

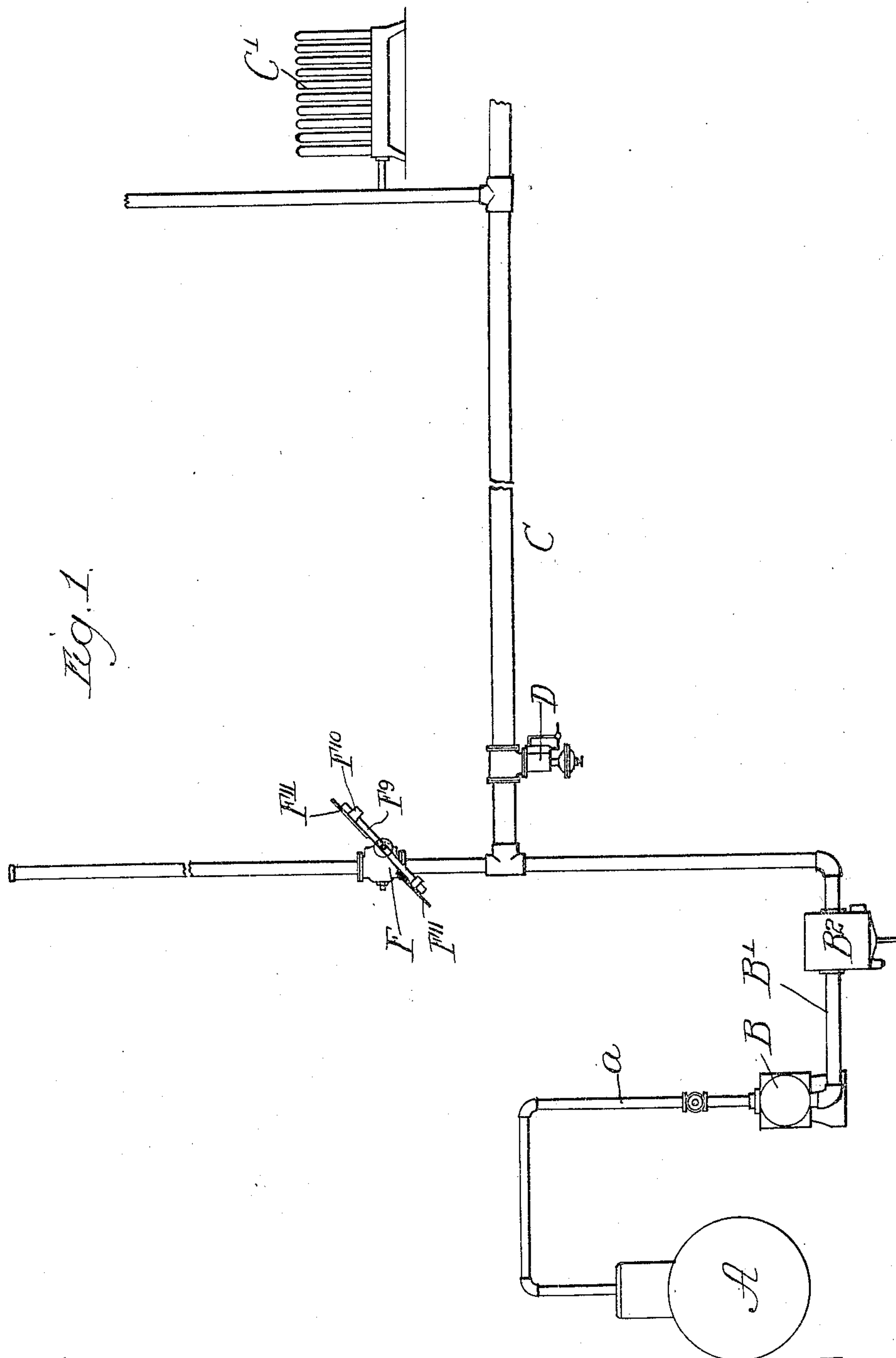
No. 793,607.

PATENTED JUNE 27, 1905.

E. F. OSBORNE.
COMBINED AIR CHECK AND RELEASE VALVE.

APPLICATION FILED MAY 19, 1904.

3 SHEETS—SHEET 1.



Witnesses:
H. G. Barrett
W. L. Hall.

Inventor
Eugene F. Osborne
by *Cooley & Brown*
his Attys

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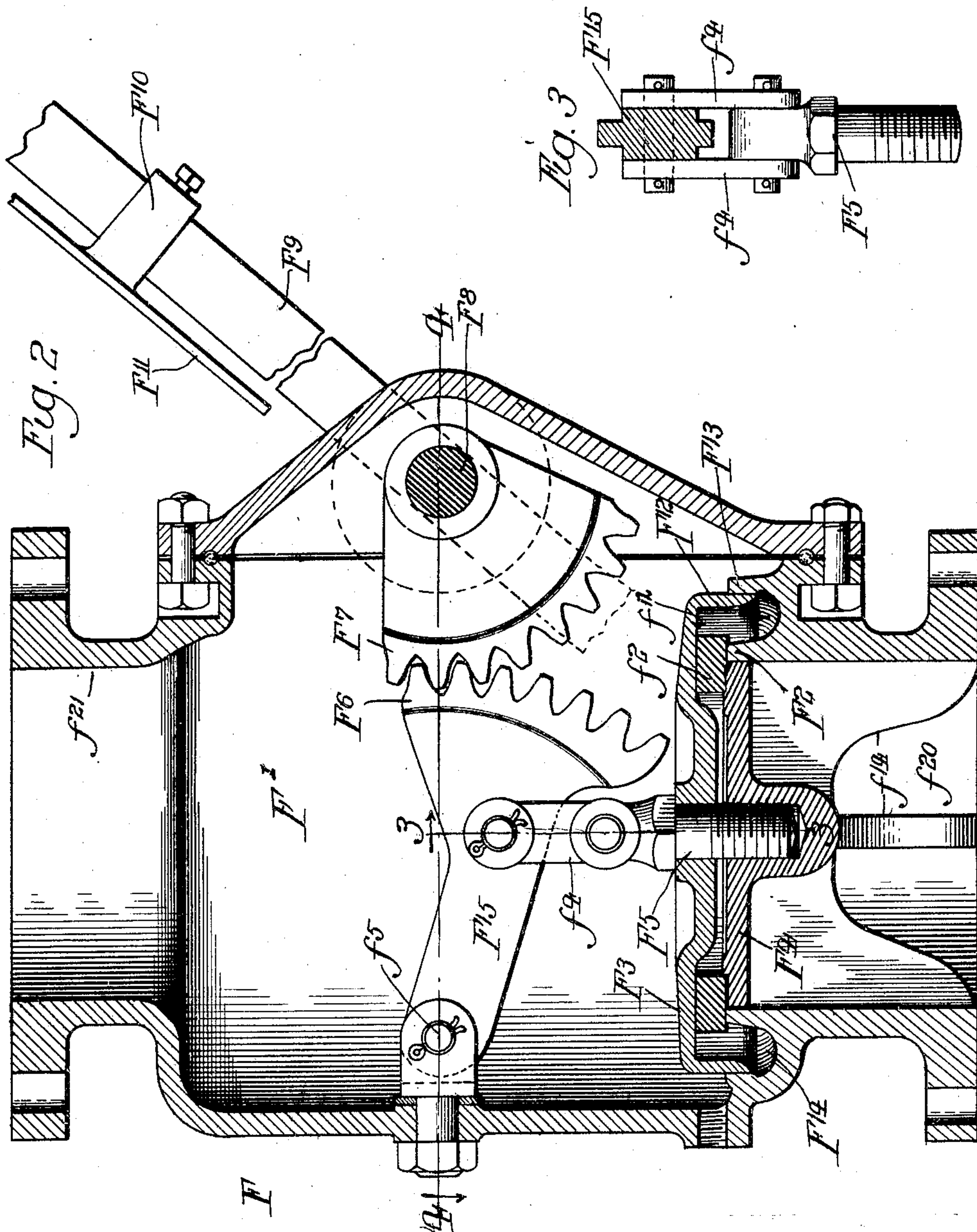
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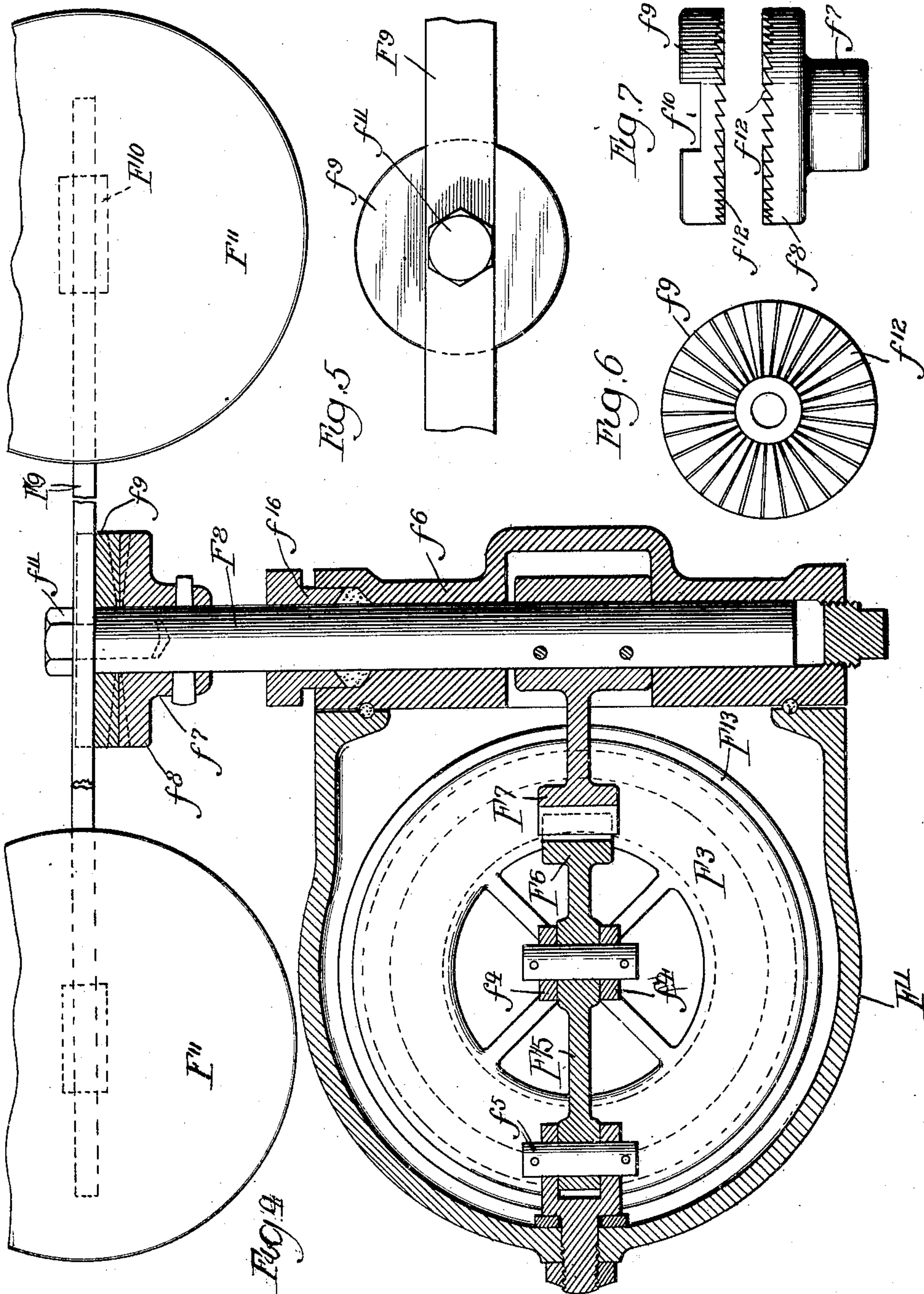
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Witnesses:
H. G. Barrett
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UNITED STATES PATENT OFFICE.

EUGENE F. OSBORNE, OF CHICAGO, ILLINOIS, ASSIGNOR TO OSBORNE STEAM ENGINEERING COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

COMBINED AIR-CHECK AND RELEASE VALVE.

SPECIFICATION forming part of Letters Patent No. 793,607, dated June 27, 1905.

Original application filed November 23, 1903, Serial No. 182,334. Divided and this application filed May 19, 1904. Serial No. 208,777.

To all whom it may concern:

Be it known that I, EUGENE F. OSBORNE, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in a Combined Air-Check and Release Valve; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

This invention relates to a combined air-check and release valve adapted to be used in the exhaust-pipe of steam-engines, wherein the steam, after a portion of the heat thereof has been converted into power in the engine-cylinder, is passed into a condensing apparatus in which the steam is condensed. The heat remaining in the steam may be further utilized in a condensing apparatus having the form of a steam-heating system in the manner shown in my copending application for United States Letters Patent, Serial No. 182,334, filed November 23, 1903, of which this application is a division, or said condensing apparatus may be of any of the well-known types of that class in which the steam is condensed without attempt to utilize the heat of condensation. In the apparatus shown in said application a reducing-valve is inserted into the exhaust-pipe between the engine and said air-check and release valve, the purpose of which reducing-valve is to reduce the pressure of the steam to a point below atmosphere, the steam being employed in the heating device at such low or negative pressure.

In the practical use of a combined power and heating system, such as is illustrated in my aforesaid application, it oftentimes occurs that by reason of the continuous use for a given load of the engine and a variable use of the heating system or a variation of the load in the engine within wide ranges the heating system does not utilize all of the exhaust-steam discharged from the engine, so that there is in the exhaust-pipe of the engine an

excess volume of steam, which if allowed to collect therein would soon produce such a back pressure on the engine-piston as to greatly reduce its efficiency or completely stop the engine.

It is the purpose of the combined release and air-check valve shown in the present application to provide a device by the use of which is prevented a back pressure in the exhaust-pipe beyond a certain or predetermined maximum pressure, preferably near atmospheric pressure, and which when such pressure is exceeded is promptly opened and held open independently of the steam-pressure in the exhaust-pipe, thereby requiring no steam-pressure to hold the same open nor producing pressure in the exhaust-pipe when the valve is open. The movable part of the valve is held closed with but little force which is overcome to start the valve to open with a pressure but slightly greater than atmospheric pressure. Said movable part of the valve is connected with a balancing device which is so related to the movable part of the valve that the latter overbalances the weight of the balancing device when the valve is closed; but when the valve starts to open the balancing device acts with a gradually-increasing force. When the valve is fully open, the parts—to wit, the valve closure and balancing device—are in a practically unstable equilibrium and the kinetic energy of the steam flowing past the valve serves to hold the valve open, though without producing pressure in the exhaust-pipe. Upon the reduction of pressure within the exhaust-pipe the atmospheric pressure acts to close the valve and prevents the leakage of air into the exhaust-pipe.

My improved valve is adapted to be held normally fully opened or fully closed and to be promptly opened when its opening movement begins. To this end the valve is so constructed that when closed the area against which the atmospheric pressure acts is in excess of that against which the steam acts, so that a slightly greater than atmospheric pressure is required to start the opening move-

ment of the valve, and after the valve is partially open the area against which the steam acts is suddenly increased to practically that against which the air acts. As a result the valve when opened sufficiently to expose the added surface of the closure to the action of the steam tends to open quickly. In the ordinary use of the valve it is designed to be opened by the blows produced by the exhausting impulses of the engine rather than by an accumulative pressure in the exhaust-pipe.

In the practical operation of the apparatus in which my valve is embodied the conditions are usually such that the valve does not open and close frequently. Usually in an apparatus of this kind there is ample exhaust-steam, so that under ordinary conditions the valve will be open and the exhaust-pipe beyond the valve filled with steam, though perhaps not passing therethrough in any considerable volume. Upon a decrease in volume of the exhaust-steam, and a consequent decrease in pressure in the exhaust-pipe, the valve is closed to avoid the leakage of air into the exhaust-pipe. After a resumption of the former conditions the valve is again opened to release the exhaust-steam in the manner described.

I preferably employ in connection with the valve of the character described a retarding device, associated with the counterbalancing device, which is so constructed as to prevent abrupt movements of the valve during its opening and closing movements, whereby is prevented such jars and shocks on the moving parts of the valve as is objectionable. I also preferably employ in connection with the movable part of the valve a device in the nature of a dash-pot, which is located within the valve-casing and coöperates with the valve-closure in a manner to retard the closing movement of the closure, and thereby prevent the valve-closure and seat being injured by the abrupt closing of the valve.

I have shown in the drawings one approved form of my improved air-check and release valve; but it will be understood from the description which follows that the structural details thereof may be varied without departing from the spirit of my invention.

As shown in the drawings, Figure 1 is a diagrammatic view illustrating the relation of my improved valve in a combined power and steam heating system. Fig. 2 is an axial section of the valve. Fig. 3 is a detail section taken on line 3 3 of Fig. 2, the parts being removed from the valve-casing. Fig. 4 is a horizontal section taken on line 4 4 of Fig. 2. Figs. 5, 6, and 7 are details illustrating devices for adjusting the angle of the weighted lever constituting part of the counterbalancing device for the valve-closure.

As shown in the drawings, A designates a steam-generator, and B an engine of a power plant, which engine receives steam from the generator through a pipe *a*.

B' designates the exhaust-pipe of the engine, which is connected with the distributing-pipe C of the heating system, and C' designates a steam-heating device or radiator receiving steam from the distributing-pipe C.

B² designates a steam-separator in the exhaust-pipe.

D designates any approved form of back-pressure or reducing valve which reduces the pressure of the steam in the distributing-pipe C. As herein shown, said reducing-valve is of the type illustrated in my copending application for United States Letters Patent, Serial No. 69,202, filed July 22, 1901.

F designates the combined air-check and release valve constituting the present invention and which is located in the exhaust-pipe beyond its connection with the distributing-pipe C.

Inasmuch as the present invention relates solely to the said air-check and release valve and does not *per se* have to do with the heating device, the regulating parts of the system such as are embodied in a practical system are not herein shown.

The valve F comprises an annular casing F', which is reduced at its ends to constitute inlet and outlet passages *f*²⁰ *f*²¹, respectively, provided with flanges for attachment to the sections of the exhaust-pipe B'. The casing is provided interiorly thereof near its lower end with a reduced annular flange F², which constitutes an extension of the inlet branch *f*²⁰ of the valve-casing and is formed at its upper end to constitute a seat against which fits a vertically-movable valve-closure. Said closure embraces an upper plate F³ or lower disk F⁴, which fits closely within the annular flange F², and a ring *f*² confined between said plate and disk and extends radially beyond the disk for contact with the annular valve-seat. Said ring is made of a metal softer than the valve-seat and is located so as to be readily removable. The plate and disk are clamped together by a screw-threaded stem which constitutes the valve-stem F⁵. The stem extends centrally through the upper plate F² and has screw-threaded engagement with a socketed lug formed on the lower face of the disk. The disk F⁴ is provided with guide lugs or ribs *f*¹⁴, which hold the closure properly aligned with respect to its seat when the valve is open. Said stem F⁵ is connected at its upper end by means of links *f*⁴ *f*⁴ with an oscillatory vertically-swinging lever F¹⁵, which is pivoted at one end to a pivot-pin *f*⁵, affixed to one side wall of the casing, and is provided at its other end with a curved gear-segment F⁶. Said gear-segment F⁶ meshes with a similar gear-segment F⁷, which is non-rotatively fixed to the shaft F⁸, that is rotatively mounted in a sleeve-bearing *f*⁶, formed, as herein shown, in a removable part of the valve-casing.

One end of the rock-shaft F⁸ extends outwardly through the sleeve *f*⁶ and said end of

the sleeve is provided with a stuffing-box f^{16} , which surrounds the rock-shaft to prevent the leakage of air or steam past the same. Rigidly attached to said extended end of the shaft is a weight-arm F^9 . The arm carries at its outer end an adjustable weight F^{10} and also a flat retarding-plate F^{11} , which is herein shown as attached to or formed integral with the weight F^{10} . So far as the effect of the retarding-plate is concerned it need not be formed on or attached to said weight F^{10} . If desired, a second retarding-plate F^{11} may be attached to the end of the arm opposite the weight F^{10} . It is to be understood that said retarding-plates are designed to be made light and do not serve *per se* as weights. When the valve is closed, as shown in Fig. 2, the weighted arm F^9 assumes an angle to the horizontal in the neighborhood of sixty degrees, and the said weight and movable parts of the valve are so proportioned that when the arm is at this angle the valve and the parts which move therewith overbalance the weight F^{10} and its arm. A pressure in the exhaust-pipe somewhat in excess of atmospheric pressure is required, therefore, to initially lift the valve to open the same. By reason of the disposition of the weight and the arm shown, however, when the valve begins to open by reason of the superior steam-pressure beneath the same in the exhaust-pipe the raising of said valve acts through the gears F^6 F^7 to throw the outer end of the arm F^9 downwardly, and when said lever begins to move downwardly its weight aids to open the valve, and such force is gradually increased until the lever approaches a horizontal position. The retarding plate or plates F^{11} prevents the valve from being too abruptly opened by the combined action of the steam-pressure and the weight. The weight is so proportioned relatively to the weight of the valve and the parts which move therewith that when the lever occupies its lowest position, and when therefore the valve-closure is fully opened, the arm and weight balance the closure and the parts which move therewith in such manner that no other force other than that exerted by the kinetic energy of the steam escaping past the same is required to hold the valve open. The valve is thus held open in a state of unbalanced equilibrium. When the valve is thus open and the pressure in the exhaust-pipe falls below atmospheric pressure, such atmospheric pressure acts on the upper face of the closure to close the valve. The closing movement of the valve is retarded, however, to prevent the closure striking the seat with objectionable force by the retarding plate or plates F^{11} and by the action of a dash-pot device hereinafter to be described.

Means are provided for varying the angle of the arm F^9 relatively to the rock-shaft F^8 , whereby, taken in connection with the movability of the weight in the lever, as shown, the

action of the weight may be properly adjusted to balance the movable part of the valve, as described. Said means consist of a short collar f^7 , which is rigidly affixed to the rock-shaft F^8 and is provided with an annular flange f^8 and a disk f^9 , which is free to rotate on said rock-shaft and is adapted to be rigidly interlocked with the arm F^9 . The interlocking connection shown consists of a notch f^{10} in the outer face of the disk which receives said arm, and the arm and disk are affixed to the shaft with the faces of the flange f^8 and disk f^9 engaging each other by means of a screw-bolt f^{11} , extending through the arm and disk and into the end of the rock-shaft, as shown in Fig. 4. The adjacent or contacting faces of the disk or flange are provided with ratchet-teeth f^{12} , Figs. 6 and 7, whereby when said parts are locked together by the bolts f^{11} the disk f^9 and interlocked arm are held immovably with respect to the rock-shaft at the angle desired.

Referring now to the construction whereby the lifting action of the steam on the valve-closure is increased during the first part of the opening movement of the valve, the same is made as follows: The increased area of the valve against which the steam acts as the valve begins to open consists of that part of the ring f^2 which is in line with the annular seat F^2 and a circumferential extension f^{12} of the plate F^3 . Said supplemental area of the valve is not subject to the pressure within the exhaust-pipe until the disk F^4 is raised fully above the seat-flange F^2 ; but when said disk is so raised above said seat-flange the action of the steam on the added area of the valve is to give an added impetus to the rise of the valve, with a result of increasing the speed of its opening movement. Said extension f^{12} of the valve-plate F^2 is provided with a downwardly-turned annular rim F^{12} , which fits closely within an annular inwardly-facing seat formed in a vertical annular flange F^{13} in the casing just outside the seat-flange F^2 , thereby forming between the flanges F^2 F^{13} an annular chamber F^{14} , which is more or less filled with water. The lower edge of the rim F^{12} is shown as made of such length that it does not move off its annular seat during the opening movement of the valve until after the disk F^4 has fully passed the level of the seat-flange F^2 . When the disk F^4 is raised sufficiently to permit the steam to pass between the same and the seat-flange into the annular chamber F^{14} , the expansive action of the steam acts upon the added or supplemental area of the valve-closure, and after the valve-closure has been raised sufficiently for the steam to escape past the rim F^{12} the kinetic energy of the steam is also brought to bear against the valve to open the same. Upon the closing of the valve-closure due to the reduction of pressure in the exhaust-pipe the lower edge of the flange F^{12} enters the annular chamber F^{14} before the disk F^4 enters

the annular seat-flange and displaces a portion of the water from said chamber before the passing of the disk into said seat-flange cuts off the escape of water. The part of said annular chamber F^{14} not filled with water is filled with steam, and when said disk F^4 passes below the seat-level said steam is imprisoned in said chamber. In the further descent of the valve-closure after the steam is thus imprisoned the said steam is compressed, with a result of retarding the seating movement of said closure. The parts are so proportioned that the closure is brought to rest gently against its seat, thereby avoiding wear by impact of the closure and seat. It will be observed that by reason of the escape of the water from the annular chamber F^{14} so long as space is afforded for such escape between the disk F^4 and seat-flange the steam is sealed in the upper part of said chamber and is not allowed to escape, whereby the cushioning effect of the full body of steam so trapped is utilized.

The operation of the valve above described may be briefly stated as follows: When steam is being utilized in the circulatory pipe C of the steam-heating system or is received by any other condensing apparatus as rapidly as it is discharged into the exhaust-pipe, the combined air-check and release valve is closed, so as to prevent the leakage of air into the exhaust-pipe. Upon a reduction of the use of the steam in the steam-heating system or other condensing apparatus or upon an increase of the volume of exhaust-steam the pressure in the exhaust-pipe is increased, and such increase of pressure on the under side of the valve-closure resisted by the atmospheric pressure on the upper side thereof acts to force the valve-closure away from its seat. By reason of the overbalance of the movable parts of the valve tending to hold the same closed and the retardation of the movements thereof by the retarding devices described the valve does not begin to open until there is an accumulated pressure in the exhaust-pipe somewhat above atmospheric pressure. In other words, it is not intended that the valve shall be opened at each temporary increase of pressure due to each separate exhausting impulse. The valve is designed to be opened, however, upon the required accumulated pressure by the blow or impact due to the exhausting impulse and when so opened shall remain open until the mean or average pressure in the exhaust-pipe shall be again reduced below atmospheric pressure—that is to say, owing to the retardation of the movements of the valve-closure, which operates with the effect of a brake, the valve-closure does not seat during the temporary reductions of pressures between successive exhausts of the engine. The valve-closure is raised by the combined effects of the accumulated pressure and the supplemental area subjected to the action of the steam after

its initial opening movement. The overbalance of the valve-closure is gradually overcome as it rises, and the weight-arm F^9 assumes a horizontal and more effective position and the parts are so disposed that when the arm occupies a horizontal position it almost balances the valve-closure and the parts which move therewith, and the valve is held fully open thereby and the kinetic energy of the steam flowing past the same. It will be understood that the area of the steam-passage in the casing around the closure when the latter is raised is substantially the same as the area of the exhaust-pipe, whereby there is little or no check to the escape of the steam through the valve. The retarding plate or plates F^{11} prevent the valve-closure from being quickly raised or lowered and also prevents the closure being seated at each temporary reduction of steam-pressure in the exhaust-pipe. Upon a reduction of the pressure in the exhaust-pipe caused either by a decreased load on the engine or an increased use of the steam in the heating system or other condenser the valve is closed by the atmospheric pressure acting downwardly against the closure, and thereby preventing air entering the exhaust-pipe through said valve. Upon the closing of the valve the cushioning effect of the steam and water present in the chamber F^{14} after the lower edge of the rim F^{12} has passed the upper edge of the flange F^{13} and the disk has passed into the annular flange F^2 acts to prevent the abrupt seating of the valve in the manner before described.

I claim as my invention—

1. The combination with a steam-engine, its exhaust-pipe, and a condensing apparatus which receives steam from said exhaust-pipe, of a combined air-check and release valve in the exhaust-pipe beyond its connection with the condensing apparatus, comprising, in combination with a casing and its valve-seat, a vertically-movable closure which engages said seat to close the valve, and designed to be shifted to open the valve by a pressure slightly greater than the normal back pressure of the engine, and a balancing device associated with the closure and into the influence of which the closure is automatically brought as it is moved away from its seat, said balancing device holding the closure fully open independent of the steam-pressure of the exhaust-pipe.

2. The combination with an engine, its exhaust-pipe, and a condensing apparatus which receives steam from said exhaust-pipe, of a combined air-check and release valve in the exhaust-pipe beyond the connection of the exhaust-pipe with the condensing apparatus, comprising in combination with a casing and its valve-seat, a closure engaging said seat in a manner to close the valve, and designed to be opened by a pressure slightly greater than the normal back pressure of the engine, and a balancing device associated with the closure

and constructed to automatically balance the closure and the parts movable therewith when the closure is in its open position.

3. The combination with a steam-engine, 5 its exhaust-pipe and a condensing apparatus which receives steam from said exhaust-pipe, of a combined air-check and release valve in the exhaust-pipe comprising in combination with a casing and its valve-seat, a vertically- 10 movable closure which engages said seat to close the valve and designed to be shifted to open the valve by a pressure slightly greater than the normal back pressure of the engine, a balancing device associated with the closure 15 and into the influence of which the closure is automatically brought as it is moved away from its seat, said balancing device holding the closure fully open independent of the steam-pressure in the exhaust-pipe and a re- 20 tarding device for retarding the movement of the balancing device.

4. The combination with an engine, its ex- 25 haust-pipe, and a condensing apparatus which receives steam from said exhaust-pipe, of a combined air-check and release valve in the exhaust-pipe beyond the connection of the ex- haust-pipe with the condensing apparatus comprising, in combination with a casing and its valve-seat, a valve-closure engaging said 30 seat to close the valve, and designed to be opened by a pressure slightly greater than the normal back pressure of the engine, and a balancing device constructed to substan- 35 tially balance said closure and the parts which move therewith when the closure is in its open position, comprising a swinging arm which is operatively connected at one end with the valve-closure and provided at its other end 40 with a weight, said arm assuming an upwardly-inclined position when the valve is closed, and swinging downwardly as the valve is opened.

5. The combination with an engine, its ex- 45 haust-pipe, and a condensing apparatus which receives steam from said exhaust-pipe, of a combined air-check and release valve in the exhaust-pipe beyond the connection of the ex- haust-pipe with the condensing apparatus comprising, in combination with a casing and its valve-seat, a valve-closure engaging said 50 seat to close the valve and designed to be opened by a pressure slightly greater than the normal back pressure of the engine, a bal- ancing device constructed to substantially bal- 55 ance said closure and the parts which move therewith when the closure is in its open po- sition, comprising a swinging arm which is operatively connected at one end with the valve-closure and provided at its other end with a weight, said arm assuming an up- 60 wardly-inclined position when the valve is closed, and swinging downwardly as the valve is opened, and means for varying the angle of said arm relatively to the horizontal plane of the axis of movement of said arm.

65 6. The combination with an engine, its ex-

haust-pipe, and a condensing apparatus which receives steam from said exhaust-pipe, of a combined air-check and release valve in the exhaust-pipe beyond the connection of the ex- 70 haust-pipe with the condensing apparatus, comprising, in combination with a casing and its annular valve-seat, a valve-closure engag- ing said seat to close the valve, and designed to be opened by a pressure slightly greater than the normal back pressure of the engine, 75 a balancing device constructed to substan- tially balance said closure and the parts which move therewith when the valve is open, said balancing device embracing a swinging arm which is operatively connected at one end 80 with the valve-closure and provided at its other end with a weight, and an air-retarding device attached to and movable with the arm.

7. The combination with an engine, its ex- 85 haust-pipe, and a condensing apparatus which receives steam from said exhaust-pipe, of a combined air-check and release valve in the exhaust-pipe beyond the connection of the ex- haust-pipe with the condensing apparatus, 90 comprising, in combination with a casing and its valve-seat, a valve-closure engaging said seat to close the valve, and designed to be opened by a pressure slightly greater than the normal back pressure of the engine, a bal- 95 ancing device constructed to substantially bal- ance said closure and the parts which move therewith when the valve is open, said balanc- ing device embracing a swinging arm which is operatively connected at one end with the 100 valve-closure and provided at its other end with a weight, said lever assuming an up- wardly-inclined position when the valve is closed, and moving to a substantially hori- zontal position during the opening movement 105 of the valve, and a flat plate attached to said lever and movable therewith and acting to retard the movement of said lever and the associated valve-closure during both the open- ing and closing movements of the valve.

8. The combination with a steam-engine, 110 its exhaust-pipe and a condensing apparatus which receives steam from the exhaust-pipe, of a combined air-check and release valve in the exhaust-pipe beyond its connection with the condensing apparatus comprising, in com- 115 bination with a casing and its valve-seat, a valve-closure engaging the seat to close said valve and designed to be opened by pressure of the steam in the exhaust-pipe, and a bal- ancing device operatively connected with the 120 closure and constructed to substantially bal- ance the closure and the parts which move therewith when the valve is opened, thereby requiring no pressure in the exhaust-pipe to hold the valve open. 125

9. The combination with a steam-engine, its exhaust-pipe and a condensing apparatus which receives steam from the exhaust-pipe, of a combined air-check and release valve in the exhaust-pipe beyond its connection with 130

the condensing apparatus comprising, in combination with a casing and its seat, a valve-closure engaging the seat to close said valve and adapted to be opened by pressure of the steam in the exhaust-pipe, a balancing device operatively connected with the closure and constructed to substantially balance the closure and the parts which move therewith when the valve is opened, thereby requiring no pressure in the exhaust-pipe to hold the valve open, and a retarding device associated with the balancing device and acting to prevent abrupt movements of the parts during both the opening and closing of the valve.

10. The combination with a steam-engine, its exhaust-pipe and a condensing apparatus which receives steam from said exhaust-pipe, of a combined air-check and release valve in said exhaust-pipe beyond its connection with the condensing apparatus comprising, in combination with a casing and its annular valve-seat, a valve-closure engaging the seat to close the valve, a stem connected with said closure, a vertically-swinging lever above the valve-closure pivoted at one end in said casing and connected between its ends with said stem and provided at its other end with a gear-segment, a second segment meshing with the first segment, and a vertically-swinging weighted arm rigid with said second segment.

11. The combination with a steam-engine, its exhaust-pipe, and a condensing apparatus which receives steam from said exhaust-pipe, of a combined air-check and release valve in the exhaust-pipe beyond its connection with the condensing apparatus, comprising, in combination with a casing and its annular valve-seat, a valve-closure engaging the seat to close the valve, a stem attached to said closure, a vertically-swinging lever hinged to the casing above said closure and connected with the stem, and provided with a gear-segment, a rock-shaft mounted in the casing, a gear-segment fixed to the rock-shaft and meshing with the gear-segment of said lever, an arm affixed to said rock-shaft and a weight attached to said arm, said weight and arm being constructed to substantially balance the weight of the valve and the parts which move therewith when the valve is open.

12. The combination with a steam-engine, its exhaust-pipe, and a condensing apparatus which receives steam from said exhaust-pipe, of a combined air-check and release valve in the exhaust-pipe beyond its connection with the condensing apparatus, comprising, in combination with a casing and its valve-seat, a valve-closure engaging the seat to close the valve, a stem attached to said closure, a lever hinged to the casing above said closure and connected with the stem, and provided with a gear-segment, a rock-shaft mounted in said casing, a gear-segment fixed to said rock-shaft and meshing with the gear-segment of said lever, a vertically-swinging arm fixed to said

rock-shaft, a weight attached to said arm, said weight and arm being constructed to balance the weight of the valve and the parts which move therewith when the valve is open, and means for varying the angle of said arm with respect to the horizontal plane of the axis of said rock-shaft.

13. The combination with a steam-engine, its exhaust-pipe, and a condensing apparatus which receives steam from said exhaust-pipe in the exhaust-pipe beyond its connection with the condensing apparatus, of a combined air-check and release valve, comprising, in combination with a casing and its annular valve-seat, a valve-closure engaging the seat to close the valve, a stem attached to said closure, a vertically-swinging lever hinged to the casing above said closure and connected with the stem, and provided with a gear-segment, a rock-shaft mounted in the casing and extending at one end thereof, a gear-segment fixed to the rock-shaft and meshing with the gear-segment of said lever, an arm fixed to said rock-shaft, a weight attached to said arm, said weight and arm being constructed to balance the weight of the valve and the parts which move therewith when the valve is open, and a flat retarding-plate attached to and movable with said arm.

14. The combination with a steam-engine, its exhaust-pipe, and a condensing apparatus which receives steam from the exhaust-pipe, in the exhaust-pipe beyond its connection with the condensing apparatus, of a combined air-check and release valve comprising, in combination with a casing and its annular valve-seat, a valve-closure engaging said seat to close the valve and subjected at its lower side to the pressure of the exhaust-pipe and at its upper side to atmospheric pressure, the side of the valve subjected to steam-pressure being of less area, when the valve is closed, than the side which is subjected to atmospheric pressure, and the area subjected to the steam-pressure being increased when the valve opens, and means independent of the steam-pressure in the exhaust-pipe for balancing the valve-closure in its open position.

15. The combination with a steam-engine, its exhaust-pipe, and a condensing apparatus which receives steam from the exhaust-pipe, of a combined air-check and release valve in the exhaust-pipe beyond the connection thereof with the condensing apparatus, comprising, in combination with a casing and its annular valve-seat, a valve-closure engaging said seat to close the valve and subjected at its lower side to the pressure of the exhaust-pipe and at its upper side to atmospheric pressure, the side of the valve subjected to steam-pressure being of less area, when the valve is closed, than the side which is subjected to atmospheric pressure, and the area subjected to steam-pressure being increased when the valve opens, and a dash-pot within the casing for

retarding the final seating movement of the valve.

16. The combination with a steam-engine, its exhaust-pipe, and a condensing apparatus which receives steam from the exhaust-pipe, of a combined air-check and release valve in the exhaust-pipe beyond its connection with the condensing apparatus, comprising, in combination with a casing and its annular valve-seat, a valve-closure engaging said seat to close said valve and subjected at its lower side to the pressure of the exhaust-pipe and at its upper side to atmospheric pressure, the side of the valve subjected to steam-pressure being of less area, when the valve is closed, than the side which is subjected to atmospheric pressure, and the area subjected to the steam-pressure being increased when the valve opens, a dash-pot within the casing for retarding the final seating movement of the valve, and means independent of the steam-pressure in the exhaust-pipe for balancing the valve in its open position.

17. The combination with a steam-engine, its exhaust-pipe and a condensing apparatus which receives steam from the exhaust-pipe, of a combined air-check and release valve in the exhaust-pipe beyond its connection with said condensing apparatus comprising, in combination with a casing and its annular valve-seat, a valve-closure engaging the seat to close the valve and subjected at its lower side to the pressure of the exhaust-pipe and at its upper side to atmospheric pressure, said closure being provided radially outside the seat with a radial extension which is subjected to steam-pressure when the valve is partially opened, thereby increasing the lifting action of the steam on the valve-closure, and the casing being provided with an interior annular chamber which coöperates with an annular part on said extended portion of the closure and constituting a dash-pot to retard the final seating movement of the closure.

18. The combination with a steam-engine, its exhaust-pipe, and a condensing apparatus which receives steam from the exhaust-pipe, of a combined air-check and release valve in the exhaust-pipe beyond its connection with the condensing apparatus comprising, in combination with a casing and its annular seat, a valve-closure engaging said seat to close the valve and subjected at its lower side to the pressure in the exhaust-pipe and on its upper side to atmospheric pressure, said closure being extended radially beyond its seat, an annular chamber surrounding the valve-seat, and a rim depending from the valve-closure and fitting closely within said chamber, said chamber and rim constituting a dash-pot to retard the closing movement of the valve-closure.

19. The combination with a steam-engine, its exhaust-pipe, and a condensing apparatus receiving steam from the exhaust-pipe, of an

air-check and release valve in the exhaust-pipe beyond its connection with the condensing apparatus, comprising, in combination with a casing and its annular valve-seat, a valve-closure comprising a plate provided with a seat-ring which fits against a disk to the under side of said plate and fitting within the annular seat and extends below the seat when the valve is closed, said plate being extended radially beyond the seat and provided with a depending annular rim, and an annular flange located outside of the seat and between which and the said flange is formed a chamber which receives the rim of said closure-plate.

20. The combination with a steam-engine, its exhaust-pipe, and a condensing apparatus receiving steam from the exhaust-pipe, of an air-check and release valve in the exhaust-pipe beyond its connection with the condensing apparatus, comprising, in combination with a casing and its annular valve-seat, a valve-closure comprising a plate provided with a seat-ring which fits against a disk to the under side of said plate and fitting within the annular seat and extends below the seat when the valve is closed, said plate being extended radially beyond the seat and provided with a depending annular rim, and an annular flange located outside of the seat and between which and the said flange is formed a chamber which receives the rim of said closure-plate, said annular rim of the closure-plate being made of such length that the said disk of the closure is raised above the seat-line before said rim is raised above the flange into which the rim extends.

21. The combination with a steam-engine, its exhaust-pipe, and a condensing apparatus receiving steam from the exhaust-pipe, of a combined air-check and release valve comprising a casing, an annular seat therein, a closure comprising a plate provided with a seat-ring which fits against the seat and attached thereto, a disk which fits within the annular seat and extends below the seat when the valve is closed, said plate being extended radially beyond the seat and provided with a depending annular rim, and an annular rim located outside of the seat and between which and the said rim or flange is formed a chamber which receives the rim of said closure-plate, and means for balancing the valve when opened independently of the pressure of the steam in the exhaust-pipe.

22. The combination with a steam-engine, its exhaust-pipe and a condensing apparatus which receives steam from the exhaust-pipe, of a combined air-check and release valve in said pipe comprising, in combination with the valve-casing and its annular valve-seat, a valve-closure which fits flat on said seat to close the valve, a dash-pot within the casing for retarding the final seating movement of the closure comprising an annular chamber surrounding the seat and adapted to receive

water of condensation from the exhaust-steam,
and an annular flange on the closure radially
outside of its seating-face which enters said
chamber before the closure seats and which
5 fits closely within the outer wall of the cham-
ber but not filling the same.

In testimony that I claim the foregoing as

my invention I affix my signature, in presence
of two witnesses, this 16th day of May, A. D.
1904.

EUGENE F. OSBORNE.

Witnesses:

WILLIAM L. HALL,
GERTRUDE BRYCE.