other impurities and moisture which are thrown out into the impact chamber A′ by centrifugal force violently impinge against the baffle plates E in said chamber. The effect of this action is twofold. First, the plates are thoroughly wetted and the impact of the water against the plates at such high velocity fills the chamber completely with an exceedingly fine mist, thereby bringing the gas and water into most intimate contact and thus effecting the condensation of the tar vapors. Second, the tar and other impurities striking against the wetted surfaces are entrained with the water and separated from the gas. From the impact chamber A′ the gas passes into the spray chamber A², where it is again set in rotation through the action of the second rotating impeller B². The gas in rotating in this chamber and the impact chamber A′ throws outward all particles of water, condensed tar and impurities. The cone-shaped films of spray produced by the nozzles F in this chamber further increase the separation. As the gas moves in a direction opposite to the discharge of the sprays, it tends to spread or flatten out the conical water films so that they fill the entire cross section of the chamber, and all portions of the gas must impinge upon these water films, which results in a very thorough cleansing action. The water separated from the gas in the impact chamber and that from the spray in the spray chamber also serves to flush out these chambers, and as the water can circulate through the spaces between the outer edges of the baffles E and the circular wall of the impact chamber both chambers are kept free from tar deposits. The water with the entrained tar and dirt is drained from these chambers through the pipe G. From the spray chamber A² the gas is forced to pass inwardly through the second impeller B² which further separates the gas from the heavier particles of water and impurities, by centrifugal action and dries the gas. As before stated, the connected hollow impellers B² B³ form continuous or uninterrupted passages for the gas which are closed except at the peripheries of the impellers, and the diameter of the last impeller B³ being somewhat greater than that of the second impeller B² insures a pressure in the surrounding chamber A³ which shall be as great or slightly greater than the pressure in the spray chamber A². The effect of this construction is such as to prevent any of the imperfectly cleaned and dried gas from leaking or escaping from the spray chamber outside of the impellers into the pressure chamber A³. Owing to the slight difference in pressure between these chambers, there will be a slight leakage of the purified gas from the chamber A^3 into the chamber A^2 around the outside walls of the impellers B^3 B^2, but this leakage will be negligibly small, owing to the slight differences in the pressures, and any leakage in the opposite direction will be prevented. It is not necessary therefore to have machined surfaces to produce the small clearances between the impellers and shell required in machines using open fans or impellers, and this results in a great saving of power. The fact that the first impeller B′ is of larger diameter than the second one also assists in the production of pressure, and the combined effect of the described construction is such as to give the necessary difference in pressure between the gas entering and leaving the machine to positively move the gas to the gas holder or consumers.

In Fig. 4, the machine is shown provided with means for maintaining a substantially constant gas pressure at the discharge end of the machine. These means comprise a pivoted damper H controlling the discharge connection *a′* and connected, for instance, by an arm *h* secured to its shaft, and a link *h′*. to the movable bell of a gasometer I. A pipe *k* at one end enters the discharge connection *a′* and at the other end enters the gasometer, so that the pressure in the latter will fluctuate with that in the discharge connection. When the discharge pressure exceeds the desired maximum the gasometer bell will rise and close the damper H more or less, thereby decreasing the pressure produced by the machine, and the decreasing pressure will allow the gasometer bell to again descend and open the damper. A damper actuated by other suitable pressure-operated mechanism could be employed.

A machine constructed as described will remove all condensed tar with the other solid impurities from the gas, but will not eliminate the tar which is in the form of a perfect vapor or gas, and it is found that such tar vapor will condense after leaving the purifier and cause trouble in cases where the gas is used directly in the gas engine. Such condensation with the consequent deposition of the tar in the engine can be prevented by superheating the gas on leaving the purifier sufficiently to raise the temperature of the tar vapor above its dew point. To accomplish this in the machine shown the end wall at the discharge end of the machine and the discharge spout or connection are made hollow or jacketed, as indicated at L *l* respectively, and provided with inlet and outlet pipes for circulating the engine exhaust or other suitable heating medium through these jackets. The temperature of the gas leaving the machine is thus raised sufficiently to superheat the tar vapor and prevent the condensation thereof, but the heat is localized at the discharge end of the machine and does not prevent the condensation and separation of the tar from the gas in the impact and spray chambers A′ and A^2. The gas could be thus superheated, as it leaves the purifier or before it can be chilled sufficiently to condense the tar vapor, by any other suitable means.

I claim as my invention:

1. The combination of a shell having a central intake opening at one end and a discharge opening at the opposite end, a rotary impeller in said shell adjacent to said intake opening and having a central intake and a peripheral discharge for the gas, a second rotary impeller having a peripheral intake and a central discharge for the gas, baffles arranged in said shell around said first impeller against which the gas impinges, the annular space in said shell around said second impeller being unobstructed, and means for discharging water into the annular space in said shell around said second impeller, substantially as set forth.

2. The combination of a shell having a central intake opening at one end and a discharge opening, a rotary impeller in said shell adjacent to said intake opening and having a central intake and a peripheral discharge for the gas, a second rotary impeller having a peripheral intake and a central discharge for the gas, baffles arranged in said shell around said first impeller against which the gas impinges, the annular space in said shell around said second impeller being unobstructed, means for discharging water into the annular space in said shell around said second impeller, and a third rotary impeller having a central intake connecting with the discharge of said second impeller and a peripheral discharge, substantially as set forth.

3. The combination in a gas washing machine, of a circular shell, a rotary impeller in said shell for causing the gas to rotate in the shell, and spray nozzles which are arranged to discharge the water into said shell around said impeller in a direction opposite to the direction of rotation of the gas, substantially as set forth.

4. The combination in a gas washing machine, of a circular shell, a rotary impeller in said shell for causing the gas to rotate in the shell, and spray nozzles in said shell around said impeller and constructed and arranged to discharge hollow conical films of water around said impeller in a direction opposite to the direction of rotation of the gas, substantially as set forth.

5. The combination of a shell having a central intake opening at one end and a discharge opening at the opposite end, a rotary

impeller in said shell adjacent to said inlet opening and having a central intake and a peripheral discharge for the gas, a second rotary impeller having a peripheral intake and a central discharge, a plate projecting outwardly from the peripheries of said impellers and dividing the surrounding annular space in the shell into two chambers which communicate over the edge of said projecting plate, baffles in one of said chambers, means for spraying water into the other of said chambers, and a third impeller which receives the gas centrally from said second impeller and discharges it peripherally, substantially as set forth.

6. The combination in a gas washing machine, of a shell having two annular peripheral chambers therein, two hollow rotary impellers in said shell communicating at their peripheries with said annular chambers and connecting centrally to form uninterrupted gas passages through said impellers from one chamber to the other, one of said impellers being of larger diameter than the other, whereby the gas enters at the periphery of the smaller impeller and is discharged at the periphery of the larger impeller and a greater pressure is produced in the annular chamber surrounding said larger impeller, substantially as set forth.

7. The combination in a gas washing machine, of a rotary impeller having a central intake and a peripheral discharge for the gas, a second rotary impeller having a peripheral intake and a central discharge for the gas, and a third rotary impeller having a central intake connecting with the discharge of said second impeller and a peripheral discharge, said first and third impellers being of larger diameter than said second impeller, and a shell surrounding said impellers and having an intake opening adjacent to the intake of said first impeller and a discharge opening adjacent to the discharge of said third impeller, substantially as set forth.

8. The combination in a gas washing machine, of a shell having gas intake and discharge openings, rotary impellers in said shell, a damper controlling said discharge opening, means operated by the pressure of the discharging gas, and connections between said means and said damper for controlling the position thereof in accordance with the gas pressure, substantially as set forth.

9. In a gas purifying machine, the combination of a casing, and means located in said casing for purifying the gas, means for keeping the gas cool while being purified, a part of said casing through which the gas discharges after being purified having a jacketed wall for a heating medium whereby the discharging gas is heated to prevent condensation of the tar vapor, the heating medium being confined to the vicinity of the discharge opening, substantially as set forth.

Witness my hand, this 4th day of December, 1907.

WILLIS H. CARRIER.

Witnesses:
WM. L. FOX,
ELVANS K. NEWTON.