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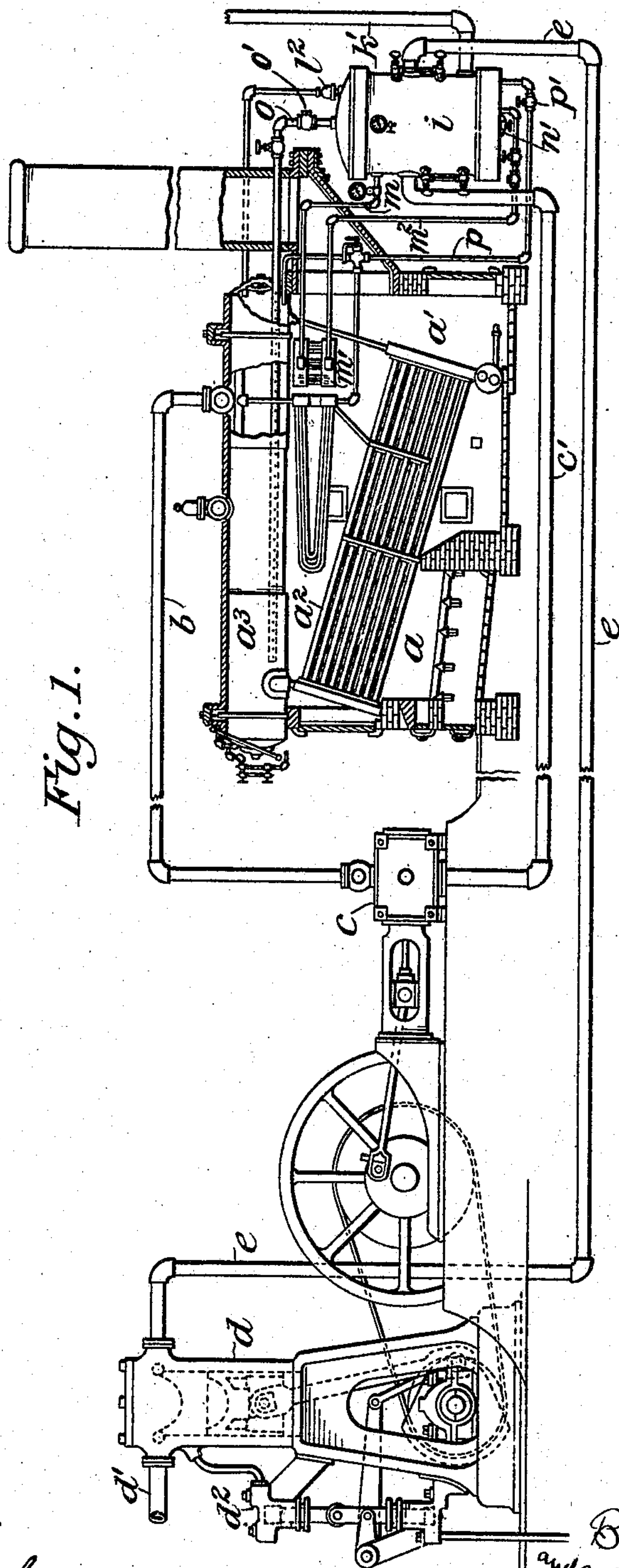
PATENTED MAR. 26, 1907.

A. B. GOODSPEED & B. BESKOW.

APPARATUS FOR INCREASING THE EFFICIENCY OF STEAM GENERATING
POWER PLANTS.

APPLICATION FILED APR. 27, 1903. RENEWED APR. 9, 1906.

2 SHEETS—SHEET 1.



Attest:

A. N. Jesbera
M. A. Brayley.

Inventors:

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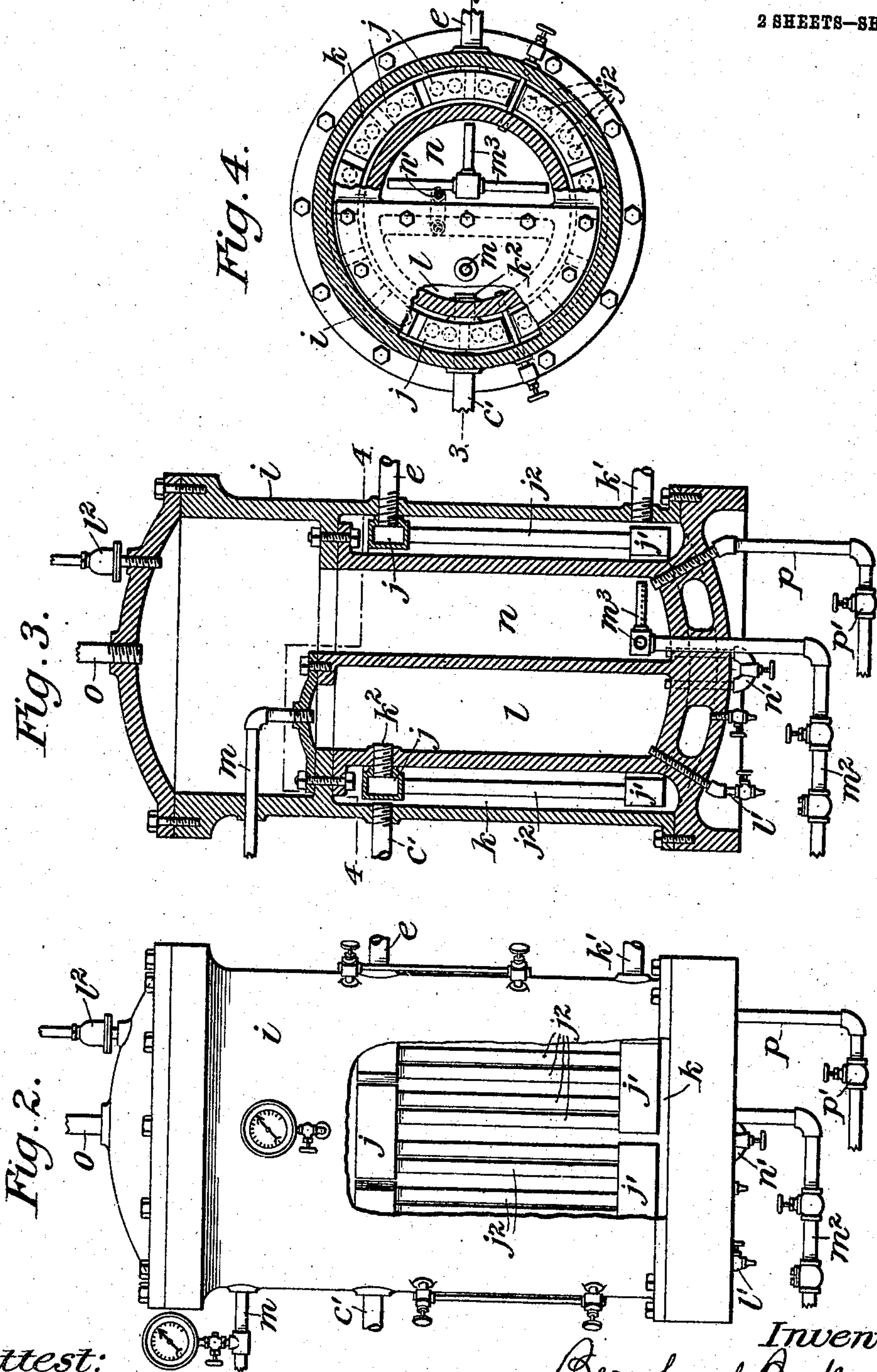
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UNITED STATES PATENT OFFICE.

ARTHUR B. GOODSPEED AND BERNHARD BESKOW, OF NEW YORK, N. Y.,
ASSIGNORS TO INDUSTRIAL DEVELOPMENT COMPANY, OF NEW YORK,
N. Y., A CORPORATION OF NEW YORK.

APPARATUS FOR INCREASING THE EFFICIENCY OF STEAM-GENERATING POWER PLANTS.

No. 848,027.

Specification of Letters Patent.

Patented March 26, 1907.

Application filed April 27, 1903. Renewed April 9, 1906. Serial No. 310,742.

To all whom it may concern:

Be it known that we, ARTHUR B. GOODSPEED and BERNHARD BESKOW, citizens of the United States, residing in the borough of Manhattan, of the city of New York, in the State of New York, have invented certain new and useful Improvements in Apparatus for Increasing the Efficiency of Steam-Generating Power Plants, of which the following is a specification, reference being had to the accompanying drawings, forming a part hereof.

In another, application filed April 8, 1903, Serial No. 151,577, there is described and claimed a method of increasing the efficiency of steam-generating power plants, such method consisting, in substance, in charging air with aqueous vapor and delivering the charged air into the steam-generator to be mingled therein with the steam. The nature of such method is more particularly described in said application by reference to a form of apparatus which is adapted for the practice of the method. In the present application it is sought to cover an apparatus for the practice of the method referred to, the form of apparatus which is chosen for illustration and explanation of the nature of the present invention being substantially the same as the form of apparatus illustrated in the application referred to, although differing therefrom in some details. The invention so far as it is embodied in apparatus will be more fully described hereinafter, with reference to the accompanying drawings, in which—

Figure 1 is a view, partly in longitudinal section and partly in outline, illustrating a convenient form of apparatus. Fig. 2 is a view in elevation, on a larger scale, partly broken out, of the generator or charger represented in Fig. 1. Fig. 3 is a vertical central section of the same on the plane indicated by the line 3 3 of Fig. 4. Fig. 4 is a view in horizontal section on the irregular plane indicated by the line 4 4 of Fig. 3.

The present improvements are capable of application to any ordinary steam-generating plant, one form of which is represented in Fig. 1 of the drawings as comprising a fire-box a , a combustion-chamber a' , water-tubes a^2 , and a steam-drum a^3 . The steam-drum is connected, as usual, by a pipe b with

an engine c of any usual or preferred type, and in the form of apparatus represented the pressure of steam alone in the boiler is relied upon to start the engine, and thereby to bring into operation the other parts of the apparatus with which the invention is more particularly concerned. An air-compressor d , which likewise may be of any suitable type and is herein represented as a wet compressor having an air-supply (indicated at d') and a cooling-water supply, (indicated at d^2), is operatively connected with the engine c , and the air compressed thereby, together with the water which has been used for cooling the air during compression, and is carried along with the compressed air, is delivered through a pipe e to the generator or charger i , wherein the capacity of the air to absorb moisture either from the water carried along with it or from water which may be subsequently introduced, already increased somewhat above the normal by the increase of temperature due to compression, is further increased, the purpose being to charge the air as nearly as possible to the point of saturation under the existing conditions of temperature and pressure. The pipe e is connected to one of a series of upper and lower headers j and j' , which are connected successively by pipes j^2 . This system of headers and pipes, through which the air and water travel, is located within an annular chamber k in the charger i , the exhaust-steam from the engine c being delivered to such chamber through a pipe c' and allowed to escape therefrom at an opposite point, as through a pipe k' . The temperature of the air in its passage through the system of pipes and headers is therefore raised substantially to the temperature of the exhaust-steam, and the air therefore becomes heavily charged with aqueous vapor absorbed from the water which is carried along with it.

Within the charger is a chamber l , into which the partially-saturated air and water are delivered, as at k^2 , and in which the separation of the water from the air takes place. The partially-saturated air is then conducted from a point at or near the top of the chamber l by a suitable pipe m to a reheater m' , which may be located within the combustion-chamber a' of the steam-generating plant near the flue, where the air will become still

further heated from the otherwise waste heat which is about to escape from the combustion-chamber through the flue provided for the purpose. From the reheater the partially-saturated and now more highly-heated air is returned through a pipe m^2 to a chamber n , into the bottom of which it is discharged through a perforated pipe m^3 . The water which was separated from the air in the chamber l is admitted to the chamber n through a U connection n' , and as the pressure in the two chambers is the same the water will stand at the same height in the chamber n as in the chamber l . There is thus in the lower part of the chamber n a body of water, through which the already partially-saturated and highly-heated air is forced, taking up still more moisture and approaching more nearly to the point of saturation. From the upper part of the chamber n the heated and charged air is conducted either directly through a pipe o into the steam-drum a^3 of the boiler, or, if desired, is first conducted through another charger similar to that already described. The water from the lower part of the chamber n , the temperature of which has been raised to a high degree, may be delivered to the boiler, as feed-water, through a pipe p , which may be provided with a stop-cock p' . The chamber l may also be provided with a draw-off pipe and cock l' , through which the water in the chamber l may be drawn off from time to time, if necessary. The pipe o may be provided with a check-valve o' to prevent the escape of steam from the boiler when starting up.

The motor fluid which is delivered to the steam-drum of the boiler from the generator or charger i to be mingled in the boiler with the steam therein has qualities which are possessed neither by the uncharged air nor by the steam. It is in the nature of a gaseous body which is neither steam nor air, and whatever its specific qualities may be and whatever may be its action when mingled with the steam in the boiler it is certain that the results which follow from the admission of such motor fluid to the boiler are such as cannot be produced by steam alone, the deficiency of the steam-generating plant being thereby increased considerably above the maximum efficiency which it is possible to secure under precisely similar conditions with steam alone. It is to be understood, of course, that the motor fluid passes with the steam to the working cylinder or cylinders of the engine and that the results herein referred to are measured by the power developed in the engine.

Since the water which is used in the compressor, whether the compressor be wet or dry, to cool the compressor is ultimately delivered to the boiler, the compressor, as will be observed, itself becomes an initial heater

for the feed-water, the still further increase of the temperature of the feed-water being effected by the exhaust-steam and the reheated air. Furthermore, since the feed-water is carried along with the compressed air and in the charger i is subject to the pressure of the air, which is necessarily slightly higher than the steam-pressure in the boiler, the feed-water is delivered to the boiler without requiring the operation of a special feed-pump or injector. In the practical operation of the apparatus it is also desirable to connect the safety-valve l^2 of the chamber l directly with the boiler, so that whenever any excessive pressure is developed in the chamber l such excess of pressure may be utilized in the boiler rather than wasted by discharging into the air. Furthermore, in beginning the operation of the apparatus the generator or charger i may be filled with water drawn through the reheater m' , suitable connections being provided for the purpose, so that the generator shall be heated to a high initial heat at the time of beginning its operation.

It will be obvious that the details of construction of the generator or charger and the relative arrangement of the same with respect to the engine and the steam-generating plant may be varied from what is shown and described herein, as well as the construction and relative arrangement of the compressor, it being understood that the object to be attained is the charging of the air with aqueous vapor as nearly as possible to the point of saturation before its delivery to the boiler, and incidentally the heating of such air to a temperature as high as possible, the otherwise waste heat, both of the exhaust-steam and of the products of combustion, being utilized to effect the increase in temperature by which the capacity of the air for absorption of moisture is increased.

We claim as our invention—

1. The combination with a steam-boiler and an engine connected therewith, of means for delivering air under pressure to the boiler, means for heating the air before delivery to the boiler, and means for highly charging the air with aqueous vapor before delivery to the boiler, substantially as shown and described.

2. The combination of a steam-boiler and an engine connected therewith, of an air-compressor, connections therefrom to the boiler, means for heating the air before delivery to the boiler, and means for highly charging the air with aqueous vapor before delivery to the boiler, substantially as shown and described.

3. The combination with a steam-boiler and an engine connected therewith, of an air-compressor, connections therefrom to the boiler, means for heating the air before delivery to the boiler, means for highly charging the air with aqueous vapor before delivery to the boiler, and means for supplying water to the compressor to cool the same and for delivering

ering the water heated in the compressor to the boiler, substantially as shown and described.

4. The combination with a steam-boiler and an engine connected therewith, of a wet air-compressor, means for supplying water to the compressor to cool the same, means for heating the air and water delivered by the compressor to cause the air to absorb aqueous vapor, and means for delivering the air charged with aqueous vapor and the water to the boiler, substantially as shown and described.

5. The combination with a steam-boiler and an engine connected therewith, of an air-compressor, a generator or charger to which the air is delivered in the presence of water, means for conducting the exhaust-steam from the engine to the generator or charger to heat the same, and means for delivering the air to the boiler, substantially as shown and described.

6. The combination with a steam-boiler and an engine connected therewith, of an air-compressor, a generator or charger to which the air is delivered in the presence of water, means for heating said generator or charger, a reheater located in proximity to the boiler, means for conducting the air from the generator or charger to the reheater and back from the reheater into the generator or charger in the presence of water, and means for conducting the air from the generator or charger to the boiler, substantially as shown and described.

7. The combination with a steam-boiler and an engine connected therewith, of a generator or charger comprising a separating-chamber, a recharging-chamber and means for heating the same, means for supplying air to the separating-chamber in the presence of water, a reheater located in proximity to the boiler, means for conducting the air from the separating-chamber to the reheater and back to the recharging-chamber in the presence of water, and means to deliver the air from the recharging-chamber to the boiler, substantially as shown and described.

8. The combination with a steam-boiler and an engine connected therewith, of a wet air-compressor, means for supplying water thereto, a generator or charger comprising a separating-chamber and a recharging-chamber, means to deliver air and water together from the compressor to the separating-cham-

ber, a reheater located in proximity to the boiler, means to conduct the air from the separating-chamber to the reheater and back to the recharging-chamber in the presence of water, and means to deliver air from the recharging-chamber to the boiler, substantially as shown and described.

9. The combination with a steam-boiler and an engine connected therewith, of a generator or charger comprising a preheating-chamber, a separating-chamber, a recharging-chamber and a series of pipes and headers in the preheating-chamber, means to deliver exhaust-steam from the engine to the preheating-chamber, means to deliver air under pressure to said system of pipes and headers and thence to the separating-chamber in the presence of water, a reheater located in proximity to the boiler, means to conduct air from the separating-chamber to the reheater and back to the recharging-chamber in the presence of water, and means to deliver the air from the recharging-chamber to the boiler, substantially as shown and described.

10. A generator or charger for charging air with aqueous vapor, comprising a preheating-chamber, means for supplying steam to said preheating-chamber, a series of pipes and headers located in said preheating-chamber, means for supplying air and water to said system of pipes and headers, a separating-chamber to which said series of pipes and headers is connected, a recharging-chamber, means to conduct water from the separating-chamber to the recharging-chamber, and means to conduct air from the separating-chamber to the recharging-chamber near the bottom thereof, substantially as shown and described.

11. The combination with a steam-boiler and an engine connected therewith, of a charger or generator, means to heat the same, means to deliver air under pressure to the generator or charger in the presence of water, means to conduct the air from said charger or generator to the boiler, and a check-valve included in said last-named means, substantially as shown and described.

This specification signed and witnessed this 18th day of April, A. D. 1903.

ARTHUR B. GOODSPEED.

BERNHARD BESKOW.

In presence of—

ANTHONY N. JESBERA,
M. A. BRAYLEY.