Mk. 5 Failures Blamed on Overstressing

AIR FORCE SAYS KNOWN LIMITATIONS WERE EXCEEDED IN FLIGHT

Since the high altitude Mk. 5 extended wing version of the Avro CF-100 entered service with the RCAF, two have been involved in fatal accidents while participating in air shows. In both instances, eyewitness reports and actual photographs indicate that structural failure occurred during or immediately following low level flying displays involving high-speed maneuvers. In both instances, complete disintegration of the airframes was preceded by structural failure of the extended portions of the wings. During July, as a result of the numerous critical press reports generally reflecting on the structural integrity of the CF-100, RCAF Headquarters released the following statement, the complete text of which is reproduced herewith.

ON MAY 26, 1956 an RCAF CF-100 crashed at Kinross, Mich., during an air show, and while carrying out a high speed, low level run. Both occupants were killed.

An RCAF Board of Enquiry was appointed, and its findings included the following recommendations:

(a) that a competent aerodynamicist examine the general flying characteristics of the Mk. 5 wing, complete with rocket pod.

(b) that a complete wing of a Mk. 5 Canuck (CF-100) be submitted to a structural integrity test.

The action covered by the first recommendation of the Board of Enquiry had, in fact, been carried out before the accident, and was repeated following the accident. The second recommendation was examined but not acted upon because of other information revealed in the full investigation.

One Step: A Board of Enquiry into any flying accident is only one step in a complete series of investigations and studies which follow accidents. An essential function of a Board of Enquiry is to collect quickly evidence from witnesses and physical evidence available on the spot, before it has time to be dissipated. Boards of Enquiry make findings and recommendations, but they do not, in themselves, constitute a full and authoritative investigation. The findings of such Boards are reviewed in conjunction with other relevant information, by a series of specialists before final recommendations or conclusoins are arrived at. Consequently, the recommendations of a Board of Enquiry are not necessarily adopted in full.

At the same time that a Board of Enquiry is taking place a parallel and independent investigation is carried out by specialist officers from the Accident Investigation Branch of the Directorate of Flight Safety. This examination is more scientifically analytical and in consequence is more time consuming. These officers are specialists employed for long periods of time at this work and are well qualified to appreciate the the most minute aspects of both operations and engineering. They have at their disposal the resources and assistance of experts not only of the RCAF but of other government and civilian agencies.

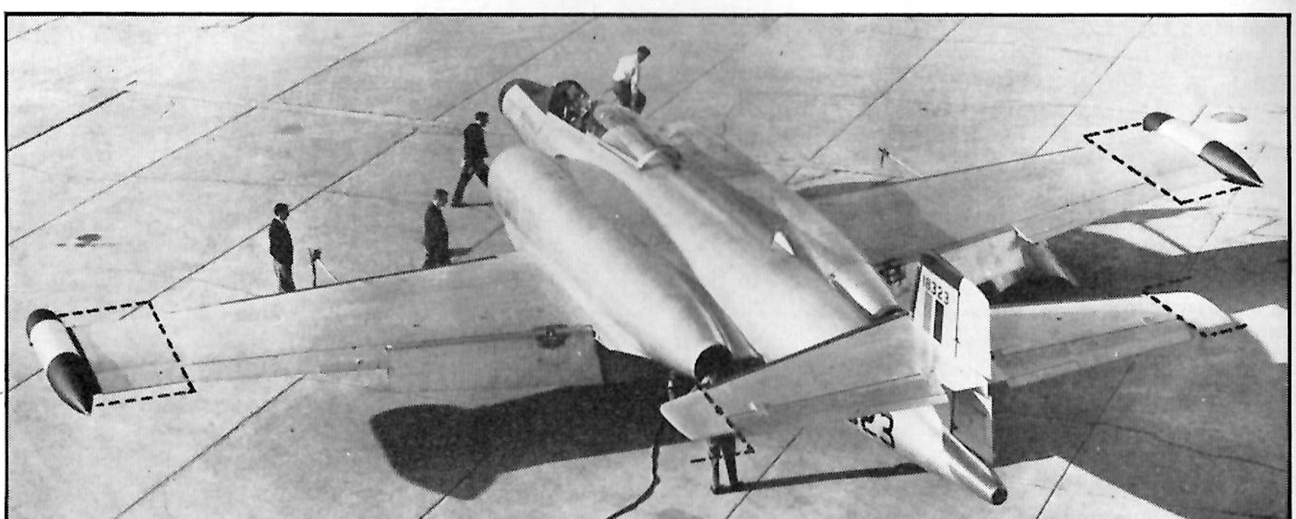
It is only after the Directorate of Flight Safety has combined its evidence with that of the Board of Enquiry and made its recommendations that the investigation can be concluded.

Forecasting Effects: Ground loading tests are valuable and are extensively used during the design phase of an aircraft, to forecast the effects of calculated loads upon the structure. Such tests to establish the "structural integrity" of the Mk 5 wing were in fact carried out during February, 1955.

These tests involved placing loads on the wing structure until the breaking point was reached. The Mk. 4 wing is essentially the same as the Mk. 5 wing inboard of the extended tips. The highest stresses occur in the Mk. 5 wing in this inboard portion. Conse-

(Continued on page 74)

Dotted lines below indicate sections which were added to the mainplanes and tailplanes of the Mark 4 CF-100 to make the Mark 5 version. Purpose of the extensions was to improve materially the high altitude performance of the CF-100. At the same time, addition of extra span, without modification of the primary structure of the inboard sections of the wings and stabilizers, made it necessary that a "G" restriction be put on the Mark 5 for low altitude operation. Cause of Mk. 5 failures was exceeding of this restriction, Air Force Headquarters maintains.



NUMBER FOUR: The DoT recently took delivery of its fourth Piper Apache at the Piper plant at Lock Haven, Penn. Shown here from left to right: A. R. Pinder, Assist. to Superintendent of Air Regulations, DoT; W. T. Piper, Sr., of Piper Aircraft; and Glenn R. White of Trans Aircraft Co., Hamilton, Ont., Canadian Piper distributor.

the camera position was changed in the ventral fuselage and a seat added for the cameraman. Installed is a Swiss-built Wild RC-5 camera.

Operationally, the Mosquitoes carry a crew of three. They fly their photo-lines at 30,000 feet at 335 mph, with a 4 to 4½ hour range. They are equipped with the latest in Collins radio equipment and have a U.S. designed and built oxygen system installed.

The Long Road: Spartan Air Services has come a long way from the two airplanes and eight employees of 1947. As of 1956 the firm's air fleet has increased to 50 aircraft and the payroll now includes 360 people, most of whom are technical specialists. The annual gross has increased to the $5 million mark, with 1957 looking ever better. Working on a world-wide basis, Spartan has contracts in such far-off places as Africa, South America and India.

In looking toward the future, the company intends to obtain more complete utilization of its helicopters during the winter months. High-level photography continues to be a large part of the program, while more of Canada's north is to be mapped using Shoran. Aerial-prospecting is expected to be more important than ever. During this summer's operations, 32 mining companies are concerned in Spartan's Operation Ungava.

This airborne search for nickel and copper deposits encompasses an area of 5,000 square miles and is costing some $300,000. The search area stretches from Cape Smith at the north-east tip of Hudson Bay, across the Ungava Peninsula to Wakeham Bay on Hudson Strait.

This is the type of operation that Spartan Air Services Limited is equipped, willing and prepared to do. Theirs is a modern day Canadian success story.

ANTI-COLLISION LIGHT

(Continued from page 24)

the technical data on the lights, of why a pilot must be jolted into recognizing a collision course as soon as another aircraft becomes visible.

He explains: "If two planes on a collision course are travelling at the same speed and altitude, one plane, as observed from the other, will have no apparent movement and will stand perfectly still in the windshield. Aside from the fact that the other plane is getting relatively larger, there is no stimulus to sting the pilot into action to avoid the imminent accident. The sight of the rapidly flashing lights should provide the stimulus that will alert the pilot."

Not Enough: Mr. Atkins says "the present system of red and green blinking wingtip lights are not distinctive enough, are not visible at a distance of more than three miles and don't tend to produce the instantaneous reaction required."

The production light, to be sold in Canada, will measure approximately five inches wide, nine inches high and 11 inches long.

Duration of the light's flash is said to be 1/1,000 of a second—too fast to cause contraction of the eye's pupil, which would result in partial blindness. Mr. Atkins says that the lamp's brilliant light has almost unlimited visibility on a clear night. During daylight the light can be seen very well also. He cited the example of an early test during a snow storm where normal visibility was one-half mile, yet the lights could be seen for seven-eighths of a mile.

Mr. Atkins uses some strong arguments in his pitch to sell his product. The main reason, he says, for the few air collisions recorded to date is because of the relatively small number of airplanes which fly in a very large air space. As the number of airplanes increases, the law of probability indicates that more collisions will occur, unless drastic steps are taken to avoid them.

Congested Areas: Citing U.S. statistics for the decade ending in 1955, he points out that 86 per cent of mid-air collisions occurred within five miles of an airport and 90 per cent happened at or below 3,000 feet.

"Near airports, cockpit crews are extra alert, the tower provides up-to-the-moment information about aircraft movements. Air traffic control and radar, aircraft and airport lighting—all conspire to eliminate mid-air accidents, yet near the airport is where the vast majority of collisions occur.

"There must be something wrong with the information that present aircraft lighting systems are giving the pilot," Mr. Atkins concludes.

CF-100 STATEMENT

(Continued from page 22)

quently, it was practicable to use a Mk. 4 wing with Mk. 5 loadings for these tests. From this data the ultimate breaking point of the Mk. 5 wing was conclusively determined by the structural tests.

These ground tests were in due course confirmed by flight tests carried out by test pilots to the limits specified. These flight tests confirmed the integrity of the design. Flight tests of this nature, applying actual loads under flight conditions, are of greater significance than the simulated loadings of ground tests.

Limitations: In the case of any aircraft of any type, there are limits of speed and "G" force, which vary with altitude and other conditions, beyond which the aircraft cannot be pressed without danger of structural failure. Consequently, operating limits are set for each type of aircraft, within the limits of proved structural strength. There is no evidence to indicate that in any CF-100 accident, failure took place within the established limits. Rather, all available evidence points the other way.

In the case of the Kinross crash no evidence was found to indicate that the actual strength of the Mk. 5 wing was less than the designed strength, which had been previously confirmed by ground and air tests. However there was evidence to support the final conclusions of the full investigation that the aircraft had been flown beyond those limits allowable for it.

In case of many military aircraft, particularly high performance fighters, it is essential to obtain maximum possible performance in peacetime for training purposes; in war for obvious reasons. This means that such aircraft must be flown fairly close to their permissible limits with regard to speed and "G" forces. On the other hand in the case of civilian aircraft and some types of military planes, particularly transport aircraft, it is possible to operate with a wide margin between structural design limits and operating performance figures. Every aircraft has its design limits, military aircraft only are required to press these limits in order to achieve maximum performance. This has been a characteristic of military flying since the advent of the aircraft as a weapon.

Speed Reduction: Some time after the Kinross accident, the maximum allowable speed at low altitudes for the Mk. 5 was reduced. This was not related in any way to wing strength factors. It was due to a control characteristic in the previous speed range that might allow the pilot unwittingly to perform too rapid a maneuvre.

It would be regrettable if any implication were wrongly allowed to persist that the CF-100 Mk. 5, like all marks of this splendid aircraft, had been subjected to improper or insufficient testing, either on the ground or in the air.

Every individual CF-100 is thoroughly tested on the ground and in the air by both the manufacturer and the RCAF. These tests, plus the amount of flying experience with the Mk. 5 since it went into squadron service in early 1956, have shown that the aircraft is structurally sound.

CALL AND HAUL

(Continued from page 21)

transportation of troops and critical supplies. For Reconnaissance.

By Signals: For wire laying and courier services.

By Ordinance: For the transportation of logistical supplies.

By the Medical Corps: For the evacuation of casualties and for the limited transportation of medical supplies.

General Delivery: In the Korean conflict the Beaver earned an enviable reputation as a command plane. Popularly referred to as the "Generals' Jeep" it was used extensively by Generals Ridgeway, Van Fleet and Mark Clark. It was also the plane chosen to transport President Eisenhower during his tour of the Korean front in 1952.

A typical example of the use of organic aircraft by a technical branch of the army, was the survey operation undertaken by the 30th Engineer Group in Alaska in 1955. This covered an area of roughly 86,000 square miles. In this operation helicopters were used to drop surveyors at control points whose locations ranged from tiny patches of tundra to dizzy crags and ledges at 8000-foot elevations in the mountains. Other than at the main bases at Umiat and Kotzebue, no landing strips existed anywhere in the area. Beavers and Otters, operating on floats and skis, were used to fly supplies into the base camps which were established, and also out to temporary rendezvous with the helicopters in the field. Time was an important factor in this undertaking. Typical of the terrific tempo which characterized the entire operation was the transfer of 80,000 lbs. of equipment from one base to another by six Otters in one night.

The unique advantages of STOL

and VTOL aircraft to the army were proven day in and day out throughout this entire operation. When open water began to appear around the shorelines of some of the frozen lakes on which supplies were being landed, Beaver and Otter skiplanes made landings on the ice pans which were left floating in the centre. The supplies were then transferred ashore by canoes flown in aboard the aircraft.

"Operation Trade Wind" was another outstanding topographical survey operation that was undertaken by U.S. Army Engineers. Somewhat similar in concept to the mission completed in Alaska, the completion of the project will benefit some 15 republics in Central and South America.

Artillery's Eyes: Historically, U.S. Army Aviation originated with the necessity for finding some means of observing and adjusting long range artillery fire. Its date of birth is officially recorded as the year 1861, when a military balloon over Fort Corcoran (Washington) D.C. directed artillery fire by telegraphy against the Confederate Army in Virginia.

In 1908, Orville Wright and Lieut. Foulois successfully completed the first evaluation of a U.S. Army airplane in a flight that took place at Fort Myer Virginia. The flight was without incident and the plane was therefore immediately acquired by purchase by the United States Government. "By the end of 1909" Lieut. Foulois later wrote in his whimsical style in an official memorandum, "the military air strength of the United States of America consisted of one partially trained pilot" (himself), "eight Enlisted men, one civilian mechanic — and one badly damaged airplane"!

United States Army chronology does not record the role played by the U.S. Army Air Corps. in World War I. This period is historically regarded as an early chapter in the development of the present Air Force. However, in 1942, Army Aviation, as such was reactivated. In that year, L-4 aircraft were assigned to field artillery units of infantry and armoured divisions of the U.S. Army.

The L-4 was an off-the-shelf light airplane — the popular Piper Cub — resplendent in a regimental coat of olive drab, but in other respects the same little 70-mile-an-hour flivver plane which played such a memorable role in the development of private flying in America. Higher performance Piper aircraft were then available, but Army Aviation was restrained from indulging in any high flying ideas at this stage of its career by a 65 hp limitation. With the L-4 equipment they had — complete with airspeed indicator, altimeter and a magnetic compass, U.S. Army pilots went aloft day after day to call the shots for the gunners during the grim, eventful duration of World War II.

Big Fleet: The years that have rolled by since that memorable milestone was left behind in 1942 have seen giant strides of progress achieved by U.S. Army Aviation. Today the number of aircraft operated by the United States Army exceeds that of many of the World's largest Air Forces.

Army people have a deep rooted love of tradition and a tendency to liken new things to the old familiar objects which they supersede. A G.I. will tell you that the helicopter is just the old proverbial army mule with a windmill fastened on between his ears. "And", he will add with a deep sigh of satisfaction, "With a lot less 'ornery' disposition — and a cleaner pair of heels."

The Army's helicopter program came into being in 1950, when the first helicopter company was formed. (A company consists of 21 aircraft.) Two companies of helicopters saw service during the Korean War. The army was visibly impressed with the job that VTOL aircraft were able to accomplish in Korea — to the extent that the present program calls for a total of 36 helicopter companies by 1960.

When P.F.C. Joe Doke got his first good look at the Beaver and Otter, with their generous payload capacity and special loading features, he just naturally labelled them the army's airborne trucks. The Beaver earned the title of the "flying half-ton truck", and the Otter became known as the "flying one-ton truck". The airborne trucking business has thrived. Since the first Beaver for the American Armed Forces went into service in 1951, some 700 military L-20's have rolled off D.H. Canada's production lines at Downsview. A total of 95 Otter U-1A's delivered to the U.S. Army are in operation in some 20 countries throughout the World. Another 30 are on the way. The missions

LUCAS-ROTAX IN B.C.: Lucas-Rotax Ltd. recently opened a Vancouver plant located at Sea Island Airport. Plant provides facilities for overhaul and servicing of fuel systems for jet and turboprop aircraft. Primarily it will be used for servicing fuel and electrical systems of CPA's Britannia fleet.

they are called upon to perform are many and varied. Dropping tear gas to disperse a rioting mob was a simple chore for a Beaver. Delivering a helicopter by airmail was all in the day's work for an Otter, (the helicopter was a De Lackner Aerocycle — the first helicopter ever transported by an army fixed wing aircraft).

Turning Point: Authorization for the purchase of five new DHC-4 Caribous marks the turning of another page in U.S. Army Aviation history. The Caribou will carry 48 fully equipped combat troops, two jeeps, or 22 hospital litters. It will gross 24,000 lbs. From the L-4 to the DHC-4 represents an eventful interval of time that has seen Army Aviation come a long way.

Perhaps no one is better qualified to appreciate how far it has come than Lieutenant Colonel Allcorn. This Officer (Captain Allcorn at the time) was chosen to fly the first army airplane into battle in North Africa. The Navy launched his Cub from an aircraft carrier 60 miles out at sea. But no one in the Navy knew that the Army had any airplanes. Lacking specific information, they took a hostile view of the L-4, and on its way in to the beachhead, every ship in the fleet opened fire on Captain Allcorn's tiny unarmed machine. Artful evasive action on the Captain's part succeeded in eluding the guns of the fleet, but what Captain Allcorn was thinking about the Navy under his breath he could have been summarily court martialled for.

Over on the beachhead his luck ran out. The people on the beach had heard the shooting out at sea and had a warm reception ready for Captain Allcorn's attempt to penetrate inland. They let him have everything that they could bring to bear in his direction and finally a gunner on a tank got a good bead on him and succeeded in shooting him down (not fatally, he is today a Lieut. Colonel in the U.S. Army). The open season on Army Cubs was terminated on the same day on which the first L-4 was bagged. Captain Allcorn's unfortunate experience led to the issue of an official communique to the American Armed Forces notifying them that the Army now had airplanes, that they were there to serve a useful purpose, and they were not to be shot down. Army Aviation was here to stay.

LESSON IN LIGHTNESS

(Continued from page 17)

planes during his earlier war days. Cheshire had always been regarded as a brilliant thinker, though sometimes prone to erratic, unconventional ideas. When Cheshire saw the new cowlings ready to be put on his airplanes, he objected in strong terms. He asked permission to leave them off. As far as he was concerned the bomber was just plain overloaded, and any extra weight, for any purpose, was just going to make the airplane worse. His Wing Commander disagreed. So Cheshire's request slowly wound its way up through official channels until it reached the Air Officer Commanding, Air Vice Marshal Carr. Fortunately Carr decided to give Cheshire's idea a chance. So his squadron flew off into the night without the additional cowls.

In the end Cheshire proved his point. Losses still climbed in the other squadrons, while his held the line. Official opinion from the Wing Commander up took a quick turn. Cheshire's idea caught fire. Airplanes were now stripped of the front turret, the mid-upper turret followed suit, and finally much of the heavy armour plate. Though this seemed to be denuding the bomber of its protection, such was not the case. With the reduced weight, as well as the reduced drag, the bomber was more maneuverable with full load than ever before. The losses dropped markedly. And the aircraft went on to be a really useful operational type.

In spite of this sample, I think that the British did better at keeping their aircraft weights down during World War II than the Americans. Their Spitfires, Mosquitoes, and several others were good examples of structural efficiency. Undoubtedly they had certain flying features that made them popular and operationally effective. Yet there seems no doubt that, all other things being equal. a low structure weight is a real prerequisite to a good airplane. The old Lancaster bomber is probably the best example of British handiwork in this respect.

To carry the Torch: About the beginning of the last war the RAF decided they needed a big bomber if they were going to carry the torch to the continent of Europe. A contract was therefore signed with A. V. Roe, England. Under the experienced eye of the late Sir Roy Chadwick the drawings for the new plane began to move into the shop. This was the Avro "Manchester", a twin engined, 55,000 lb. gross weight airplane. It was a big bomber for its day.

The Manchester design was keyed to a new Rolls-Royce engine, with an "X" cylinder configuration, the Vulture. The Vulture was designed to give 1845 hp at 5,000 ft. The test flights of the bomber started out all right, and other Manchesters were moving from the production line at a slow pace. Soon teething troubles developed with the Vulture. Rolls-Royce engineers worked overtime trying to sift out the design bugs from their brainchild. Furthermore, there were distressing reports drifting around with the aircrews, as the first Manchester came into operational use, that the Vulture installations were catching fire in the air. Finally even Rolls decided that the middle of a war was no time to be spending vital man hours trying to sort out a baulky engine development. The Vulture was cancelled. And Avros started work on what was popularly called a "four engined Manchester", using four, smaller, Rolls Merlin engines.

Now it is often easier on a redesign, when the gross weight is rising, to make real weight savings. I strongly suspect that this is the true cause of the high structural efficiency of the Lancaster, as the new airplane was called. Never-the-less, although the Lancaster had many parts that were salvaged from the Manchester design, there was also a lot of new design work. The fuselage was almost the same size and shape, but the wing was increased in area and the new power plants were added.

Over the Tree Tops: The Lancaster first headlined the BBC news in April, 1942. At that time 12 Lancasters roared over the tree tops of France and Germany, in broad daylight, to bomb the Nazi diesel engine factory at Augsburg. The bombers got caught in the cross fire from a couple of German fighter squadrons. Only five heavily damaged airplanes came home. Still the Lancaster, with its fine flying qualities, was on its way. It was later to be called the greatest single factor in the winning of the war for the West. And its light structure was a definite factor in its favor. As the British magazine "Flight" said in its August, 1942, issue, ". . . the structure weight of the Lancaster is less than 30 percent of the gross weight, a figure which points to a very high degree of structural efficiency." The British designers could be justifiably proud of their efforts.

With this lesson from the Lancaster, and the other World War II examples of the penalty of a pound, you might think that the lesson in lightness had been thoroughly learned. But such is not the case. In fact, when the Russian-built tanks thundered over the border between North and South Korea, in June, 1950, we seemed to start all over again. Though this time there was a new twist to the task.

In the early days of the Korean War the U.S. battled the invaders of their air corridor with whatever airplanes they had on the spot. The battle was going badly. For the U.S. piston engined planes and their Thunderjet fighter, were easily outclassed by a light, fast Russian jet, the MiG-15. A sudden shock struck home. The new F-86 Sabre fighters were rushed to the scene in quantity. In the final analysis the heavier better equipped and flown Sabre, won the air battle by downing the MiGs in a ratio of over ten to one.

While the struggle for air superiority was being fought, however, and the results were still in doubt, the old textbook on lightness was dusted off. Almost every modification that added even an ounce to the Sabre was sifted and sorted with infinite care. This applied even to the Canadair Sabres rolling out of Montreal. Never have I seen so many weight-consuming modifications rejected. "Watch that weight" became a byline that was forced on us by another adversary, just as the Japanese had done almost ten years before.

Reaction: The upshot of this relearning of the lesson had new offshoots in the post war period. E. H. Heinemann, Chief Engineer for the Douglas Company, argued for a decrease in complexity to save weight. Group Captain A. U. Houle took a similar line in the RCAF magazine, "The Roundel". The British light weight fighter, the Folland Gnat, was a physical attempt to follow this thought. NATO issued a specification for a light ground attack fighter, several models of which are now being flight tested and evaluated. The USAF signed a contract with Lockheed for the light fighter, the F-104. All these attempts at weight saving were not primarily aimed at inculcating a high degree of structural efficiency to new airplanes — which I believe is the basic lesson from both wars. Instead they sought to cut out vital equipment and so produce a lighter, smaller, and faster airplane. This is a somewhat different line of attack from the lesson in lightness, though both stem from the same strain.

In Canada we haven't gone for the cut down fighter concept, and a lot of large air forces seem to be having a lot of second thoughts on them. Still we have augured up weight savings on production aircraft to a degree. For example, the RCAF's interceptor, the CF-100, went through a rigid weight saving campaign. As a result several thousand pounds were pared off and this, along with other modifications, came out as the Mark 5. The weight reduction alone, however, accounted for about half of certain performance improvements. The Sabre built by Canadair went through the weight wringer and several hundred pounds were wrung from later marks. Even the new Canadair Argus has been screened to keep the weight down, to try and hold the line at the original weight estimate that was compiled before the airplane was built.

Our efforts, like those of other Western nations, are usually aimed at cutting out fuel and equipment after the early airplanes have been built, and usually long after it's in production. R. D. Hiscocks, Asst. Chief Engineer for de Havilland of Canada, once told me, "We note with dismay that current radio installations in the Beaver are approximately seven times as heavy as the installations which were considered adequate when this airplane first appeared on the market." So the equipment field is always fertile for weight savings.

Lightness Preoccupation: While this course of action is certainly correct, it is not, I think, the basic truth from the lesson in lightness. What we should concentrate on is the design of light, sructurally efficient, airplanes, engines, and items of equipment. All our research, design and development should be funneled along this channel with a fervor that brooks no failure. Moreover, we should cease looking at modifications to these components on a piecemeal basis. Too often we hear, "This modification only weighs 24 pounds. It will have a negligible effect on the airplane's performance. Let's put it on."

But it isn't the effect of one 24 lb. modification. It's the rising, creeping spiral of one small weight increase after another. In the end, the overweight airplane is a flop. I think there is no better way of emphasizing this point than to consider the rivets in a 300,000 lb. airliner. The Society of British Aircraft Constructors estimates that there are 2 million of them. If the designer cuts the length of each rivet, that he calls for on his drawings, a fraction of an inch, the Society considers that he could save as much as 200 lb. To an airline, this is one paying passenger. And that's a fair slice of revenue.

To me this lesson in lightness is clear. Yet somehow we have failed to drive it home to our engineers, designers, draftsmen, mechanics and operators. And unless we do. we'll be shocked again by another enemy in another war. Or we'll be beaten in the air transport market by another nation that has applied this philosophy to fast and efficient airliners. It was weight savings that the veteran U.S. Navy aeronautical engineer, Ivan H. Driggs, was referring to when he pleaded for some common sense in our aircraft programs. I agree with him. Let us not have to learn this lesson the hard way again.

SHEARWATER

(Continued from page 14)

at RCN Air Station Shearwater are already practicing them at their home base. A mobile mirror landing system simulator was recently brought over from England. It was set up at the end of the runway in use and put into operation almost as soon as it arrived.

In making a landing approach with the mirror system, the pilot is guided by a colored lights presentation in the