May 14, 1929. A. R. SMITH 1,713,055

SMOKE PRODUCER

Filed July 31, 1923 3 Sheets-Sheet 1

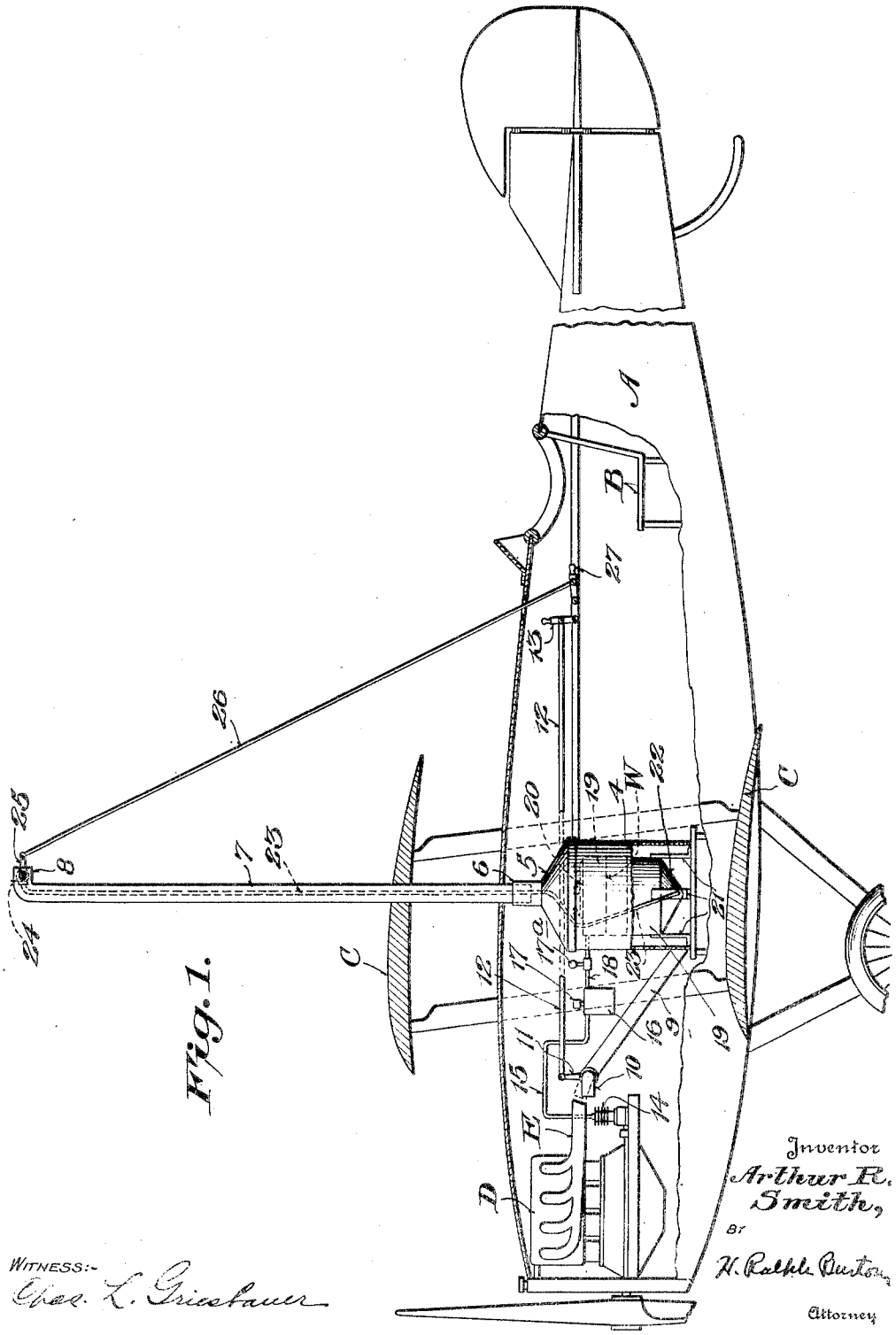


Fig. 1.

Witness:-
Chas. L. Grieshauer

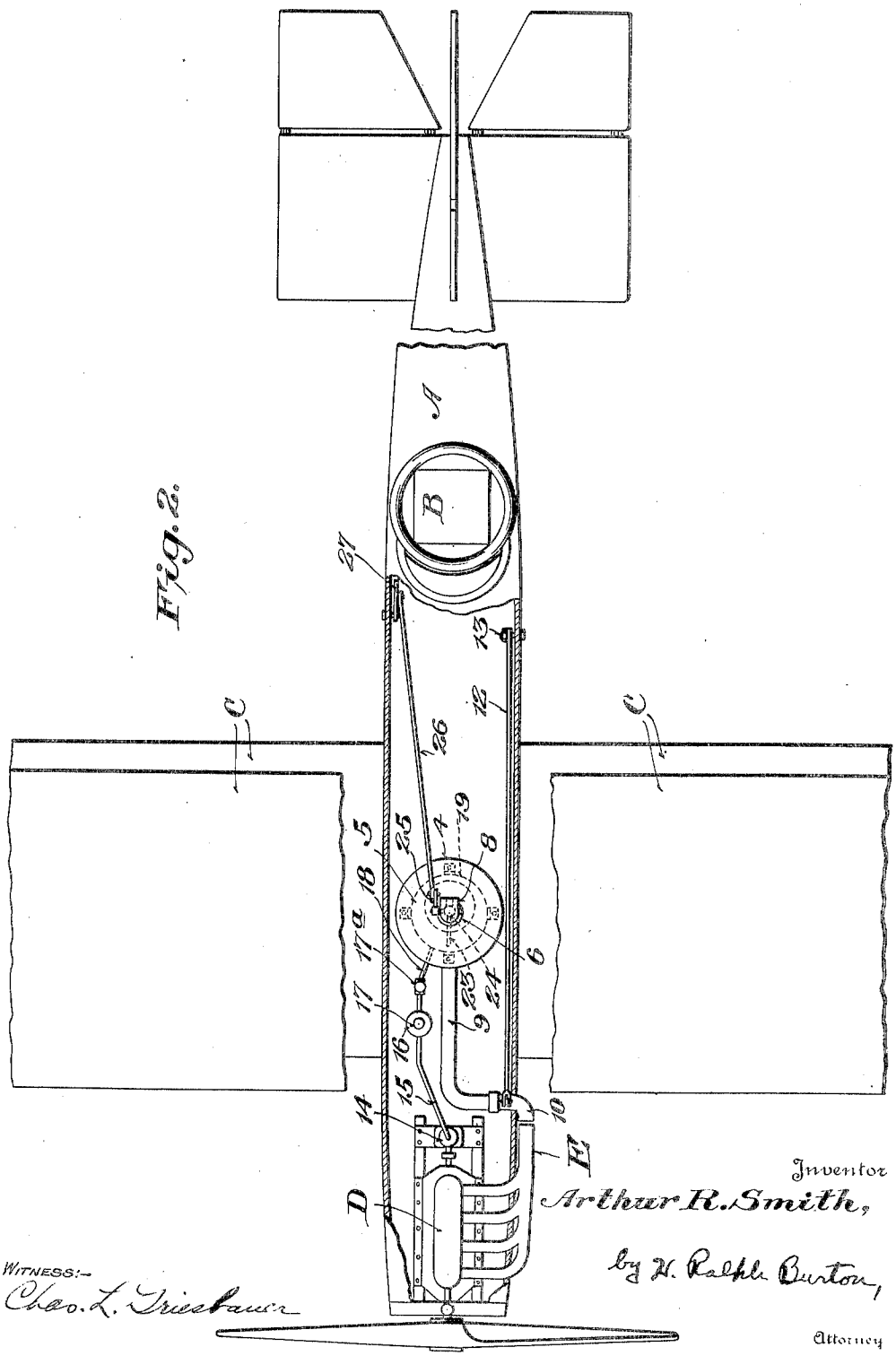
Inventor
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Filed July 31, 1923 3 Sheets-Sheet 2

Fig. 2.



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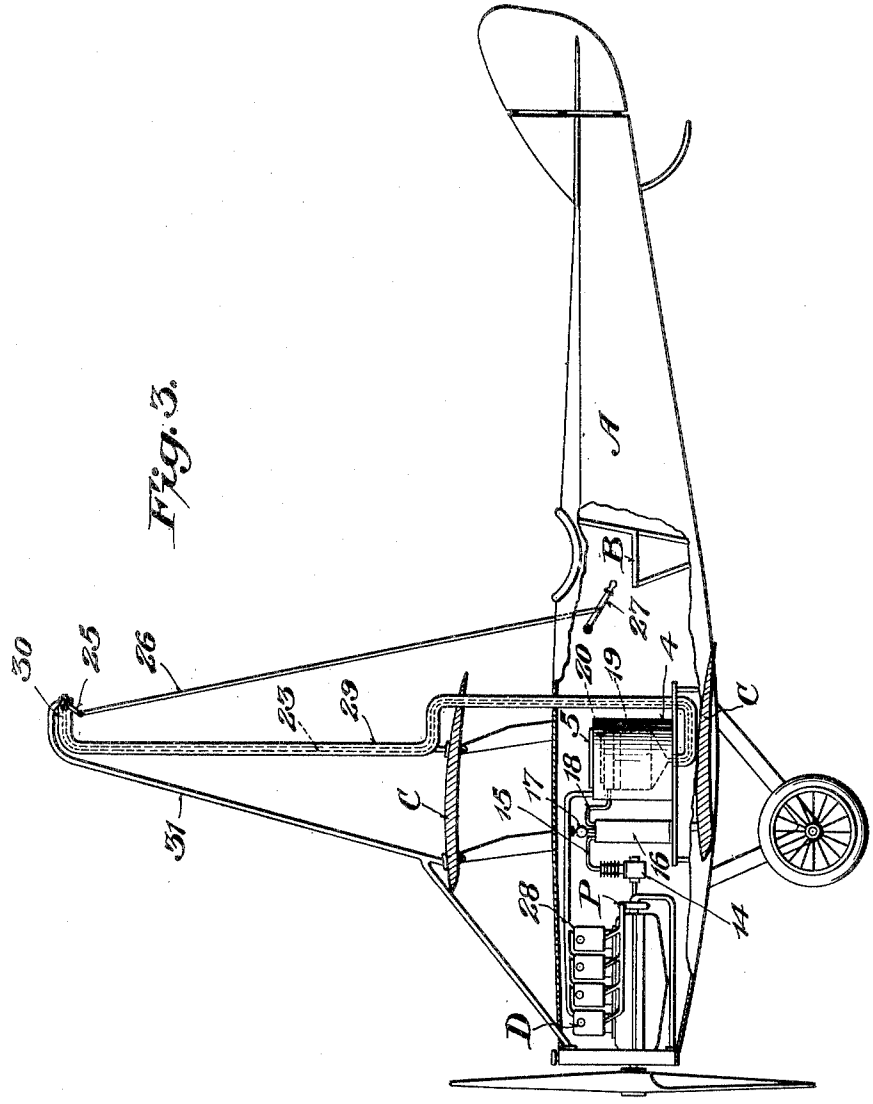
Witness:-
Chas. L. Triesbauer

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SMOKE PRODUCER

Filed July 31, 1923 3 Sheets-Sheet 3

Fig. 3.



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Patented May 14, 1929. 1,713,055

UNITED STATES PATENT OFFICE.

ARTHUR R. SMITH, OF FORT WAYNE, INDIANA; IDA SMITH, ADMINISTRATRIX OF SAID ARTHUR R. SMITH, DECEASED, ASSIGNOR OF ONE-HALF TO JAMES S. SMITH AND ONE-HALF TO IDA SMITH.

SMOKE PRODUCER.

Application filed July 31, 1923. Serial No. 654,887.

The invention pertains to production of smoke and its discharge from aircraft. It relates particularly to discharge of smoke from heavier-than-air craft in sky writing, but also is adapted to the formation of smoke and its discharge for other purposes.

It is an object of the invention to provide means, easily controlled by the operator, that efficiently will treat smoke-producing material and discharge it into the atmosphere.

Another object of the invention is to provide means for employing heat from the propelling-engine of an aircraft to bring smoke-producing material to such temperature as will permit its conveyance to the place of discharge into the atmosphere.

When considered in connection with the description herein, the characteristics of the invention will be apparent from the accompanying drawings, forming part hereof, wherein adaptations of the invention to an airplane are disclosed, for purposes of illustration.

Although the disclosures herein exemplify what now are considered to be preferable embodiments of the invention, it is to be understood that it is not the intention to be limited necessarily thereto in interpretation of the claims, as modifications and adaptations within the limits of the claims can be made without departing from the nature of the invention.

Like reference-characters refer to corresponding parts in the views of the drawings, of which—

Fig. 1 is a side elevation, partly in section and with parts broken away, showing an arrangement of apparatus in accordance with the invention;

Fig. 2 is a plan view, certain parts of the airplane being broken away and other parts omitted; and

Fig. 3 is a view similar to Fig. 1 illustrative of another arrangement.

In the drawings, A designates the fuselage of an airplane of conventional form, B an operator's seat therein, C the sustention-planes, D the propelling-engine, and (as seen in Figs. 1 and 2) E the exhaust-manifold having its discharge end outside of the fuselage, the parts being shown to some extent diagrammatically and only to the degree necessary for exemplification of the invention.

As seen in Figs. 1 and 2, a casing 4, preferably of cylindrical form and having a dome-shaped cover 5, is installed in the fuselage, in the adaptations shown in a position between the engine and the operator's seat. The cover at its top has a sleeve 6, from which a pipe or other suitable vent-conduit 7 leads through, and to a point above, the upper plane of the machine, and that pipe has a rearwardly-deflected discharge-terminal 8. The casing 4 contains the heating-chamber of the device, and the cover 5 thereof is arranged in such manner that it may be moved to afford access to the interior of the chamber. In the adaptation disclosed, the pipe 7 is held fixedly by being attached to the upper wall of the fuselage and to the upper plane, the cover-sleeve 6 is slidable on the lower portion of the pipe, and the cover is movable upwardly off the casing.

Hot exhaust fluids from the engine are conveyed by a pipe or other suitable conduit 9 to the lower portion of the heating-chamber inside of the casing 4, from which they pass upwardly through the pipe 7 and are discharged into the atmosphere. The pipe 9 in its forward portion extends laterally toward a side wall of the fuselage, and it has thereon a turnable elbow 10, which extends through the fuselage-wall and has its terminal portion turned toward and capable of being brought opposite and close to the discharge end of the exhaust-manifold E. The elbow has fixed thereon an arm 11, which is connected by a member 12 with a hand-lever 13 within reach of the occupant of the seat B, whereby the elbow may be swung to alter the relative position of its intake end with respect to the discharge end of the exhaust-manifold and thereby regulate the amount of hot fluids conveyed through the pipe 9 to the heating-chamber.

An air-pump 14, actuated in any suitable manner and preferably by the propelling-engine, forces air through a pipe 15 to a storage-tank 16 having a relief-valve 17 and thence through a pipe 18 to the upper portion of a casing 19 inside of the casing 4. Instead of using an air-pump, the storage-tank may be charged with air at sufficient pressure before the machine leaves the ground, in which event a pressure-reducing valve 17^a is located in pipe 18.

The inner casing 19 contains the fuel or combustion chamber of the apparatus, in

which the smoke-producing material, is treated as hereinafter explained, it preferably is of cylindrical form, and it is smaller than, and has its side wall separated from, the side wall of the casing 4. The casing 19 has a removable or liftable cover 20, it is supported on the bottom of the casing 4 by legs 21, and it has an inverted-cone-shaped bottom 22 positioned somewhat above the bottom of the heating-chamber. It is apparent that the hot fluids in the heating-chamber entirely surround the inner chamber. A pipe 23 leads from near the lowermost point of the bottom 22 upwardly through the fuel or combustion chamber and through the pipe 7, where it is heated by the exhaust fluids passing out through that pipe, to a point slightly to the rear of the rearwardly-deflected discharge-terminal 8. Discharge from pipe 23 is controlled by a valve 24 operated by an arm 25 connected by a member 26 with a hand-lever 27 within reach of the occupant of the seat B.

In the form of apparatus disclosed by Fig. 3, instead of employing heat conveyed from the engine-exhaust, hot water of the engine-cooling system is used. The heating system of that form includes a pipe 28 leading from the jackets of the engine-cylinders to the casing 4, a pipe 29 leading from the bottom of that casing upwardly to a point above the upper sustention-plane and having a rearwardly-deflected terminal portion 30 at its upper end, and a return-pipe 31 leading therefrom to the engine-radiator. The pipe 23 in this arrangement, instead of extending upwardly through the inner chamber, extends downwardly from the lowermost point thereof and thence follows inside of the water-pipe 29 to its upper end, where it extends through the wall of, and projects from, the rearwardly-deflected terminal portion 30. It will be seen that in this form the heating system of the apparatus is a part of the cooling system of the propelling-engine, in which system there is the usual pump P connected by pipes with the cylinder-jackets and radiator.

Apparatus in which hot liquid from the engine is used to bring smoke-producing material to the requisite temperature, and a process that involves employment of hot liquid for that purpose, are described and claimed in my Patent No. 1,526,570, issued February 17, 1925, on an application divisional of this application.

When the apparatus is in operation, or is maintained in readiness for operation, the inner casing 19 contains a material that evolves smoke when heat or air or both are applied thereto, or that produces smoke effect when discharged into the atmosphere; the inner chamber and the pipe 23, which carries smoke material therefrom to the place of discharge above the upper sustention-plane, are maintained at all times in heated condition; and by means of the air-pump or of a precharged storage-tank and the pipes leading therefrom to the inner chamber sufficient air pressure above atmospheric is maintained in that chamber to cause immediate discharge of material therefrom through the pipe 23 upon the opening of the valve 24. Of course, when the apparatus of the form disclosed by Figs. 1 and 2 is not in use or is not expected to be used for some time, the elbow 10 may be turned to the position where it will receive little, if any, of the fluids from the exhaust-manifold.

White phosphorus has been found in the practice of the invention to be among the substances suitable for use in the apparatus for attainment of the results desired. That substance in the commercial form usually is in sticks or cakes. It melts under water at about 111 degrees F. When discharged into the air in melted condition, it ignites spontaneously and produces dense smoke. When that substance is used as the smoke-producing material, it preferably is covered with a layer of water in the casing 19, as indicated at W in Fig. 1, to prevent preignition in that place under the influence of air and heat.

The inner casing 19 being charged with a smoke-producing material—say white phosphorus for example—the casing and its contents are heated by fluids conducted to the heating-chamber. With the form of apparatus shown by Figs. 1 and 2, the temperature in the heating-chamber is regulated by adjustment of elbow 10 to bring it more or less opposite to the discharge end of the exhaust-manifold and thereby to cause it to receive more or less of hot fluids therefrom and less or more air from the atmosphere. With the form of apparatus exemplified by Fig. 3, the water of the circulating system of the engine always gives a sufficient temperature for the melting of white phosphorus.

As the material in the casing 19 melts, it is forced upwardly through the pipe 23 by pressure of air entering the casing from pipe 18 when the valve 24 is open. Air pressure in the inner casing is maintained automatically by relief-valve 17 or by pressure-reducing valve 17^a at a degree not exceeding that predetermined as suitable; and, assuming that the air-pump constantly operates or that the storage-tank remains charged, that pressure is maintained at all times.

The hot exhaust fluids, or the hot water of the engine-cooling system, as the case may be, maintain the smoke material at sufficient temperature for the desired results until it reaches the point of discharge. In the case of white phosphorus, for example, it is kept in melted condition until discharge. It is desirable not only to discharge that substance in melted condition, but also at such temperature above the melting point to which it may be brought

safely in order to counteract the low temperature of the atmosphere at high altitudes, which otherwise might prevent ignition on discharge. The apparatus is capable of bringing the material to that temperature.

When the operator wishes to have streams of smoke formed in the air, he opens valve 24 to the extent necessary to permit emission of the required amount of smoke material. In the case of white phosphorus, the material at the temperature it is emitted ignites upon contact with the atmosphere and produces dense smoke. When it is intended to trail the smoke in such manner as to form signs, characters, letters, words, etc., the airplane is maneuvered to produce the desired forms.

Another substance that may be used advantageously in the apparatus for production of smoke is red phosphorous powder, which is placed in the inner chamber and forced by the air therein under pressure to the discharge end of pipe 23, where in the case of the apparatus disclosed by Figs. 1 and 2 it mixes with the hot exhaust fluids, ignites, and produces dense smoke.

The apparatus also is adapted to the burning of a smoke-producing material in the inner chamber, wherein the air under pressure furnishes the necessary amount of oxygen for combustion and at the same time contributes to the causing of the passage of produced smoke through the pipe 23 to the point of discharge. The particular form of apparatus employed in such a case is dependent upon the character of the combustible. If it is one that requires added heat to facilitate combustion, the form of Figs. 1 and 2, in which hot exhaust fluids are applied to the inner casing, is used. If the combustible is one that is liable to overheat the inner casing, the form of apparatus disclosed by Fig. 3, in which the engine-cooling water surrounds the inner casing, is used.

An important feature of the invention is the discharge of smoke, or of material that will produce smoke on contact with the atmosphere, into a strata of air that is not disturbed by the propeller, sustention-planes, and other parts of the machine in flight.

One of the ways this may be done is disclosed by the drawings, wherein the exhaust-fluid pipe 7 and the smoke-material pipe 23 in the case of the form of Figs. 1 and 2 and the circulating-water pipe 29 and the pipe 23 in the case of the form of Fig. 3 extend upwardly to a point considerably above the upper sustention-plane into atmosphere that is undisturbed by the advancing machine. Smoke or smoke material thus discharged is less apt to be disturbed than when, as is of common practice, it is discharged at the tail of the machine or at other places in the slip streams or in the back wash from the propeller. It will be seen, therefore, that characters, words, etc., formed by maneuver of a machine equipped with this apparatus retain their integrity and visibility for a longer period than when smoke or smoke material is discharged into machine-disturbed air.

Although the invention is described herein with particular reference to the production of smoke in sky writing, the apparatus also is adapted to the production of smoke for screening and other purposes.

The term "smoke material" is used hereinafter to indicate either smoke produced in the apparatus or material that produces smoke on discharge from the apparatus into the atmosphere.

Having thus described by invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In an aircraft having an engine with an exhaust-conduit discharging hot fluid from its end, a receptacle arranged to contain smoke-producing material, a conduit having an end adjacent to and movable toward and from a position opposite to the end of said exhaust-conduit and arranged to apply hot fluid from said exhaust-conduit to the exterior of said receptacle, and a pipe leading from said receptacle and arranged to discharge smoke material therefrom.

2. In an aircraft having an engine with an exhaust-conduit discharging hot fluid from its end, a receptacle arranged to contain smoke-producing material, a pipe terminating at one end adjacent to the exterior of said receptacle, an elbow at the other end of said pipe turnable toward and from a position opposite to the end of said exhaust-conduit, and a pipe leading from said receptacle and arranged to discharge smoke material therefrom.

3. In an aircraft, a receptacle arranged to contain smoke-producing material, a casing surrounding said receptacle, a pipe extending outwardly from said casing, means whereby heat is supplied to the interior of said casing and pipe, and a smoke-material pipe leading from said receptacle through said casing-pipe and arranged to discharge into the atmosphere at its outer end.

4. In an aircraft, a receptacle arranged to contain smoke-producing material, a casing surrounding said receptacle, a pipe extending outwardly from said casing, means whereby hot fluid is conveyed to the interior of said casing and pipe, and smoke-material pipe leading from said receptacle through said casing pipe and arranged to discharge into the atmosphere at its outer end.

5. In an aircraft having an engine, a receptacle arranged to contain smoke-producing material, a casing surrounding said receptacle, a pipe extending outwardly from said casing, means whereby hot fluid from said engine is conveyed to the interior of said casing and pipe, and a smoke-material pipe leading from said receptacle through said

casing-pipe and arranged to discharge into the atmosphere at its outer end.

6. In an aircraft having an engine with an exhaust-conduit, a receptacle arranged to contain smoke-producing material, a casing surrounding said receptacle, a vent-pipe extending outwardly from said casing, a pipe leading from said exhaust-conduit to the interior of said casing, and a smoke-material pipe leading from said receptacle through said vent-pipe to its end.

7. In an aircraft, the combination of a propelling-engine, a closed receptacle arranged to contain smoke-producing material, a pump driven by said engine arranged to compress air into said receptacle, a casing surrounding said receptacle, a pipe extending outwardly from said casing, means whereby hot fluid from said engine is conveyed to the interior of said casing and pipe, a smoke-material pipe leading from said receptacle through said casing-pipe and arranged to discharge into the atmosphere at its outer end, and a valve whereby discharge from said smoke-material pipe is controlled.

8. In an aircraft, the combination of a propelling-engine having an exhaust-conduit, a closed receptacle arranged to contain smoke-producing material, a pump driven by said engine arranged to compress air into said receptacle, a casing surrounding said receptacle, a vent-pipe extending outwardly from said casing, a pipe leading from said exhaust-conduit to the interior of said casing, a smoke-material pipe leading from said receptacle through said vent-pipe, and a valve whereby discharge from said smoke-material pipe is controlled.

9. In an aircraft, a receptacle arranged to contain smoke-producing material, a casing surrounding said receptacle, a pipe extending from said casing into the atmosphere beyond said aircraft ordinarily undisturbed by operation thereof, means whereby heat is supplied to the interior of said casing, and a smoke-material pipe leading from said receptacle through said casing-pipe and arranged to discharge into the atmosphere at the outer end of said casing-pipe.

10. In an aircraft having an engine, a receptacle arranged to contain smoke-producing material, a casing surrounding said receptacle, a pipe leading from said casing into the atmosphere beyond said aircraft ordinarily undisturbed by operation thereof, means whereby hot fluid from said engine is conveyed to the interior of said casing and pipe, and a smoke-material pipe leading from said receptacle through said casing-pipe and arranged to discharge into the atmosphere at the outer end of said casing-pipe.

11. In an aircraft having an engine with an exhaust-conduit, a receptacle arranged to contain smoke-producing material, a casing surrounding said receptacle, a vent-pipe extending from said casing into the atmosphere beyond said aircraft ordinarily undisturbed by operation thereof, a pipe leading from said exhaust-conduit to the interior of said casing, and a smoke-material pipe leading from said receptacle through said vent-pipe and arranged to discharge into the atmosphere at the outer end of the vent-pipe.

12. In an aircraft having a fuselage and a sustention-plane attached thereto, a receptacle in the fuselage arranged to contain smoke-producing material, a casing surrounding said receptacle, a pipe extending upwardly from said casing to a point above said plane, means whereby heat is supplied to the interior of said casing, and a smoke-material pipe leading from said receptacle through said casing-pipe and arranged to discharge into the atmosphere at the upper end of said casing-pipe.

13. In an aircraft having a fuselage, an engine therein, and a sustention-plane attached thereto, a receptacle in the fuselage arranged to contain smoke-producing material, a casing surrounding said receptacle, a pipe extending upwardly from said casing to a point above said plane, means whereby hot fluid from said engine is conveyed to said casing and pipe, and a smoke-material pipe leading from said receptacle through said casing-pipe and arranged to discharge into the atmosphere at the upper end of said casing-pipe.

14. In an aircraft having a fuselage, an engine therein with an exhaust-conduit, and a sustention-plane attached thereto, a receptacle in the fuselage arranged to contain smoke-producing material, a casing surrounding said receptacle, a vent-pipe extending from said casing upwardly to a point above said plane, a pipe leading from said exhaust-conduit to the interior of said casing, and a smoke-material pipe leading from said receptacle through said vent-pipe and arranged to discharge into the atmosphere at the upper end of said vent-pipe.

In witness whereof I affix my signature.

ARTHUR R. SMITH.