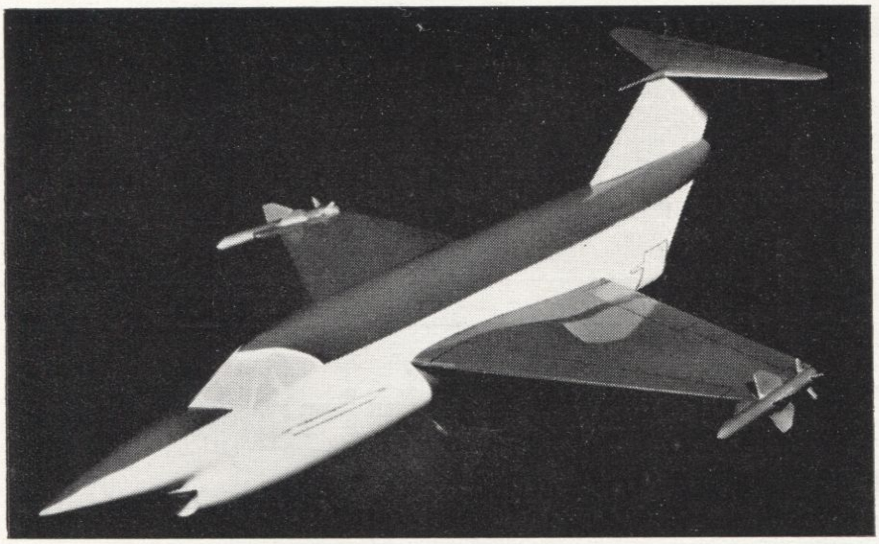

Unless there is a sudden change of Government policy the S-R.177 will not be built, and it is to be regretted that this interesting design has been shelved owing to lack of funds and foreign orders. The history of the development of the 177 is in itself of interest, and it is published here by kind permission of Saunders-Roe.

The Saunders-Roe S-R.177

THE story of the S-R.177 began when Saunders-Roe started a serious study of aircraft for combat at extremely high altitudes. The company had put forward proposals for a water-based transonic fighter aircraft which was a natural development of the S-R/A.I. jet-propelled fighter flying-boat.

Whilst these proposals did not receive interest and support the work which had been done did enable the company to break new ground and turn to the design of mixed rocket and jet-powered aircraft.

Its design team had already investigated the requirements of aircraft designed to fly at 100,000 ft. and had irrefutable proof of the advantages of a mixed unit configuration. In particular, the two most important characteristics of performance—climb to height and duration at altitude—were improved by the addition of a jet engine to the all-important rocket engine.

These advantages were borne in mind when the Ministry of Supply invited tenders for a pure rocket-propelled, high-altitude interceptor, Saunders-Roe was one of the companies awarded the contract, and when the specification was later amended to include provision of a jet engine, the way was clear for the mixed unit interceptor, although at that stage the turbojet was intended only to allow the rocket aircraft to cruise back to its base after a sortie.

With the basic concept laid down, the next step was to determine the best engineering method of meeting the requirements. Various engines—some in the development stage, others little more than proposals—were considered, and it was obvious from the start that the choice of the oxidant to be used was a vital factor. H.T.P. was studied, so were Nitric Acid and Liquid Oxygen. The natural qualities of each, both pros and cons, were carefully evaluated, and the final choice of H.T.P. was one that we have never regretted.

So, the S-R.53 was conceived with the Spectre rocket engine and the Viper which was the most suitable jet engine at that time.

This aircraft was in no way a research project. It was built to a Royal Air Force requirement. Its performance and armament were designed to be in harmony with existing and proposed ground equipment and radar installations. It was built to intercept an attack a little higher and faster than that which could be mounted by existing bombers—and this it could easily do.

However, although most people realise that it takes a team to design an aircraft, it is not so well known that it takes the combined efforts of the best brains of the Services, the Ministry of Supply and its establishments, such as the Royal Aircraft Establishment and Radar Research Establishment, to ensure that the finished aircraft integrates into the whole complex, highly-technical pattern of our air defence system. At no time must the continued development of the complete ground-air interception network be held up because of the limitations of any one component.

So, as design and construction of the S-R.53 proceeded, careful note was taken of all ideas, suggestions and hints of future requirements that were made at the frequent discussions and meetings with the Services and the Ministry of Supply. These meetings were followed up by friendly visits to R.A.F. stations, and one fact which soon became clear was the eventual necessity for air-to-air radar, homing devices and electrical equipment which would be independent of altitude.

Yet the design of much of this equipment was only beginning, and if full provision had been made for it in the S-R.53, it would have been out-of-phase with the time scale.

Thus, late in 1953 and in parallel with the design and construction of the S-R.53, Saunders-Roe began to design a direct development of this aircraft. This was known as the S-R.177.

Proposals for this very advanced interceptor were placed before the Ministry of Supply in 1954, and the design contract for this aircraft was finally received in 1955.

The S-R.177 is aerodynamically similar to the S-R.53, the main differences being in its armament, interception equipment and automatic pilot equipment. In addition, by combining the cruising economy of a much more powerful turbojet with the great high-altitude thrust of the Spectre, it can make much wider use of the advantages of the mixed power formula than can the lower-powered S-R.53.

The basic ideas which led to this Saunders-Roe mixed unit conception are simple. An interception operation calls for the aircraft to perform a flight sortie that involves periods of low and medium speed flight and also calls instantly for high acceleration and rates of climb and turn. To achieve this, high thrust is essential, especially at altitude.

This can be achieved in many ways . . . by propeller . . . by jet . . . by rocket . . . by ramjet. But whatever method is used the basic quantities are, "the weight of engine to give one pound of thrust at the height required", "the weight of fuel consumed by this pound of thrust for every minute it is used". Evaluation of these two quantities and choice of the most efficient engine installation points the way to the best aircraft for the job; and if the problem is confined to interception, and the required sortie pattern is considered in relation to the range of possible threats, a simple choice emerges.

The choice narrows to the turbojet, the fully-variable-thrust rocket engine and the ramjet engine. The importance of acceleration narrows the field still further to either the turbojet with reheat and the rocket engine or all three types of powerplant, which might be considered as the next step in the development of the mixed unit principle.

Looking at the reheated turbojet, these engines have reached the stage where for every pound of thrust at sea-level the engine weight is about 0.20 lb. But the same engine at 60,000 ft. and Mach 1.0 delivers only some 4 per cent of its sea-level thrust. If, under these conditions the engine weight is 1.39 lb. for every pound of thrust, each pound of thrust is using about .035 lb. of fuel per minute.

In the case of the rocket engine each pound of thrust at sea-level involves an engine weight of about 0.05 lb. What is more important is that this thrust is maintained and even increased with altitude, so that at 60,000 ft. the rocket gives 50 per cent more thrust than at sea-level. This must be balanced against the high fuel consumption of the rocket engine, in which about 0.25 lb. of fuel and oxidant are consumed every minute for each pound of thrust.

However, the supersonic duration and acceleration time available to deal with the threat of a high-speed bomber, demands that the final attack period at high speed and altitude should last only a few minutes and, consequently, the rocket fuel consumption need take place only during this time.

A calculation to optimise the aircraft size and versatility reveals that a smaller and lighter aircraft can be obtained by combining a single large jet engine with a rocket engine rather than using two large jet engines.

The particular advantage of the mixed unit aircraft is its versatility. For example, its total engine installational weight may be only about 10 per cent of the take-off weight; whereas the corresponding figure for the pure-jet type is about 25 per cent. It is true that the mixed unit aircraft will carry a greater percentage of its take-off weight in fuel and oxidant. But the landing weight, the rocket propellents consumed, is very low and the by-product of this apparent disadvantage is the ability to land on comparatively small runways. Take-off from the same runways naturally presents no obstacle in an aircraft with such a reserve of power.

Yet this is merely the start of a long list of advantages offered by a mixed unit interceptor. There is, as we have said, ample thrust in flight, particularly as the aircraft climbs to extreme altitudes. Heights like 60,000 ft. or 70,000 ft. can be achieved in a very few minutes and, for the first time in this sort of problem, performance is not dictated by aerodynamic drag. In fact, put another way, it is essential to have a fully-variable-thrust rocket under the simple control of the pilot, because the application of full thrust in level or near-level flight would cause the aircraft to accelerate rapidly, the peak being limited as a rule by fuel carried.

With drag no longer the dominant factor, an increase of drag will entail only more throttle and, hence, greater fuel consumption. So equipment such as the radome can be designed for maximum overall operational efficiency rather than minimum drag. Fuselages, or wings can be designed to take bulkier equipment, within aerodynamic stability limits. A typical example is that bulky, low-pressure landing gear could be fitted for operation from hastily-prepared aerodromes with only a small loss of supersonic duration but no loss of speed.

However, the S-R.177 is not just another fighter aircraft, it was designed as a weapons-system vehicle in such a way that it could easily keep pace with systems, developments, and operational requirements of increasing severity. It was designed so that during each stage of its development it could be a highly effective weapon capable of giving continuous protection against the existing and anticipated threats. It was designed with the maximum versatility to take full advantage of its inherently large internal fuel capacity so that the same vehicle could be used for a wide variety of long-range strike support, photo reconnaissance and ground attack duties as an all-kerosene aircraft operating on its jet engine alone.

Its flight-control system—designed and under development by Smiths, Messier and Saunders-Roe—will, in its final form, be capable of development to the stage where it will offer full automatic guidance. Security requirements prevent any enlargement of this but we believe that the ultimate guided weapon can be achieved most efficiently by this method of approach, and that the 177, more than any other form of defence, will provide reliable, efficient and continuous protection until such time as the ultimate weapon has been perfected.

Britain Enters the Space Age

Air League Conference

THE world stands on the threshold of space travel. Three man-made satellites circling the globe on the fringe of space have turned fantasy and fiction into fact; space scientists, branded as cranks a few years ago, have become prophets whose predictions have proved to be right—rather sooner than perhaps some of us would have liked.

These satellites are a direct extension of guided weapons techniques and guided weapons may be said to have sprung from the V1 and V2 of the last war. Today, every newspaper reader is aware of the scientific jargon of rocketry—ICBM, IRBM, sustainer motors, boosters, beam riders—terms like these are commonplace to us all.

The Air League, in its role as a national watchdog on aeronautical matters, has observed these developments with concern and is anxious that the young people of today should realise the full significance of guided weapons and space travel. Where does Great Britain stand in all these matters—can she afford to stand back from space travel? Questions like these spring readily to mind and need to be carefully studied by all of us.

With all this very much in mind, the Air League has arranged a conference at the Royal Festival Hall, London, on Monday, 14th April next, at which His Royal Highness, The Duke of Edinburgh, Patron of the Air League, has consented to speak. Marshal of the Royal Air Force Sir Dermot Boyle, Chief of the Air Staff, will be Chairman at the conference, which will be addressed by experts from the Royal Aircraft Establishment, and from industry. The conference will close with a Brains Trust when members of the audience will be invited to put questions to the experts.

Among subjects to be covered by the experts will be the techniques of launching sputniks, design and construction problems, control systems and methods of propulsion.

The conference will last from 10.30 a.m. to 1.30 p.m. (doors open 10 a.m.). It is intended for senior students from schools and technical colleges and for the younger people like apprentices and junior scientific officers from industry.

The Air League is a non-profit-making body, and in order to cover the costs of the conference, a charge of 7s. 6d. has to be made for tickets. Reduced rates are available for parties.

ALL-ENGLAND CONTEST RESULTS

THE eleventh All-England Contest held in the Lecture Theatre of the Royal Institution on Saturday, 18th January, held many surprises, and the result probably caused as much surprise to the Royal Netherlands Air Force team, who went home covered with glory and four magnificent trophies.

THE AWARDS

The Silver Hurricane

Awarded to the team scoring highest aggregate marks

THE ROYAL NETHERLANDS AIR FORCE

The B.E.A. Viscount Trophy

THE ROYAL NETHERLANDS AIR FORCE

The Silver Heracles

Awarded to the leading team of cadets of the Air Training Corps or Combined Cadet Force

No. 276 (CHELMSFORD) SQUADRON, A.T.C.

The Bristol Britannia

Awarded to the competitor obtaining highest marks

A. VAN NIEKERK (ROYAL NETHERLANDS AIR FORCE)

The Royal Netherlands Trophy

A. VAN NIEKERK (ROYAL NETHERLANDS AIR FORCE)

Winner of the **Air Pictorial Trophy,** now awarded to the highest-scoring A.T.C. or C.C.F. competitor was Cpl. C. M. HOWLETT of 276 Squadron, with 32 marks.