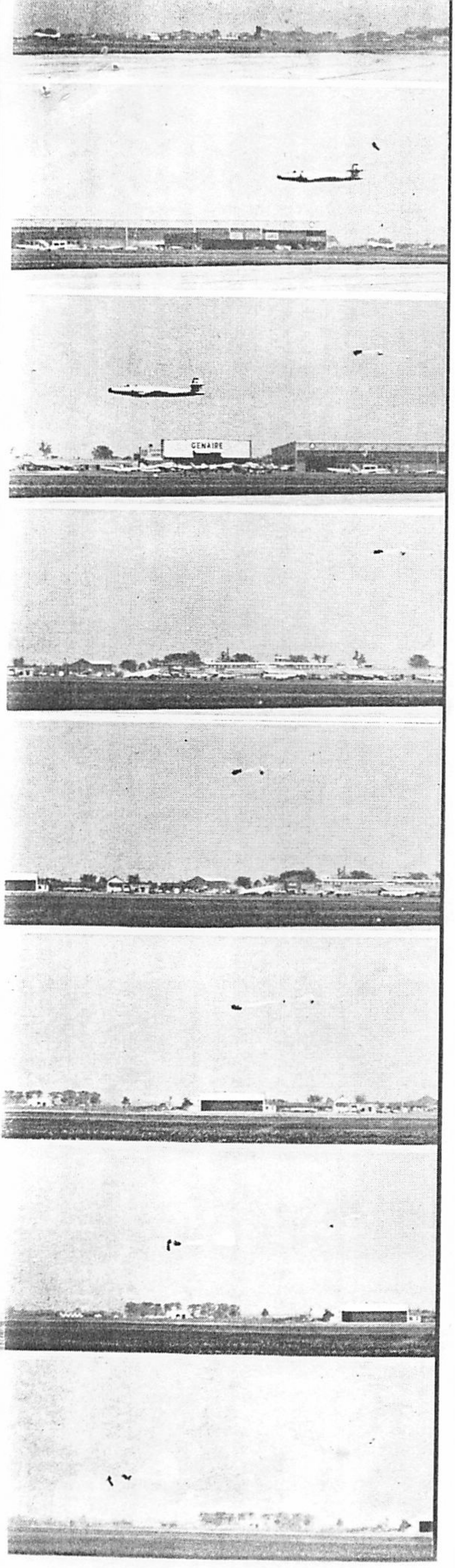

Ejection Seats

By ARCHIE MILLAR

Part I

THE PROBLEM of how to get the pilot out of a fast-moving aircraft existed even before the end of World War II, but it was only when jet aircraft began to go into service in large numbers that the problem became increasingly acute. It is significant that in the operating manuals for early types of jets, the drill for abandoning the aircraft was invariably vague and usually took the form of a "suggested procedure". The suggested procedure was to roll over and attempt to fall out from an inverted position, a rather dubious proposition for the pilot of a fast aircraft presumably already in difficulties.

Nowadays, with the installation of ejection seats, the procedure for abandoning an aircraft, far from being vague, is probably the most clearly defined and positive action that the pilot must memorize before taking the aircraft off the ground. There are many types of ejection seats in use. The manufacture of this particularly valuable piece of equipment has already become a highly competitive field.

Basic Problems: The ejection seat designer faces two fundamental problems. The first is to get the pilot out of the aircraft. The second is to ensure that he lands safely. That the problem has been largely solved in the case of the more conventional jet types is proved by the number of successful ejections that take place every year, yet there is little doubt that the advent of supersonic flight has in many instances again returned the drill for abandoning an aircraft to what is virtually a "suggested procedure" with no guarantee of success. It is generally assumed that a modern ejection seat will successfully carry the pilot clear of the aircraft structure even at supersonic speeds. However, the successful completion of the operation is largely dependent on individual circumstaces.

Martin-Baker Aircraft Co. Ltd.,* a British firm which had extensive experience in the manufacture of aircraft sub-assemblies and complete aircraft, was one of the first to take an interest in ejection seats. The problems they faced, and largely solved, and the means they employed have been duplicated in some measure by all other ejection seat manufacturers. Although the individual characteristics of each seat are blanketed with patents, the operations of all are fundamentally the same.

Martin-Baker first became interested in the development of an ejection seat during 1944. How to get a man weighing perhaps 200 lbs. out of an aircraft travelling even at the fairly moderate speed of 400 knots was not a simple problem to solve, especially as there was no previous data to work on and nobody had ever carried out such a manoeuver successfully. However, a few simple calculations proved that the energy required could not be provided by any arrangement of springs or other mechanical contrivances without an excessive weight penalty, and it was obvious almost from the outset that an explosive charge would be necessary to produce the desired result.

Trial & Error: What type of explosive to use, how to design a seat to use it and, in particular, how to use it to achieve the desired result without injuring the occupant of the seat was a problem that only long and patient experiment could solve. A 16-foot test rig was erected and a crude seat was built and attached in such a manner that it could be shot up the rig by various combinations of explosives, while being photographed by a high-speed movie camera operating at 700 frames per second. The seat was loaded with sandbags to simulate a weight of 250 lbs. at the time of ejection. Not only were different types of propellant used, but variations in the size of the expansion chambers and cartridge cases were also investigated to ascertain the best combinations. From an analysis of the movie film, estimates were made

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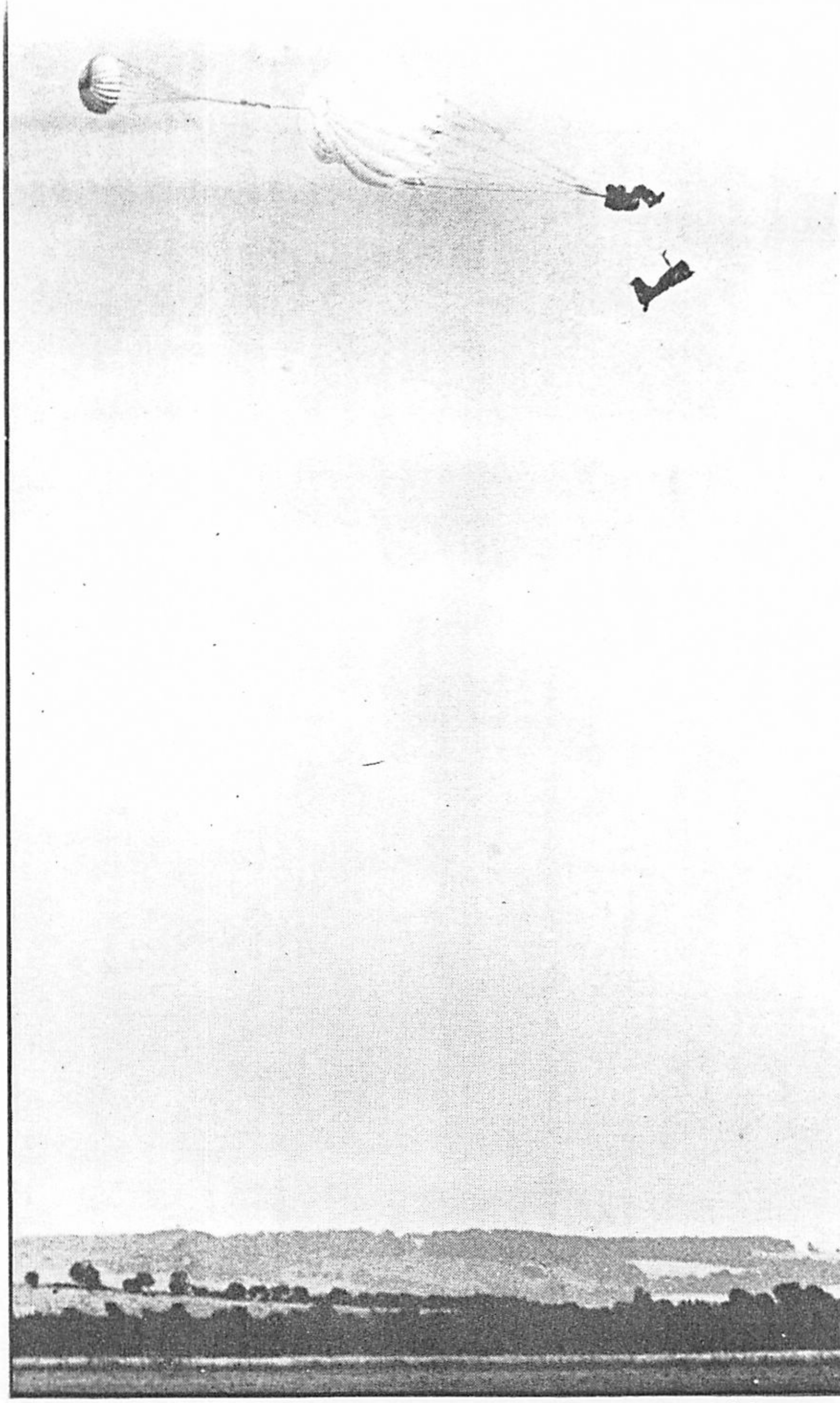
**Martin-Baker has recently formed a Canadian subsidiary which is establishing a plant at Collingwood, Ont.*

of the various rates of acceleration.

Eventually the experiments were continued with live personnel. Using a single cartridge the high pressure at the beginning of the stroke limited the ejection to about 15 feet. However, these experiments led to a number of important developments. It was soon found that foot rests were required to relieve pressure under the thighs from the weight of the legs.

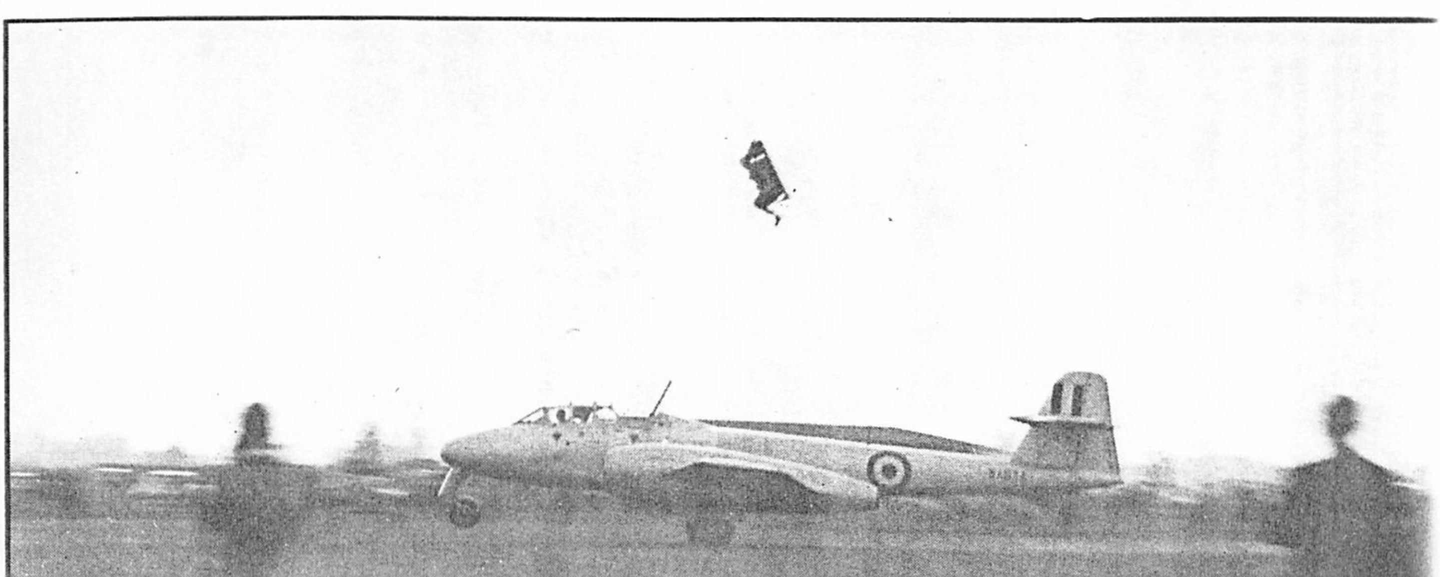
Unfortunately, one of the volunteer subjects of these experiments received injuries to his vertebrae, so that Martin-Baker engineers arranged to see operations being carried out by surgeons on patients who had received similar injuries from other causes. As a result of the discussions it was decided that the initial acceleration was the cause of injury and the process would have to be reversed, i.e. the pressure should be built up slowly at first, rising to a maximum after a more gentle acceleration had, in effect, compressed the body of the seat occupant. This was achieved by the use of a two-cartridge arrangement. A small charge initiated the ejection and was followed immediately by the firing of a second and larger charge which completed the operation. This modification solved most of the basic problems and by the use of the two-cartridge arrangement, it became possible for a person of normal physique to make ascents of 70 feet up to a new and much larger test rig, without any apparent discomfort.

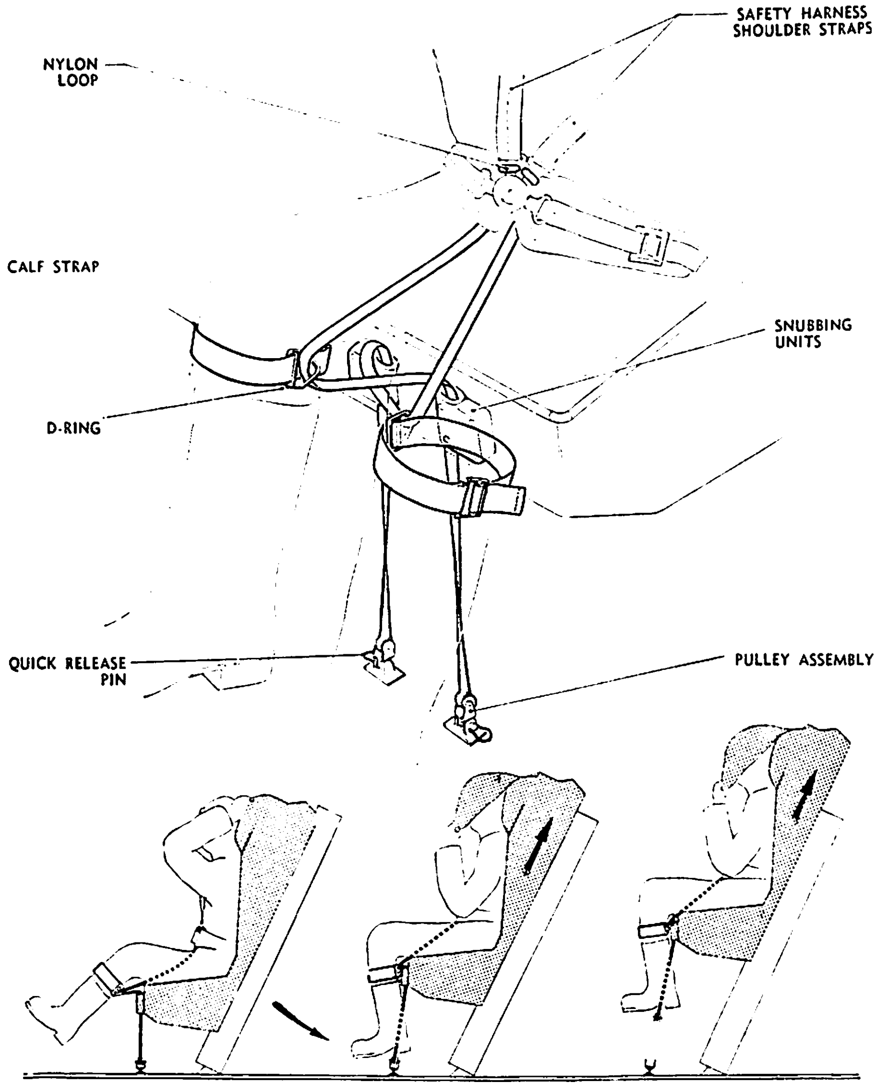
These initial experiments confirmed one of the points which is basic to all successful ejection procedures, namely, that the vertebrae must be erect. If the head is bent downwards, or if the knees are too high, the spine will be curved



—A Flight Photo

Series of pictures on page opposite shows a low level ejection of a dummy from a CF-100, using a Martin-Baker automatic seat. Below is shown S/L J. S. Fifield ejecting from a Meteor which is still running along the runway; above, same ejection, with the main chute developing, and M-B automatic seat falling away.





Drawings illustrate layout and function of Martin-Baker Patent Leg Restraint.

and the front edges of the vertebrae will be closed together, considerably increasing the possibility of injury. So the height of the foot rests and the position of the head rest is of considerable importance.

Flight Experiments: The first dummy ejections were carried out from a Boulton-Paul Defiant. The fuselage was modified to take the ejection seat, then the tail of the aircraft was jacked up to bring the aircraft to its normal flying attitude and a dummy loaded seat was ejected into a net. This performance was again analyzed by the use of high-speed cine cameras and in May, 1945, flight tests commenced. A standard supply-dropping parachute was attached to the seat, which was loaded with a dummy for all the tests. The pilot was provided with a remote firing control. After a number of ejections had been carried out at speeds up to 360 mph which was the approximate maximum level speed of the Defiant, development work on the rig continued while modifications were carried out to a Gloster Meteor jet aircraft to enable experiments to be carried out at higher speeds.

The problem of ensuring that the seat occupant maintained the correct posture at the time of ejection was largely solved by the installation of a blind to cover his face. The face blind has been a distinctive feature of all Martin-Baker's seats ever since. It is by drawing the face blind down over his head that the occupant fires the explosive charge and in addition to holding his head back on the headrest in the correct position, it also protects his face from the airstream once he leaves the aircraft.

Other Considerations: The experiments made with the test rig and experimental installations in aircraft proved that the ejection system was fundamentally safe and efficient. However, the actual mechanical operation and the installation of the seat into operational aircraft, presented a continuing series of problems.

Once the seat was ejected clear of the aircraft, it was recognized that some means of slowing it down and stabilizing it was required. This was solved by the use of a drogue, carried in a container attached to the seat. When the seat left the aircraft, the drogue was released by means of a static line. The drogue prevented the seat from spinning and enabled the pilot to free himself of the seat harness and fall clear to make a normal descent.

A development of this early design went into production as the MK. 1 seat and with it, many successful ejections were made. It rapidly became a standard installation on virtually all high-speed aircraft in service in the RAF, the Royal Navy and the Air Forces of many other countries. In Canada, the seat was installed into the CF-100. For the past few years, incidentally, the Mk. 1 seat and its automatic successor, and other Martin-Baker equipment, has been manufactured by Canadian Flight Equipment Ltd. under a license arrangement which has recently been terminated.

later developments

ALTHOUGH the early seats found ready acceptance, providing as they did the first solution to the ejection problem, it was quite obvious that they were only the beginning. Even as the production lines were set up for the manufacture of the early type seats, experiments were being carried out to develop the idea further.

The line of development for ejection seats is quite clear. They must be made to operate at faster speeds and higher altitudes, they must not impose higher strains on the user, and there must be a continuous effort to reduce the weight, or at least keep it at its present low level.

It was quickly recognized that the succesful operation of ejection seats was tied in not only with the physical abilities of the user, but also with the speed of his mental reactions. To be ejected from an aircraft, the occupant need only resort to a simple drill of removing his feet from the flying controls, placing them on the seat footrests and pulling a blind over his face. However, once ejected, it was essential, with the early type of seat that he remain sufficiently alert not only to release himself from the seat but also to carry out the drill for a normal free-flight parachute descent. A number of factors made this undesirable. The ideal state was obviously to make all operations after leaving the aircraft automatic.

Getting a Lift: While experiments to achieve this highly desirable result were proceeding, a training program was instituted to familiarize users of the seat with the sensation of being ejected. The original test rig was developed into a training rig on which pilots were able to gain a fair idea of the sensation of being shot into the air at velocities equal to those of the seat as installed in the aircraft. When the U.S. Navy showed interest in the seats, a special test rig was built and shipped to the U.S. Navy Yard at Philadelphia. U.S. Navy personnel made a large number of rides on the rig at velocities up to 60 feet per second. Seats were also installed in two types of Naval aircraft and dummy and live ejections were successfully carried out.

In the meantime, all the desirable automatic features had been built into experimental seats and the Mark 2 seat was ready for delivery. In view of the large number of Mark 1 seats in service, a conversion kit was produced by which the automatic features could be built into the existing seats.

The actual ejection is carried out in the same manner. However, on the seat leaving the aircraft, a mechanism built into the seat commences to operate and releases the drogue after a predetermined time-lapse. The need for a long static line is eliminated.

After a predetermined number of seconds, the mechanism causes the occupant to be thrown forward out of the seat and automatically opens his parachute. The pilot's function is merely to make the initial ejection; the entire sequence thereafter is entirely automatic. An additional refinement is the inclusion of a barostatic device set to operate at a predetermined altitude. If the pilot is forced to leave the aircraft at a very high altitude, the barostat mechanism has the effect of retaining the occupant in the seat until he has fallen to a predetermined altitude. He is thus exposed to low temperatures in rarified air for only a comparitively short period. Several further refinements have been added, in particular an automatic leg restraint which ensures that the occupant's legs are in the right position at the moment of ejection.

The most important developments being carried out at present are those aimed at speeding up the entire process of ejection so that it can be carried out at low levels. This has mainly involved adjusting the timing of each stage in the sequence and ensuring that each component operates with the maximum efficiency. Experiments are also being carried out with telescoping ejection guns and multiple drogue systems and so successful have these experiments been that successful ejections have been carried out from an aircraft still on the runway.

(Ed.: Other types of ejection seats will be discussed in the second part of this article, which will appear in the May issue.)

AUTOMATIC SEATS FOR F-86 & T-33

Aerial tests of various automatic seat ejection systems designed for increased safety when bailing out of the T-33 or Sabre jet aircraft, were conducted by the RCAF during February and March at Uplands and Cold Lake.

Fully automatic ejection seats, of the Martin-Baker type, have already been perfected for the RCAF's CF-100 interceptor, and have been in use for some time. However, this system, due to space limitations, is not adaptable to the American type seat in the Canadair-built T-33 Silver Star and Sabre jets.

With the present equipment, the pilot ejects the seat, then frees himself from the harness which straps him to it, after which he must manually open the chute. In the automatic system, developed for the RAF by the Gregory-Quilter Parachute Co., more commonly known as the G. Q. Parachute Co. and represented in Canada by Field Aviation Co. Ltd., Oshawa, the single action of pulling down the protective hood of the ejection seat over his face ejects the pilot from the airplane with a force of more than 800 pounds. He is then automatically separated from his harness and seat at the proper moment by special timing devices. A similar device automatically opens his parachute at a pre-set interval.

By incorporating these new devices the RCAF expects to greatly reduce the possibilities of human error during emergency escapes from the T-33 and the Sabre. This increased safety factor should prove particularly advantageous for low-level escapes which might become necessary shortly after take-off or just before landing, when every second counts.

Approximately 15 dummy ejections from the rear seat of a T-33, using the automatic equipment and the Irvin Flexible back pack parachute with a 24 foot canopy, were carried out at RCAF Station Uplands. In all tests the T-33 was used because the Sabre is a single seat aircraft. Consequently, the new ejection equipment was not actually air tested on the North American ejection seat now in use in the Sabre, but only on the Lockheed seat as installed in the T-33.

Various combinations of equipment were tested at the same time. In the Sabre seat ground tests, the North American ejection seat was equipped with the "Z" type safety harness manufactured by G. Q. in conjunction with automatic opening devices by the same firm. In addition, the G-Q Parachute auto rip Mark VII parachute opening device was installed in the Irvin Flexible back pack parachute now in use.

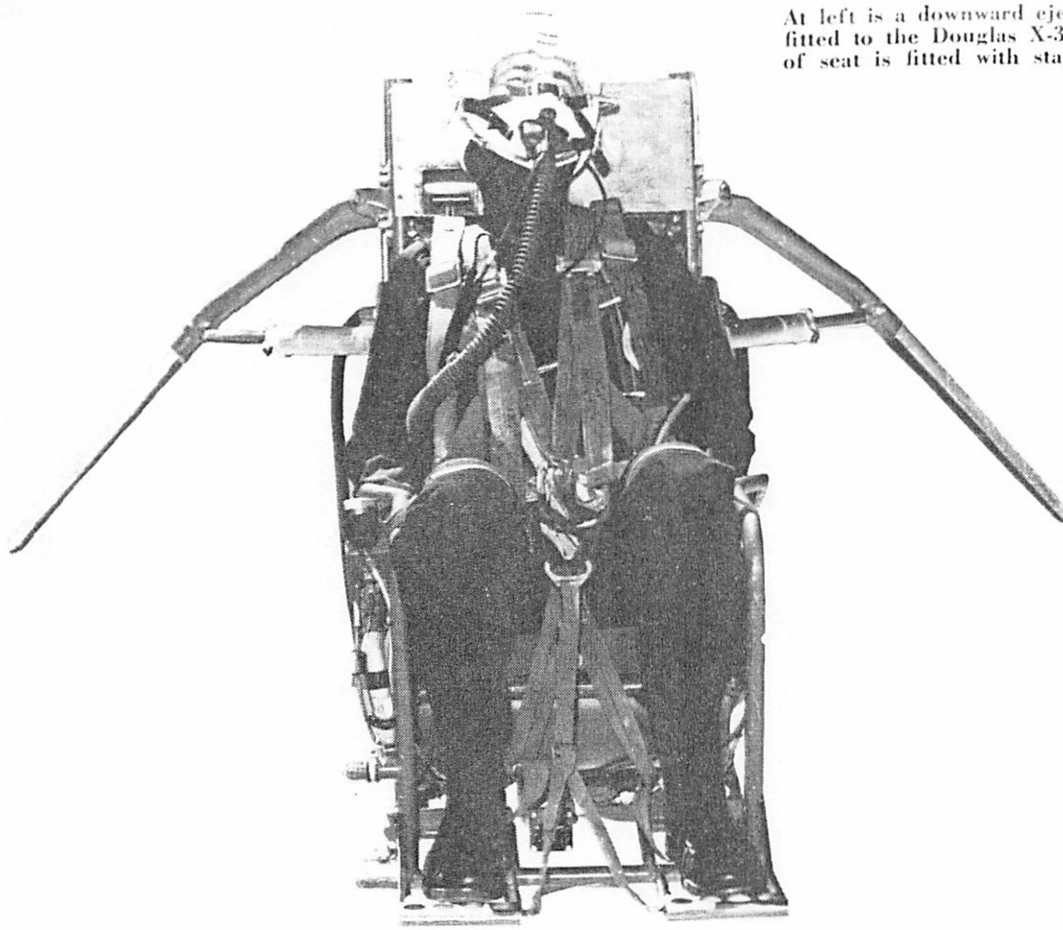
In the T-33 the "Z" type harness was already standard and the tests were carried out with the addition of the automatic release and opening devices to the Lockheed seat and the Irvin Flexible back pack chute.

Additional tests were carried out to evaluate the Pioneer Guide Surface parachute with the large canopy, and the G. Q. Mark XX parachute. Both of these chutes were designed for high speed opening.

Assisting the RCAF's Central Experimental & Proving Establishment during the tests was Arthur Harrison, development engineer throughout the British development trials in connection with the Folland lightweight ejection seat which now incorporates the devices. Mr. Harrison has made 108 jumps himself, many of them delayed drops up to 15 seconds, during which time he records, sometimes electronically and sometimes with a knee pad, the reactions of the particular piece of equipment he happens to be testing. Also assisting was Sir Raymond Quilter, chairman and managing director of the G-Q Parachute Co., and veteran of 187 jumps himself. He was the first man in the world to carry out a delayed jump.

The trials were carried out at various speeds and altitudes including low-level ejections at approximately 200 feet. The tests also included parachute jumps from a Dakota aircraft by volunteer pararescue airmen in order to evaluate various types of parachutes, including another G-Q parachute said to open in two seconds.

At left is a downward ejection seat as fitted to the Douglas X-3. This type of seat is fitted with stabilizing fins.



Ejection Seats

By ARCHIE MILLAR

Part 2

IN THE U.S., a wide variety of ejection seats are in use, many designed and produced by the manufacturer of the aircraft to which the seat is fitted, but some designed and built by specialist firms. An attempt has been made to standardize on some features and a specification, MIL-S-6326, lays down the basic requirements for seats used in USAF aircraft.

The seat installed in Sabre Aircraft was originally designed by North American Aviation Inc., and has proved to be highly effective when circumstances have made it necessary to eject from these high-speed aircraft. Although the seat is actuated in substantially the same manner as the Martin-Baker seat, it differs considerably in detail. No face blind is fitted, the seat being operated from handles on the arm-rests and a trigger under the right hand-grip.

Preparing to Blow: When the left hand-grip is pulled, it locks the shoulder harness preparatory to ejection. The right hand-grip actuates a micro-switch on the canopy seal system, causing the canopy seal to deflate. It also fires the canopy remover. As the canopy leaves the aircraft, a lanyard from the canopy pulls the ejection seat catapult sear safety pin from the catapult, thus "arming" the seat.

The seat is fired by squeezing the trigger inside the right-hand hand-grip. The propelling force is roughly comparable to that of a 37 mm shell.

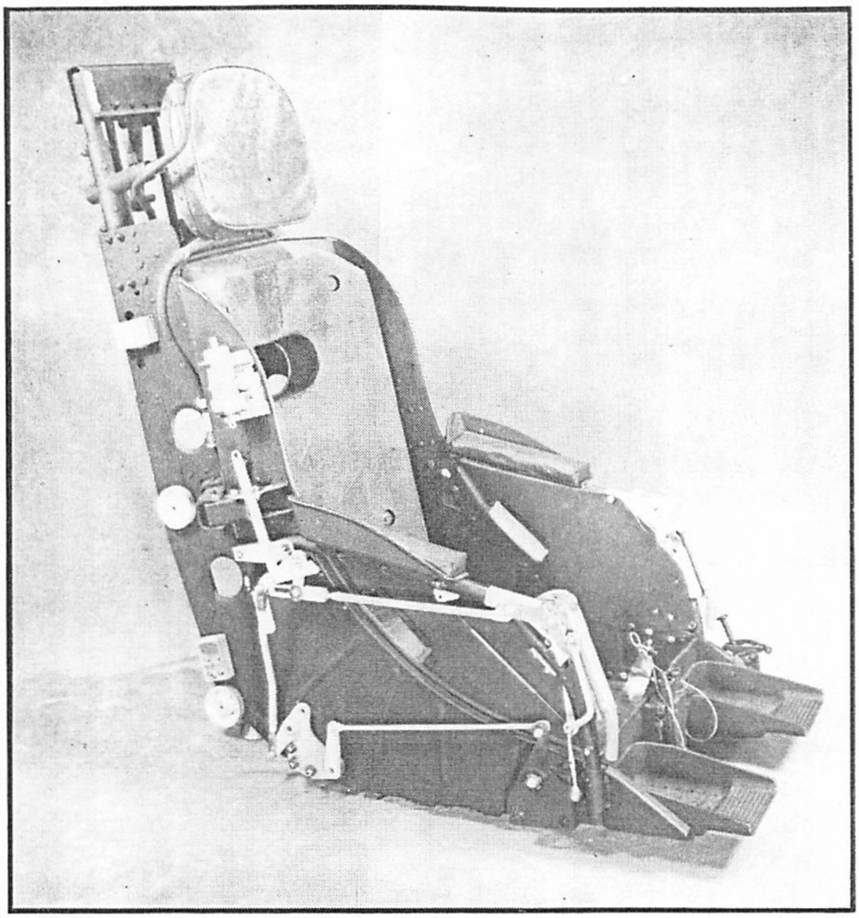
In almost all cases, U.S. seats are integrated into the aircraft, i.e., the mechanism for jettisoning the canopy is linked with that for ejecting the seat.

One of the largest independent U.S. manufacturers of ejection seats is the Weber Aircraft Corporation which has produced a wide range of seats for the USAF and USN. All the seats are basically similar but they differ greatly in detail.

Weber seats are individually designed or modified from standard designs to suit specific aircraft. The aircraft manufacturer provides an "envelope" — a specification and set of drawings of the section of the aircraft to which the seat will be fitted. Weber engineers then "tailor" the seat to fit the aircraft, ensuring that it fulfills all the relevant specifications to the satisfaction of the customer.

Multiplied Problems: For multi-seat aircraft, the requirements may vary widely, since it is sometimes necessary that the co-pilot be provided with a seat which can be rotated through 180 degrees from facing aft to facing forward. This also involved an additional complication because the footrests, which are important parts of any ejection seat, have to be retracted under the seat until immediately before ejection.

Weber seats must be bottomed before firing and this is accomplished by a ballistics actuator. The occupant lifts the left hand armrest to lock the inertia reel which anchors the seat harness.



This is a Weber ejection seat, fitted in many USAF aircraft. A version of this seat is made in Canada by Thor Industries Ltd. for the Canadair F-86 Sabre.

The action of raising the right-hand hand-grip sets off a sequence of thrusters and initiators which bottom the seat, stow the control column, and finally jettison the canopy.

The canopy is usually attached to the seat by a lanyard. The lanyard removes a safety pin, thus "arming" the seat, after a two second delay. The seat occupant can then, by squeezing a handle inside the handgrip fire the catapult which ejects the seat.

The seat is attached to the aircraft structure by a second lanyard which, after a two second delay fires an initiator which releases ballistically the occupant's lap belt and shoulder harness so that he falls clear of the seat to make a free parachute descent.

The seat of course provides interior space for a survival kit and cushion and a back-type parachute.

All Weber seats are provided with quick disconnect fittings ready for connection during installation of the seat into the aircraft.

Downward Ejection: Downward ejection has been the subject of a great deal of experimentation. Although it poses obvious problems to the designer of the aircraft, downward ejection offers a great advantage in that it virtually eliminates the risk of collision with the tail surfaces and therefore can be used successfully with a less powerful propelling force, or, conversely, permits ejections at faster speeds with the propelling forces presently in use.

The Douglas Aircraft Company, co-operating with the USAF Research & Development Command, has carried out extensive investigations into the problems of downward ejection at supersonic speeds to produce a seat which can be ejected downwards from the experimental Douglas X-3 high speed research aircraft.

At supersonic speeds, some method of stabilization is obviously required and Douglas engineers made extensive wind-tunnel tests before equipping their seat with guide vanes which open automatically when the seat has left the aircraft. They also deliberately increased the weight of the seat by installing on it the entire oxygen system and found, surprisingly, that this reduced the total weight of the aircraft and occupant.

The new seat was extensively tested on a high-speed track and in wind tunnels. Eventually, it underwent a series of ejections from the bomb bay of a fast jet bomber. The tests showed that the design had been successful, the fins maintaining the seat in a safe attitude without tumbling, until it slowed down and reached an altitude from which the pilot would be able to make a safe descent.

Solution Yet: Although the problem of supersonic ejection has not yet been fully solved, George Smith, a North American test pilot, abandoned an F-100 at Mach 1.05, using a conventional type seat and survived the ejection, although with fairly serious injuries.

Smith's aircraft went into a dive at 35,000 feet and reached 6,500 feet before he was able to get out. The aircraft has been estimated to have been travelling at 1,140 feet per minute or 777 miles per hour and the blast of air which hit him as he left the aircraft is estimated to have subjected him to a decelerative force of 40 g's, equivalent to increasing his weight to 8,000 pounds. Although Smith survived the experience, mainly owing to a singular series of co-incidences which caused him to be picked out of the ocean and rushed to hospital in a minimum time, it is obvious that the seats presently in use for subsonic aircraft are inadequate protection against the forces imposed by ejection at supersonic speeds.

North American maintain a special Human Factors group of engineers whose sole task is to study the effects of high speed and high altitude flying on the human body. The supersonic bail-out of George Smith touched off what has been perhaps the most intensive series of experiments relating to high speed ejection carried out to date, experiments in which high speed ejections have been simulated by the use of the rocket propelled sled at Edwards AFB in the Mojave Desert (see February issue of *Aircraft*, p. 39—Ed.).

Future Developments: What of the future? It is probable that even in their present advanced state of development, ejection seats are only at the threshold of the real problems. High altitude flight is becoming commonplace and we may soon be entering outer space. Since aircraft are man-made creations and as such are always liable to failure, some provision must be made for abandoning them at very high speeds and extreme altitudes.

The one successful supersonic ejection already made caused considerable injury to the seat occupant. Obviously some kind of shield is required to protect the occupant of the seat from the airstream when the seat leaves the aircraft.

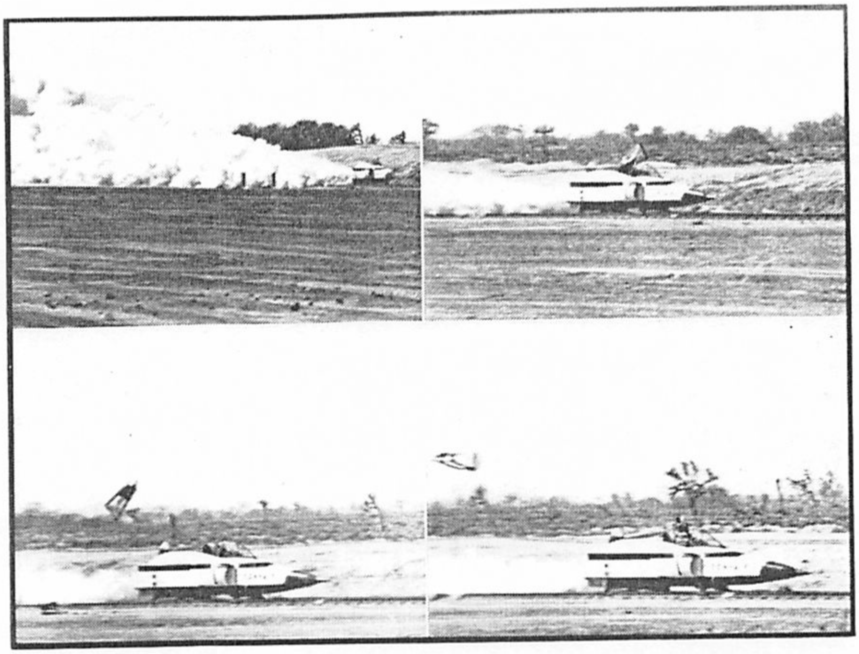
There may also be increasingly important psychological problems. Supersonic flight within an enclosed pressurized and heated cockpit produces very little physical sensation but little is known of the reactions of the average pilot once the canopy has been ejected. Some mechanical linkage whereby release of the canopy also ejects the seat—an extension of the present interlocking system—may be indicated for single seat aircraft.

Ejection through the canopy is also feasible, although the strength of the modern Plexiglas canopy makes this procedure hazardous. Since the feasibility of downward ejection, except at low altitudes has already been demonstrated the actual ejection from large aircraft is somewhat simplified. There seems no reason why large military aircraft should not be fitted with a multiplicity of such seats. However, the abandoning of an aircraft by more than one person at the same time adds a problem of intercommunication, especially as the speed at which the modern military aircraft operates makes the time factor vitally important.

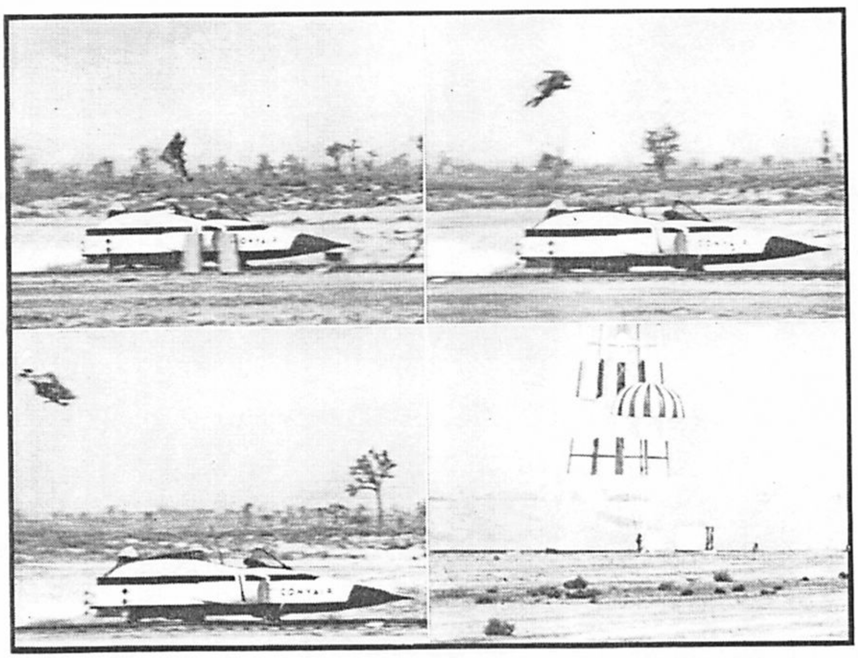
Capsule Ejection: The idea of a self contained capsule which could envelop the pilot and be ejected from the aircraft, or could be a part of the actual aircraft capable of being instantly detached from the body of the structure is not a new one but so far, the mechanical problems encountered have precluded its use. The difficulty is, of course, that of permitting the flying controls and other services to be accessible to the pilot up to the instant of ejection. Nevertheless the necessity for the provision of such a capsule is becoming increasingly apparent.

Ejection Drill: Although a large number of highly skilled technicians are presently employed in improving present devices for abandoning aircraft at the extremes of altitude, speed and acceleration, the human factor is still the one which poses the most problems. In the U.S. it has been estimated that roughly 22% of all seat ejections result in fatalities, yet the vast majority of these are ejections made at low speeds under comparitively mild conditions. Experience proves that seat designers

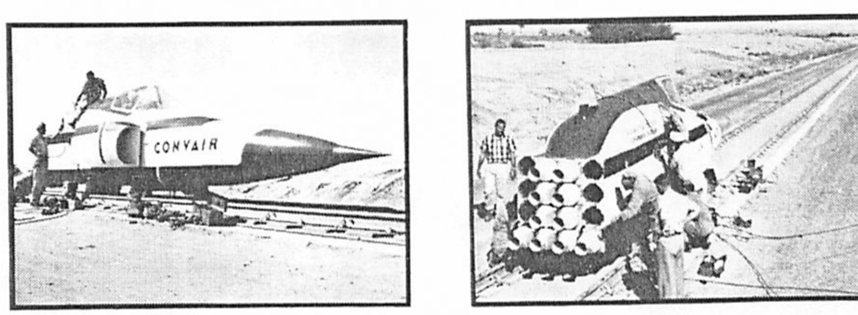
(Continued on page 84)



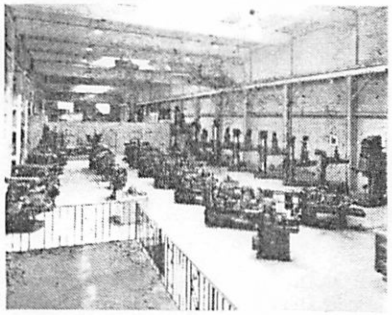
Picture sequence shows Convair rocket sled used to test F-102A ejection system: top L, with five rockets firing, sled approaches peak velocity; R, as sustainer rocket maintains sled speed, powder charge blasts canopy open; bottom L, canopy flies off and seat ejection begins; R, ejection continues.



Top, L, dummy pilot and seat have cleared cockpit: top R and bottom L, seat and dummy rise still higher as sled speeds forward under impulse of sustainer rocket. Latter two photos were taken about .025 sec. apart. Lower R, unharmed dummy floats down seconds after separating from seat at trajectory peak.



Pictures above show close-up of the sled as it is being readied for run down 10,000 ft. track at USAF Edwards AFB. Runs as fast as Mach. 0.98 have been made. Provision is made for installation of up to sixteen rocket motors.



TOOL SHOWROOM: Shown is a view of the machine tool bay of new A. R. Williams Machinery Co. Ltd. showroom in Toronto. Approximately $1,000,000 worth of machine tool, materials handling, and industrial supply equipment is on display.

facilities for which tenders are expected to be called within the next two months.

Also nearing completion is the new $600,000 aircraft taxiing and parking area in front of the administration building. Work on the 400 yard concrete strip was started last year. An additional $100,000 has been authorized by DoT for a 60 ft. movable control tower. Tenders for the construction of the tower have already been received.

In the interior, the DoT has awarded a contract to Dawson Wade & Co. for the construction of a $1,200,000 airport, six miles northeast of Williams Lake. It is designed to handle the largest aircraft now on commercial operations. At the same time, the Aero Club of B.C. is still petitioning the government to provide a light aircraft airport at Spanish Banks, also to be used as a secondary airport to Vancouver's International Airport. At the present time White Rock is under serious consideration for this purpose.

At Edmonton, an aerial survey of the new DoT airport near Nisku, 16 miles south of the city's centre on the Calgary highway, will commence early this spring according to Hon. George Prudham, Minister of Mines & Technical Surveys. The survey will cover an area of some 16 square miles, with additional surveys of the administration and other building sites and runways. The runways will be over 10,000 ft. in length. Tenders are expected to be called for the construction work this winter, with the actual construction beginning with the spring of 1957.

At Winnipeg, the construction of the new east-west runway at Stevenson Field is continuing on schedule and the present north-south runway has been extended and strengthened to accommodate heavier aircraft. In addition, the DoT has announced its intention to build a new $1,000,000 terminal building to accommodate the steadily increasing passenger and commercial traffic.

STARFIGHTER

(Continued from page 60)

mounted atop the swept vertical fin.

Forced Down: The downward ejection seat is the first of its kind to be installed in a production jet fighter and the ejection sequence is of some interest. Lockheed says that to eject himself the pilot has only to pull a handle to start the following automatic chain of events: (a) the cockpit is depressurized and the stick pops forward out of the way; (b) the parachute shoulder harness snaps onto the pilot, his legs are pulled close to the body by "mechanical straps", and ankle clamps hold the feet in place; (c) an explosive cartridge releases the escape hatch and jettisons the seat downward and outward; (d) the pilot's seat belt unsnaps, freeing him from his seat, and at a pre-set altitude the parachute opens.

The dive brakes are located on the fuselage sides, back of the wing. A drag parachute is installed under the fuselage, near the end of the tailpipe.

A large engine access door, on the bottom of the fuselage, serves a dual purpose. In addition to providing ready access to the engine, the door's inner panel holds most of the hydraulic equipment, to facilitate servicing.

Dimensions are: span, 21 ft. 11 in.; length, 54 ft. 9 in.; height, 13 ft. 6 in.

EJECTION SEATS

(Continued from page 37)

have usually credited a man, acting under emergency conditions, with the ability to think and act faster than, in many instances, he is capable of thinking and acting.

Although efforts to improve methods

of escape will continue, a successful ejection must always depend, in the final analysis, on the psychological reactions of the airman. If, when the time to eject arrives he does not know the correct ejection precedure, no technological features will be of avail. For this reason, a thorough understanding of the seat is absolutely essential. The user need not know the internal workings of each component but it is essential that he should know exactly how to operate the seat and what effect his actions will produce. During World War II paratroopers found that the process of bailing out could be reduced by constant drilling to what was virtually an instinctive reaction. There seems no reason why this lesson should not be applied to the ejection procedure, i.e., that the aircrew be drilled to eject virtually "without thinking" once the decision to abandon has been taken. In an emergency there is little time to begin remembering a drill learned from a text-book.

In the RCAF, text-book instruction on emergency ejections is supplemented by training in a dummy cockpit fitted with an ejection seat identical with the one which the pupil will be using. In this, all the necessary actions can be demonstrated and the pupil can carry out the complete drill and produce the same effects as far as it is feasible to do so on the ground.

TU-104

(Continued from page 30)

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and tailplane have 45° deg. sweep, with a thickness/chord ratio of about 10%, thereby assuring a higher critical Mach number than that of the wing and consequently the maintaining of tail control even when the wing reaches its limiting conditions. Structures are of twin web, torsion-box form with separate leading edges. There is no sign of surface heating and the fin and rudder are rather roughly finished on this airplane.

Highpockets: The landing gear is very tall, which makes it look slender. This characteristic is attributable to the fact that the gear is another Badger component and since the Badger has a shoulder wing, long legs are a necessity. The main undercarriage has four-wheel bogies with front tension pistons to damp the the first shock of the rear wheels touching down, and to prevent pitching while taxi-ing. Twin nosewheels are used, with hydraulic dashpost steering. Tire pressures are palpably lower than Western practice.

The flying controls do not appear to be power operated. The ailerons, which are mounted on false spars, have sealed pressure balances and what look like large spring tabs. The rudder and elevator have unshrouded inset-hinge aerodynamic balances with rather small tabs —probably for trimming only. Fowler flaps are fitted between the ailerons and the undercarriage nacelles, and the engine nacelles, but not the fuselage.

The power units type (M-109, probably single-spool axials) are the big question mark. The airplane is about the size of the Comet 3 and would be expected to weigh about 150,000 lb. by Western standards. It may not, however, since Soviet economy usually prefers prestige to payload, as witness the sparse seating used in the Aeroflot DC-3's, Il-12's and Il-15's. Yet when operated by the satellites, these airliners carry normal loads.

Impression of Size: The air intakes and powerplant bays are big. Power is certainly about 15,000 lb./st./th. and is probably derated from the bomber engines of 18,000 to 20,000 lb./st./th.
