

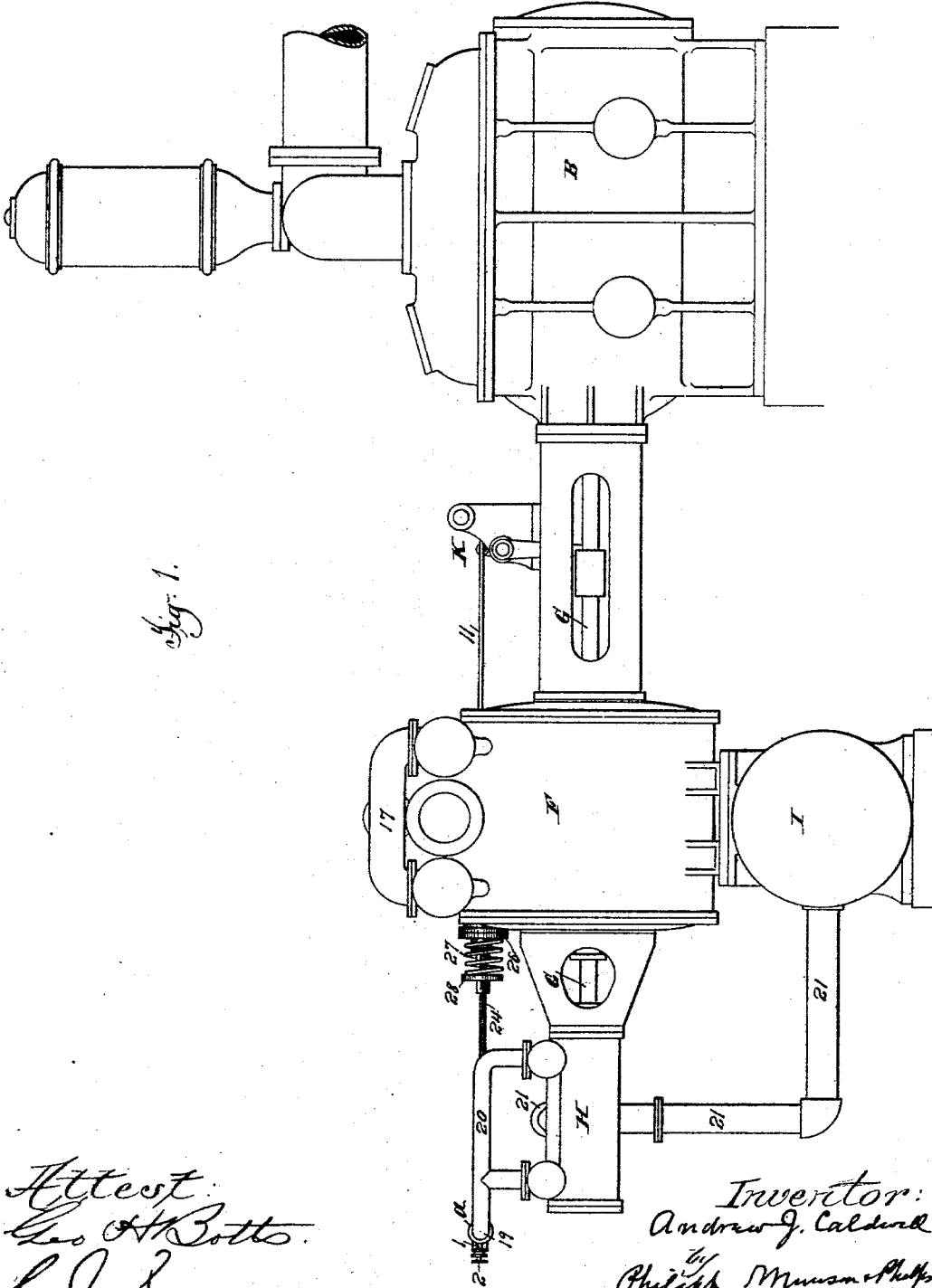
(No Model.)

3 Sheets—Sheet 1.

A. J. CALDWELL.
 DUPLEX ENGINE.

No. 596,981.

Patented Jan. 11, 1898.



Attest:
Geo. H. Botta.
C. J. Sawyer

Inventor:
Andrew J. Caldwell
by Philipp Mueser & Philip
Hells

(No Model.)

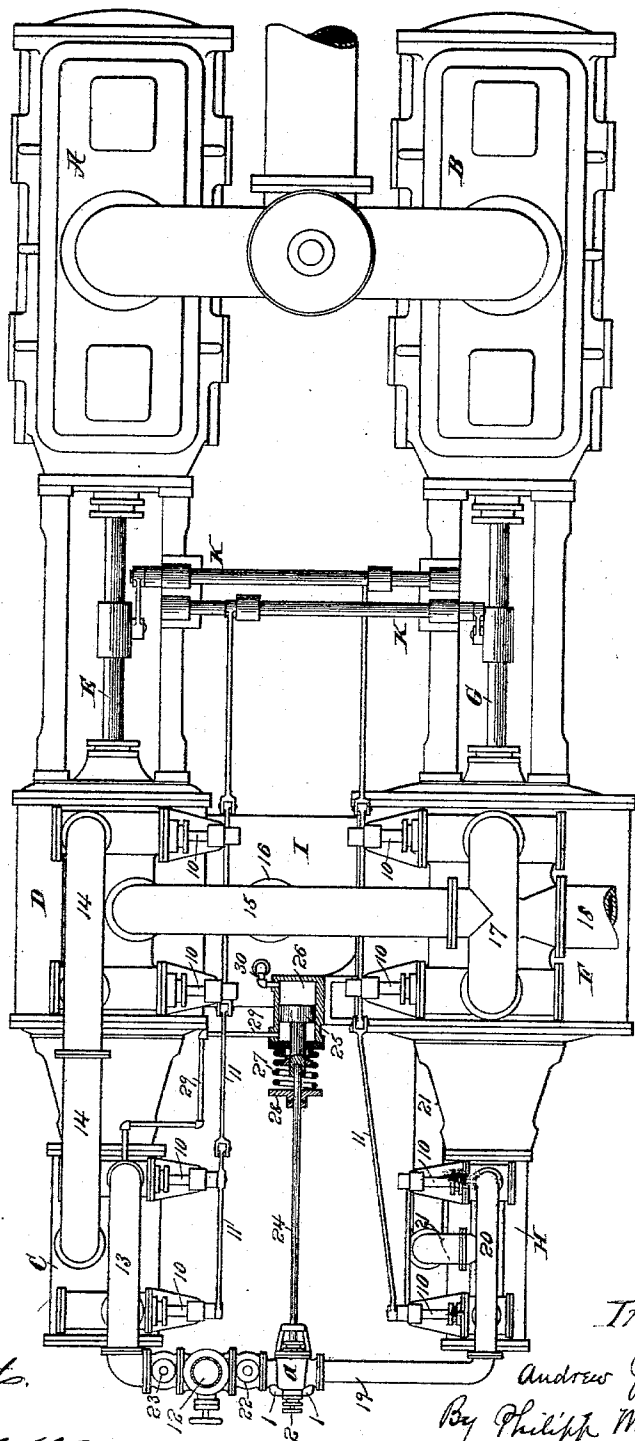
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Fig. 2.



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(No Model.)

3 Sheets—Sheet 3.

A. J. CALDWELL.
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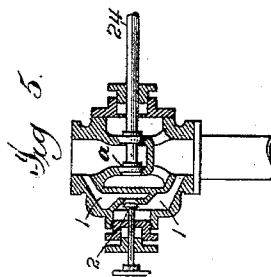
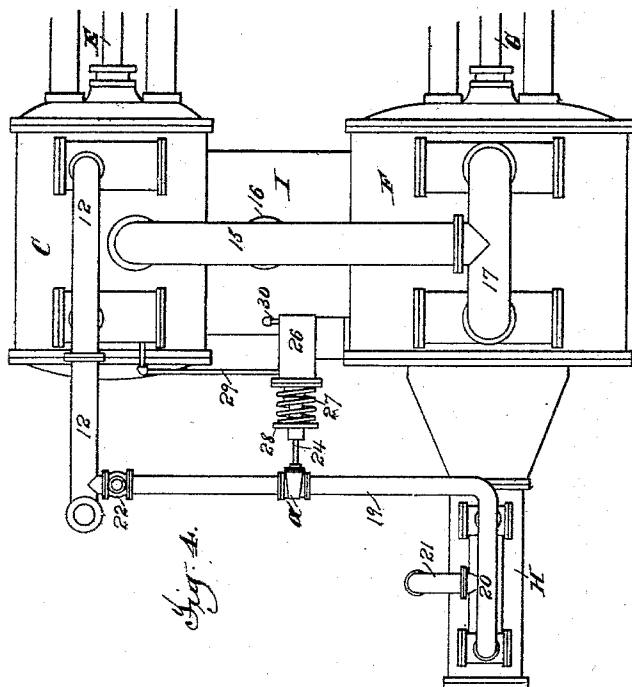
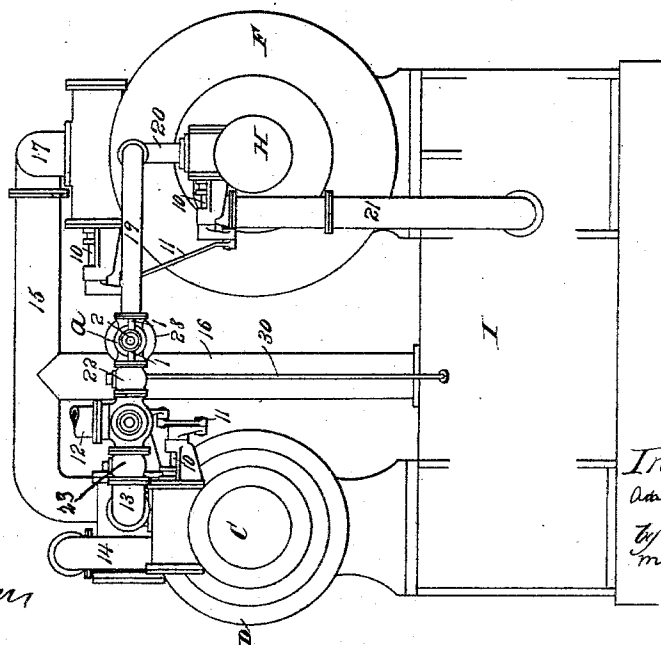


Fig. 3.



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Inventor:
A. J. Caldwell
By Phillips,
Munson & Phelps

Atty

UNITED STATES PATENT OFFICE.

ANDREW J. CALDWELL, OF BROOKLYN, NEW YORK, ASSIGNOR TO THE
HENRY R. WORTHINGTON, OF ELIZABETH, NEW JERSEY.

DUPLEX ENGINE.

SPECIFICATION forming part of Letters Patent No. 596,981, dated January 11, 1898.

Application filed June 13, 1895. Serial No. 552,616. (No model.)

To all whom it may concern:

Be it known that I, ANDREW J. CALDWELL, a citizen of the United States, residing at Brooklyn, county of Kings, and State of New York, have invented certain new and useful Improvements in Duplex Engines, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

This invention relates to duplex engines, and especially to multiple-expansion engines of that class in which the steam is used expansively from one side of the engine to the other, as in triple and quadruple expansion engines and compound engines in which the high and low pressure cylinders are located on opposite sides of the engine.

The object of my invention is to provide a simple and efficient construction of duplex engines in which the total effective power on the two sides of the engine may be readily adjusted as desired by power derived from an equalizing-cylinder on one side of the engine, so that a regular and uniform movement on both sides of the engine is secured, and especially to provide means whereby inequality of power on opposite sides of the engine shall be automatically corrected. In securing these results I employ a small equalizing-cylinder on one side of the engine, by which the power on that side of the engine may be increased or diminished and the relative power on the two sides of the engine thus adjusted as desired, this power-regulating cylinder forming a power-equalizing cylinder in constructions in which the invention is applied for securing equality of power on the two sides.

While the improvements forming my invention are of general application in all duplex engines in which the steam is used expansively from one side of the engine to the other side and it is desired to provide means for increasing the power on either side, so as to secure exactly the desired relative power on the two sides, the improvements have been designed in connection with an engine of the class known as the "Worthington duplex pumping-engine," and will be shown and described as applied thereto. Such engines are shown in many prior Letters Patent, of which especial reference is made herein to Patents

Nos. 283,261, 283,315, 292,525, 332,857, 341,534, 401,401, and 444,543.

As the invention rests chiefly in the general construction and arrangement of the engine, a full understanding of the same can best be given by an illustration and a somewhat detailed description of an engine embodying the invention as applied for equalizing the power on the opposite sides of the engine, and such description will now be given, reference being had to the accompanying drawings, forming a part of this specification, in which—

Figure 1 is a side elevation of a horizontal duplex triple-expansion pumping engine embodying the improvements. Fig. 2 is a plan view of the same. Fig. 3 is a front elevation of the steam end. Fig. 4 is a plan view of the steam end of a compound duplex engine embodying my improvements, and Fig. 5 is a detail section of the valve controlling the supply of steam to the equalizing-cylinder.

Referring now to Figs. 1 to 3, the water end of the engine is of the ordinary construction, consisting of the water-cylinders A B, having plungers which are connected directly with the piston-rods on the opposite sides of the engine and provided with the usual suction and force chambers, which communicate, respectively, through the usual valves with the suction and force mains. At the steam end, in which the improvements forming the present invention are embodied, the engine is provided with a high-pressure cylinder C and intermediate cylinder D, forming one side of the engine and having their pistons carried by the common piston-rod E, which is connected to the pump-piston in water-cylinder A. Upon the opposite side of the engine is the low-pressure cylinder F, having the piston-rod G, connected to the pump-plunger in water-cylinder B. A receiver I is provided, into which the intermediate cylinder exhausts and from which the low-pressure cylinder is supplied, this receiver being preferably placed, as shown, immediately under and forming a support for the intermediate and low-pressure cylinders, and the high-pressure cylinder is preferably mounted on the end of the intermediate cylinder, so that the receiver forms a support for the entire steam end of the engine.

For the purpose of supplying any slight de-

5 efficiency of pressure upon the low - pressure
 side of the engine and preserving a constant
 balance of effective power between the two
 sides a small equalizing-cylinder H is placed
 upon the low-pressure side of the engine, the
 piston-rod G of the low-pressure cylinder be-
 ing extended through the latter and carrying
 also the piston of the equalizing - cylinder.
 This equalizing-cylinder may be supplied with
 10 steam from the receiver I; but it is prefer-
 ably supplied with high-pressure steam from
 the boiler, as this supply may then be varied
 without interfering with the steam-supply to
 the low-pressure cylinder, and, moreover, a
 15 smaller equalizing-cylinder may thus be used.

All the cylinders are provided with the
 usual valves, which may be of any suitable
 construction, but are preferably of the rotary
 form shown in the Patents Nos. 401,401 and
 20 444,543, above referred to, and operated in the
 same manner as in these patents, the valve-
 stems 10 being connected by crank-arms to
 valve-rods 11 on opposite sides of the engine,
 and these valve-rods being connected to the
 25 usual valve-operating mechanism K between
 the steam and water ends, by which the valves
 upon one side of the engine are operated from
 the other side.

The high-pressure cylinder C receives its
 30 supply of steam from the supply - pipe 12
 through induction - pipe 13 and exhausts
 through exhaust-pipe 14 into the steam-chest
 of intermediate cylinder D. The interme-
 diate cylinder D in turn exhausts through
 35 horizontal exhaust-pipe 15 and vertical pipe
 16 into the receiver I, and this exhaust-steam
 passes from the receiver to the low-pressure
 cylinder through pipe 16 and induction-pipe
 17 of the low-pressure cylinder, the low-pres-
 40 sure cylinder in turn exhausting, as usual,
 through the pipe 18. The equalizing-cylinder
 H is supplied with high-pressure steam from
 the supply-pipe 12 through pipe 19, connect-
 ing with induction-pipe 20 of the equalizing-
 45 cylinder, the equalizing-cylinder exhausting,
 preferably, into the receiver I through ex-
 haust-pipe 21.

In order that the power upon opposite sides
 of the engine may be adjusted in first start-
 50 ing the engine and that any inequality of
 power resulting from variations in the run-
 ning conditions of the engine may readily be
 corrected, it is necessary that means be pro-
 vided for regulating the admission of steam
 55 to the equalizing-cylinder H, and for this pur-
 pose throttle 22 is provided on pipe 19 and a
 throttle 23 is preferably used on the induc-
 tion-pipe 13 of cylinder G for adjusting the
 supply for the other cylinders of the engine,
 60 as usual.

The throttle 22 or any equivalent means for
 controlling the steam-supply to the equaliz-
 ing - cylinder H by hand may be the only
 means of control used and an efficient con-
 65 struction produced, as any variations in the
 power on opposite sides of the engine may
 readily and quickly be corrected thereby. It

is desirable, however, that the supply of steam
 to the equalizing-cylinder should be con-
 trolled automatically, and for this purpose I
 70 provide the following construction by which
 the supply of steam to the equalizing-cylin-
 der is automatically increased in case of any
 deficiency of pressure in the low - pressure
 cylinder and decreased as the pressure in the
 75 low-pressure cylinder rises, so as to preserve
 a constant balance of power upon the two
 sides of the engine.

The pipe 19 is controlled by a valve *a*, the
 valve-rod 24 of which carries a piston 25, which
 80 moves in a cylinder 26, mounted in any suit-
 able position, the valve-rod 24 and valve *a* be-
 ing normally pressed into position to close
 the valve by means of a spring 27 pressing
 against the head of the cylinder 26 and a col-
 85 lar 28 on the valve-rod. The opposite ends
 of the cylinder 26 are connected by means
 of pipes 29 30 with, respectively, the steam-
 chest of high-pressure cylinder C and the re-
 ceiver I, the pressure in receiver I being ap-
 90 plied to force the piston in a direction to close
 the valve *a* and the pressure from the high-
 pressure cylinder to open the valve. It is
 evident that the pressure within the receiver
 I is that of the low-pressure side of the engine,
 95 so that the valve *a* will be controlled in ac-
 cordance with the relative pressures on the
 opposite sides of the engine, and in case of
 any excess or deficiency of pressure upon
 either side the piston will be actuated in the
 100 proper direction to admit more or less steam
 to the equalizing-cylinder, as the case may be,
 the spring 27 being graduated, preferably, so
 as to exert just the required pressure to over-
 balance the excess of pressure exerted on one
 105 side of the piston 25 by the high-pressure
 steam from the pipe 29 when the power upon
 the opposite sides is equal and hold the valve
 normally closed.

It is desirable that some steam should be
 110 admitted to the equalizing-cylinder H at all
 times to keep the parts in proper condition,
 and this result may be attained by properly
 constructing the valve so as to form a by-
 pass. In the construction shown, however, I
 115 provide a by-pass 1 around the valve *a*, which
 is preferably controlled by a cock 2, so that
 a fine adjustment of the amount of steam
 normally admitted to the equalizing-cylinder
 120 may be obtained.

The operation of the engine with the au-
 tomatic control of the equalizing-cylinder will
 be understood without further description, it
 being evident that the pressure in the equal-
 125 izing-cylinder H is under the control of the
 pressure on the two sides of the engine, so
 that any deficiency of pressure on either side
 of the engine due to changes in water-pres-
 sure or other causes will be immediately com-
 pensated for by increase or decrease in the
 130 supply of steam to the equalizing-cylinder H,
 and a perfect uniformity of action on the two
 sides of the engine is secured.

In Fig. 4 I have shown my improvements

as applied to a compound engine, the receiver I now being placed between and forming a support for the high-pressure and low-pressure cylinders, the intermediate cylinder being omitted. The low-pressure cylinder receives its steam from the receiver I and high-pressure cylinder C through the same connections as previously used from the intermediate cylinder, and all the connections between the equalizing-cylinder and other parts of the engine are the same as previously described. It is evident also that the use of the equalizing-cylinder construction shown is not limited to compound and triple-expansion engines, but that it may readily be applied to all duplex multiple-expansion engines in which the steam is used expansively from one side of the engine to the other. Thus in the quadruple-expansion engine shown in Patent No. 283,315, above referred to, the equalizing-cylinder may be added on the low-pressure side and its supply taken from the boiler or receiver 11. If the supply be taken from the receiver, it will retard the high-pressure side as well as assist the low-pressure side, the regulating effect of a slight variation in the supply thus being increased.

The application of my improvements to other engines of the general duplex class will be understood without further illustration or description. It will be understood also that modifications may readily be made in the general arrangement and detail construction shown without departing from my invention.

What I claim is—

1. A multiple-expansion duplex engine having a power-equalizing cylinder on the weaker side, substantially as described.

2. A multiple-expansion duplex engine having a power-equalizing high-pressure cylinder on the low-pressure side, substantially as described.

3. A multiple-expansion duplex engine having a power-equalizing cylinder on the low-pressure side and provided with means for regulating the supply of steam to the equalizing-cylinder in accordance with the variations of pressure on the opposite sides of the engine, substantially as described.

4. A multiple-expansion duplex engine having a power-equalizing cylinder on the low-pressure side, and provided with means for automatically regulating the supply of steam to the equalizing-cylinder in accordance with the variations of pressure on the opposite sides of the engine, substantially as described.

5. The combination with a multiple-expansion duplex engine having a power-equalizing cylinder on the low-pressure side, of a valve controlling the supply of steam to the equalizing-cylinder, and means for applying to said valve the pressure on the low-pressure side of the engine to close the valve, substantially as described.

6. The combination with a multiple-expansion duplex engine having a power-equalizing cylinder on the weaker side, of a valve

controlling the supply of steam to the equalizing-cylinder, and means for applying the pressure on the opposite sides of the engine to move the valve in opposite directions, whereby the valve is controlled in accordance with the relative pressures on the opposite sides of the engine, substantially as described.

7. The combination with a multiple-expansion duplex engine having a power-regulating cylinder on one side, of a valve controlling the supply of steam to the regulating-cylinder, and means for applying the pressure on the opposite sides of the engine to move the valve in opposite directions, whereby the valve is controlled in accordance with the relative pressures on the opposite sides of the engine, substantially as described.

8. The combination with a multiple-expansion duplex engine having a power-regulating cylinder on one side, of supply-pipe 19 for said regulating-cylinder, valve *a* controlling said pipe, and piston 25 connected to said valve and pressed in the direction to close the valve by the pressure on the power-regulating-cylinder side of the engine, substantially as described.

9. The combination with a multiple-expansion duplex engine having a power-regulating cylinder on one side, of a supply-pipe 19 for said regulating-cylinder, valve *a* controlling said pipe, and piston 25 connected to said valve and subjected on opposite sides to the pressure on opposite sides of the engine, the pressure on the power-regulating-cylinder side tending to close the valve, substantially as described.

10. The combination with a multiple-expansion duplex engine having a power-regulating cylinder on one side, of supply-pipe 19 for the regulating-cylinder, valve *a* controlling said pipe, piston 25 connected to said valve and subjected on opposite sides to the pressure on opposite sides of the engine, the pressure on the power-regulating-cylinder side tending to close the valve, and a spring aiding the pressure on the power-regulating-cylinder side, substantially as described.

11. The combination with a multiple-expansion duplex engine having a power-regulating cylinder on one side, supply-pipe 19 for the regulating-cylinder, valve *a* controlling said pipe, piston 25 connected to said valve and subjected on opposite sides to the pressure on opposite sides of the engine, the pressure on the power-regulating-cylinder side tending to close the valve, and a by-pass for admitting a constant supply of steam past said valve, substantially as described.

12. The combination with a multiple-expansion duplex engine having a receiver through which the exhaust of one side passes to the other side, of a high-pressure-equalizing cylinder on the side receiving the exhaust, said equalizing-cylinder exhausting into the receiver, substantially as described.

13. A multiple-expansion duplex engine

having a power-regulating cylinder on one side, substantially as described.

14. A multiple-expansion duplex engine having a power-regulating cylinder on one side and provided with means for automatically regulating the supply of steam to the regulating-cylinder in accordance with the variations of pressure on the opposite sides of the engine, substantially as described.

15. A duplex engine having a power-regulating cylinder on one side and provided with means for regulating the supply of steam to the regulating-cylinder in accordance with the variations of pressure on the opposite sides of the engine, substantially as described.

16. A duplex engine having a power-regulating cylinder on one side and provided with means for automatically regulating the supply of steam to the regulating-cylinder in accordance with the variations of pressure on the opposite sides of the engine, substantially as described.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

ANDREW J. CALDWELL.

Witnesses:

B. W. PIERSON,

ALEXANDER D. CHEW.

It is hereby certified that in Letters Patent No. 596,981, granted January 11, 1898, upon the application of Andrew J. Caldwell, of Brooklyn, New York, for an improvement in "Duplex Engines," errors appear in the printed specification requiring correction, as follows: On page 1, lines 23 and 29, the word "equalizing" should read *auxiliary*; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed, countersigned, and sealed this 1st day of February, A. D., 1898.

[SEAL.]

WEBSTER DAVIS,
Assistant Secretary of the Interior.

Countersigned:

A. P. GREELEY,
Acting Commissioner of Patents.