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Chapter 11

BRITISH ROCKETRY DURING WORLD WAR II*

John Becklake†

The story of British rocket development in the 19th century has been well documented [1, 2, 3]. The development work of men like Congreve, Hale and Boxer had taken the old gunpowder war rocket to near the limit of its potential. During the 19th century other peaceful uses for the gunpowder rocket, apart from firework displays, began to appear. Prime among these was the lifesaving rocket [4], where again British entrepreneurs and engineers, like Trengrouse from Cornwall, played a leading role.

However from the end of the 19th century until the mid 1930s British interest in the rocket either as a weapon of war or as a means of space travel disappeared. Britain produced no spaceflight theoreticians like Tsiolkovsky from Russia, single minded rocket engineers like Goddard from America, or popularizers of space travel like Oberth from Transylvanian Germany. In 1933 the British Interplanetary Society was formed, but unlike its sister societies in America, Germany and Russia, almost no practical work was carried out by the society or its members. Space historians have cited the Explosives Act of 1875 as the deterrent to rocket experiments by the general public in Britain. This "Guy Fawkes Law," as it became known, banned all experimentation with, or manufacture of, gunpowder, dynamite, etc., by private individuals. The Act was later taken to cover experiments with liquid propellant rockets. Although a few limited rocket experiments by small groups in Britain did proceed unhindered during the 1930s, the full weight of the law descended on some Manchester Interplanetary Society members when they fired some crude powder rockets at Clayton Place near Manchester in 1937. However this act was no reason for a lack of interest in governmental and industrial circles in Britain in the development of the rocket.

It is probably fair to say that it was only in Germany that any real interest was shown in the rocket in the early 1930s. In Germany the main interest in the rocket was by the military, as a rediscovered weapon of war. However by 1935 the situation had begun to change in Britain, and in this paper I would like to sketch the

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story of British rocket development from 1935 to the end of the 1939-1945 war. Although this will include the development of the ballistic anti-aircraft and barrage rockets, the paper will concentrate on the work, which really began in 1942, aimed at producing an operational guided missile. Several such projects (BRAKEMINE, LITTLE BEN, LOPGAP and STOOGE) began during this period, and, although none reached the operational stage, they provided, or at least had, the potential to provide valuable experience and test vehicles for post-war developments.

BALLISTIC ROCKET DEVELOPMENT

In December 1934 Sir Hugh Elles, Master of Ordnance, called a meeting at the War Office to "review our (Britain's) present knowledge of rockets in general." It was realized at the time that Germany was putting considerable effort into rocket development and, with the storm clouds of war gathering once again over Europe, there was a fear that Britain would not be able to produce enough anti-aircraft guns to protect herself. In April 1935 the Research Department of the Woolwich Arsenal was asked to pursue the development of rockets using cordite as the propellant. British cordite was 50 per cent nitroglycerine, 41 per cent nitrocellulose and 9 per cent diethyl diphenyl urea (Carbonite). During the following summer, in July 1936, it was decided to undertake a systematic study of rockets for various warlike purposes. This study was co-ordinated by a subcommittee of the Committee of Imperial Defence and the research work was placed under the direction of Dr. (later Sir) A. D. Crow. The main objectives in priority order were:

1. Anti-aircraft defense
2. Long range attack
3. Air weapon against hostile aircraft
4. Assisted take-off for aircraft.

In the event, circumstances dictated that almost all the effort went into anti-aircraft rocket development. From this arose the 2 inch and 3 inch unrotated projectile (UP) cordite rocket which saw many varied uses during the war. The initial requirement was for a rocket weapon which had similar performance to the 3 inch anti-aircraft gun. Much of the development work resulted in pragmatic solutions by using the materials, etc., that were readily available, rather than seeking ideal solutions. Initially it was thought that if the cordite charge were allowed to burn on its external as well as its internal surface, the metal tube of the rocket would quickly burn through, and so a search for a suitable material to bond the cordite charge to the rocket wall was initiated. This search was unsuccessful. In desperation almost it was decided at the end of 1937 to fire some rockets with a "loose" cordite charge held in place inside the rocket, and to allow burning to take place on all charge surfaces. The tube was also coated with a heat resistant material. This proved successful, rather to the surprise of the rocket engineers, and the first flights of such a system were made in February 1938. An example of a typical 2 inch UP rocket is shown in Figure 1. The 3 inch version of the rocket which, in fact, became the standard British anti-aircraft rocket, was given extensive flight tests, including 2500 rounds fired in Jamaica at the end of 1938 and the beginning of 1939. Initially, the

General Staff found the results of these tests unacceptable, because the performance fell short of that specified, and the accuracy was poor compared with existing anti-aircraft guns. The use of the smaller loose charge and the employment of a thicker wall for the rocket had degraded the performance below that of the original design. In spite of this the 3 inch and, to a lesser extent, the 2 inch rockets saw much service as anti-aircraft and mass barrage rockets and on rocket firing aircraft. Also, they were employed as boost motors for many of the guided missile systems developed in Great Britain, as I shall describe later. The development work carried out on these rockets, and particularly on the mass production of cordite, was used by the U.S.A. when they began rocket development later on in the war.

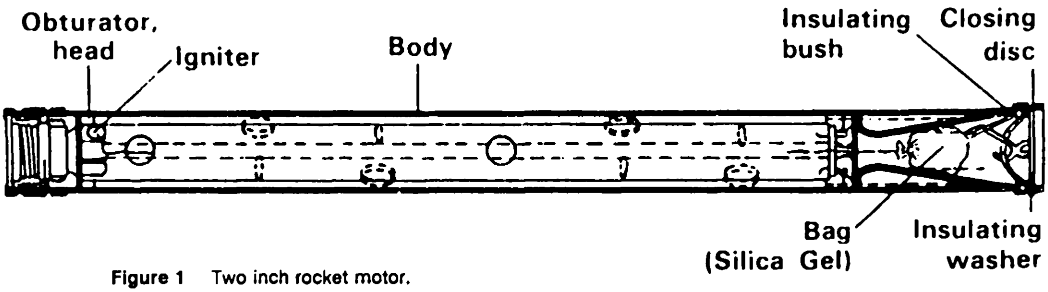

Figure 1 Two inch rocket motor.

GUIDED MISSILES

Some guided weapons work had been carried out in Britain in the 1920s and 1930s in the form of radio-controlled, pilotless aircraft like Larynx and Queen Bee. However early in the 1940s, with the realization of the need to combat high and fast flying aircraft, many proposals appeared for rocket powered, anti-aircraft weapons that could be guided onto their target. Some of these ideas were not pursued, because it was felt in many circles that the production of such a weapon was a long term development problem. Examples include a suggestion by Wing Commander Lester in May 1942 [5] for a "self steered anti-aircraft projectile" and a proposal called Spaniel [5] to modify a 3 inch rocket to act as a guided missile. It had been decided, understandably in the circumstances, to concentrate Britain's limited research and development resources on projects that could be brought to fruition in a short timescale. However as mentioned earlier, by various means, several British guided weapon projects were started before the end of the 1945 war.

BRAKEMINE

By far the most advanced of these projects at the end of the war was Brakemine, a ground-to-air-missile developed jointly by Anti-Aircraft Command and A. C. Cossor Ltd.

This project began early in 1943, when, almost simultaneously, two proposals were written on the subject. The first was by Captain Sedgefield of the Royal Electrical and Mechanical Engineers [6] entitled "Notes on a radio controlled rocket" and the second by Mr. L. H. Bedford, Director of Research at A. C. Cossor Ltd., in conjunction with Mr. Jofeh, describing a similar missile which would be controlled via a radar beam locked onto the target aircraft.

Both of these papers quickly landed on the desk of Major General Sir Frederick Pile, who was then General Officer, Commanding, Anti-Aircraft Command. Pile called a meeting on the 27th of April 1943 to discuss these proposals, at which both Sedgefield and Bedford were present. One outcome of this initial and subsequent meetings was that several sub-committees should be set up to investigate the various subsystems of the missile in more detail, rather than attempt to develop an operational weapon at that stage. However, it is obvious that not all of those present at the meeting agreed with this suggestion. One result was that AA Command decided to "go it alone" and proceed to develop Brakemine under the following guidelines:

1. An AA Command team under Sedgefield, by now a Major, would develop the missile structure, its control, firing and command systems and
2. A Cossor team, working under Bedford, would develop the Brakemine receiver and guidance system. It is worth noting that A. C. Cossor themselves bore the cost of all the services and facilities provided by them.

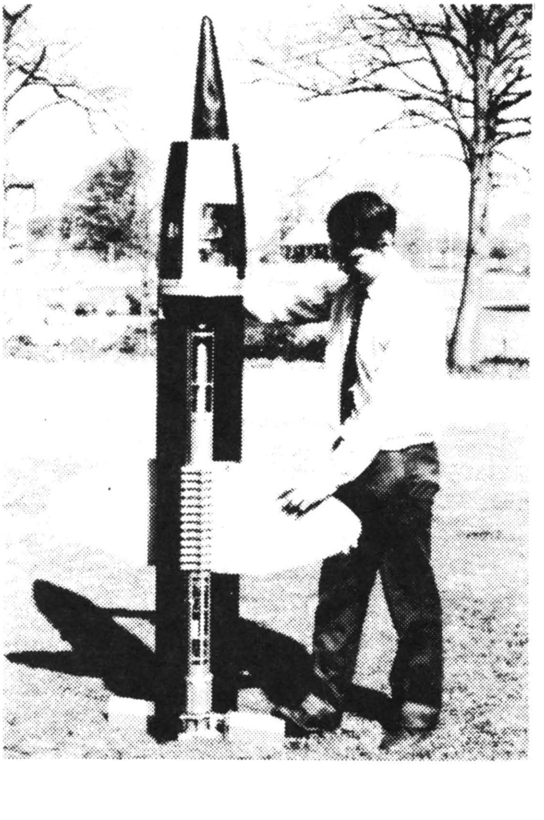

Figure 2 Sectioned Brakemine

In February 1944 the first drawings of Brakemine were produced, which showed a missile with 4 wings and 4 control fin surfaces. The thrust was to be provided by eight standard 3 inch solid fuel UP rockets. This design was changed almost immediately to six 3 inch UP rockets as the boost, and to two wings and two control fins. This basic design remained throughout Brakemine's development, and an example of this missile (see Figure 2) is on display at the Royal Electrical and Mechanical Engineer's museum at Arborfield, near Reading in England.

Work on Brakemine was halted for approximately 1 month during June and July 1944, when the V-1 attack on England began, but despite this the first dummy test round was ready for firing in the late summer of 1944. It was launched into the North Sea from Walton-on-Naze in Essex at the end of September 1944.

Brakemine was a radar beam rider missile. As the designer of its guidance system, L. H. Bedford later wrote [7]:

> "What we set out to do was to make a missile ride the axis of a conventional conically scanned radar beam, taking it as we found it without any special coding or command link features. What the missile had to do, therefore, was to interpret the radar signals as to reckon its displacement from the beam axis and then to make the manoeuvres necessary to null this."

The radio receiver was contained in the space inside the circle of the six boost rockets, and the gyroscopes and servo-motors were mounted at the front of the missile. The system of control and change of direction was by "twist and steer", essentially the same as that used in aircraft. The hydraulically operated control surfaces were mounted at the rear of the missile.

Brakemine Parameters

Length	2.01 meters
Body diameter	0.27 meters
Wing span	0.84 meters
Range (approx.)	8 kilometers
Weight	145 kilograms
Maximum speed	Supersonic

As is the case with all such projects, early failures occurred. The first two dummy rounds with the control fins locked in the neutral position did not fly far, and ended up in the sea just off Walton-on-Naze. Round 3 disintegrated just before the end of its flight, and this problem was eventually traced back to differential heating between the inside and outside surfaces of the whole missile. These and other problems were overcome, and by round 10 confidence was high enough to persuade the technical team to add the guidance system to the Brakemine dummy. This was tested on rounds 11 to 16, when some evidence of control resulted in a decision to increase the size of the control fins and to move the wings forward slightly. Round 17, fired towards the end of 1945, incorporated these changes and was launched into a fixed radar beam. This round also showed evidence of intelligent control of the missile, but by this time the war had ended.

LITTLE BEN (LONGSHOT)

The Little Ben (Longshot) project began in 1944 as a research vehicle at the Royal Aircraft Establishment at Farnborough and arose from a joint Naval and Air Staff requirement for an air-to-air guided missile. During the development Little Ben also began to be considered as a test vehicle for ground-to-air missile systems. The code name was changed to Longshot in April 1945.

Little Ben/Longshot was a supersonic, rocket propelled, radio guided missile. Initially other methods of guidance had been considered, including a photo-electric system with the missile flying along a searchlight beam in the ground to air mode, but these were rejected in favor of the radio control. The Longshot vehicle consisted of two main parts: the propulsion unit of three standard, 3 inch UP rockets and the control and guidance unit, known as the DART, which would also have included the warhead. The DART carried four wings and tail fins mounted in a cruciform pattern to provide lift and stability, plus two ailerons to provide roll stabilization.

By July 1945 the design of the missile was well advanced. This showed a projectile 2.67 meters long, weighing 68 kgms with a maximum speed of some 1300 km/hr. The DART was 1.19 meters long, 0.08 meters in diameter and weighed 20 kgms (see Figure 3). A breadboard model of the control and receiver electronics had been successfully tested at the Telecommunications Research Establishment, which had responsibility for that part of the development, and work was under way to miniaturize this to fit into the space available. Also, several test projectiles, with dummy DARTs plus full propulsion units, had been fired to test the ballistic dispersion of the system.

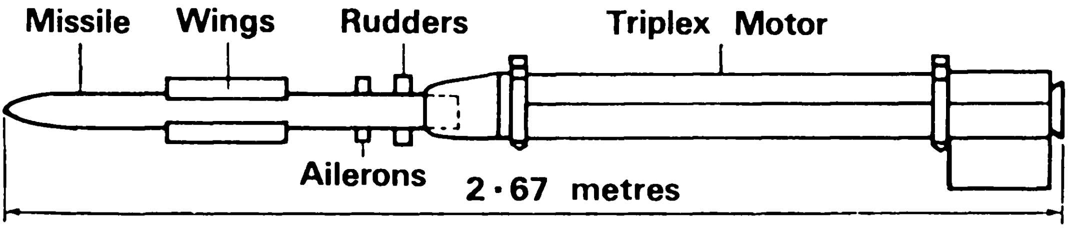

Figure 3 Longshot (1945)

LOPGAP

In the Autumn of 1943 the Admiralty began to investigate the guided missile as an additional means of defending their ships, and on the 16th of March 1943 their Assistant Director of Research and Development chaired the first meeting of the Guided Anti-Aircraft Projectile (GAP) Committee. The meeting had been called to consider whether to set up an organization to co-ordinate the research and development work needed to produce an operational guided weapon. The War Office and the Ministries of Aircraft Production and of Supply were represented at the meeting although in the event the Ministry of Aircraft Production took little part in the co-operative work on the GAP committee. In fact, there appears to have been very little active co-operation between the groups working on the 4 missile projects described in this paper. In July 1944 the main committee set up a working committee under Sir Alwyn Crow to "proceed with the research into GAP on the scale fixed by the main committee."

It was decided during the Autumn of 1944 to design and build a full scale projectile, which would act as a flying test bed for the development of the various missile subsystems. This became LOPGAP (Liquid Oxygen Petrol Guided Anti-Aircraft Projectile). The initial design for LOPGAP was produced in December 1944 by the Armament Design Department of the Woolwich Arsenal, who had overall responsibility for the co-ordination of the project (see Figure 4). Although the design went through many changes, in its initial configuration LOPGAP was 4.31 meters long without boost, 0.25 meters in diameter and weighed 193 kgm. The sustainer motor was liquid fueled, and LOPGAP was the only rocket vehicle using such a propulsion system under development in Britain at that time. The Asiatic Petroleum Company were given the contract to develop the combustion chamber and burner, mainly because they were the sole company in Britain with any experience of liquid fuel motors, following the work of Lubbock with his oxygen/petrol assisted take off unit [8]. Also, because of the background, the same fuel and oxidizer were chosen. This sustainer motor was designed to have thrust of 488 kilograms (1075 lb), and LOPGAP was to be accelerated to 1500 km/hr by a boost motor consisting of seven 5 inch solid fuel rockets.

The brief of the GAP Committee was widened early in 1945 to cover the development of all forms of guided weapon, and by the end of 1945, 35 LOPGAP dummy rounds had been fired to test boost separation, dispersion and telemetry systems. The dummy round consisted of a mild steel shell the same contours as LOPGAP and with fixed wing and control surfaces. A 2 inch rocket of similar mass flow rate as the proposed sustained motor was fitted to the rear to simulate conditions when the boost was jettisoned.

STOOGE

Around the middle of 1945 the Ministry of Supply asked the Fairey Aviation Company to design and construct a guided missile to combat Japanese suicide planes. This was by far the least developed of the four British guided missile projects by the end of the Second World War, and in fact the war had ended before any design work started. The project did, however, continue as a research and development vehicle for several years.

Stooge was a surface-to-air missile controlled from the ground by radio. It was powered by four 5 inch solid fuel rockets, with a further four standard 3 inch UP rockets acting as a boost, giving the missile a top speed of 800 km/hr (see Figure 5).

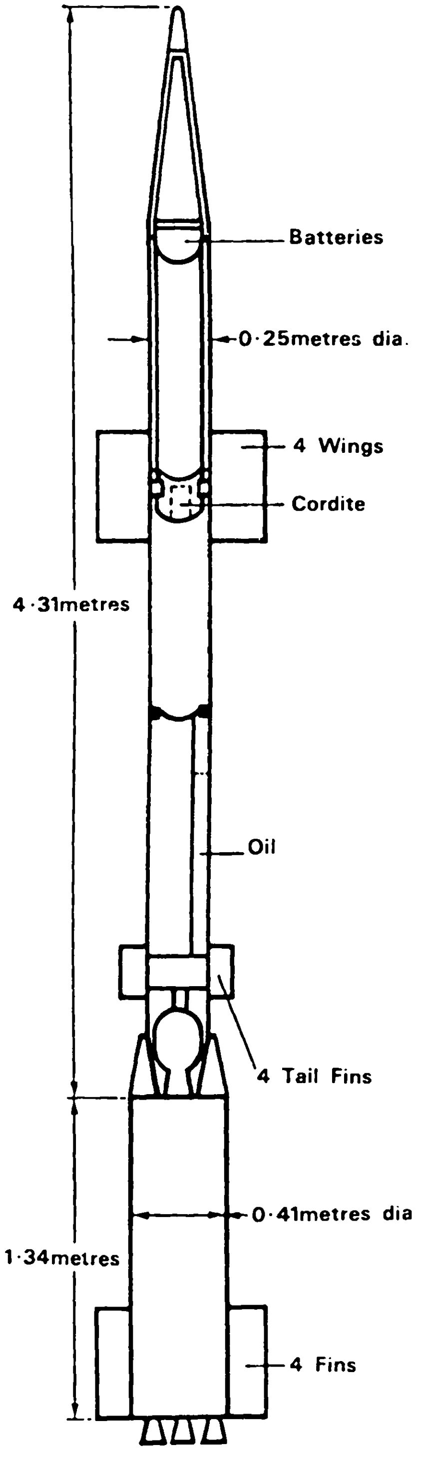

Figure 4 LOPGAP (initial design—December 1944)

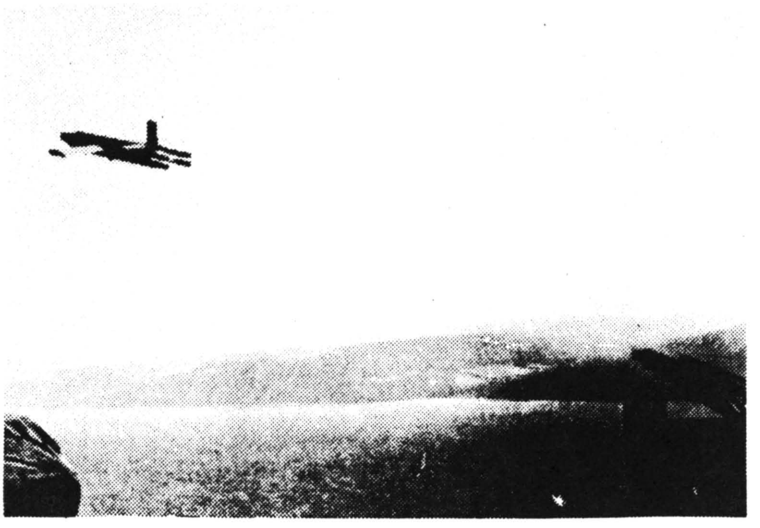

Figure 5 Stooge in flight (1949)

SUMMARY

By the end of 1945 Britain had four guided missile or rocket test vehicle projects under development. Many test flights had been conducted on the Brakemine project and dummy Little Ben/Longshot and LOPGAP vehicles had been fired. Work on Brakemine continued at Walton-on-Naze until the end of 1946, when the project was canceled primarily because the LOPGAP test vehicle was considered a more suitable flying test bed for missile components than Brakemine. Longshot flights continued for sometime, but the main emphasis in British rocketry immediately after the war was on LOPGAP. In June 1947 the responsibility for LOPGAP was transferred to the Royal Aircraft Establishment. The following month methyl alcohol replaced petrol as the fuel, and in August 1948 LOPGAP was renamed RTV1 (Rocket Test Vehicle 1). Work on this vehicle continued into the 1950s. Flights of Stooge also continued after the war, until at least 1949, but the project vehicle, which by then was associated with the Fairey Aviation vertical take-off fighter program, effectively led nowhere.

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