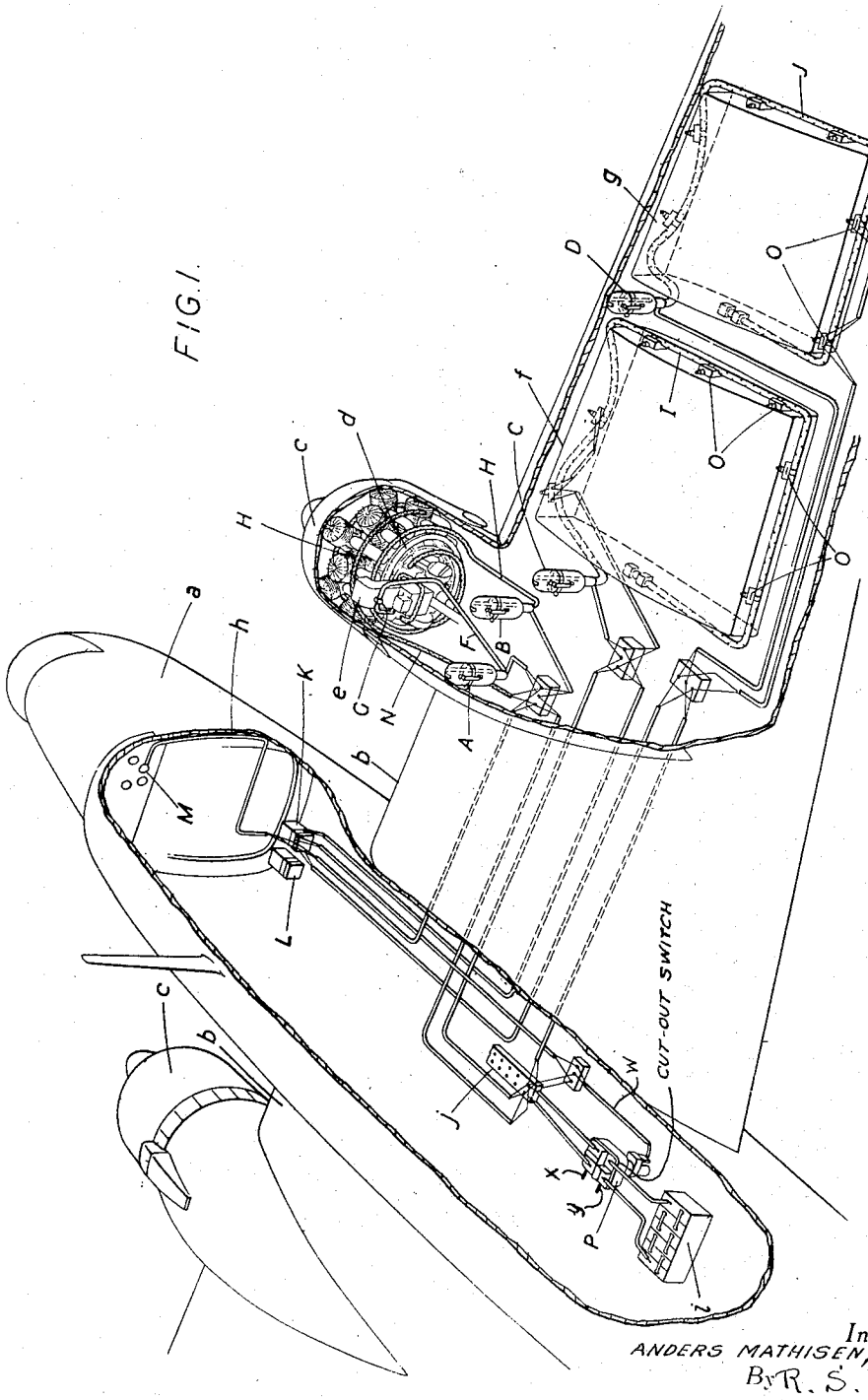
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ELECTRICAL FIRE PREVENTING SYSTEM FOR AIRCRAFT

Filed May 15, 1943 4 Sheets-Sheet 1

FIG. 1.



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ELECTRICAL FIRE PREVENTING SYSTEM FOR AIRCRAFT

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FIG. 2.

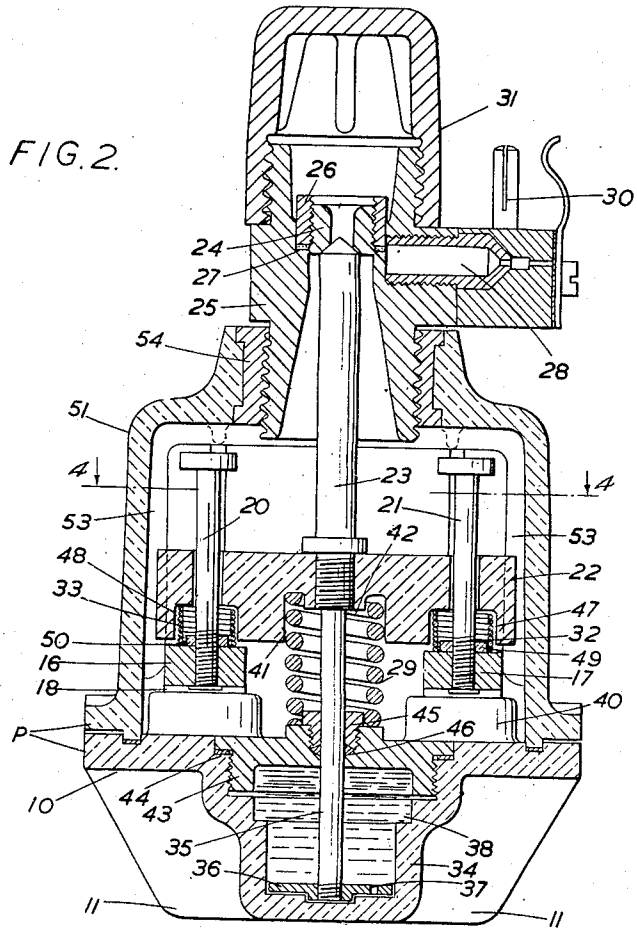
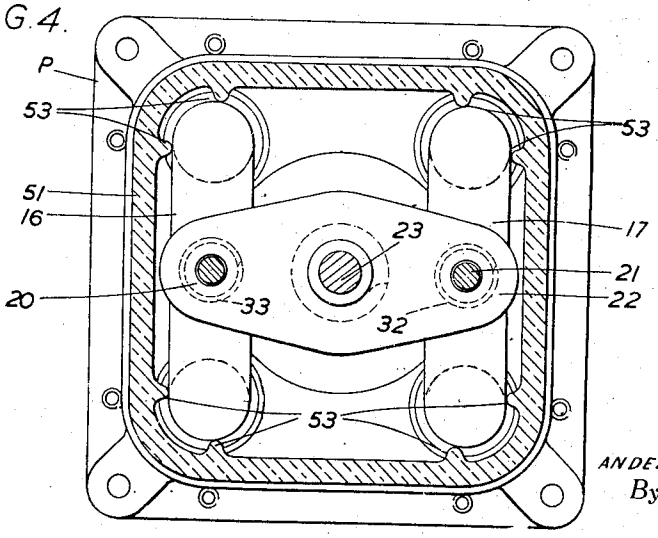


FIG. 4.



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FIG. 3.

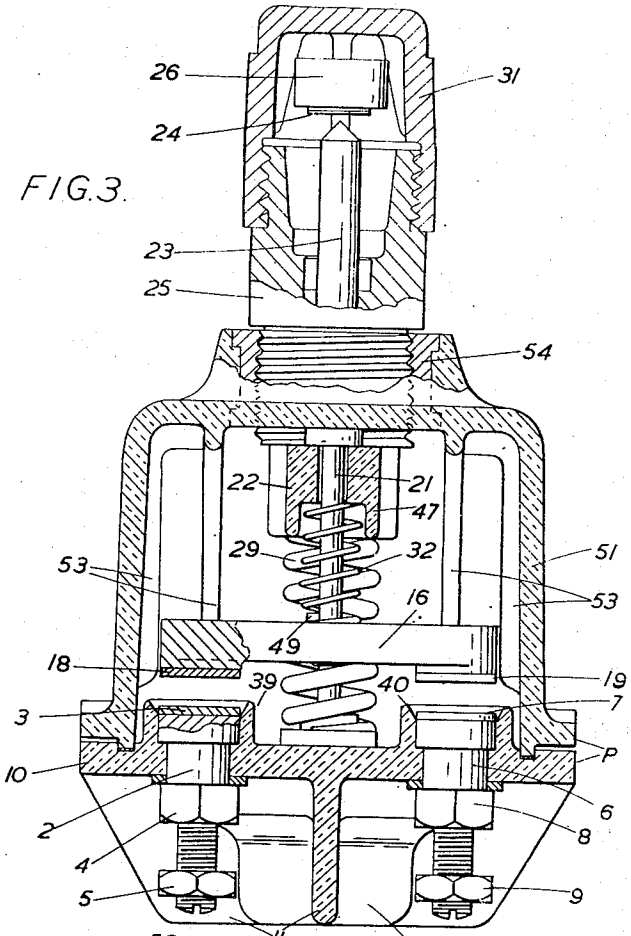
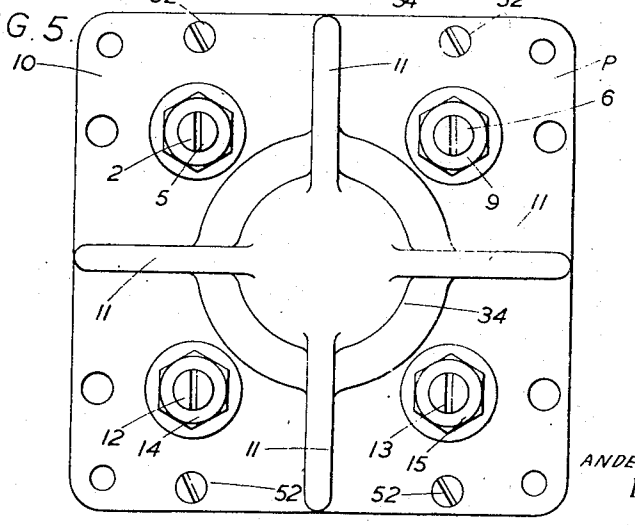


FIG. 5.



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ELECTRICAL FIRE PREVENTING SYSTEM FOR AIRCRAFT

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FIG. 6.

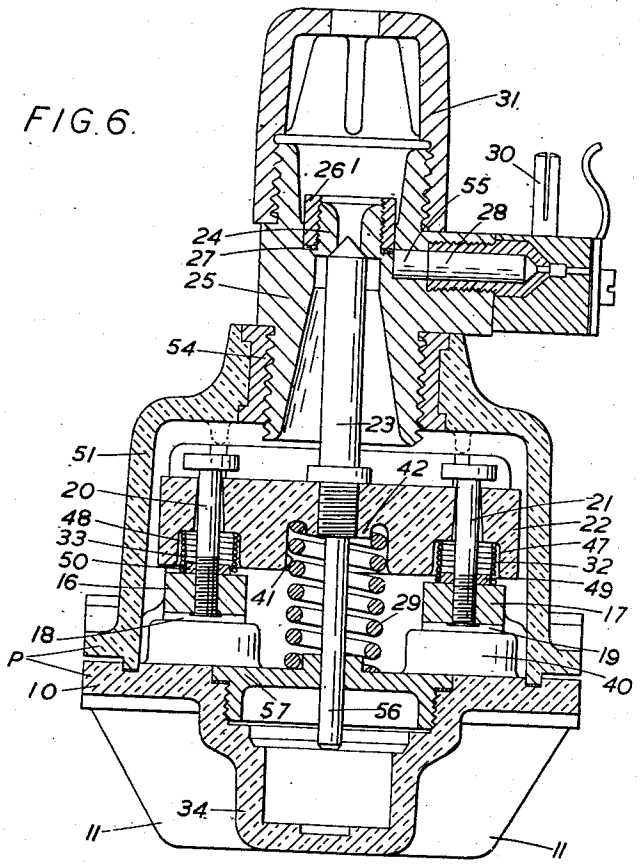
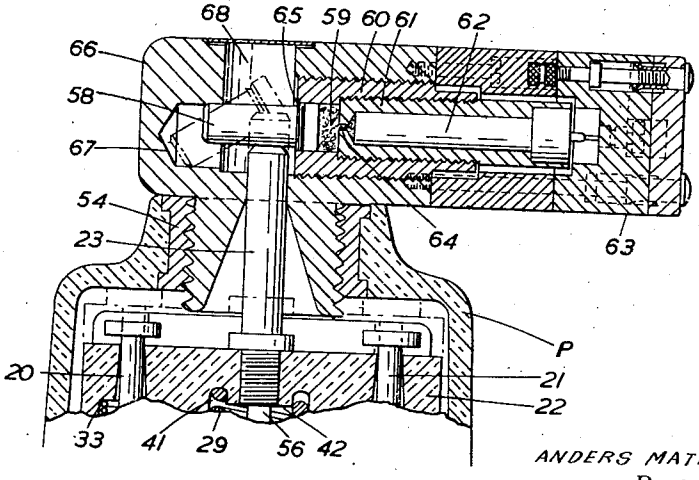


FIG. 7.



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UNITED STATES PATENT OFFICE

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ELECTRICAL FIRE PREVENTING SYSTEM FOR AIRCRAFT

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Application May 15, 1943, Serial No. 487,176
In Great Britain July 8, 1942

11 Claims. (Cl. 169—2)

This invention relates to certain new and useful improvements upon or modifications in electrically actuated fire preventing and fire extinguishing systems.

Extensive use of such described systems heretofore known has proved that these in general provide a satisfactory means for reducing fire risks upon aircraft but experience has shown that electrical equipment and especially the cables upon the aircraft may be damaged or fractured in aircraft crashes, and the principal object of the present invention is to provide a fire-fighting equipment for aircraft comprising an electric circuit cut-out switch incorporating contact members of substantial current carrying capacity, which members are adapted to be closed under substantial pressure, means being provided for opening said contacts when abnormal deceleration is applied to the aircraft, such opening however being arranged to take place after a slight time lag between the application of deceleration to the aircraft and the opening of said contacts, for the purpose of ensuring that fire extinguishers and other types of equipment, which require electric current for operation under crash conditions, are effectively operated before the electric current supply is disconnected.

The cut-out switch is provided with means for closing the contact members, said means being in the nature of a solid abutment which is adapted to apply substantial pressure to the contact members of the cut-out switch in order to ensure high current carrying capacity of said contacts.

The means for effecting opening of said contact members of the cut-out switch is preferably in the form of an explosive charge adapted to displace said abutment when the charge is ignited by electrical means.

The means for effecting opening of the cut-out switch preferably comprises an inertia element operated electric switch adapted to effect ignition of said explosive charge when abnormal deceleration is applied to the aircraft.

One object of the present invention is to ensure continued operation of electric equipment upon aircraft such as electric ignition devices, and electrically automatically operated fire extinguishers and other electrical apparatus, during the period between the application of abnormal deceleration to the aircraft and the opening of said cut-out switch, and to this end a slight time lag is introduced in the operation of said switch, and while any type of time lag device may be used, a preferred method of obtaining a prolonged time lag of the order of from five to ten seconds is by the introduction of a liquid-containing dash-pot device which when incorporated in said cut-out switch mechanism, is adapted to permit retarded movement of a contact actuating member normally forced by said abutment into contact with bridge members of the contact arrangement of the cut-out switch, resilient means such as springs being interposed between said actuating member and the contact bridge members to permit relative movement therebetween, whereby the contact bridges are retained in contact with the contact studs of the device for a predetermined period, after ignition of the explosive charge, and consequent instantaneous removal of the abutment.

An alternative method of introducing a time lag of the order of from one to two or three seconds is by the employment of a slow-burning electrically ignited fuse device which ignites the explosive charge after the requisite time lag following ignition due to operation of the inertia element operated switch.

The cut-out switch comprises two pairs of contact studs the first pair being adapted for connection to the current carrying cables from a storage battery as normally used upon aircraft, the other pair of contact studs being connected to the cables extending to the electrical equipment of the aircraft, usually drawing heavy currents such as motor starters and various heating equipment.

The studs connected to the individual cables from the storage battery and the cables extending to the electrical equipment on the aircraft are adapted to be bridged by bridge members of substantial section, which bridge members are mounted upon an insulating actuator having spring means associated therewith which normally tend to move said actuator away from the contact studs, said insulating actuator also being provided with means for engagement with a solid material abutment of the device so as to force said bridge members into contact with said contact studs against the action of the spring normally tending to open the cut-out device.

According to a further feature of the invention, fire-fighting equipment for aircraft as described above incorporates one or more electrically actuated fire extinguisher fluid containers associated with each engine, an inertia element operated switch device being provided for effecting discharge of said containers over the engines under crash conditions, fire-responsive switch means being furthermore provided for effecting discharge of said containers when a fire occurs on one of the said engines, manual switch con-

trol means being also provided for effecting discharge of said containers when desired by aircraft crew members.

Further objects and features of the invention will appear from the following description of the invention with reference to the accompanying drawings in which embodiments of the invention are shown by way of example and in which—

Figure 1 shows fire-fighting equipment upon an aircraft.

Figure 2 shows one form of cut-out switch in vertical section, the mechanism being shown in the normal circuit closing position.

Figure 3 shows a side view of Figure 2 in partial section, the mechanism being shown in the circuit opening position.

Figure 4 is a sectional plan view taken on line 4—4 of Figure 2.

Figure 5 is a base view of the cut-out switch viewed from below Figure 3.

Figure 6 is a view corresponding to Figure 2 and showing a modified form of mechanism, and

Figure 7 is a partial sectional view of a further modification of part of the device shown in Figure 2.

Similar letters and numerals of reference relate to like parts in all the figures of the drawings.

In Figures 1, *a* denotes the fuselage of an aircraft and *b* the wings and *c* the engine nacelles. *d* denotes a radial cylinder engine of the downdraught carburettor type having an air intake denoted *e*.

The fire-fighting equipment comprises fire extinguisher liquid containers A and B associated with the engine *d*, and extinguishers C and D are associated with fuel tanks *f* and *g*.

Extinguisher A has a plain pipe portion F extending to a spray nozzle G on air intake *e*, and from this connects further to a horizontal loop of perforated spray piping which encircles the carburettor system, the pipe being then bent into a vertical loop encircling the aero engine accessory parts so as to spray these parts with fire extinguishing liquid when extinguisher A is discharged.

Fire extinguisher B has a plain pipe portion H extending from extinguisher B to the engine mounting plate, the perforated pipe portion then encircling the crank case of the engine at the rear of the cylinders, the pipe then extending between the lower cylinders to encircle the crank casing in front of the cylinders.

Extinguisher C has a perforated pipe I extending therefrom to encircle fuel tank *f*, and extinguisher D has a perforated pipe J extending therefrom to encircle fuel tank *g*.

The various extinguishers are controlled by a plurality of automatic and manually operated switches including inertia element operated switch K which is mounted in a forward position in the fuselage on transverse fuselage structure frame member *h* below the floor and adjacent the skin of the aircraft, so that impacts will be imparted to switch K when an aircraft makes a belly landing. Switch K effects discharge of all extinguishers A, B, C and D in a crash.

Gravity operated switch L is also provided for effecting discharge of all the extinguishers when an aircraft turns over on its back.

Pilot-operated push button switch M is provided in the pilot's compartment for effecting discharge of extinguishers A and B if an engine is found to be on fire.

A cable type of flame detecting element N is associated with extinguishers A and B which element will effect discharge of these extinguishers if a fire occurs on the aero engine.

Flame detecting switches O are associated with fuel tanks *f* and *g* which switches when ignited by flame from burning escaping fuel will effect discharge of extinguishers C or D associated with the tank on fire.

The fire-fighting equipment is electrically energised from the aircraft storage battery *i* which has the conducting leads connected to automatic cut-out switch P further hereinafter described in detail.

The storage battery leads extend from the cut-out switch P to a multi-terminal block or distributor panel *j*, the circuit arrangements being such that electric current from the storage battery through the electrically ignited fire extinguisher discharge heads is passed upon closure of any one of the various controlling switches to effect discharge of the extinguisher in the part of the aircraft on fire.

The fire-fighting equipment disclosed in Figure 1 is that associated with the starboard wing of the aircraft, but it will be understood of course that identical equipment is provided in the port wing, which is however not being shown for the sake of clearness.

Referring to Figures 2, 3, 4 and 5 which show the construction of automatic cut-out switch P, numeral 2 denotes a contact stud of substantial section faced with a soft high-conductivity disc 3 (Fig. 3) brazed or similarly secured thereto, said stud being provided with a locknut 4 and a securing nut 5 which is adapted to secure a cable lug extending from the aircraft storage battery to said stud. Fig. 2 shows the cut-out switch in normal unactuated position with contacts closed, and Fig. 3 shows the cut-out switch in actuated position with contacts open.

Numeral 6 denotes a second stud provided with disc 7 and nuts 8 and 9 to which stud a lug secured to the cable *x* (Fig. 1) extending to the aircraft electrical equipment requiring large currents is secured.

Studs 2 and 6 (Fig. 3) are mounted in an insulating base 10, said base being provided with spacing lugs 11 adapted to reduce risk of electrical contact between the adjacent studs, and said base carries an additional pair of studs 12 and 13 fitted with securing nuts 14 and 15, whereto the second cable from the accumulator and the corresponding cable *y* (Fig. 1) extending to the heavy current electrical equipment of the aircraft are connected.

Studs 2, 6 and 12, 13 are bridged by a pair of displaceably mounted bridge members 16 and 17, of substantial current carrying capacity, said members being also provided with soft high conductivity discs 18 and 19 brazed or otherwise secured thereto.

Bridge members 16 and 17 are provided with guide and actuating studs 20 and 21 which are engaged by a transverse insulating actuator 22 which is provided with a strut member 23 adapted to engage a solid material abutment 24 which is integral with a similar material screwed fitting 25, said abutment being screw-threaded and provided with a nut 26 adapted to confine an explosive charge 27 between said abutment nut and the walls of fitting 25, so that when the charge is ignited by an electrically ignited fuse device 28 the abutment 24 will be blown away to permit upward movement of strut 23 and

actuator 22, under action of spring 29, into the position indicated in Figure 3 to open the electrical connection between studs 2 and 6, 12 and 13. The mechanical connection between abutment 24 and fitting 25 is restricted, so that it is readily broken by the explosive charge.

Fuse 28 is of a known type and is provided with electrical leads adapted to be connected to plug-in socket pins 30 with which an appropriate plug-in socket of a known type is adapted to engage, said socket being connected to the inertia switch and the aircraft storage battery as through cable *w* (Fig. 1) to effect ignition of fuse 28 when the contacts in the inertia switch close.

In order to restrict the movement of abutment 24 and nut 26 after displacement by the explosive charge, a cap 31 is secured to fitting 25, said cap 31 being provided with vanes adapted to reduce the impact whereby parts 24 and 26 would otherwise strike the walls of cap 31.

Springs 32 and 33 are interposed between bridge members 17 and 16 and insulator actuator 22, the arrangement being such that when abutment 24 is blown away, actuator 22 commences to move in the upward direction, whereas springs 32 and 33 owing to their expansion retain contact bridges 16 and 17 in contact with studs 2, 6 and 12, 13 for a predetermined time lag.

In the device shown in Figures 2, 3, 4 and 5, the time lag is obtained by a dash-pot device constituted as an oil containing chamber 34 formed in insulating base 10 into which an extension 35 of strut 23 having a vane 36 secured thereto projects so that the vane is submerged in liquid in chamber 34 as indicated in Figure 2.

Vane 36 is provided with a restricted diameter orifice 37 which regulates the retardation applied by extension 35 and vane 36 to the movement of actuator 22, and chamber 34 is provided with a large diameter portion 38 which permits rapid movement of extension 35 and vane 36 when the vane 36 passes into this portion of the chamber, and by this means a quick break action is obtained between discs 3, 7 and 18, 19.

As will be seen, the amount of relative movement between bridge pieces 16 and 17 and actuator 22 is restricted by the heads on studs 20 and 21, as bridges 16 and 17 will be moved together with actuator 22 when these heads rest upon the actuator, the relative amount of displacement obtainable by actuator 22 and bridge pieces 16 and 17 being indicated in Figure 3.

As the current carrying capacity of contacts 2, 6, and bridge pieces 16, 17, is required to be of a high order of between 500 and 600 amperes, arc reducing means in the form of cup-shaped projections 39 and 40 are provided from base 10 as indicated in Figure 3.

In order to obtain satisfactory operation of the device the following minor constructional expedients are adopted:

Spring 29 is guided in actuator 22 in a recess 41 provided with a centralising spigot 42 in which strut 23 is screwed as indicated in Figure 2.

To prevent loss of fluid from the dash-pot device, a gland cap 43 is screwed into base 10, a liquid-excluding washer 44 being provided at the joint to prevent leakage of fluid between these parts. Cap 43 is provided with a gland device comprising gland nut 45 which in addition to compressing packing 46 serves as a centralising spigot for spring 29.

Springs 32 and 33 are housed in recesses 47 and 48 in actuator 22, and are located by lock-nut devices 49 and 50 secured upon studs 21 and 20.

The above described mechanism parts for the cut-out switch P are housed in an insulation casing 51 secured to base 10 by screws 52, and in order to eliminate angular displacement of bridge pieces 16 and 17, said housing is provided with guide ribs 53 as indicated in Figure 4, which furthermore serve to strengthen the casing.

As will be seen from Figures 2 and 3, fitting 25 is adapted to be screwed into casing 51 by means of a metal insert 54, and the pressure exerted by abutment 24, strut 23, actuator 22, springs 32 and 33 on bridge pieces 16 and 17, is obtained by screwing fitting 25 into insert 54 with the requisite force.

In the modification shown in Figure 6, the time lag is obtained by the insertion of a short length of fuse cable 55 which when ignited by fuse 28 burns at the rate of 1" in 4 seconds, and as the length of fuse cable is approximately ¼" a time lag of approximately one second is obtained, which is of the order required for ensuring operation of fire extinguishers and other aircraft equipment before the switch contacts open.

In this case the dash-pot device mechanism is omitted but strut 23 is provided with a guide pin 56 passing through modified gland cap 57 which serves as a guide for pin 56 and as a support and location for spring 29.

As will be seen, studs 21 and 20 are shortened and springs 32 and 33 are permanently in a comparatively highly compressed state, but a slight relative movement is obtained between actuator 22 and bridge pieces 16 and 17, as the resilient connection between these parts obviates the necessity for obtaining a high degree of alignment between studs 2, 6 and 12, 13 and the co-acting bridge pieces 16 and 17.

In the further modification shown in Figure 7, abutment 24 is replaced by a pin 58 which extends from an explosive chamber 59 in a sleeve 60 into which a fuse holder 61 containing a delayed action fuse 62 is fitted.

Fuse 62 has electrical leads similar to fuse 28, and these are connected to a terminal block device 63 to which connections from the inertia switch and the accumulator can be connected, the fuse 62 being of the delayed action type having a delay period of between 2 and 3 seconds in accordance with requirements.

Fuse holder 61 is provided with a restricted orifice 64 through which ignition of the explosive in the chamber 59 is obtained without risk of blow-back.

Pin 58 is screwed or otherwise firmly secured in sleeve 60 by screw threads 65 which serve to locate pin 58 and to obviate risk of loss of explosive gases between pin 58 and sleeve 60.

The above parts are secured in a fitting 66 adapted to be screwed into insert 54, said fitting having a recess 67 produced therein into which pin 58 can be blown when the explosion takes place, a vertical recess 68 being similarly formed in fitting 66 permitting additional displacement of pin 58 and the upward movement of strut 23 as indicated in dotted lines in Figure 7.

Having thus fully described my invention, what I claim as new and desire to protect by Letters Patent is:

1. Fire-fighting equipment for aircraft comprising one or more electrically actuated fire extinguisher fluid containers, an electric current supply source, a load circuit connected to said

source, an electric circuit cut-out switch incorporating electric current carrying contacts of substantial current-carrying capacity having the contacts connected in said circuit, means for closing said contacts under substantial pressure, impact operated switch means for effecting discharge of said containers and for effecting opening of said cut-out contacts when abnormal deceleration is applied to the aircraft, and means for introducing a time lag between the application of deceleration to the aircraft and the opening of said contacts.

2. Fire-fighting equipment for aircraft incorporating one or more electrically actuated fire extinguisher fluid containers associated with each engine, an electric current supply source, flame-operated switch means associated with each engine and adapted to effect discharge of said containers when a fire occurs on said engines, an electric circuit cut-out switch, and an inertia element operated switch device adapted upon application of abnormal deceleration to the aircraft to effect discharge of said containers over said engines under crash conditions and having means for effecting operation of said cut-out switch after a slight time lag between the application of deceleration to the aircraft and the operation of said cut-out switch.

3. Fire-fighting equipment for aircraft incorporating electrically actuated fire extinguisher fluid containers associated with the fuel tanks, an electric current supply source, flame-operated switch means associated with each individual fuel tank adapted to effect discharge of individual containers associated with individual fuel tanks when a fire occurs on said tanks, an electric circuit cut-out switch, and an inertia element operated switch device adapted upon application of abnormal deceleration to the aircraft to effect discharge of said containers over said fuel tanks under crash conditions and having means for effecting operation of said cut-out switch after a slight time lag between the application of deceleration to the aircraft and the operation of said cut-out switch.

4. Fire-fighting equipment for aircraft incorporating one or more electrically actuated fire extinguisher fluid containers associated with each engine and individual fire extinguisher fluid containers associated with the aircraft fuel tanks, an electric current supply source, flame-operated switch means associated with said engines and with each individual fuel tank adapted to effect discharge of individual containers associated with said engines and fuel tanks when a fire occurs on said engines or fuel tanks, an electric circuit cut-out switch, and an inertia element operated switch device adapted upon application of abnormal deceleration to the aircraft to effect discharge of said containers over said engines and fuel tanks under crash conditions and having means for effecting operation of said cut-out switch after a slight time lag between the application of deceleration to the aircraft and the operation of said cut-out switch.

5. In fire-fighting equipment according to claim 4, a gravity element operated switch adapted to effect discharge of said containers when an aircraft turns over on its back during landing operations.

6. In fire-fighting equipment for aircraft comprising a fire risk, discharge means for delivering fire-extinguishing fluid on said fire risk, a container of fire-extinguishing fluid, electrically actuatable release means mounted for controllably connecting said container to said discharge means, crash operable control means, a source of electric power, a distribution line leading from said source to power consuming units, an emergency switch serially connected in said distribution line and being normally adapted to maintain said distribution line closed and comprising actuating means actuatable by operation of said control means for operating said switch to open said distribution line, and connections between said distribution line and said release means and comprising means actuatable by said control means for applying electrical actuating energy to said release means when said control means is operated.

7. In fire-fighting equipment for aircraft comprising a fire risk, discharge means for delivering fire-extinguishing fluid on said fire risk, a container of fire-extinguishing fluid, electrically actuatable release means mounted for controllably connecting said container to said discharge means, crash operable control means, a source of electric power, a distribution line leading from said source to power consuming units, an emergency switch serially connected in said distribution line and being normally adapted to maintain said distribution line closed and comprising actuating means actuatable by operation of said control means for operating said switch to open said distribution line, and connections between said distribution line and said release means and comprising means actuatable by said control means for applying electrical actuating energy to said release means when said control means is operated, said switch further comprising time delay means for appreciably delaying its actuation to open said distribution line after operation of said control means.

8. In fire-fighting equipment for aircraft comprising a fire risk, discharge means for delivering fire-extinguishing fluid on said fire risk, a container of fire-extinguishing fluid, electrically actuatable release means mounted for controllably connecting said container to said discharge means, crash operable control means, a source of electric power, a distribution line leading from said source to power consuming units, an emergency switch serially connected in said distribution line and being normally adapted to maintain said distribution line closed and comprising actuating means actuatable by operation of said control means for operating said switch to open said distribution line, connections between said distribution line and said release means and comprising means actuatable by said control means for applying electrical actuating energy to said release means when said control means is operated, said switch further comprising circuit closing and opening movable elements, and two-step time delay means adapted after the operation of said control means to move said elements in a first step relatively slowly toward but not up to circuit opening position and in a second step starting just before circuit opening position to move said elements relatively rapidly beyond circuit opening position.

9. In fire-fighting equipment for aircraft comprising a fire risk, discharge means for delivering fire-extinguishing fluid on said fire risk, a container of fire-extinguishing fluid, electrically actuatable release means mounted for controllably connecting said container to said discharge means, crash operable control means, a source of electric power, a distribution line leading from said source to power consuming units, an emer-

gency switch serially connected in said distribution line and being normally adapted to maintain said distribution line closed and comprising actuating means actuatable by operation of said control means for operating said switch to open said distribution line, said control means being a crash operable switch, and connections between said control means, said distribution line and said release means, for applying electrical actuating energy to said release means when said control means is operated.

10. In fire-fighting equipment for aircraft comprising a fire risk, discharge means for delivering fire-extinguishing fluid on said fire risk, a container of fire-extinguishing fluid, electrically actuatable release means mounted for controllably connecting said container to said discharge means, crash operable control means, a source of electric power, a distribution line leading from said source to power consuming units, an emergency switch serially connected in said distribution line and being normally adapted to maintain said distribution line closed and comprising actuating means actuatable by operation of said control means for operating said switch to open said distribution line, said control means being a crash operable switch, and connections between said control means, said distribution line and said release means, for applying electrical actuating energy to said release means when said control means is operated, said actuating means for said switch comprising an electrically fused explosive element connected to said control means for explosion by operation thereof.

11. In fire-fighting equipment for aircraft comprising a fire risk, discharge means for delivering fire-extinguishing fluid on said fire risk, a container of fire-extinguishing fluid, electrically actuatable release means mounted for controllably connecting said container to said discharge means, crash operable control means, a source of electric power, a distribution line leading from said source to power consuming units, an emergency switch serially connected in said distribution line and being normally adapted to maintain said distribution line closed and comprising actuating means actuatable by operation of said control means for operating said switch to open said distribution line, said control means being a crash operable switch, and connections between said control means, said distribution line and said release means, for applying electrical actuating energy to said release means when said control means is operated, said actuating means for said switch comprising an explosive element and an electrically actuatable slow-burning fuse attached to said explosive element and connected to said control means for ignition by operation thereof.

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