# TECHNICAL NOTES

## Engine Icing

The following is a safety bulletin, written by Alexander N. Troshkin, air safety specialist in power plants, and issued by the Civil Aeronautics Board.

Reports have been received from air-carrier pilots of adapter temperature readings of approximately 35° F. or higher during operating conditions which were strongly indicative of induction ice. This was usually attributed to a defective or off calibration thermometer.

During the current induction system de-icing investigation being conducted under the direction of the N.A.C.A. by the National Bureau of Standards, this same phenomenon of temperature readings above 32° F. was observed even though the ice formation was definitely visible in the adapter.

**Operating Conditions**

The conditions of the test operations were such as to simulate actual engine operations with respect to air, fuel and water ingestion in the induction system. Air was passed through the induction system of a Wright G200 engine at the rate of approximately 4,000 pounds per hour, which is equivalent to operating the engine under cruising conditions to 625 h.p. Under these operating conditions water was admitted into the induction air through a series of spray nozzles at the rate of 15 grams per cubic meter of air to simulate a water content in the mixture equivalent to that which would be obtained when flying througn heavy rain.

When the gasoline was turned on the mixture temperature thermometer in the adapter dropped to 20.5° F. and subsequently it gradually rose to 32° F., where it remained constant for a short period as the ice formed around the temperature indicator bulb. The temperature then continued to rise until it stabilized at approximately 41° F. Notwithstanding these temperature indications a visual inspection through a glass enclosed aperture provided in the adapter showed the bulb and adapter to be coated with a heavy deposit of ice, which was building up at a rapid rate.

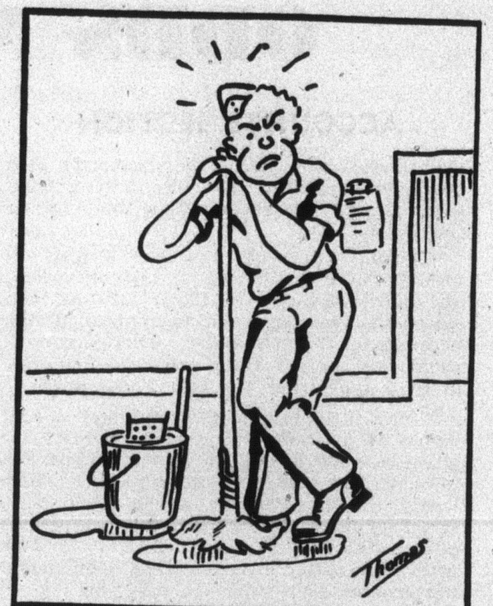
**Action Explained**

After careful consideration this phenomenon was attributed to the insulating effect of the ice formed on the adapter walls and thermometer bulb. A brief review of adapter icing is necessary in order to explain this action. Consideration must be given to the fact that there are two heat sources acting on the adapter and thermometer bulb. The rear engine compartment heat results in a heat flow through the adapter walls into the interior and through the outside thermometer section into the bulb inside the adapter. Counteracting this heat flow is the cooling effect of the mixture passing through the adapter. The cooling effect of the mixture is greater than the heating effect of the rear engine compartment heat on the adapter. The inside surface of the adapter and the thermometer bulb is rapidly reduced in temperature to that of the mixture which under some conditions may be 32° F. or below. Moisture condensed out of the air due to the drop in temperature and / or free water ingested will be deposited on the inside surface of the adapter and on the thermometer bulb. If the temperature of the mixture is 32° F. or lower, the deposited moisture forms ice.

After the ice film has formed the cooling effect of the mixture on the adapter wall and bulb is gradually reduced with the increase in ice deposited due to the insulating effect of the ice. The thermometer bulb and inside adapter walls are being cooled by the contact ice with the result that the bulb thermometer will indicate 32° F. and not the mixture temperature, which may be considerably below 32° F. The rate of cooling by the contact ice is substantially lower than that existing when the high velocity low temperature mixture is in direct contact with the bulb and adapter walls. The reduction is apparently sufficient so that the heat flow from the outside of the adapter as conducted through the walls and thermometer bulb assembly is great enough to melt the ice at the point or surface of contact and adhesion. This is substantiated by the fact that in all ice formation tests it has been observed that the ice plug in the adapter is not frozen to the walls, etc. It is entirely loose but suspended in the adapter due to the adapter shape and / or various protuberances. The heat under these conditions continues to flow into the bulb and is then under some conditions sufficient to raise the bulb temperature reading to above 32° F. or, as in the case of the test results previously discussed, to 41° F.

**Danger Evident**

The danger of such erroneous temperature indication is self-evident. Unless the operating personnel is conversant with this insulating effect there is the danger of blaming any rapid loss of power on other factors than ice, since the mixture temperature indicator would read above the icing temperature. Sufficient power may be lost before the pilot becomes aware of the true condition to make the heat de-icing system ineffective. Particular attention should be paid to the temperature indicator **for evidence** of this phenomenon during taxiing, take-off, or an approach through an icing condition when carburetor heat would be reduced or operated fully cold.



"STICK" TIME PHOOEY





# TECHNICAL NOTES

## Effects of Acceleration

An aircraft in flight may be subjected to acceleration forces due to either loads which are generated by virtue of atmospheric disturbances or by the manipulation of controls on the part of the pilot. The directions of these forces may be variable in the case of atmospheric disturbances; for example, when a gust is encountered, the direction of the gust may be either vertically up or down or horizontal, or at any angle with respect to the axis of the aircraft. The primary effect of gusts is to alter the air flow about the aircraft surfaces, that is to say, they alter momentarily the angle of incidence of the air foil and thus alter the lift and drag both in magnitude and direction. The application of control loads by the pilot has the effect of changing the attitude of the aircraft, and the more violent the application of control loads, so is the change in attitude more rapid. It should be borne in mind that any aircraft can be broken in the air by the misapplication of control loads.

The transmission of acceleration forces to the pilot is by means of physiological phenomena, and the intensity of the pilot's reaction is a measure to some degree of the accelerations which have been experienced by the aircraft. Pilots, when experienced, can assess the probable acceleration being experienced by the aircraft structure as a result of their own physiological reactions, they can, therefore, control their aircraft to within safe limits of manoeuvrability, as they can associate the magnitude of the acceleration against their corresponding reactions.

To demonstrate the effect of acceleration, it is convenient to have a steel wire or strip to one end of which is attached a lead ball. If the strip is held horizontally by one hand, rapidly moved in a vertical direction, the ball momentarily does not move. The magnitude of the deflection of the wire, or for that matter, the displacement of the lead ball from its former position, is a measure of the acceleration which has been applied to the system. This device as described above will, of course, only measure the component of acceleration in the vertical plane, the movement of the support to the system of course having been in a vertical direction.

It should be borne in mind that air forces vary according to the square of the speed, and, therefore, when accelerations are associated with higher speeds, the air foil loadings are increased very considerably. For this reason, manipulation of controls at higher speeds requires to be more delicate than at lower speeds, since the more rapid change in attitude, so is the accelerating force proportionately greater.

All aircraft are designed to certain acceleration factors. Factors for a particular class of aircraft are usually of the same order, but there is considerable variation between the factor required on, say a single seater fighter and a heavy bomber. The latter correspond to the factors required on heavy civil transports. In other words, the design factors are graded according to the weight of the aircraft and its probable duties. It is quite possible that an aircraft can be designed which has greater strength than the human frame against failure. Devices have been invented to support the human frame against failure under severe acceleration forces, where, owing to the duties being undertaken, this is necessary.

In order to provide an impression as to the magnitudes of acceleration forces, let us suppose that an aircraft weighing 2000 pounds is subjected to an acceleration which renders its momentarily effective weight 6000 pounds. This is merely an acceleration of 3G and is by no means uncommon. Then the loads on the air foil have vertical components which sum up to 6000 pounds, and a pilot weighing 200 pounds now has an effective weight of 600 pounds and hence his weight on the seat structure can be 600 pounds. Correspondingly, the loads on the tail unit are increased in magnitude, and what is more, the redistribution of air forces is such that they are effectively concentrated on a smaller area due to the changes in the relative air flow; whence there may be a very much smaller area supporting a greater load than before the acceleration was encountered. Aircraft are designed to ensure adequate strength under various loading conditions occasioned by different attitudes and speeds. For example, in centre pressure forward position with the centre pressure at approximately 1/3 of the chord aft of the leading edge, a certain air loading distribution is obtained. In the attitude of top speed, that is to say, centre pressure back, another loading condition exists. This latter condition naturally loads the rear spar greater than the front one for the particular condition, and in centre pressure forward it is the front spar which takes the maximum load. The design factors for these two conditions are not equal, the C.P.F. being greater. In the pull-out from a dive, the centre of pressure moves forward and the net result is a very high concentration of air load along the forward portion of the wing. The factor of strength under this condition is, therefore, considerably less. Similar remarks apply to tail load distributions and, of course, this has effect on fuselage strength.

Below are quoted two examples of the effect of acceleration. If a Spitfire is stalled in a steep turn at 320 m.p.h., the effect is the application of a load equal to twelve times the weight of the aircraft. When a Harvard is pulled out of a dive, six times the weight of the aircraft can be generated momentarily. It should be borne in mind that control loads can increase in magnitude to a degree which renders the actuation of controls outside the strength of a pilot under some conditions of flight. A common condition wherein this is achieved is in a Fairchild 71 type aeroplane which possesses Gottingan air foil section 387. This is a so-called thick air foil, and the combination of tail plane associated with this type aircraft, results in the production of tail loads far beyond the ability of the pilot to handle in fast glide speeds.



**"DON'T EARN YOUR WINGS"**
or
**"GET A FITTED PAIR FREE FROM SAINT PETER"**

Always take off with a cool motor—you waste so much gas warming the engine.
Don't fasten the safety belt—that's for sissies.
Don't look for other planes in the air—they will miss you most of the time anyway.
Practise your steep turns over your girl friend's house—she will think you are the cutest corpse.
Always fly into a thunderstorm—it must be interesting for few ever come back after they go into one.
Stretch your glides to the last inch—if you don't reach the spot you will make a nice one anyway.
Your gas gauge is always correct—only old-fashioned pilots look in the tank to check.
Pull the nose very high in slips—it gives the ground observers a bad case of the jitters.
When approaching a strange field always sneak in low and straight—it is such a surprise to the local fliers.
When a 'plane is placarded for a maximum speed—see if you can't squeeze a few more miles out of the old crate.
Don't have your parachute packed every month—that's just a racket thought up by the 'chute makers.

(U.S. AIR SERVICES MAGAZINE)

## THE R.C.A.F. THEATRE
PRESENTS
**The Following Attractions**

**August 14-15**
H. M. PULHAM, ESQ.
Hedy Lamarr, Robert Young
Midnight Snack

**August 16**
HENRY & DIZZY
Jimmie Lydon, Charlie Smith
Pipeye-Pupeye — Blue Streak
Popular Science No. 2
Ants in the Plants—Fuller Bluff Man

**August 17-18**
A GENTLEMAN AFTER DARK
Brian Donlevy, Miriam Hopkins

**August 19-20**
TWIN BEDS
George Brent, Joan Bennett

**August 21-22**
TO BE OR NOT TO BE
Carole Lombard, Jack Benny

**August 23**
MEXICAN SPITFIRE AT SEA
Lupe Velez, Leon Errol

**August 24-25**
TO THE SHORES OF TRIPOLI
Maureen O'Hara, John Payne

**August 26-27**
WE WERE DANCING
Norma Shearer, Melvyn Douglas
Pound Foolish — Alley Cat

**August 28-29**
JOAN OF PARIS
Michele Morgan, Paul Henreid

**August 30**
WEEKEND FOR THREE
Dennis O'Keefe, Jane Wyatt

**August 31 and Sept. 1st**
LARCENY INCORPORATED
Edward G. Robinson, Jane Wyman