

June 4, 1946.

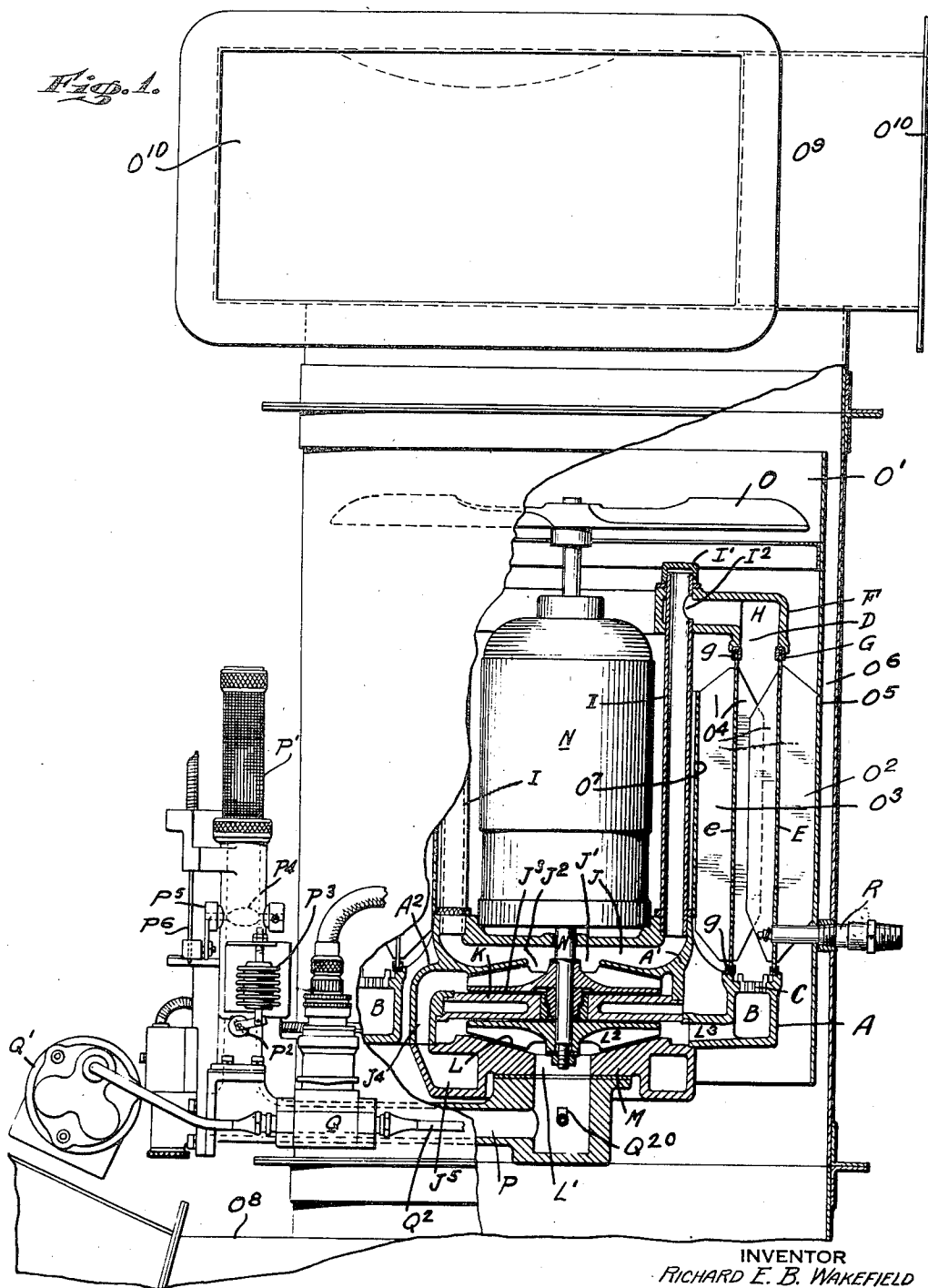
R. E. B. WAKEFIELD

2,401,393

AIRPLANE HEATING SYSTEM

Filed Nov. 21, 1942

2 Sheets-Sheet 1



INVENTOR
RICHARD E. B. WAKEFIELD

BY
John E. Hubbell
ATTORNEY

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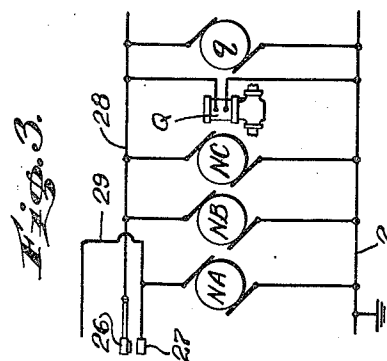
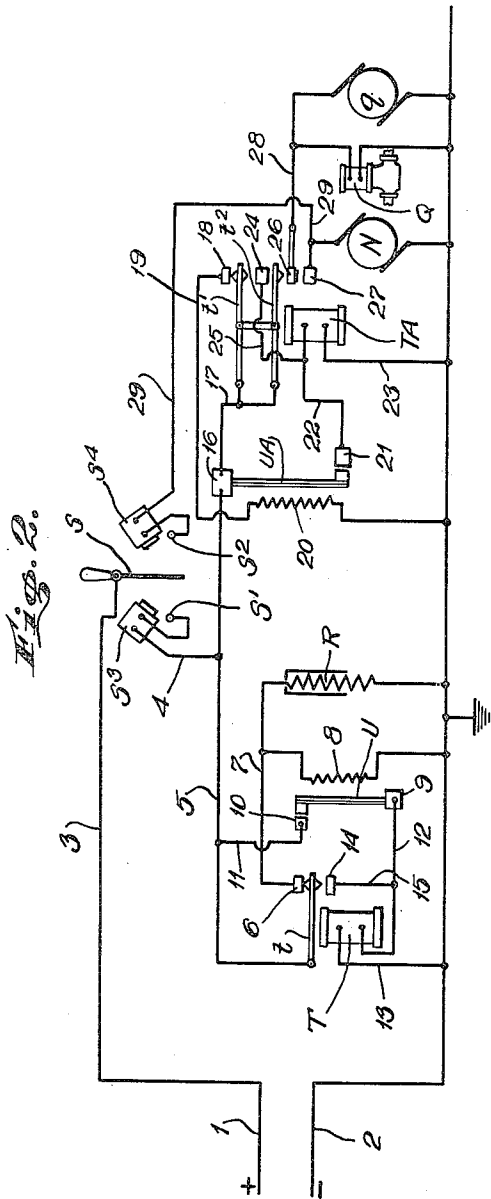
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AIRPLANE HEATING SYSTEM

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2 Sheets-Sheet 2



INVENTOR
RICHARD E. B. WAKEFIELD

BY *John E. Hubbard*
ATTORNEY

UNITED STATES PATENT OFFICE

2,401,393

AIRPLANE HEATING SYSTEM

Richard E. B. Wakefield, Aldan, Pa., assignor to
Selas Corporation of America, a corporation of
Pennsylvania

Application November 21, 1942, Serial No. 466,423

9 Claims. (Cl. 126—110)

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The general object of the present invention is to provide an improved airplane heating system for supplying heated air to the cabin and other spaces of transport and war planes desirably heated, and for defrosting and other special airplane purposes. More specifically stated, the object of the present invention is to provide an airplane heating system comprising a heater, electric motor fan means for moving combustible material into, and products of combustion out of the heating unit including a combustion chamber, and electrical ignition means extending into said chamber, with improved means for controlling and timing the operation of said ignition means and motor means, so as to insure desirable heater starting and operating conditions.

Although not to be limited thereto, the invention is especially applicable to a heater of the compact, lightweight, high capacity type like that disclosed in Patent No. 2,388,970 granted November 13, 1945. In the operation of such a heater, motor driven fan means maintain draft conditions for rapidly moving a combustible mixture of air and gasoline into the combustion chamber of the heating unit and for rapidly moving products of combustion therefrom, and heat is transmitted at a correspondingly rapid rate to an air heating space separated by thin metallic walls from the heating unit, and through which air to be heated is moved by a motor driven circulating fan.

In starting such heaters into operation under adverse conditions created by very low atmospheric temperatures, augmented at times by very low atmospheric pressures, difficulty is sometimes experienced in igniting the combustible mixture supplied to the combustion chamber, and maintaining its ignition for the few seconds required to heat up the combustion chamber from its cold temperature, which may be twenty or more degrees Fahrenheit below zero, to a temperature above the ignition temperature of said mixture.

In the practical use of such heaters, a hot wire igniter extending into the combustion chamber has been found preferable to spark plugs or other ignition means, and an important specific object of the present invention is to provide heater conditions permitting the rapid heating of a hot wire igniter to an ignition temperature, without objectionable risk of injuriously overheating the igniter in the subsequent regular operation of the heater.

For the attainment of said specific object, I have devised electric energizing means for the hot wire igniter and for the fan driving motor

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or motors of the heating system which is operable, in starting the heater into operation, to supply heating current to the igniter during a short energization period comprising an initial portion in which the igniter is heated to an ignition temperature; and a final ignition portion to start said motor or motors into operation at the beginning of said final ignition portion of the ignition energization period. With energization means operating as described, the rapid heating of the igniter to an ignition temperature is not prevented nor made difficult by the cooling action of cold combustible mixture entering the combustion chamber, nor by the cooling action of air moved through the heating space of the heater, and the risk of an objectionable accumulation of unburned gasoline in the combustion chamber is substantially eliminated. The deenergization of the hot wire igniter as soon as ignition is well established materially reduces the risk of injuriously overheating the igniter and prolongs its operating life.

A practically important object of the invention is to provide a heating system which may have its operation started, maintained and terminated with a minimum demand on the time and attention of the operator. In the preferred form of the invention, the heating system is started into and maintained in operation by the adjustment of a simple switch from an off position into a normal operative position, and the heater operation is terminated by the return of the switch to its off position. In some cases the control switch is advantageously adapted by its adjustment into and out of a second operating position to operate the heater circulating fan for ventilation purposes, without operating the heater.

The control of the heating system by simple control manipulations is especially important because the operator of the heater may be able to give little time or attention to the heater. For example, the pilot of a fighter plane must observe or manipulate a multiplicity, sometimes as many as 40, instruments and control elements all within a very short period and sometimes under severe combat conditions.

In the preferred form of the present invention, the adjustment of the control switch into its normal operating condition energizes the igniter and two timing mechanisms, one of which terminates the energization of the igniter at the end of a suitable energization period which ordinarily is less than one minute, while the second timing mechanism energizes the fan driving

motor or motors at a time suitably subsequent to the beginning and suitably prior to the end of said energization period.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, however, its advantages, and specific objects attained with its use, reference should be had to the accompanying drawings and descriptive matter in which I have illustrated and described preferred embodiments of the invention.

Of the drawings:

Fig. 1 is an elevation partly in section of an airplane heater of known type;

Fig. 2 is a diagram illustrating the electric circuit arrangement employed in a preferred embodiment of the present invention; and

Fig. 3 is a diagram illustrating a modification of a portion of the circuit arrangement shown in Fig. 2.

In Fig. 1 I have illustrated an improved form of airplane heater of the type disclosed in the above mentioned patent, as an example of a heater well adapted for use in my improved heating system and capable of improved operating results when so used, but said heater of itself comprises nothing claimed as novel herein.

The heater structure illustrated in Fig. 1 comprises a base member or casting A formed with an annular burner chamber B surrounding a central fan housing portion A' connected to the wall of the burner chamber B by integral connecting arm portions A². The burner inlet chamber B is open at its upper side, and the casting A is recessed to provide a seat for an annular orifice wall C which separates the burner inlet chamber B from an annular space or chamber D. The orifice wall C is formed of thin, radially extending, plate like members of ceramic material having orifice forming grooves in their sides which are adapted to pass a combustible mixture from the chamber B into the chamber D, generally as disclosed in Patent 2,228,114, granted January 7, 1941.

The inner and outer walls of the space D are hollow cylinders e and E, shown as formed of sheet metal parts and each clamped between the base casting A, and a top casting F. As shown, the upper and lower edges of the chamber wall E are received in slots formed in the adjacent sides of upper and lower clamping rings G, and the upper and lower edges of the wall e are received in slots formed in clamping rings g which differ from the clamping rings G only in that they are of smaller diameter. The castings A and F are rabbeted to provide seats for the clamping rings g and G.

The top casting F is formed with an annular chamber H into which the upper end of the chamber D opens. Products of combustion passing from chamber D into chamber H, pass down from the latter through tubes I disposed between the heater axis and the chamber, and serving as hollow tie bolts connecting the castings A and F. As shown, each of the tubes I has its lower end threaded into a corresponding opening in the top wall of an exhaust fan inlet chamber J formed in the fan housing portion A' of the bottom casting. Each tube I has its upper end engaged by a cap nut I' threaded on the upper end of the tube and engaging the top wall of the top casting F, thereby clamping the walls E and e between the castings A and F. Each

cap nut I' also forms a closure for the upper end of the bore of the corresponding tube I. Each tube I is formed with a lateral opening or port I² through which products of combustion pass from the chamber H into the bore of the tube.

The fan inlet chamber J communicates through a central port J' with a subjacent exhaust fan chamber J² having its top wall formed by the housing A' and having its bottom wall formed by a separable disc like partition member K. The member K also forms the top wall of a combustion air fan chamber L. The bottom wall of the chamber L is formed by a separable fan housing member M. A rotating fan J³ of the turbo blower type is mounted in the chamber J² and draws products of combustion from the inlet chamber J through the port J' and discharges those products through downwardly extended channels J⁴. The latter are formed in the portion of the casting A between the disc K and the burner chamber B and their lower ends communicating with an annular outlet chamber J⁵ formed in the subjacent housing member M, and provided with an outlet passage, not shown in the drawing, through which the products of combustion formed in the heater are discharged into the atmosphere enveloping the airplane in which the heater is mounted.

The fan casting element M is formed with a central inlet L' to the fan chamber L, through which a fan L² of the turbo blower type working in the chamber L draws combustion supporting air. The air thus moved through the chamber L is passed from the latter through discharge conduits L³ to the burner inlet chamber B.

As shown in Fig. 1, the combustion supporting air supply fan L² and the exhaust fan J³ are carried by the lower end portion of the shaft N' of an electric motor N, preferably a series motor, which is axially disposed in the heater. The upper end of the motor shaft of the motor N carries an air circulating fan or blower O employed to move the air being heated through the heater and also capable of use as a ventilating fan at times when the heater is not in use. As shown in Fig. 1, the circulation fan O works in a fan chamber O' receiving air from outer and inner spaces O² and O³ at the outer and inner sides, respectively, of the combustion space. In the normal use of the heater the spaces O² and O³ are air heating spaces, and to increase the rate at which heat is absorbed from the chamber D and given up to the air moving through the spaces O² and O³, the chamber walls E and e are each provided with internal and external radial fins or ribs O⁴ of sheet metal. The fins O⁴ extending radially away from the outer chamber wall E are surrounded and have their outer edges in contact with a cylindrical sheet metal shell O⁵. In some cases the latter may be the outer heating casing, but as shown in Fig. 1, the wall O⁵ is spaced inwardly from a separate heater casing to provide a narrow annular heat and sound insulating space O⁶. The inner edges of the fins O⁴ at the inner side of the wall e engage a cylindrical baffle O⁷.

The fan O draws air to be heated from a receiving chamber O⁸ beneath the heater space into the lower ends of the annular spaces O² and O³, and into the lower end of the space surrounded by the baffle O⁷, and draws heated air from the last mentioned space and the spaces O² and O³ into the fan chamber O'. The space sur-

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rounded by the baffle O' receives the motor N which is cooled by the air passing through said space. The fan chamber O' is beneath and opens into a distributing chamber O⁹ having a plurality of outlets O¹⁰ which may deliver heated air to conduits, not shown, for conveying the air to various points of use, or in some cases, the upper end of the outlet chamber O' may open directly to the airplane space in which the heater is located.

Combustion supporting air is supplied to the inlet L' of the pump chamber L, by a supply pipe P, which in some cases may lead to an inlet louvre carried by the airplane shell and supplying air drawn directly from the external atmosphere, but ordinarily, and as shown, however, the pipe P receives air from the airplane cabin space in which the heater is mounted and a fire check P' is provided to avoid risk of back fire in said space. The inlet pipe P includes a damper P² shown as a butterfly valve, and a device P³ responsive to atmospheric pressure for adjusting the damper P² to automatically reduce its throttling effect, as the atmospheric pressure diminishes, from the initial maximum throttling condition of the damper which exists when the atmospheric pressure has the normal sea level pressure.

As shown, the inlet pipe P also includes a manually operable butterfly valve P⁴, having an operating arm P⁵ spring biased to maintain the valve in its wide open position. The valve P⁴ is provided primarily to enable the airplane pilot to facilitate ignition, when necessary, in starting the heater into operation, by temporarily choking the combustion supporting air supply and thereby increasing the fuel to air ratio in the mixture supplied to the burner inlet chamber B. The lever P⁵ may be actuated directly by the fingers of the pilot in some cases, but, as shown, the pilot may actuate the lever P⁵ through a flexible transmitter P⁶ extending from the heater to a conveniently located push button station, not illustrated.

The supply of gasoline to the heater shown in Fig. 1 is directly controlled by an electro-magnetic or solenoid valve Q, interposed in the pipe Q² through which liquid fuel is supplied by a pump Q' to a nozzle Q²⁰. The pump Q' is operated by an individual driving motor q. The nozzle Q²⁰ has a restricted orifice through which a jet of gasoline is discharged against the inner portion of the impeller of the combustion air supply fan L², and the latter serves as a mechanical atomizer for the liquid fuel, breaking the latter up into minute particles which are entrained by the combustion supporting air supplied to the burner chamber B. The heater may be provided with a thermostatic means (not shown), automatically interrupting the supply of fuel to the heater when the temperature of heater chamber D rises unduly, as it may do on an interruption in the normal flow of air to be heated through the heating spaces O² and O³.

As shown, a hot wire igniter R extends into the chamber D through the surrounding walls of the heater, for use in igniting the fuel and air mixture passing into the bottom part of said chamber from the burner chamber B when the heater is being started into operation.

In the normal contemplated use of the heater shown in Fig. 1, the valve Q is open and the pump Q' supplies gasoline at a suitable pressure to the nozzle Q²⁰. The combustion supporting air supply fan L², mechanically atomizes the gasoline

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discharged by the nozzle Q²⁰, and mixes it with the combustion supporting air and moves the mixture into the burner inlet chamber B. From the latter, the combustible mixture passes through the orifices in the wall C into the chamber D, and burns in that chamber. Products of combustion are drawn out of the chamber D and discharged by the exhaust fan J³.

The igniter R is energized to ignite the combustible mixture in starting the heater into operation, but advantageously is deenergized as soon as ignition is effected and raises the temperature in chamber D above the ignition temperature of the combustible mixture.

In Fig. 2 I have diagrammatically illustrated a control system embodying the invention for the heater shown in Fig. 1, which comprises a manually operated control switch S adjustable into a heating or heater operation position at one side, and into a ventilating or ventilator operation position at the other side of an intermediate neutral position. Associated with the control switch S are means producing the following effects when the switch is moved into its heating position: namely—the energization of the igniter R, the deenergization of the igniter at the end of a suitable energization period, which, for example, may be 45 seconds, the energization of the fuel pump motor q and the opening of the fuel valve Q after a suitable interval, for example 30 seconds following the energization of the igniter and suitably prior to the deenergization of the igniter, and the energization of the fan motor N on, or promptly after, the energization of the pump motor q and the opening of the valve Q. After the heater has thus been started into regular operation the energization of the fuel pump motor q and fan motor N is maintained and the fuel valve Q is kept open until the control switch S is moved out of its normal operating position.

The movement of the switch S into its ventilating position does not energize the igniter R or fuel pump motor q and does not open the valve Q, but does energize the fan motor N which is then operated to effect the ventilating action of the fan O.

In Fig. 2 the control switch S is shown in its intermediate neutral, or non-operative position, and the other movable control elements are shown in positions assumed by them when the heater and its adjuncts are out of operation. Advantageously, the switch S is biased for movement into its neutral position from which it is movable clockwise into its heating position, and counter-clockwise into its ventilating operation position. When the switch S is adjusted into its heating position it normally energizes an electro-magnetic device S³ for holding the switch S in its heating position with a force exceeding the bias force tending to return the switch to its intermediate position, but insufficient to interfere with the manual adjustment of the switch out of its heating position. A second electro-magnetic device S⁴, similarly tends to maintain the switch in its ventilating position following its adjustment into that position.

The electrical energy used in operating the heater and control mechanism shown in Fig. 2, is furnished by supply conductors 1 and 2 which may be branches of the direct current supply system customarily provided to serve a variety of airplane purposes having nothing to do with heating or ventilation. As shown, and as is customary, the negative supply conductor 2 is grounded. A branch conductor 3 connects the switch S to

the supply conductor 1. The movement of the switch S into its heating position connects the switch contact S' to the conductor 3 and thereby to the supply conductor 1, and normally effects the immediate closure of separate energizing circuits for the igniter R, for the heating coils 8 and 20 of thermal switches U and UA, respectively, and for the switch holding magnet S³.

The igniter energizing circuit then closed may be traced as follows: conductor 1, conductor 3, switch S, contact S', winding of switch holding device S³, a conductor 4, conductor 5, switch arm t of a relay T, contact 6, conductor 7, and igniter R to supply conductor 2. The heating coil 8 for the thermal switch U is connected between the conductors 7 and 2, in parallel with the igniter R, and is thus energized when, and only when the igniter R is energized.

The thermal switch U comprises a bimetallic bar which is anchored at one end to a stationary terminal 9, and is adapted to flex when suitably heated to move its other end into engagement with a stationary contact 10 connected by a conductor 11 to the conductor 5 and thereby close an energizing circuit for the relay T, said circuit including the conductors 5 and 11, the contact 10, the thermal switch U, its terminal 9, a conductor 12, the winding of the relay T, and a conductor 13 connecting the second terminal of the relay to the supply conductor 2. When the thermal switch U is cold it does not engage the contact 10.

The thermal switch U is designed to be operatively heated by the heating coil 8 so as to energize the relay T at the end of a suitable predetermined period of 45 seconds or so, following the energization of the igniter R, long enough to put the heater into full operation under normal operating conditions. When the thermal switch U effects the energization of the relay T, the latter attracts its switch arm t and moves it out of the position shown in Fig. 2 and into which it is suitably biased. When the switch arm t is thus moved it disengages the contact 6, and moves into engagement with a contact 14. The movement of the switch arm t out of engagement with the contact 6, deenergizes the igniter R and the heating coil 8 for the thermal switch U.

When the arm t engages the contact 14, it closes a holding-in circuit for the relay T, which comprises the conductor 5, switch arm t, contact 14, conductors 15 and 12, winding of relay T and conductor 13. This holding-in circuit for the relay T is maintained, under normal operating conditions, until the switch S is moved out of its heating position, and it prevents the reenergization of the igniter R and heater coil 8 as long as it maintains the energization of relay T.

The initial movement of the switch S into its heating position closes an energizing circuit for the heater coil 20 of the thermal switch UA, said circuit comprising the conductors 4 and 5, the stationary terminal 16 of the switch UA, the conductor 17, switch arm t' of a relay TA, stationary contact 18, conductor 19, and the heating coil 20 which has one terminal connected to the conductor 19 and has its other terminal connected to the supply conductor 2.

The thermal switch UA may be a duplicate of the switch U, comprising a bimetallic metal bar which is connected at one end to its stationary terminal 16, and which deflects when suitably heated to move its other end into engagement with a stationary contact 21 from which it is separated when cold. The thermal switch UA is

designed to engage the contact 21 after a predetermined heating period of 30 seconds, for example, following the energization of the ignition device R. Said period is intended to be sufficient to heat the device R up to its operating temperature, and to be suitably shorter than the period during which the igniter R is energized, to permit the pump and fan motors q and N to come into full operation, and the valve Q to be fully opened and thus permit the heater to start into full operation before the igniter R is deenergized.

When the thermal switch UA heats up and connects its terminal 16 and contact 21, it closes an energizing circuit for the relay TA, which includes the terminal 16, thermal switch UA, contact 21, conductor 22 connected to one terminal of relay TA, and conductor 23, which connects the second terminal of relay TA to the supply conductor 2. The energization of the relay TA moves its switch arm t' out of engagement with the contact 18 and into engagement with a stationary contact 24. The movement of the switch arm t' out of engagement with the contact 18 opens the above described energizing circuit for the heating coil of the relay UA. However, the movement of the switch arm t' into engagement with the stationary contact 24 closes a holding-in circuit for the relay TA which is operative to maintain the energization of the latter after the thermal switch UA cools and disconnects the terminal 16 and contact 21. Said holding-in circuit comprises a conductor 25 connecting the contact 24 to the conductor 22, and thereby through the winding of relay TA to conductor 2. When switch arm t' engages contact 24 it connects the latter to the conductor 17, and thereby to the switch contact S' and through the switch S to the supply conductor 1.

The relay TA includes a second switch arm t², link connected to the switch arm t' so that the two switch arms move simultaneously in the same direction. When the relay TA is energized the switch arm t² is attracted and engages a movable contact 26 and moves the latter into engagement with a stationary contact 27. Contact 26 is suitably biased to the intermediate position shown in Fig. 2 in which it is between the switch arm t² and contact 27, and does not engage either. The contact 26 is connected by a conductor 28 to one terminal of the fuel pump motor q, and to one terminal of the electromagnetic valve Q. The second terminal of the latter and the second terminal of the motor q are connected to the supply conductor 2. The switch arm t² is connected to the conductor 17 and thence, through circuit connections previously described, to the supply conductor 1, when the switch S is in its heating position. In consequence, the energization of the relay TA and the resultant movement of the switch arm t² operatively energizes the valve Q and fuel pump motor q through the contact 26, and operatively energizes the fan motor N which has one terminal connected through conductor 29 to the contact 27 and thence to the supply conductor 1, and has its other terminal connected to the supply conductor 2.

When the switch S is moved into its ventilating position in which it engages the contact S² it completes an energizing circuit for the fan motor N and for the holding-in device S⁴, but does not complete any other energizing circuit. The energizing circuit completed by the movement of the switch S into engagement with the switch contact S² includes supply conductor 1, conductor 3, switch S, switch contact S², winding of switch

holding device S⁴, the previously mentioned conductor 29 and the corresponding terminal of the fan motor N, the second terminal of which is connected to the supply conductor 2.

Each of the thermal switches U and UA is, in effect, a timing device, and in conjunction with the associated relay T or TA, respectively, forms a timing mechanism which opens or closes one or more operating circuits, after a predetermined time interval following the energization of the heating coil of the thermal switch. The normal duration of the coil heating period required to produce the desired switch action, is determined by the design of the thermal switch and the value of the current passed through its heating coil employed. As previously suggested, the time required to heat the thermal switches U and UA up to operating temperatures may ordinarily be of the order of 45 seconds and 30 seconds, respectively. As will be apparent, however, while those periods are advantageously as short as safe operating conditions permit, they may vary considerably without interfering with the general operation of the apparatus, provided that the switch UA attains its operating temperature sufficiently subsequent to the initiation, and sufficiently prior to the termination of the period during which the igniter R is energized.

As will be apparent, a heating system of the character illustrated diagrammatically in Fig. 2 and including a heater structure of the character illustrated in Fig. 1, is well adapted for the attainment of all of the hereinbefore stated objects of the present invention. During the initial igniter heating portion of the igniter energization period none of the fans is in operation, and therefore the heating of the igniter to a suitable ignition temperature is not delayed or interfered with by the cooling action of combustible mixture moving into the combustion chamber, or by the cooling action of air moved through the heater by the circulating fan O. When the fans start into operation and combustible mixture begins to move into the combustion chamber D, the igniter R will normally be hot enough to effect the immediate ignition of the entering mixture.

The fact that the igniter heating coil 8 is de-energized almost immediately after the heater comes into regular operation, insures an appreciably lower average igniter temperature during regular operation than would exist if the energization of the igniter were maintained, and thus tends to prolong its operative life.

The system shown in Fig. 2 possesses certain safety advantages, in that an accidental interruption in the current flow through the switch S will deenergize the holding-in device S³ or S⁴ then in service and thereby open all operating circuits, and only a brief interruption in the current flow through the heating coil 20 of the timing switch mechanism UA is required for the de-energization of the relay TA and the resultant interruption of the supply of fuel and combustion air to the heater. Furthermore, if under adverse circumstances ignition in the bottom part of chamber D is not established at the end of the predetermined igniter energization period, the heater cannot be thereafter brought into operation without first moving the switch S out of, and then back into its working position and thereby initiating a new igniter energization period.

As will be apparent, the control system shown in Fig. 2 may readily be modified as required to accommodate variations in the structure and operation of the heater element of the system.

For example, when the circulating fan O, the supply fan L² and exhaust fan J³ are driven by separate motors indicated in Fig. 3 as NA, NB and NC, as may be desirable in some cases, the energizing circuit for the motor NA may include the conductor 29, and the energizing circuits for the motors NB and NC may include the conductor 28.

While in accordance with the provisions of the statutes, I have illustrated and described the best forms of embodiment of my invention now known to me, it will be apparent to those skilled in the art that changes may be made in the forms of the apparatus disclosed without departing from the spirit of my invention as set forth in the appended claims, and that in some cases certain features of my invention may be used to advantage without a corresponding use of other features.

Having now described my invention what I claim as new, and desire to secure by Letters Patent, is:

1. An airplane heater system comprising in combination an airplane heater having a combustion chamber, means including an electric fan for moving combustible material into said chamber, electrical ignition means extending into said chamber, means including an electric circulating fan for moving air to be heated in heat transfer relation with said chamber, electric energizing means including two electric timing mechanisms and a control switch having two operative positions in one of which it is operable to energize said ignition means and each of said timing mechanisms, means actuated by one of said mechanisms to deenergize said ignition means at the end of a definite energization period following its energization by said switch, and means actuated by the other timing mechanism for energizing said fans at the end of a definite time interval following its energization by said switch and shorter than said ignition energization period, and circuit means including said switch in its second operable position to energize said circulating fan without energizing said ignition means and timing mechanism.

2. In a heating system having a heating unit comprising a combustion chamber, means including a blower and a fuel supply line to supply combustible fuel mixture to said chamber, electrically operable valve means in said fuel line, an electric motor for driving said blower, an igniter for igniting the combustible mixture supplied to the chamber, circuit means including a first thermal switch which is actuated after an interval of time following initial energization of said circuit means, means including a manually operable control to complete circuits for simultaneously energizing said igniter and said circuit means, and, when said first switch is actuated, to complete a normal operating circuit for said motor and said valve means to effect heating by the unit, means including a second thermal switch having a movable member which is actuated from a first to a second position after a longer interval of time than that required to actuate said first switch to modify the igniter circuit and render the igniter ineffective without affecting said first switch and the normal operating circuit completed by the latter for said motor and said valve means, and a holding circuit energized by closure of said second switch and including means in such circuit to effect deenergization of said second switch and to shunt the contacts of said second switch when said member moves to its second position, said

holding circuit being connected with said circuit means and remaining energized so long as the normal operating circuit for said motor and said valve means remains completed.

3. In a heating system having a heating unit comprising a combustion chamber, an electrical device, means whereby combustible fuel is supplied to said chamber with the aid of said device when the latter is energized, means including a fan for circulating air adapted to be heated by the heating unit, an electric motor for driving said fan, an electrical igniter for igniting the combustible fuel supplied to the chamber, circuit means including a first thermal switch which is actuated after an interval of time following initial energization of said circuit means, means including a manually operable control to complete circuits for simultaneously energizing said igniter and said circuit means, and, when said first switch is actuated, to complete a normal operating circuit for said motor and said device to effect heating of air, means including a second thermal switch having a movable member which is actuated from a first to a second position after a longer interval of time than that required to actuate said first switch to modify the igniter circuit and render the igniter ineffective without affecting said first switch and the normal operating circuit completed by the latter for said motor and said device, and a holding circuit energized by closure of said second switch and including means in such circuit to effect deenergization of said second switch and to shunt the contacts of said second switch when said member moves to its second position, said holding circuit being connected with said circuit means and remaining energized so long as the normal operating circuit for said motor and said device remains completed.

4. In a heating system having a heating unit comprising a combustion chamber, means including a fuel supply line to supply a combustible fuel to said chamber, means including a fan for circulating air adapted to be heated by the heating unit, an electric motor for driving said fan, electrically operable valve means in said fuel line for controlling flow of fuel therethrough, an electrical igniter for igniting the combustible fuel supplied to the chamber, circuit means including a first thermal switch which is actuated after an interval of time following initial energization of said circuit means, means including a manually operable control to complete circuits for simultaneously energizing said igniter and said circuit means, and, when said first switch is actuated, to complete a normal operating circuit for said motor and said valve means to effect heating of air, means including a second thermal switch having a movable member which is actuated from a first to a second position after a longer interval of time than that required to actuate said first switch to modify the igniter circuit and render the igniter ineffective without affecting said first switch and the normal operating circuit completed by the latter for said motor and said valve means, and a holding circuit energized by closure of said second switch and including means in such circuit to effect deenergization of said second switch and to shunt the contacts of said second switch when said member moves to its second position, said holding circuit being connected with said circuit means and remaining energized so long as the normal operating circuit for said motor and said valve means remains completed.

5. In a heating system having a heating unit comprising a combustion chamber, means includ-

ing a fuel supply line to supply a combustible fuel to said chamber, means including a fan for circulating air adapted to be heated by the heating unit, an electric motor for driving said fan, electrically operable valve means in said fuel line for controlling flow of fuel therethrough, an electrical igniter for igniting the combustible fuel supplied to the chamber, circuit means including a first switch adapted to be actuated after an interval of time following initial energization of said circuit means, means including manually operable control structure to complete circuits to energize said igniter and said circuit means, and, when said first switch is actuated, to complete a normal operating circuit for said motor and said valve means to effect heating of air, means including a thermal time switch to modify the igniter circuit and render the igniter ineffective, and means including said control structure to complete a second circuit for said motor without completing said igniter circuit and said normal operating circuit for said motor and said valve means, said control structure being so constructed and arranged that said second circuit cannot be completed at the same time as the igniter circuit and normal operating circuit.

6. In a heating system having a heating unit comprising a combustion chamber, an electrical device, means whereby combustible fuel is supplied to said chamber with the aid of said device when the latter is energized, means including a fan for circulating air adapted to be heated by the heating unit, an electric motor for driving said fan, an electrical igniter for igniting the combustible fuel supplied to the chamber, circuit means including a first switch adapted to be actuated after an interval of time following initial energization of said circuit means, means including manually operable control structure to complete circuits to energize said igniter and said circuit means, and, when said first switch is actuated, to complete a normal operating circuit for said motor and said device to effect heating of air, means including a thermal time switch to modify the igniter circuit and render the igniter ineffective, and means including said control structure for completing a second circuit for said motor without completing said igniter circuit and said normal operating circuit for said motor and said device, said control structure being so constructed and arranged that said second circuit cannot be completed at the same time as the igniter circuit and normal operating circuit.

7. In a heating system having a heating unit comprising a combustion chamber, means including a fuel supply line to supply a combustible fuel to said chamber, means including a fan for circulating air adapted to be heated by the heating unit, an electric motor for driving said fan, electrically operable valve means in said fuel line for controlling flow of fuel therethrough, an electrical igniter for igniting the combustible fuel supply to the chamber, circuit means including a first switch adapted to be actuated after an interval of time following initial energization of said circuit means, a manually operable control member movable to a number of operating positions, means including said control member in one operating position to complete circuits to energize said igniter and said circuit means, and, when said first switch is actuated, to complete a normal operating circuit for said motor and said valve means to effect heating of air, means including a thermal time switch to modify the igniter circuit and render the igniter ineffective, and means in-

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cluding said control member in another operating position to complete a second circuit for said motor without completing said igniter circuit and said normal operating circuit for said motor and said valve means.

8. In a heating system having a heating unit including a combustion chamber, means to supply a combustible fuel to said chamber including a fuel supply line, a fuel pump for supplying fuel to said line, electrically operable valve means in said fuel line to control flow of fuel therethrough, means including a fan for circulating air adapted to be heated by the heating unit, electrical translating means to operate said pump, an electric motor for driving said fan, an electrical igniter for igniting the combustible fuel supplied to the chamber, circuit means including a first switch adapted to be actuated after an interval of time following initial energization of said circuit means, means including manually operable control structure to complete circuits to energize said igniter and said circuit means, and, when said first switch is actuated, to complete a normal operating circuit for said electrical translating means and said motor and said valve means to effect heating of air, means including a thermal time switch to modify the igniter circuit and render the igniter ineffective, and means including said control structure to complete a second circuit for said motor without completing said igniter circuit and said normal operating circuit for said electrical translating means and motor and said valve means, said control structure being so constructed and arranged that said second circuit cannot be

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completed at the same time as the igniter circuit and the normal operating circuit.

9. In a heating system having a heating unit comprising a combustion chamber, means including a fuel supply line to supply a combustible fuel to said chamber, means including a fan for circulating air adapted to be heated by the heating unit, an electric motor for driving said fan, electrically operable valve means in said fuel line for controlling flow of fuel therethrough, an electrical igniter for igniting combustible fuel supplied to the chamber, circuit means including a first switch adapted to be actuated after an interval of time following initial energization of said circuit means, a manually operable control member movable to a number of operating positions, means including said control member in one operating position to complete circuits for simultaneously energizing said igniter and said circuit means, and, when said first switch is actuated, to complete a normal operating circuit for said motor and said valve means to effect heating of air, means including a thermal time switch to modify the igniter circuit and render the igniter ineffective without affecting said first switch and the normal operating circuit completed by the latter for said motor and said valve means, and means including said control member in another operating position to complete a second circuit for said motor without completing said igniter circuit and said normal operating circuit for said motor and said valve means.

RICHARD E. B. WAKEFIELD.