No. 827,304. PATENTED JULY 31, 1906.

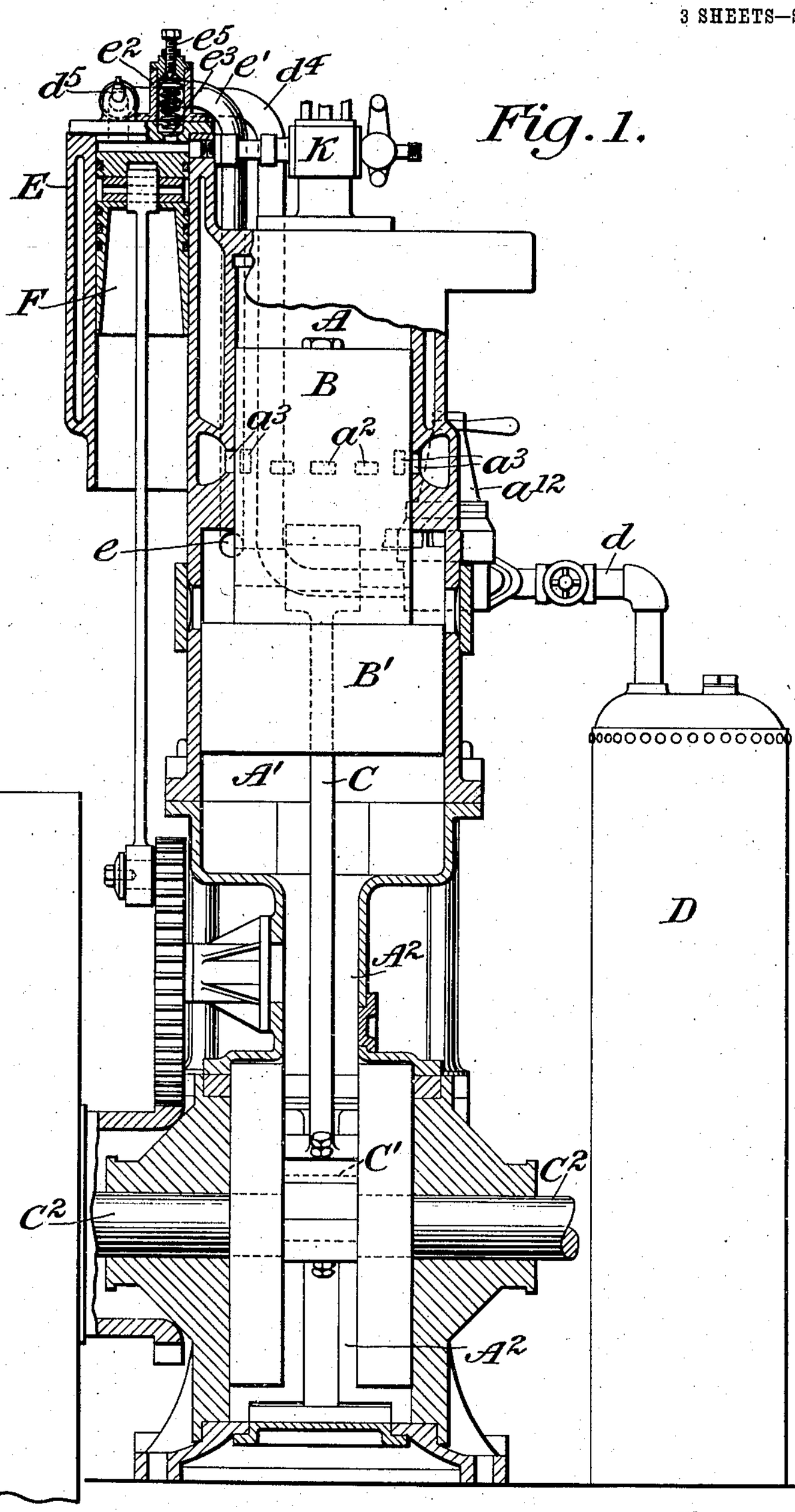
A. B. GOODSPEED.

INTERNAL COMBUSTION ENGINE.

APPLICATION FILED APR. 8, 1905.

3 SHEETS—SHEET 1.

Fig. 1.



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3 SHEETS—SHEET 2.

Fig. 2

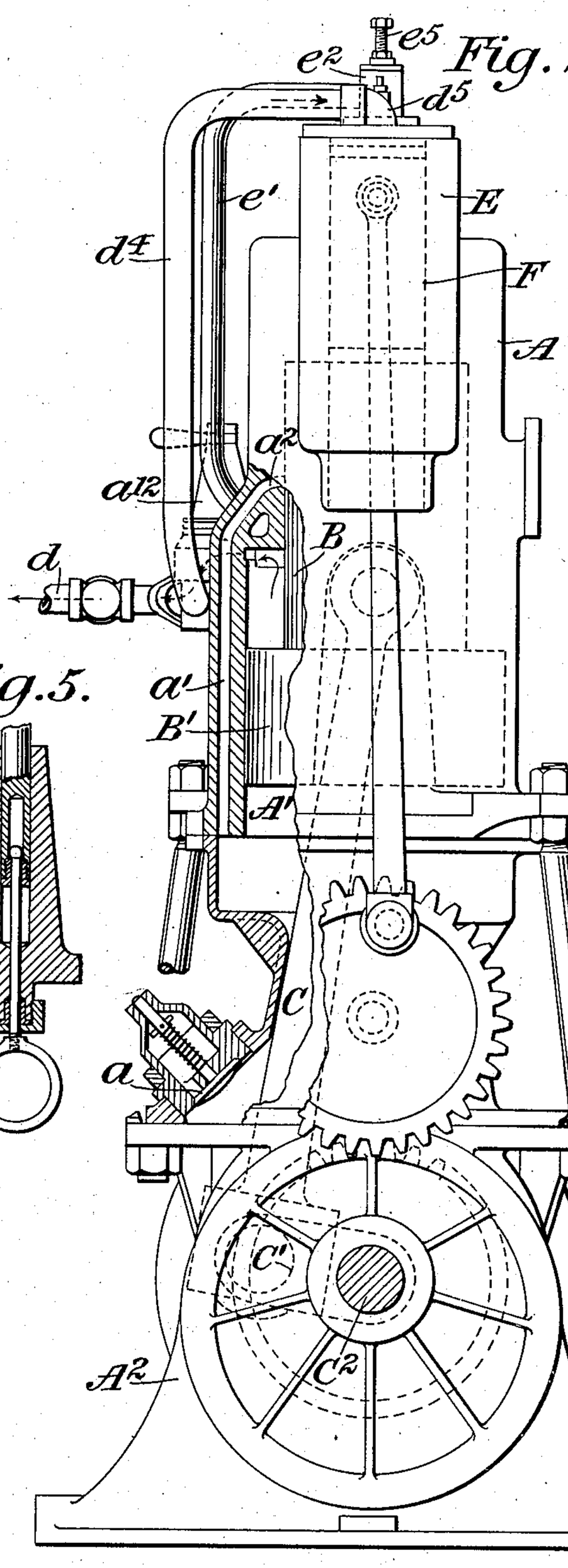

Fig. 3.

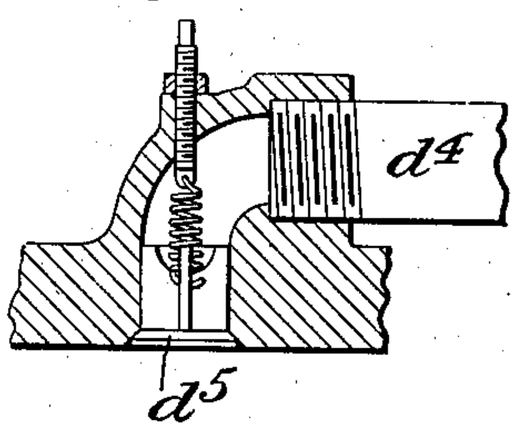

Fig. 4.

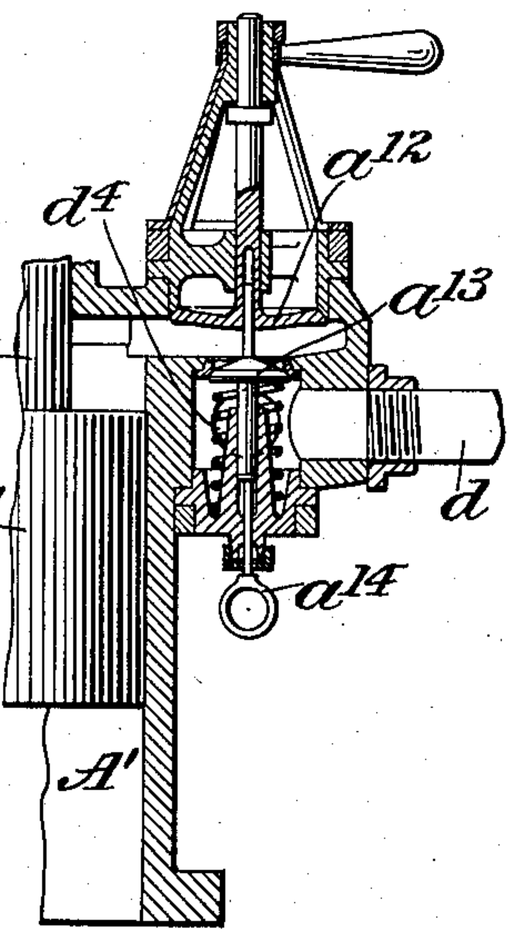

Fig. 5.

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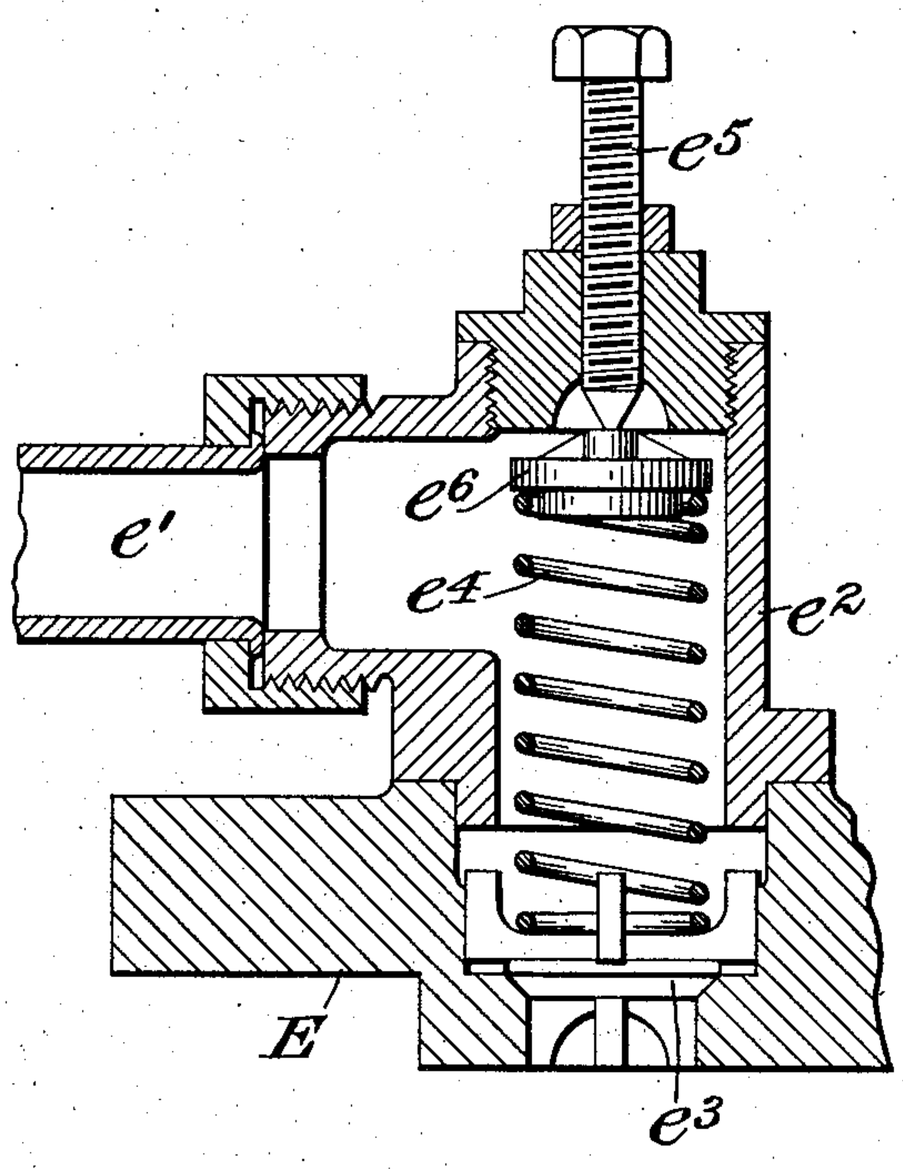
3 SHEETS—SHEET 3.

Fig. 6.



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UNITED STATES PATENT OFFICE.

ARTHUR B. GOODSPEED, OF ROSEVILLE, NEW JERSEY, ASSIGNOR TO INDUSTRIAL DEVELOPMENT COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

INTERNAL-COMBUSTION ENGINE.

No. 827,304. Specification of Letters Patent. Patented July 31, 1906.

Application filed April 8, 1905. Serial No. 254,428.

To all whom it may concern:

Be it known that I, ARTHUR B. GOODSPEED, a citizen of the United States, residing in Roseville, in the State of New Jersey, have invented certain new and useful Improvements in Internal-Combustion Engines, of which the following is a specification, reference being had to the accompanying drawings, forming a part hereof.

This invention relates to internal-combustion engines of the general type of that shown in application for Letters Patent of the United States, Serial No. 202,720, filed April 12, 1904. In the engine shown in that application provision was made whereby no more air should be admitted to the working cylinder from the auxiliary compressor than was actually required under the conditions of operation; but this was accomplished by mechanical means which acted to control the movement of the auxiliary-compressor piston, the inlet-valve of the primary compressor being also controlled to regulate the supply of air thereto. Obviously such means were effective for the purpose; but the operation of the mechanical devices employed consumed power, and work was put upon the primary compressor during the suction-stroke.

It is the object of this invention to provide means whereby the quantity of air admitted shall be governed automatically according to the requirements of the engine at the time and shall be constant under given conditions, while the somewhat-complicated mechanical devices described in said former application shall be dispensed with and the power consumed in operating the same shall be saved. The primary compressor by the application of the improved means is also relieved of the work of suction. In accordance with the invention the auxiliary compressor is made to discharge its air at any predetermined pressure into the head of the primary compressor, whereby the air compressed in the auxiliary compressor in excess of that which is used in the working cylinder is not wasted by discharging into the atmosphere, but is made to do work in the operation of the engine, the energy which was stored in the air during compression being thus conserved. At the same time the primary-compressor piston is to a corresponding extent relieved of the work of suction, and the rarefaction of the air is avoided, cooling of the air taking place with the expansion of the air admitted from the auxiliary compressor.

A further object of the invention is to provide convenient means for assisting in starting the engine.

The invention will be more fully described hereinafter with reference to the accompanying drawings, in which for purposes of explanation and illustration of the nature of the invention it is shown as embodied in an engine of the type of that shown and described in said former application.

In the drawings, Figure 1 is a view, partly in front elevation and partly in vertical central section, of an engine to which the present improvements are applied. Fig. 2 is a view of the same, partly in side elevation, as seen from the left hand in Fig. 1, and partly in vertical section. Fig. 3 is a detail view in section and on a larger scale of the inlet-valve of the auxiliary compressor. Fig. 4 is a detail view in section and on a larger scale, showing the inlet-valve of the primary compressor and the valve for controlling the connection between the primary compressor and the reservoir. Fig. 5 is a detail view in section, on a still larger scale, of a portion of the valve connections shown in Fig. 4. Fig. 6 is a detail view in section, also on a still larger scale, of the valve for controlling the connections between the auxiliary compressor and the head of the primary compressor.

The engine chosen for illustration in the accompanying drawings comprises a working cylinder A, with the compression-cylinder A′ in tandem therewith, and a closed crank-chamber A^2. The piston B is an ordinary trunk-piston having an enlarged forward end B′ to fit the compression-cylinder A′, the piston being connected, as usual, by a pitman C with the crank C′ of the usual divided crank-shaft C^2, the latter having its bearings in the side walls of the crank-chamber A^2.

The crank-chamber may be provided with a suitable inlet-valve *a* and may be connected by a duct *a′* with an air-inlet port or ports a^2, formed in the wall of the working cylinder A and arranged to be uncovered by the piston B as it approaches the limit of its forward stroke. Exhaust-ports a^3 are likewise provided in the wall of the working cyl-

inder and are arranged to be uncovered by the piston as it approaches the limit of its stroke.

Air is admitted to the primary compression-cylinder A′ through a suitable inlet-valve a^{12} (shown in detail in Fig. 4) and is discharged therefrom by an outlet-valve a^{13}, which may be incorporated in the same structure with the inlet-valve a^{12}, the outlet-valve a^{13} being connected, as by a pipe d, with a reservoir D. The air is conducted from the reservoir D either directly, as by a pipe d^4, or indirectly through cooling-coils and the jacket of the working cylinder, as described in said former application, to the auxiliary compressor E, being admitted thereto through a suitable check-valve d^5. (Shown in detail in Fig. 3.)

As in the engine shown in said former application, the air, further compressed in the cylinder E, and the fuel-oil are admitted together to the working cylinder through a suitable valve in the head thereof, (indicated at K,) and the mixture of air and oil is vaporized and ignited, burning in the working cylinder with a relatively slow combustion, so that the pressure therein under suitable working conditions does not rise above one hundred and fifty pounds. The inlet-valve is controlled by suitable means fully described in said former application and not necessary to be further described herein.

It will be understood that whatever air there may be in the auxiliary compressor after the valve K has closed, but before the piston F of the auxiliary compressor has reached the limit of its compressing stroke, will be further compressed. Such air might be allowed to escape directly into the open air, in which case the energy used in compressing the air is wasted. In said former application provision was made whereby the stroke of the piston F might be controlled, so that no more air should be compressed than was actually used in the working cylinder. In the present case all of the mechanism necessary to accomplish the result last referred to is dispensed with and the air remaining in the auxiliary compressor after the valve K has closed is delivered to the head of the primary compressor A′ through a port e and pipe e', which is connected with the head of the compression-cylinder E through a suitable relief-valve e^2. The latter may be of any suitable construction adapted for regulation. As shown in detail in Fig. 6 of the drawings, the valve-plug e^3 is held to its seat by a spring e^4. An adjusting-screw e^5 bears upon a cap e^6, which rests upon a spring e^4, so that the pressure at which the valve-plug e^3 shall lift can be regulated.

As will be understood, the air from the auxiliary compressor E is admitted to the primary compressor A′ at a time when the piston B′ thereof is making its forward or suction stroke. As the air from the auxiliary compressor expands into the primary compressor it cools the latter, preventing the rarefaction of the air therein, and relieves the piston B′ of the work of suction, the inlet-valve a^{12} closing as the air is admitted under pressure from the auxiliary compressor. The operation, as will be observed, is entirely automatic, the quantity of air admitted being determined by the requirement of the conditions under which the engine is operating at the time and being constant under uniform conditions. The quantity of air compressed in the primary compressor during the return stroke of the piston therein is always the same, and the quantity thereof which is actually used in the operation of the engine after further compression in the auxiliary compressor depends upon the cut-off of the engine. That which after further compression by the auxiliary compressor is not used is returned to the primary compressor in the manner described above. Provision is also made whereby the primary compression-cylinder may receive air from the reservoir D when the engine is being started. For this purpose the valve a^{13}, which normally is opened by excess of pressure in the primary compressor A′ over that in the reservoir D and is closed and held closed by excess of pressure in the reservoir D, is provided with a handle, as at a^{14}, by which it can be opened from the outside, so that when it is desired to start the engine, the tank D being filled with air under pressure, the valve a^{13} is opened to admit air from the reservoir to the compression-cylinder A′ behind the piston B′ to give it a forward impulse.

It will be understood that various changes in details of construction and arrangement can be made without departing from the spirit of the invention, which is not intended to be limited to the precise construction and arrangement shown and described herein.

I claim as my invention—

1. In an internal-combustion engine, the combination of a working cylinder and piston, a primary compressor, an auxiliary compressor receiving air from the primary compressor and delivering air to the working cylinder, and means whereby air may be delivered from the auxiliary compressor to the primary compressor, substantially as described.

2. In an internal-combustion engine, the combination of a working cylinder and piston, a primary compressor, an auxiliary compressor receiving air from the primary compressor and delivering air to the working cylinder, and a connection, including a relief-valve, from the head end of the auxiliary compressor to the head end of the primary compressor, substantially as described.

3. In an internal-combustion engine, the combination of a working cylinder and piston, a primary compressor, an auxiliary compressor, a connection, including a reservoir, between the primary compressor and the

auxiliary compressor, a connection between the auxiliary compressor and the working cylinder, and a connection, including a relief-valve, between the auxiliary compressor and the primary compressor, substantially as described.

4. In an internal-combustion engine, the combination of a working cylinder and piston, a primary compressor, an auxiliary compressor, a connection, including a check-valve, between the primary compressor and the auxiliary compressor, a connection, including an inlet-valve, between the auxiliary compressor and the working cylinder, and a connection, including a relief-valve, between the auxiliary compressor and the primary compressor, substantially as described.

5. In an internal-combustion engine, the combination of a working cylinder and a primary compression-cylinder in tandem, pistons for said cylinders connected to move together, an auxiliary compressor, a connection, including a check-valve, between the primary compression-cylinder and the auxiliary compressor, a connection between the auxiliary compressor and the working cylinder and a connection, including a relief-valve, between the auxiliary compressor and the primary compressor, substantially as described.

6. In an internal-combustion engine, the combination of a working cylinder and piston, a compression-cylinder and piston, a reservoir, a connection from said reservoir to said working cylinder, a connection from said compression-cylinder to said reservoir, a valve in said connection normally opening under pressure from the compression-cylinder, and means to open said valve to admit air under pressure from the reservoir to the compression-cylinder in starting the engine, substantially as described.

7. In an internal-combustion engine, the combination of a working cylinder having a valve for the admission of fuel-oil and air, a piston, a compression-cylinder and piston, a reservoir, a connection from said reservoir to said working cylinder-valve, a connection from said compression-cylinder to said reservoir, and a valve in said connection normally opening under pressure from the compression cylinder, substantially as described.

This specification signed and witnessed this 5th day of April, 1905.

ARTHUR B. GOODSPEED.

In presence of—
ANTHONY N. JESBERA,
W. B. GREELEY.