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THE PREVENTION OF FIRE IN THE AIR.

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During the war, and indeed to some extent since that time, the most dreaded of aerial accidents has been fire in the air, even as a fire at sea takes high rank among the dangers which confront the mariner. Aeronautical engineers have not lost sight of that fire hazard, however, and improvements in the design and construction of aircraft have been such that fire need no longer be feared except as a secondary factor occurring as the sequel of a mishap of some other type. The prospective aerial tourist need not be in the least disturbed by lurid press accounts of fires which have occurred under the conditions of military service or which have taken place on old airplanes lacking in proper safeguards.

The problem of fire on the airplane is of quite a different order from that on the airship, and the two types of craft will therefore be discussed separately. On the airplane, the safeguards adopted may be divided into three classes, those intended to prevent a fire from getting started, those intended to put it out if it does get under way, and, finally, those designed to limit the damage which a fire can do.

Protecting the Gasoline.

The first of these groups depends on a careful analysis of the causes from which fires may result. It is found by such an analysis that most accidents of this sort are due to engine trouble,

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and that fires can best be prevented by insuring absolutely against any leakage of gasoline and against any flame which may burst forth inside the engine compartment, being drawn into the carburetor and so running back to the gasoline tank. The use of new materials for the conveyance of gasoline and the design of new types of pipes for that purpose has substantially insured against the breakage of a pipe as a result of vibration, not an uncommon occurrence a few years ago.

The military airplane, which was always peculiarly liable to conflagrations as a result of the tanks being struck by incendiary bullets, has been made much safer than during the war by the development of leak-proof tanks, tanks made of metal and covered with a layer of rubber compound. This coating of soft rubber acts in the same fashion as the puncture-proofing compounds sometimes used for pneumatic tires, squeezing in to close instantly any hole that may be made. So great an efficiency has been attained with these tanks that it is possible to fire 30 or 40 machine gun bullets in succession substantially through the same spot without loss of gasoline and without starting a fire.

Quite aside from their military uses, however, these leak-proof tanks have another merit in that they are "crash-proof" and that they almost entirely eliminate the danger of catching fire after a rough landing as a result of breakage of the tank. One of the gravest difficulties that has to be contended with in airplanes not especially designed to be fire-resisting is the conflagration consequent on an otherwise minor landing accident, and most of the

airplane fires which have taken place in the past have really been secondary to an initial mishap in landing.

As a further precaution against leakage of fuel in a crash the tanks of commercial airplanes are sometimes placed far out on the wings and equipped with automatic valves to cut off the supply of fuel instantly in case of any damage to the pipes leading to the engine. The use either of this arrangement or of a really good crash-proof tank, together with proper engine installation, makes it practically impossible for a bad fire to start, and greatly increases the safety of the passengers.

Fire Extinguishers.

The devices for putting fires out in flight are of course secondary, since every possible precaution is first taken to prevent a fire from starting at all. Nevertheless, it is advisable both in aircraft and in ships to recognize the possibility that a fire may sometimes get started and to provide means of fighting it. A number of devices for extinguishing fire in the air have been invented and some of them have attained such a measure of success on trial as to justify their regular use alike for civil and for military airplanes. On one occasion in particular the pilot doing the testing deliberately set his airplane on fire three times in a single flight by misuse of the engine controls and extinguished the fire each time without damage to the airplane or inconvenience to himself. Most of these devices consist of a fire extinguisher inside the engine compartment and controlled from the pilot's seat,

in combination with shutters for completely closing off the eng. compartment and preventing the admission of air. If the air is fully excluded the fire will of course burn itself out in a very short time, even without the use of an extinguisher. The use of this type of fire extinguishing apparatus is dependent, of course, on the use of an engine compartment constructed of fire-proof material and completely isolated from the other parts of the airplane, and this leads naturally to the consideration of the third class of fire safeguards, those intended to limit the damage which a fire can do.

The easiest way to limit the damage is to build the airplane of fireproof material as far as possible and to devote special attention to the protection of those parts of the structure which are necessarily inflammable and to the isolation of the section where a fire is most likely to start. The constantly increasing tendency toward metal construction, to be discussed in detail in a later article in this column, is a splendid thing from the point of view of fire protection, as is also the use, already alluded to, of leak-proof gasoline tanks placed far from the engine. A further precaution against gasoline fires which has been adopted on some airplanes, both civil and military, is the use of tanks which are so located that they can be dropped from the airplane entirely in case of danger. If a fire should get started the pilot of the airplane has then only to pull a lever at his side in order to remove all support from the tanks and cut the pipe-line, thus instantly getting rid of all fuel except that actually in the pipes

and carburetor. Incidentally, the same idea has been used for lightening airplanes which were liable to forced landings on the sea, except that in that case the fuel was emptied from the tank through a large hole opened in the bottom, the tank remaining on board to serve as a float. Such extreme measures as these are hardly necessary on commercial airplanes, however.

A Flame-Tight Bulkhead.

Perhaps the most important single precaution of all has merely been hinted at under the second and third heads. Whatever else may or may not be done, it is now recognized as essential that the engine section should be completely cut off from the remainder of the airplane by a flame-tight bulkhead made either of metal or asbestos and pierced with holes as few in number and as small in size as possible. Since this is now the universal practice, and since the structure of the body in recent designs is usually of metal in the engine section, whatever it may be back by the passenger cabin, there is little incentive for a fire to spread or to keep alive if it can be kept from reaching the gasoline. The means used for preventing that have already been discussed.

Airship Hazards.

In the case of the airship, the fire hazard comes partly from the fuel, in part from the hydrogen with which the envelope is inflated. While it is very desirable that hydrogen be replaced in all cases by the non-inflammable helium, and while that will be done as soon as the helium supply makes it possible, at the same

time the danger of a gas explosion is much less than is commonly supposed. The gas is separated by a considerable distance from the engines and all other points where a fire would be likely to start, and any gas which leaks out, being so much lighter than air, instantly rises away from the points of danger. The danger of fire is much greater in observation balloons, where the steel cable connection with the ground increases the danger from static electricity and from being struck by lightning, than it is in airships.

The liability to gasoline fire in an airship must be guarded against by the same means as in an airplane. The only way to secure absolute safety in either case is to abandon the use of gasoline and run engines on a non-inflammable fuel. While this sounds like a joke, there is nothing impossible about it, for certain types of internal combustion engines are actually capable of running on heavy oils, such as the tar oil used in treating macadam roads, which will not burn under ordinary atmospheric conditions but only after they have been compressed in an engine cylinder. It remains only to adapt these engines, operating on the Diesel or Hvid cycles and spraying the fuel directly into the cylinder without the intervention of a carburetor, to airplane service, and very effective first steps in that direction have been taken.