

(No Model.)

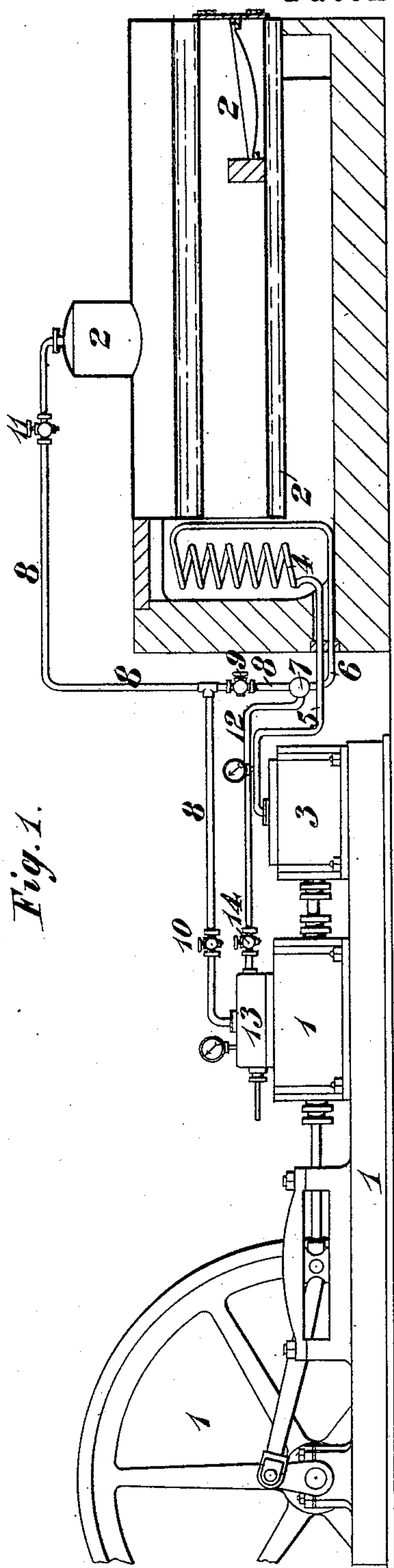
3 Sheets—Sheet 1.

E. FIELD.

APPARATUS FOR PRODUCING MIXTURES OF STEAM AND HOT AIR.

No. 479,707.

Patented July 26, 1892.



Witnesses  
C. M. Mott  
J. T. Hamner

Inventor  
Edward Field  
per O. E. Duffy atty

(No Model.)

3 Sheets—Sheet 2.

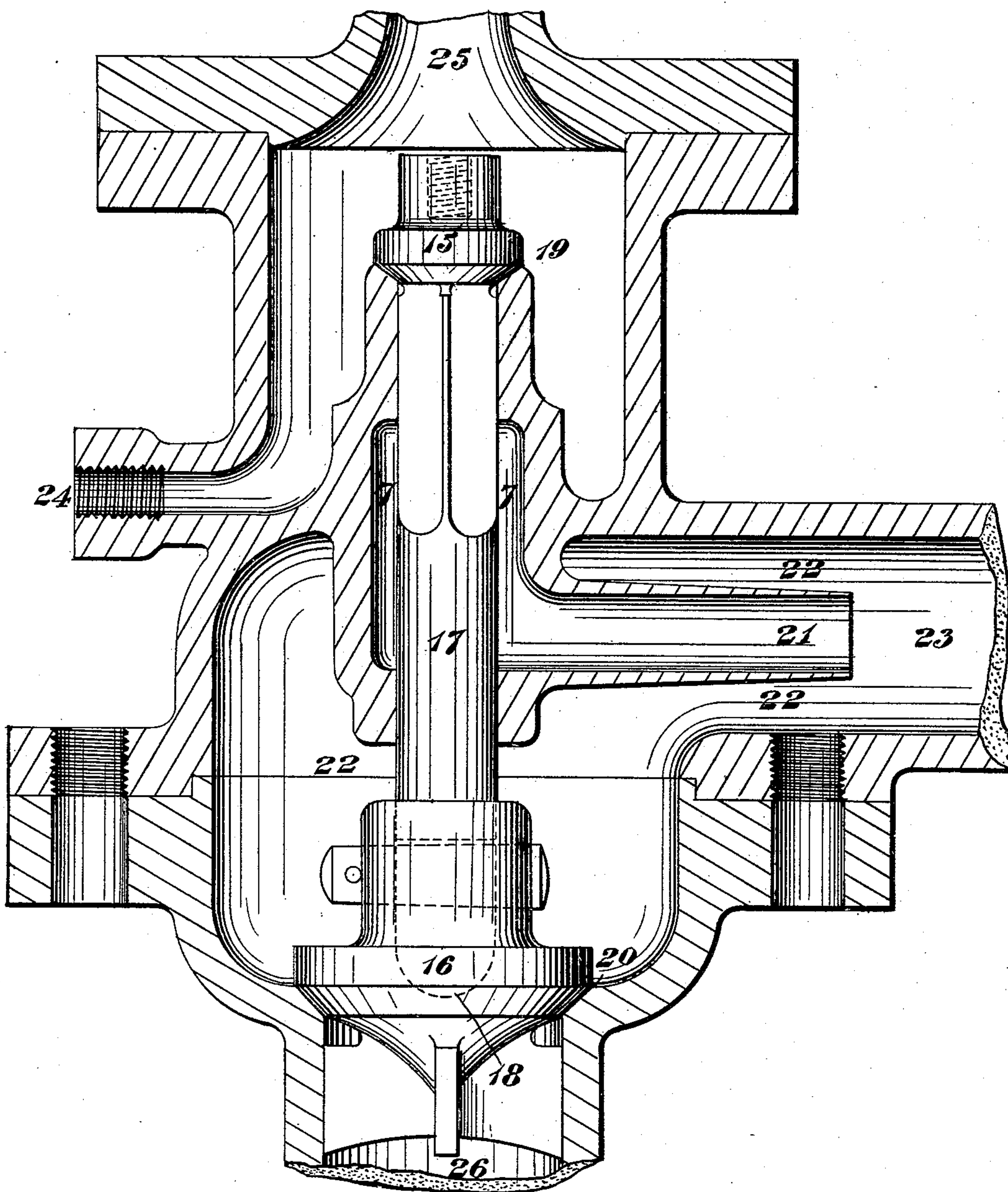
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Fig. 2.



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3 Sheets—Sheet 3.

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Fig. 6.

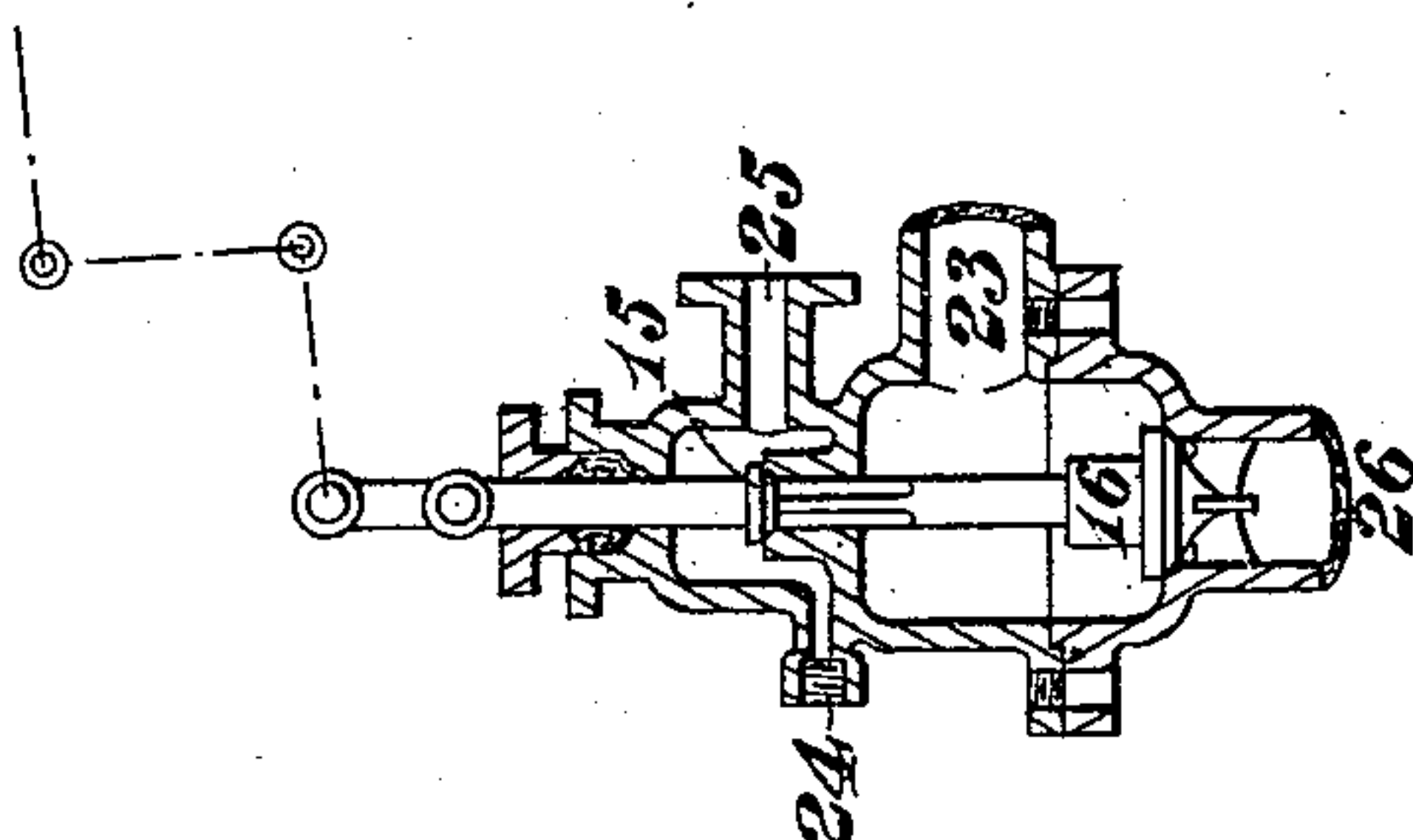


Fig. 5.

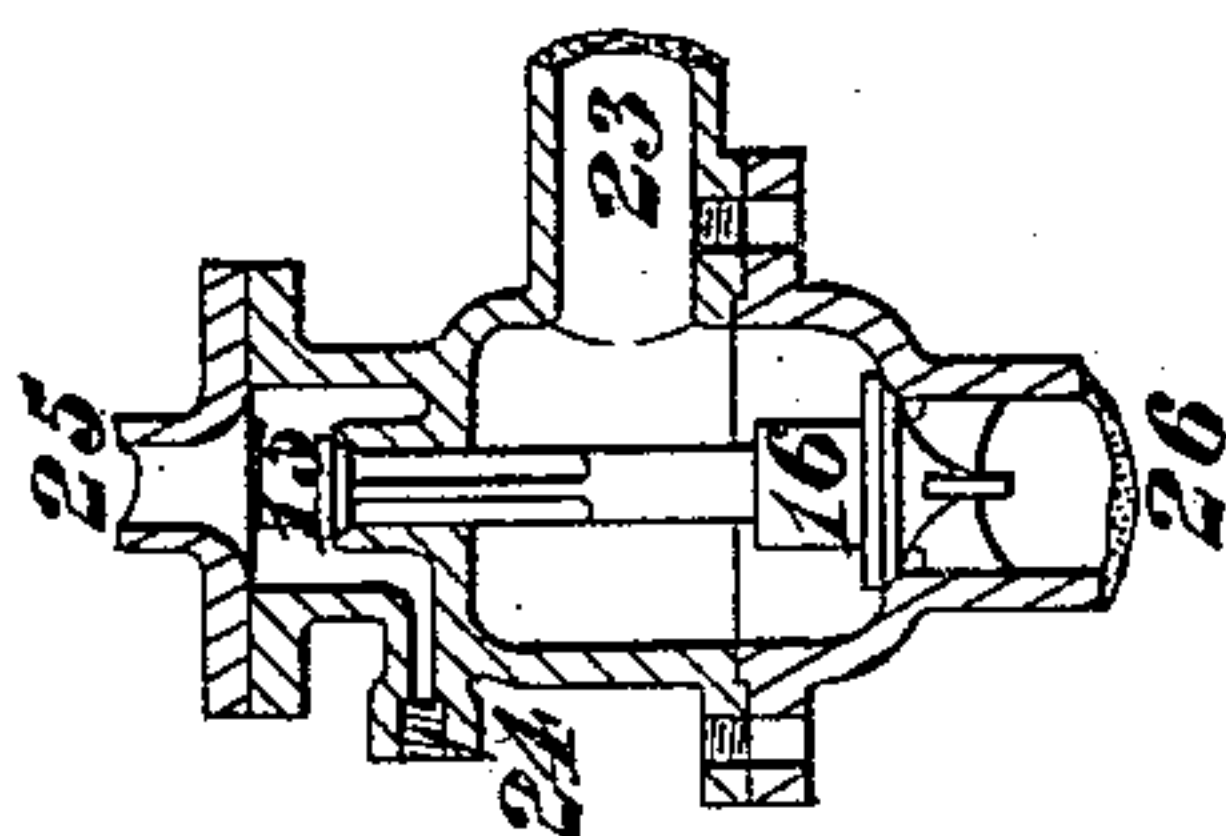


Fig. 3.

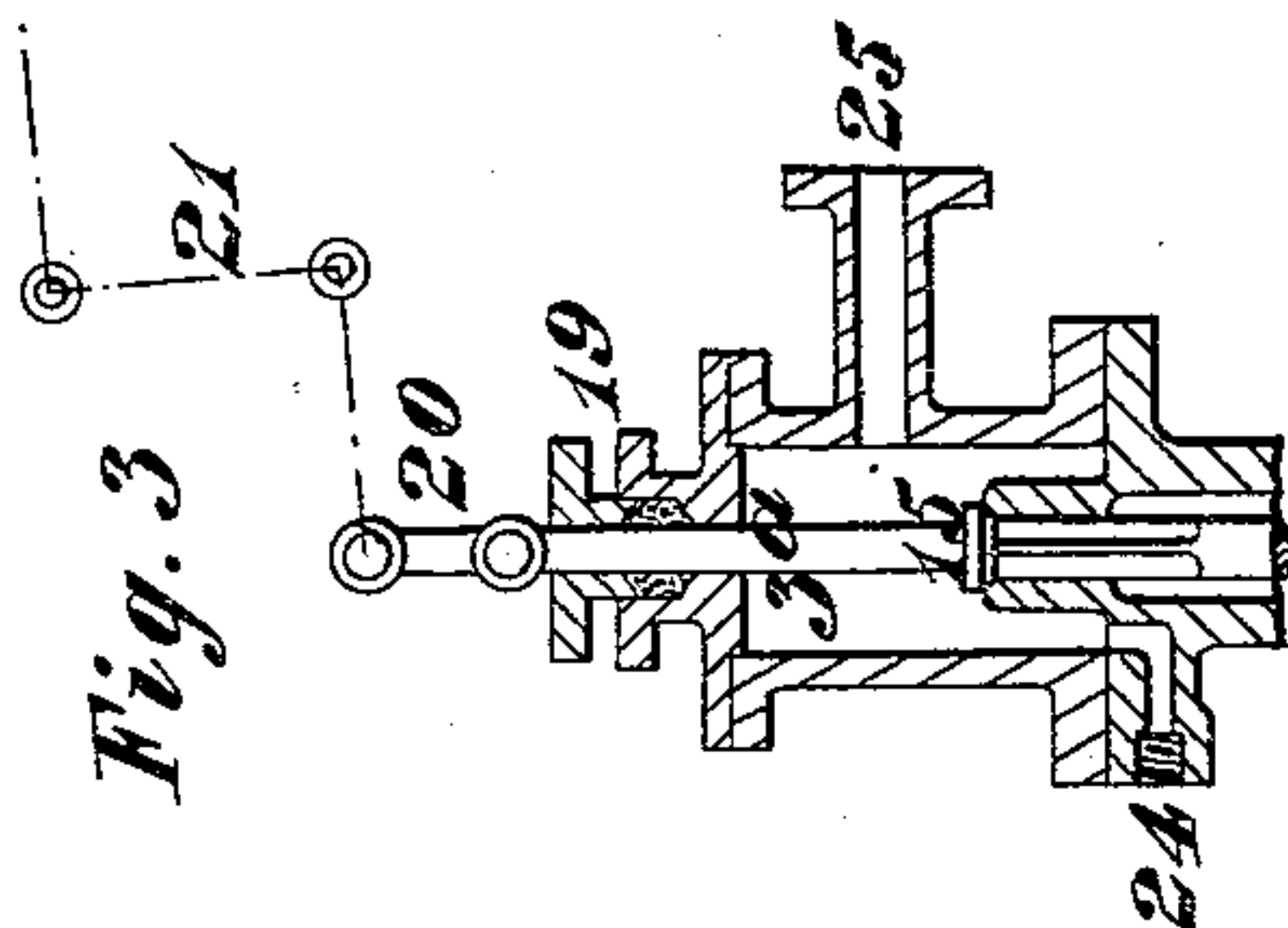
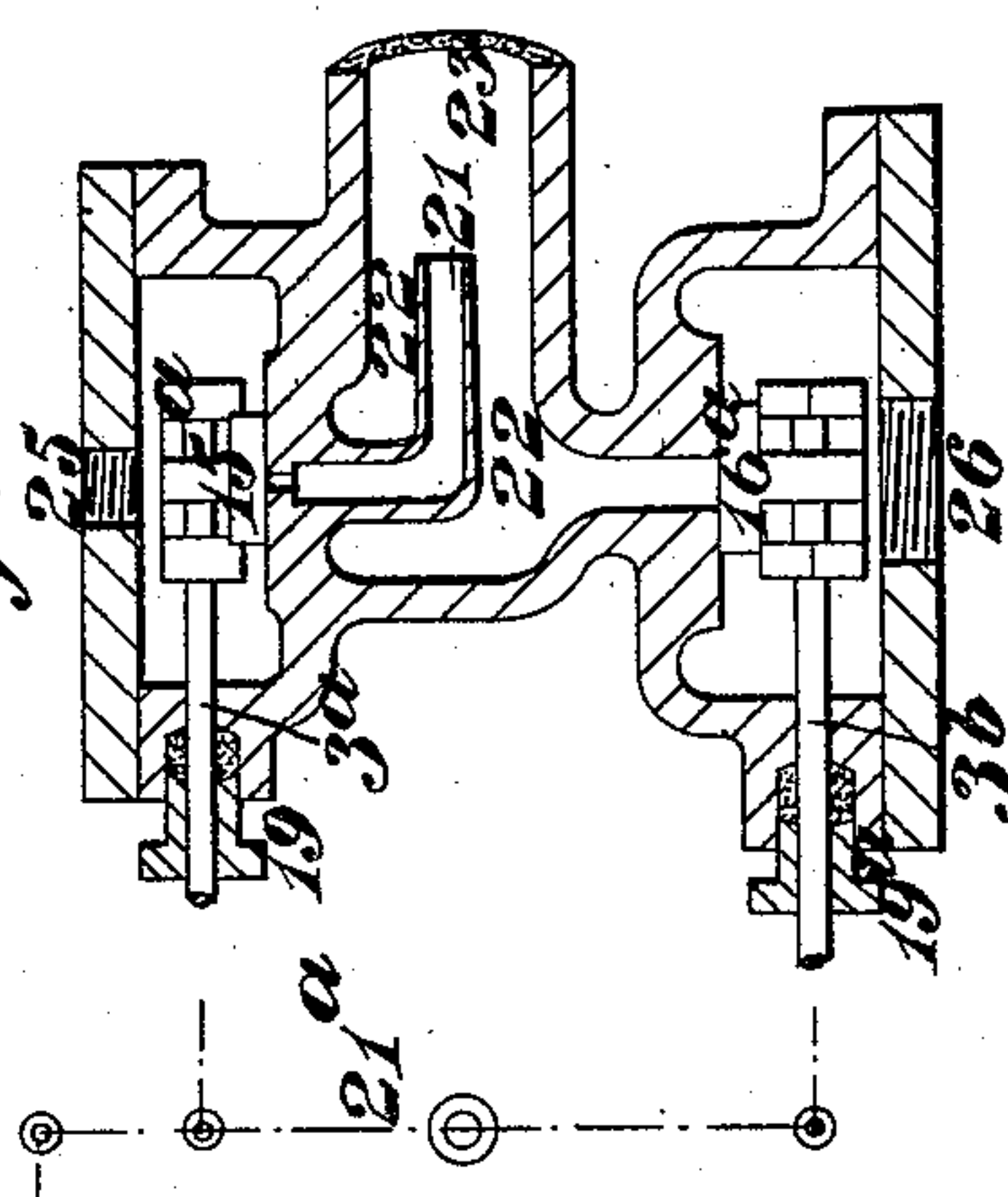


Fig. 4.



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# UNITED STATES PATENT OFFICE.

EDWARD FIELD, OF LONDON, ENGLAND.

## APPARATUS FOR PRODUCING MIXTURES OF STEAM AND HOT AIR.

SPECIFICATION forming part of Letters Patent No. 479,707, dated July 26, 1892.

Application filed March 10, 1891. Serial No. 384,509. (No model.) Patented in England March 21, 1890, No. 4,432; in France January 26, 1891, No. 210,992; in Belgium January 26, 1891, No. 93,552; in Norway February 17, 1891, No. 2,174; in Switzerland February 17, 1891, No. 3,453; in Germany February 18, 1891, No. 63,680; in Luxemburg February 18, 1891, No. 1,410; in Victoria March 25, 1891, No. 8,615; in South Australia March 26, 1891, No. 1,896; in Italy March 31, 1891, LVII, 366; in Queensland March 31, 1891, No. 1,295; in New South Wales March 31, 1891, No. 2,894; in New Zealand April 11, 1891, No. 4,933; in Brazil April 15, 1891, No. 1,152; in Spain April 24, 1891, No. 11,794; in Austria-Hungary June 17, 1891, No. 9,256, and in India October 5, 1891, No. 90.

*To all whom it may concern:*

Be it known that I, EDWARD FIELD, a subject of the Queen of Great Britain and Ireland, residing at Buckingham Street, in the city of London, England, have invented Apparatus for Producing the Mixture of Steam and Hot Air for Use as Motive Fluid in Engines, (for which I have obtained Letters Patent in Great Britain, No. 4,432, dated March 21, 1890; in France, No. 210,992, dated January 26, 1891; in Belgium, No. 93,552, dated January 26, 1891; in Austria-Hungary, No. 9,256, dated June 17, 1891; in Germany, No. 63,680, dated February 18, 1891; in Spain, No. 11,794, dated April 24, 1891; in Norway, No. 2,174, dated February 17, 1891; in Switzerland, (provisional,) No. 3,453, dated February 17, 1891; in Luxemburg, No. 1,410, dated February 18, 1891; in Italy, Reg. Att., Vol. LVII, No. 366, dated March 31, 1891; in Victoria, No. 8,615, dated March 25, 1891; in Queensland, No. 1,295, dated March 31, 1891; in New South Wales, No. 2,894, dated March 31, 1891; in South Australia, No. 1,896, dated March 26, 1891; in New Zealand, No. 4,933, dated April 11, 1891; in Brazil, No. 1,152, dated April 15, 1891, and in India, No. 90, dated October 5, 1891,) of which the following is a specification.

This invention has reference to apparatus for producing mixture of steam and hot air for use as motive fluid in engines, according to the invention described in the specification of another application for Letters Patent filed by me at the time of filing the present application, and serially numbered 384,508. In carrying out that invention air is mixed with steam as follows: The air (which it is desirable should be free from any excess of moisture) is compressed to a pressure equal, or thereabout, to the intended working pressure of the motive fluid in the engine. Then the air thus compressed is passed alone through any suitable form of heater placed in the flue or flues of a boiler or in any other convenient position where it will receive sufficient heat

from any source to raise the air under pressure passing through the heater to a temperature of, say, from 400° to 500° Fahrenheit, or thereabout, thus causing considerable increase in the volume or pressure of the air. Steam is supplied from a boiler or generator, and it and the compressed air are conducted simultaneously but separately through well-protected mains to a mixing apparatus, hereinafter called a "mixer," in which they are mixed. The steam is by preference supplied at a somewhat greater pressure than the compressed air. The mixture is conveyed from the mixer to the slide or valve jacket or casing of the motor in which it is to do work.

In the accompanying illustrative drawings, Figure 1 illustrates, partly in elevation and partly in vertical section, apparatus according to this invention for producing mixture of steam and hot air in the manner set forth, this apparatus being shown applied to a motive-power engine. Fig. 2 is a vertical section, to a larger scale, of an automatic steam and air mixer. Figs. 3 to 7, inclusive, are sectional views illustrating modified constructions of mixers, hereinafter more particularly described.

Referring to Fig. 1 of the drawings, 1 is a motive-power engine. It is shown as of a well-known horizontal single-cylinder type; but various other types might be used whether, simple or compound. Usually it will be advantageous to adopt the compound type. It is also desirable that the cylinder or cylinders and slide or valve jacket or jackets should be steam-jacketed. The water from such steam-jackets may be returned to the boiler in any known or suitable manner.

2 is a steam-boiler. It is represented as of the ordinary Cornish type, but might be of almost any other kind.

3 is an air-compressor. It should be of good construction, capable of compressing atmospheric air to the working pressure required by the motor. As represented this compressor is arranged to be driven directly; but in



many cases it will be better to drive the compressor by a separate crank, so that its action may be correctly timed. Assuming the working pressure to be sixty pounds per square inch, the capacity of the compressor may be the same as that of the motor-cylinder. In some cases the compressor may be made of a variable capacity, or it may be caused to make a larger or a smaller number of strokes within a given time than the engine, as may be found convenient.

4 is a heater having sufficient surface exposed to the action of the hot products of combustion to raise air forced through it to a suitable temperature—say from 400° to 500° Fahrenheit, or thereabout. The heater may be of any suitable construction and may be heated from any convenient source. In Fig. 1 it is shown as placed in the smoke-box of the boiler, so as to be heated by the hot gases and products of combustion passing from the boiler-furnace to the chimney.

5 is a pipe for conveying the compressed air from the compressor to the heater.

6 is a well-protected pipe for conveying the heated compressed air from the heater to the mixer.

7 is a mixer of suitable construction, as hereinafter more particularly explained with reference to the several examples illustrated.

8 is the steam-main.

9 is the steam-admission valve to the mixer.

10 is the starting-valve for the motor.

11 is a steam-shut-off valve.

12 is a well-protected mixture-main for mixed compressed hot air and steam.

13 is the slide-jacket of the motor.

14 is a mixture-regulating throttle actuated by governor.

The form of mixer I prefer to use is shown to a larger scale at Fig. 2. It is constructed with differential self-acting valves, the arrangement being such that when the valve controlling the ingress of the heated air (hereinafter called the "hot-air valve") is opened by the pressure of the hot air the valve controlling the ingress of steam (hereinafter called the "steam-valve") will also be opened, and when the hot-air valve is closed by the conjoint pressure of the mixture of steam and hot air on the hot-air valve and of the steam acting on the steam-valve the steam-valve will also be closed.

15 is the steam-valve, having an area of one.

16 is the hot-air valve, having an area of, say, eight, or thereabout; but the difference will vary according to the difference between the average pressures at which it may be intended to work. The valve 15 may be made in one piece with the stem 17 and continued down to the bottom of a socket forming a step in the upper side of the valve 16, in which it is loosely keyed, the valve 16 having a slight amount of play, so that it may readily find its seat, care being taken that when both valves are seated the spindle shall

be in contact with the step in valve 16 at the point 18.

19 is the seat of the steam-valve.

20 is the seat of the hot-air valve.

21 is the steam-nozzle; 22, the hot-air passage; 23, the mixture-conduit to the engine; 24, the condensed-water pipe; 25, the steam-inlet from the boiler; 26, the hot-air inlet from the heater.

The method of working is as follows: The engine is started with steam only by opening the valves 10 and 11, the mixture-main 12 and valve 9 being open. After a few revolutions the compressor will have forced sufficient air through the heater to raise the pressure of the air up to that of the steam. The hot-air valve 16, Fig. 2, will then be lifted by the excess of air-pressure. Consequently the steam-valve 15, Fig. 2, will likewise be opened. Hot air and steam will then rush simultaneously through the mixer, forming a volume of mixture considerably greater in bulk than the mere aggregate of the volumes of the steam and hot air, but at a pressure equal to the mean pressure of the steam and hot air. The result of this will be that the engine will run faster, for if the volume of mixture be not used by the engine an increased pressure of mixture will be the result. The direct steam communication from the boiler to the engine will then be closed by the shutting of the valve 10 and the engine will continue running at its proper normal speed, the steam-supply to the mixer being regulated by a governor or by any other suitable means at 9 or 14; or the mixture may be regulated by a valve at 14. Thus, as will be readily understood, the valve arrangement above described is entirely self-acting, closing when full pressure has been attained in the slide-jacket and opening immediately on any reduction of pressure taking place in the slide-jacket of the engine. When the mixture in the mixture-main has attained approximately the same pressure as that of the compressed hot air in the hot-air main, the compound valve will be in equilibrium and both steam and hot-air valves will be closed by the weight of the valves and stem, and will remain so until the pressure is reduced in the mixture-main by the demand of the engine, when the hot-air valve will be relieved of some of the pressure on its upper side. To reduce the speed of the engine, it is only necessary to throttle the steam passing to the mixer at 9. The construction and operation of the mixer may be variously modified. Thus, instead of the steam passing as a jet through the central passage or nozzle 21 and the compressed and heated air through the surrounding annular passage 22, the construction might obviously be so modified that the steam might go through the annular passage and the compressed and heated air as a jet through the central passage or nozzle; but I prefer the arrangement shown. In either case, as will be understood, the ob-



ject is to keep the hot gases of the air under pressure dry and separate from the steam until after the passage of the point of mixture.

Fig. 3 represents the upper part of a mixer resembling that shown in Fig. 2, but adapted to be mechanically moved. For this purpose 3<sup>a</sup> is a prolongation of the valve-stem, which extends through a stuffing-box 19<sup>a</sup> and by a link 20<sup>a</sup> is connected to a suitably-operated bell-crank 21<sup>a</sup>.

Fig. 4 illustrates a modification wherein slide-valves 15<sup>a</sup> 16<sup>a</sup>, mechanically moved, are used in lieu of the self-acting lift-valves illustrated in Fig. 2. The valve-rods 3<sup>a</sup> 3<sup>b</sup> extend through stuffing-boxes 19 19<sup>a</sup> and are connected to suitable actuating means 21<sup>a</sup>.

Fig. 5 shows a self-acting lift-valve mixer similar to that shown in Fig. 2, but without the steam-nozzle 21.

Fig. 6 shows the same adapted to be mechanically moved by the same arrangement as described with reference to Fig. 3.

I am aware that it has heretofore been proposed to employ in conjunction with a steam-supply pipe an air-compressor and air-heater for supplying heated compressed air for producing a mixture of steam and hot air; but in such apparatus the steam and hot-air valves have been opened and closed separately and in succession, so that the mixture was produced by admitting heated compressed air into a valve-chest previously charged with steam. I therefore do not claim such apparatus, broadly; but

What I claim is—

1. Apparatus for producing mixture of steam and hot air for use as motive fluid, comprising air compressing and heating apparatus, steam-supply apparatus, and a mixing apparatus having a hot-air valve and a steam-valve arranged to open and close together and simultaneously controlling the admission of heated compressed air and steam through separate inlets, substantially as described.

2. Apparatus for producing mixture of steam and hot air for use as motive fluid, consisting of air compressing and heating apparatus, steam-supply apparatus, and mixing apparatus comprising a vessel having separate inlets of unequal area for steam and hot air, a common outlet for mixed steam and air, a steam-valve, and a hot-air valve, said valves being connected together and arranged to open and close together and simultaneously control the passage of hot air and steam through said inlets, substantially as herein described.

3. In apparatus for producing mixture of steam and hot air for use as motive fluid, the combination of air compressing and heating apparatus, steam-supply apparatus, and mixing apparatus connected with said air and steam apparatus, said mixing apparatus having separate inlets for steam and hot air, a common outlet for mixed steam and air, and steam and hot-air valves of unequal area for

controlling said inlets, said valves being connected by a vertically-movable stem, whereby both valves will open and close together, substantially as described.

4. The combination, with a fluid-pressure engine, of air compressing and heating apparatus, steam-supply apparatus, a mixer having separate inlets connected to said air and steam apparatus, respectively, and a common outlet for mixed steam and air, a steam-valve, and a hot-air valve, said valves being connected together and arranged to open and close together and simultaneously control said inlets, and a mixture-main connecting the outlet of said mixer with said engine, substantially as described.

5. In apparatus for producing mixture of steam and hot air for use in engines, the combination, with air compressing and heating apparatus and steam-supply apparatus, of a mixer provided with differential self-acting valves for admitting steam and hot air simultaneously but separately thereto and a mixture-main into which mixture of heated compressed air and steam is delivered from said mixer.

6. The combination, with a fluid-pressure engine, of air compressing and heating apparatus, steam-supply apparatus, a mixer provided with differential self-acting valves capable of automatically controlling the supply of air and steam from said apparatus, and a mixture-main in communication with said mixer and with said engine.

7. The combination, with a fluid-pressure engine, of air compressing and heating apparatus, steam-supply apparatus, and a mixer provided with differential self-acting valves capable of automatically controlling the admission thereto of steam and heated compressed air from said apparatus, a steam-nozzle, and a hot-air passage, for the purpose specified.

8. For producing mixture of steam and hot air for use in fluid-pressure engines, a mixer having inlets for steam and heated compressed air, an outlet for mixture of heated compressed air and steam, and differential self-acting valves of unequal area for simultaneously controlling said inlets for steam and heated compressed air.

9. For producing mixture of steam and hot air for use in fluid-pressure engines, a mixer having inlets 25 and 26 for steam and heated compressed air, respectively, a steam lift-valve 15 and a hot-air lift-valve 16 for simultaneously controlling said inlets, said valves being of unequal areas, a stem 17, connected to said steam-valve and loosely connected to said hot-air valve, a steam-nozzle 21 in communication with said steam-inlet, and a hot-air passage 25, surrounding said steam-nozzle, substantially as herein described, for the purpose specified.

10. The combination of an engine, a steam-generator 2, an air-compressor and means for



driving the same, an air-heater in communication with said compressor, a mixer 7, a pipe 8, with valve 9, for connecting said mixer with said steam-generator, a pipe 6, connecting said mixer with said air-heater, a mixture-main 12, with valves 14, for connecting said mixer with said engine, and a pipe 8, with starting-valve 10, for connecting said engine direct with said steam-generator, substantially as herein described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

EDWARD FIELD.

Witnesses:

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