RING SIGHTS PO Box 2108, Salisbury, SP2 2BX, UK

AIMING AT A MILLION

THE HISTORY OF RING SIGHTS™

Fraser Scott

"That low man seeks a little thing to do,
Sees it and does it.
This high man, with a great thing to pursue,
Dies ere he knows it.
That low man goes adding one to one,
His hundred's soon hit;
This high man, aiming at a million,
Misses an unit."

A Grammarian's Funeral: Robert Browning

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THE HISTORY OF RING SIGHTS™

by Brigadier F. Scott (retd) – October 1999

PART ONE

Chapter One

How it began

In 1950 Fraser Scott, a thirty year old Gunner major, was posted to A5, the branch in the Ministry of Supply under the Director-General of Artillery responsible for the development of equipment which traditional weapon staff officers could not be expected to understand. So A5 did fire control including optics, radar, computing, sound ranging, flash spotting, proximity fuzes, even guided weapons; the Australians were doing an anti-tank GW; Scott was secretary for a meeting to answer their query about the size and weight of the warhead. The senior officers debated this and decided that the warhead would have to burst on the armour and blow it in without penetrating (squashhead); so it would be heavy. This made the GW large and heavy.

Scott was, inter alia, responsible for weapon sighting (except for AA); his design support was provided by the Admiralty Gunnery Establishment at Teddington where the key optical designer was Ray Budden of the Royal Naval Scientific Staff. Scott only had to present him with a need for an optical device for him to come up with a novel, but practical, solution. Such solutions were the long-necked dial sight for guns with overhead cover (later used on the 105 mm ABBOT), the paralleloscope (for avoiding the use of aiming posts; still in use by the Royal Artillery over forty years later) and an ingenious sight for light anti-tank weapons in which achieving coincidence in a dual eyepiece on the top of the tank set the tangent elevation required (never used). In 1953 we both moved on; Scott to regimental duty etc, Budden to Portland and then to Portsdown.

Both retired in 1970, Scott at 50, Budden at 60. We met by chance, after seventeen years, on the London train and Scott took Budden's telephone number. Scott was asked to make a civilian shotgun sight military (see the chapter on Pure Collimators), he rang up Budden to get help and Ring Sights™ was conceived.

We needed an engineer to make our sights so Scott recruited Bob Dickinson living in the same village. We operated as a partnership - Budden, Dickinson & Scott. In 1976 we became a limited company. We wanted to be Milsights, but the Company Registration people wouldn't allow this, so we chose Ring Sights™ since we used a central ring as the aiming mark. The capital was provided by us and the Comte de Lalaing, a Belgian count who introduced us to likely customers; running costs were found by us or by undertaking optical consultancy. None of us got paid except for our accountant, lawyers and patent agent.

Also in 1976 we exhibited at the British Army Equipment Exhibition at Aldershot on a DMA ministand (Scott had founded the Defence Manufacturers Association early in 1976).

Dickinson died suddenly so we bought out his widow; he had kept time sheets for the work he had done and these were totted up and paid for too.

By the 1980s Scott was getting bored with the administration, and dealing with agents, so he sold out to a Public Limited Company and we got our money back (and more). Budden and Scott went on doing the R & D. But the PLC changed its character and Ring Sights™ was no longer suited to them. So they sold it to the Flack family (they had already bought the exploitation rights to the solid glass sight range) who still run it today.

By the Millennium Budden will be ninety and Scott eighty so both have retired. Ring Sights™ were, by now, well known around the world; for example the BSA RS1 sight had been copied by the Chinese for civilian purposes, as had the EPC by the Russians, and we had been approached by the Chinese Embassy to license China on military sights only for this to be vetoed by the Foreign Office.

Subsequent chapters deal with each type of optical layout, in general in the chronological order of introduction.

Chapter Two

Pure Collimators

Walter Clode resigned his Army commission and bought Westley Richards, a traditional shot gunmaker in Birmingham. With it he got Harry Rogers who had designed a pure collimator shotgun sight and put it into production.

A pure collimator consists of a lens and a graticule at the focal point of the lens; the rays from the graticule emerging from the lens are therefore parallel and the graticule appears to be at infinity. There can be an air gap between lens and graticule or these can be incorporated into a solid block of optical material; see Figure 1.

Figure 1

Pure collimator

The Count had introduced Westley Richards to Fabrique Nationale (FN) in Belgium saying that this new sight was just what they needed for their military rifle the FAL (made in the UK as the SLR). FN said that the sight wasn't military so something had to be done; Walter Clode knew Scott's brother who suggested that Scott could do it. Scott was contacted, he recruited Budden and work started.

For a rifle sight the image of the graticule has to be seen against the target scene so with a pure collimator (through which there is no view of the target) one eye has to view the graticule, the other the target. So, for accurate shooting, the eyes have to be parallel. Some people's eyes rest at infinity (so are parallel), others rest with theirs on a nearer point so are not. Scott used two teenaged brothers for trials with airguns; the eyes of the less quick-witted one stayed parallel, those of the more quick-witted one did not, so the former (usually less successful) could shoot well while the latter was useless, his shots wandering off to the left as the gun was aimed with his right eye. This is because the brain likes the two eyes to see the same view (and has an automatic system to achieve it). So if the views are different the eyes are put into search mode and don't stay parallel. And, in the end, when it fails to get the same view, it switches off the view from one eye or the other; the firer can see either the target or the graticule, but not both at the same time. All this shows why the keenness, in the 1970s, for pure collimator sights faded away.

We designed and made sights, FN made the zeroing interfaces and they organised a trial on a range near Arlon in Belgium, using conscript soldiers firing with open sights and the pure collimator from Ring Sights™ by day, through into night (the soldiers had to keep both eyes open for the latter; they found that this meant that they could see better at night, so they kept both eyes open with the open sights, so improving night performance with them - so much for military training). But the outcome, aided by FN reading about reflex collimator sights, was that FN lost interest in pure collimators. We added a prism so starting out on our RC series of sights (see Chapter 3).

The key feature that spoils pure collimator sights is the aperture. For quick pick-up and easy use a large aperture is chosen, so the aiming eye sees a white dot in a black background and the other eye a dark target on a light background; this causes difficulties. If the aperture is reduced so that the aiming eye sees the target scene around the optic, the brain gets happier (but pick-up is slower). Pick-up is helped by providing a backsight, so you end up with open sights but with a pure collimator as the foresight; when the aim isn't quite right the collimator looks black, but when the aim is correct the graticule becomes visible.

Such collimators can be solid glass or plastic; the lens can be aspheric (making the sight shorter). Ring Sights™ developed and made the SPOT ON which shoots well but is slower to use than our reflex collimators. Though it is cheap no-one has adopted it yet, even though it can be lit with a tritium light source (gtls), so matching Night Vision Goggles. It is probably better than putting (gtls) on traditional open sights.

In the 1960s the Shah of Persia ordered self-propelled RAPIERs, a development of towed RAPIER, the British anti-aircraft guided weapon designed and built by British Aerospace. It is guided by the gunner keeping his sight aimed at the target aircraft throughout flight; this sight has high magnification so needs putting on to the chosen target. In the SP RAPIER this putting on is done by the No 1 in charge of the launcher vehicle who stands up next to the gunner who is looking through his sight. The No 1 has a helmet fitted with a reflex sight; he chooses the target and aims this sight at it. This line is sensed by an electro-magnetic field and thus transferred to the gunner's sight. But this field is affected by that of the launcher vehicle and by the earth's magnetic field. So some means is needed to boresight the helmet to the gunner's sight.

The Shah of Persia is thrown out before the SP RAPIERs are delivered and, in due course, the UK MoD decides to buy them. So they have to be finished and this includes provision of a boresight. BAe Bristol ring up Scott for help on this. Budden designs a pure collimator to be fixed permanently to the launcher vehicle aligned to the gunner's sight. The No 1, when the launcher vehicle is deployed to its action position, aims his helmet sight at the collimator graticule, pushes a button and his helmet sight is boresighted. Since this has to be done by day and night, the graticule has to be lit artificially. We did this by putting a gtls between the graticule and its daylight source (shine-through gtls); since it is a pure collimator, and the graticule is seen against a black field, enough light comes through the gtls for day use. This is the only use of such a system that we know of.

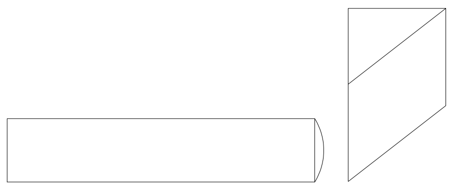
Our proposal is accepted by BAe and we license Leafield Engineering of Corsham to make the production. Since Ferranti (who make the helmet etc) insist on the collimator body being made of a special expensive plastic, we get much more royalty than was expected.

Chapter Three

Reflex Collimators: the BSA RS1

For FN we put a beamsplitter prism, for the firer to see the target through, with the aiming mark reflected from the beamsplitter surface so that it was superimposed on the target scene. To inject the aiming mark, or graticule, a 45° surface (which gives total reflection without silvering) below the beamsplitter prism was placed in line with the collimator (see Figure 2).

<u>Figure 2</u> Reflex collimator



The beamsplitter prism has a semi-reflecting surface between the two 45° surfaces. The transmission has to be lower than the reflection so that the graticule can be seen against the target scene; this means that the target scene is darkened and low light performance degraded. Keeping both eyes open helps to offset this. In addition the type of beamsplitter surface affects the degradation; ni-chrome (much liked by optical manufacturers as it is robust) loses 60%, aluminium 35 to 40%, silver 30% but a dichroic one less than 1%. So a choice has to be made. Cheaper sights have aluminium but larger sights for use with Night Vision Goggles should have a dichroic semi-coat.

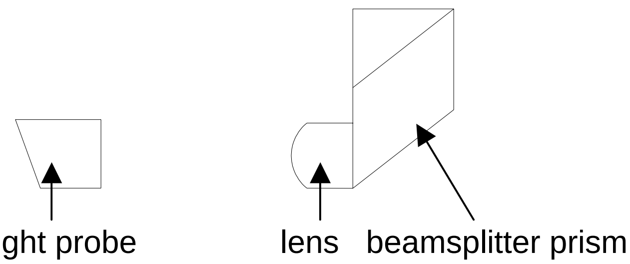
Sights were made like this for FN and they did a night trial, using their range and office staff, on their range at Zutendaal, comparing the open sights, a telescopic sight and the Ring Sight. We went there in the day for practice (only with conventional sights, not the Ring Sight). We then had supper in the hospitality house (one of the trial subjects drank all the whiskey so never hit anything). They then shot in turn at ten figure targets in the dark at the limit of visibility. M.Kops, of the range staff, hit 9 out of 10 with all three sights; but he took 2' 35" with the telescopic sight, 1' 30" with the open sights and 50" with the Ring Sight. Overall the Ring Sight got more hits in a shorter time. FN gave us a consultancy contract but made no decisions as to adoption before the contract ended. However Scott was shown a wooden mock-up of a personal defence weapon with a horizontal magazine feeding cartridges turning them through 90° before insertion into the breech (see Chapter 7).

It was now 1976. The BBC's Tomorrow's World put the Ring Sight, on the British 7.62 mm SLR (Belgian FAL), into one of their programmes. Filming was done on a range at the School of Infantry, Warminster. The shot of the target was fixed, the rifle being fired at a range of three metres to keep the cameraman safe. No real enquiries resulted from the showing.

And in 1976 we were due to have a stand at the British Army Equipment Exhibition (the catalogue entry was under Budden, Dickinson & Scott, as the company hadn't been formed when the entry was submitted). Scott wanted to have possible customers shooting at the exhibition; Webley & Scott were to have a running boar range for air guns there, so he went up to a show in Birmingham to meet the managing director. While waiting for him Scott met Mike Saxby who had been tasked to find products for Bristol Diecasting to make; we went and had a coffee. Saxby decided that a reflex collimator sight could be one of these products and, in due course, persuaded Bristol Diecasting to make it and Birmingham Small Arms to buy and market it. He trawled the British optical industry to quote for the optics and a company in Sussex quoted the lowest price; Bristol Diecasting would make the body, zeroing and dovetail interface and one of their subsidiaries at Corsham would do the assembly.

Budden specified the optic, RC-7 (as it had 7 mm aperture i.e. the beamsplitter was 7 mm square), and wrote a note on how the beamsplitter prism should be made. The surfaces through which the firer sees the target have to be adequately parallel; if separate components, 45° prism and a matching rhomboid, are made and cemented together it is difficult to achieve the required parallelism. This is how the Sussex optical company started to make them and Scott spent his time rejecting them. In the end they did what Budden's paper said and made them in strips finishing the surfaces parallel. The lens, also made conventionally by SOL, was cemented to the beamsplitter prism (see Figure 3).

Figure 3
Optical layout of RC-7



The casting tool was designed by Saxby and made by Bristol Diecasting who then made bodies in aluminium; the light probe carried the graticule (etched copper cemented to it); the light probe was acrylic sloped at the front to gather light from the sky above the target. The light probe entered the barrel of the body up to a stop being held in by a screw so that it could be easily changed. The lens entered the barrel at the other end with the beamsplitter prism upright, protected by an extension to the barrel; it was cemented in place being kept upright by trim made of thin black metal. The bottom of the barrel was open to the air so that it could breathe and not suffer from misting.

The outcome was that BSA sold some nine thousand as the BSA RS1. However they showed that they did not understand sight marketing; the light probes were always clear acrylic (whereas there should have been a choice of colour); only one graticule pattern was made (whereas there should have been a choice). No attempt was made to light the graticule artificially for low light use. So there was no exploitation, no exciting boys to experiment.

Some years later there was a Norinco delegation from China visiting BAEE. Two of them came to Ring Sights™ stand every day and, on the last day, Scott was given a present, an artefact made of shells stuck together with Araldite. He gave them a BSA RS1 sight which could be bought at a shop. Soon a Chinese copy was being sold in the UK; overall it was nicer than ours but, since the beamsplitter prisms were not parallel, it had to be used with one eye shut. We negotiated a royalty but it faded away too.

Chapter Four

Reflex Collimators; RC-25 and RC-35

We were asked to go to the Fighting Vehicle Research & Development Establishment at Chertsey to comment on a reflex collimator sight developed under contract to them. Budden was critical of certain features and felt that we could do better. So he designed a bigger optic than the RC-7, but similar in layout, with an aperture 25 mm square. He also designed the housing and the zeroing based on eccentrics. Prototypes were made as there was a British operational requirement for such a sight. We took part in a trial or demonstration on Salisbury Plain together with the other British sight and a Swedish equivalent shooting, with the 7.62 mm GPMG, at the Model Aircraft Training System A (MATS A). It was flown by its own pilot very competently. The trial was inconclusive except that the Indian Military Attache shot one wing off MATS A using the Ring Sight (even then MATS A could be flown upside down!). But the key major was posted and interest dwindled. Another BAEE was coming up with a firepower demonstration at Lulworth including MATS A and MATS B. We put in to shoot at these using the RC-25 on the GPMG on a little six wheeled buggy. We had to use a military firer; the Falklands War was in course and the infantryman we were to have had went off to it. So we got Corporal Roper from a course at the RAC Centre. I went to the first rehearsal to teach him. MATS had to be direct crossers for safety reasons so he had to use the maximum lead of 70 mils as a start and then use "burst on target" to correct his aim. We had one box of ammunition (200 rounds); this was soon fired so I ran across the firing point to get more from the tank there (I was also taking photographs). When firing ended the control tower ordered "Ring Sights™ to come here" and I was torn off a strip for running about during firing; but they had let me do it! In the second rehearsal (I was setting up at Aldershot) Roper shot down MATS B. Consternation! they only had two MATS and one was dead. He was told to aim off to avoid killing any more as there were more rehearsals, and the Press day, before the demonstration proper. When I heard this after BAEE, I wrote a letter thanking them, but making the point that I couldn't sell sights if I couldn't shoot down the practice targets.

But it was clear to me that the eccentric zeroing was unsatisfactory. Budden redesigned it on kinematic design principles and it has been satisfactory. We made one prototype; Scott was going to present his mortar locating by radar trophy on the Hohne ranges in North Germany so he took this sight with him. When he was asked by RAGTE (the gunnery instruction team there) what he would like to do on a spare day, Scott said that he would like to see people shooting at MATS A. It happened that this was to go on in the morning; at it the poor soldiers were shooting at MATS A with GPMGs without any sights. The Ring Sight was put on one, they all shot with it and were delighted. The next day was the final mortar location day and the trophy presentation; of course there were brigadiers there (who got their ears pounded on shooting at aircraft); the operational research major back in England was rung up (he had to pay attention as he was soon to go to Germany to command the tracked RAPIER battery); a trial was done, Ring Sights™ RC25 against the FVRDE sight. 8 out of 10 trial subjects wanted the Ring Sight bought (2 didn't know), 0 out of 10 wanted the FVRDE sight bought.

So we licensed Hall & Watts to make and sell the RC-25 sight. The UK MoD bought it for the .50" heavy machine guns protecting the nuclear guns in Germany.

There was another use for the Ring Sight RC-25 sight. British Aerospace at Prestwick were selling their BULLDOG aircraft to Botswana. These aircraft had forward firing machine guns and a sight was needed. We adapted the RC-25 sight for this with a special graticule. We fitted one with "Aim Readout" a CCT camera on top of the beamsplitter prism (the same view of target with graticule superimposed comes out vertically as horizontally) and a video was made of the test pilot attacking Prestwick Airport (only dry - no firing!). Each aircraft was provided with a RC-25.

British Manufacturing & Research Company Ltd (BMARC) had been set up at Grantham to make Oerlikon cannon in the UK for WW2. These used cartwheel open sights. A value engineer at BMARC was tasked with improving these; he came to Ring Sights™. The RC-25 did not have enough lead performance so we designed a larger one, the RC-35 with a 35 mm aperture. It was to go on a zeroing mount so did not have to have any alignment means.

We had to design a graticule so were given the ballistics of the cannon and the drawing of the existing cartwheel. Budden found that the cartwheel was wrong (but it is so useless that it didn't matter). We licensed BMARC to make and sell the RC-35. It was adopted by the Royal Navy and is still in service some twenty years later, although now about to be replaced by Ring Sights™ LC-40-100-NVG-RN-DTC sight. Initially the RC-35 optics were made by RS's sub-contractor, but later BMARC had them made elsewhere. The exact build specification was not always followed and we had to examine returned sights critically to identify faults.

However, like all these RC sights, there is an air gap between the lens and the graticule. For military and naval sights this is purged and filled with dry nitrogen. Every so often this process is repeated. This costs money and we hope to replace all the RN RC-35 sights with solid glass ones needing no dry nitrogen. BMARC was bought by Royal Ordnance; they have already adopted the solid glass replacement the Ring Sights™ LC-40-100-NVG-RN-DTC sight for their 20 and 30 mm cannon.

Chapter 5

Reflex Collimators: the RC-12

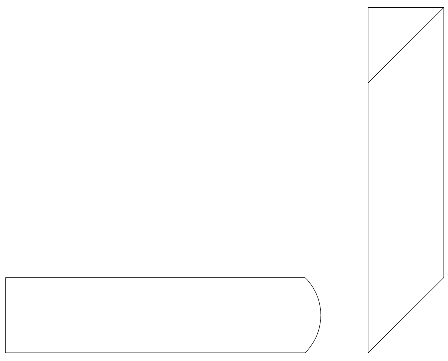
Scott had been engaged by Leafields Engineering as a general consultant. They got a contract (LASS) in the mid 1970s to study sighting for a new man-portable anti-tank weapon and Ring Sights™ were engaged to support this. As basic sights we used RC-7s derived from the BSA RS1, then in production. They were fitted to mock-up barrels which contained a camera to record the aim on firing. Trial subjects were provided by the Army. The programme ended in the autumn on Salisbury Plain at Tilshead engaging a tank. Budden had designed a simple lead predicting mount; the firer assessed the speed and course of the approaching target tank and set the speed in mph and the course as a clock hour and the mount set the sight at the correct lead. One of these had been made. The trial was between a sight designed by the Royal Armament Research & Development Establishment (RARDE) and the Ring Sight.

In the trial we were getting 80% hits first shot; the soldiers could estimate the tank's speed to ± 5 mph and its course to ± ½ an hour. They were not being hurried and the RARDE team were making rude remarks about how long they took. So I did what any sergeant would do - I told them to set the maximum speed (if the tank is slower they have time to reset) and the approximate course (they could hear the tank coming). The result was engagement in two seconds after the tank entered the engagement area. I was then accused of cheating!

Hunting Engineering Ltd were given the development contract for LAW80, the resulting weapon, and instructed to use the RARDE sight (we had written a critique of it). Two years go by, a friend at HEL rings me up to ask for a sight, I take a RC-7 and give it to their Project Manager. They buy a quantity of components to keep their development going.

Meanwhile Budden designs what they really need. LAW80 is to have a throw-away barrel which is also the rocket package. The barrel is fired from the shoulder but the sight line is in front of the eye above the barrel and offset to the left. Putting a sight on a projection makes it vulnerable and difficult to pack on a pallet. Hinging the complete sight needs a robust and reliable hinge. Budden's solution was to put a pure collimator on the barrel and a long hinged beamsplitter prism (which can be folded down) to periscope the graticule up and across to the eye (see Figure 4).

Figure 4 **RC-12 layout for LAW80**



This is adopted by HEL. We apply for a patent; the application goes through the MoD to RARDE who say that it is obvious so we shouldn't be given a patent. I get this and reply that, if it is so obvious, why didn't RARDE think of it in the two years they had? We get the patent. HEL design the complete sight including the night illumination by moving a gtls between the light probe and the graticule. Low light trials are needed and Scott suggests going to the Pershore facility for testing image intensification sights. It is in a large hangar where we can do tenth scale trials (400 metres = 40 m) and three levels of twilight and nine levels of dark can be set on a remote control. We use HEL people - one of them can engage tanks effectively with the Ring Sight at dark level 6 whereas Scott can only discern a tank at dark level 8

LAW80 is put into production by HEL in 1988, twelve years after we start to be involved. RS's sub-contractor makes all the optics as no-one else can match them for price, quality and reliable production - all due to the lessons learnt making the BSA RS1. In all 180,000 are made.

Ring Sights™ are due for royalties from the MoD under the Patents Act from "when experimentation stops". We start negotiation but get nowhere until Scott is giving a talk on Private Venture projects at a DMA seminar for the Director General of Defence Contracts. I give him a brief on RC-12 and LAW80, he motivates his staff and we get royalties seven years after we should have.

In production the lens and graticule plate of the collimator were cemented into a drawn aluminium tube. But the drawing was a little too much and small fissures could occur. All assembled collimators were subject to a leak test and failures occurred. We have now designed a solid glass collimator to avoid this but it was too late for the run.

Later on we were asked by Bofors for a sight for the AT-12 similar LAW. We were going on well when the whole project was cancelled by the Swedish MoD.

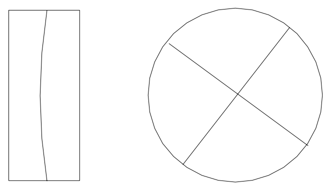
Chapter Six

The Planar Doublet Reflector

One traditional form of collimator uses a meniscus lens (concavo-convex; like a watch glass) to reflect a graticule. For the best result the curvatures have to be different and the beamsplitter surface is exposed so must be robust and ni-chrome is used. We designed such an airgun sight for Millard Bros and they put it into production.

But Budden had given thought to this and invented, so he thought, the planar doublet reflector. This has a buried spherical beamsplitter surface within two pieces of glass whose outside surfaces are parallel (see Figure 5).

Figure 5 **Planar Doublet Reflector**



To keep cost down he proposed making a large PDR and cutting it into four. We had prototypes made by our sub-contractor and made one into a sight with the quarter PDR at the front and a transmissive graticule on a BSA RS1 light probe mounted back to front. All looked good, so we applied for a patent, only to find that there was a Swedish one already. Nothing daunted we applied for a patent for the PDR complete. After we had spent some £6000 the US Patent Office produced a French patent of 1939 describing it completely; so we could not patent it but could use it, as the patent had expired. In 1939 it was not easy to make a PDR as the optical cement was Canada balsam which melted if the workpiece got hot; but now, with modern optical cements, the two components can be made, one coated, both cemented together and then worked parallel in bulk.

There was the usual decision to be taken on aperture, length and parallax (the movement of the aiming mark against the target scene as the eye is moved across the aperture). We ended with an aperture of 16 mm diameter and a focal length of 100 mm and had PDRs made to this. But this length and size does not suit automatic pistol slides (which are longer) so we also had ones made with a 12 mm aperture and a focal length of 120 mm. Since these sights are likely to be used in the open we could use a fluorescent graticule easily screenprinted with any pattern we wanted.

So pistols were fitted with sights, the PDR in a thin steel housing (made by apprentices at LEL) angled suitably, the graticule on the rear sight. These were shown to possible buyers, including FN, Steyr and Walther, but no-one really liked them. The pistol could not be holstered and, in any case, the pistol was regarded as a very short range weapon. The effectiveness was demonstrated when Scott showed it to the US R&D team at Frankfurt, Germany; they produced a female soldier to shoot the .45" Colt that we had fitted with a PDR sight. She had never fired a pistol before (let alone a .45" Colt) but she hit the figure target at 50 metres first time and every time. Scott also took a pistol to show the Swiss police at Geneva only for them to say that the range never exceeded eight metres; we were in an underground range and, to expand their minds, I put a luminescent one inch spot on the figure target and a luminescent dot on the graticule and turned out all the lights. A Swiss policeman fired, all the shots hit the target and one went through the one inch spot (which I left there). So, though the sight improved shooting, it wasn't acceptable to the shooting fraternity.

The Count interested Daisy Air Guns, maybe the leading air gun maker in the US, in our sights. He and Scott went out to Rogers, Arkansas (Daisy paid for Scott, Ring Sights™ paid for the Count) to show off our sights. The outcome, in the end, was that an agreement was signed with Cass Hough, their President, as they were leaving Gatwick Airport, for them to use our 16 mm PDR and screen-printed reflective graticules in a sight they would design and make. This turns into the Daisy Point Sight 800 which has now been sold for, say, fifteen years and copied by others. We got paid the up-front money (rather more than expected as the dollar went up considerably against the pound) but none of the agreed royalties (we didn't bother to sue them - and had better things to do).

In the mid-eighties BAe developed the AJAX Fire Control Sensor, an array of four passive IR sensors to fire a light anti-armour weapon automatically when a tank passes. The sensors have to be aimed by day and night when the weapon system is set up. BAe expected to be able to use an open sight system but clearly this is unlikely to be satisfactory. So Scott is asked to help; there is no money in the budget, no power can be taken from the pack (as it has been cleared for ECM) and it is needed in a hurry. No problem - use the 16 mm PDR, a fluorescent graticule printed for the four sensors and the weapon (to ensure no trees etc are in the way) lit by daylight or, for night, by a hand torch put suitably on top. What could be cheaper? BAe engineer it (PDR set in production aligned with the sensors) and sell it to go on the UK LAW80, the Swedish AT4 and the French APILAS (I meet an APILAS engineer and send him a copy of the French 1939 patent - no reply). The AJAX has become a multi-national project, ACEATM, but it still retains the PDR sight solution.

A PDR has also been used to aim a line-of-sight data transmission system. Ring Sights™ real problem is to find the people with an aiming problem to solve - this is the hard part, solving it is easier.

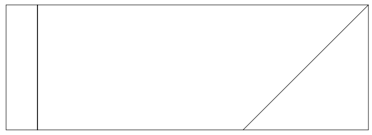
But the application of the PDR to our solid glass sights has been the greatest advance in unit power sighting - so now read on.

Chapter Seven

Solid Glass Sights: LC-7

In Chapter 3 I mentioned FN showing me a wooden mock-up of a personal defence weapon. They asked if we could do a little sight for it. I came back, told Budden and he came up with the first suggestion for a solid glass rifle sight. It had a PDR at the front and a reflective graticule buried in the glass block (always called the "prism") (see Figure 6).

Figure 6 Original solid glass sight



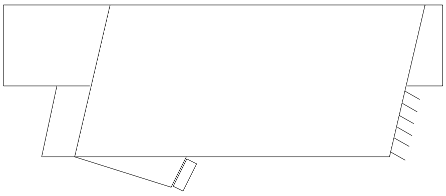
But this layout wasn't easy to make, the graticule had to be small (the target was seen through it), daylight for the reflective graticule had to come from the top of the body and night illumination had to use the same day graticule. These shortcomings were rectified much later in the HC type (see Chapter 11).

So Budden moved the graticule to the front under the PDR, where it could get its light from the target area and a dual graticule could be used, transmissive by day, reflective by night (see Figure 7).

Figure 7 The LC optical layout

The prism was sloped so that the graticule was reflected from the rear of the prism back to the PDR, focussed at infinity and back to the eye. A patch plate was put on the rear end (above the reflective area); it and the front of the PDR were worked parallel after assembly. A gtls was to be put on the base of the prism to throw light onto the reflective pattern of the graticule for night use. Prototypes were made up and Scott spent much of a day trying to get the night illumination to work; when he told Budden he couldn't succeed, Budden realised that there was not optical contact between the gtls phosphor and the glass so total internal reflection occurred. An extra prism was added to increase the angle and all was well (this feature was used to advantage much later to solve a problem on a rifle grenade sight). So the layout ended as shown in Figure 8.

Figure 8 LC-7 amended layout for night illumination



Any daylight remaining can shine into the top of the prism and light the phosphor of the gtls so assisting day/night takeover.

One of the advantages of this layout is that the large prism can be shorter because the light path goes there and back in it. The graticule pattern can cover all its plate. A disadvantage is that the same graticule pattern cannot be used by day and night; this helps rifle sights as an open T can be used at night fitted into the day pattern (usually rings). The open T does not obscure a small target; the line thickness can be thin enough to avoid affecting the automatic gain control of night vision goggles.

This optic was light enough (8 grams) to demonstrate, for example on the M16, by putting it in the handle on Blu-Tak, lining it up with the already zeroed open sights. But a proper zeroing mount was needed. Budden designed it; the optic was to be cemented to a nylon rib positioned by two screws in a housing with air spaces around the optic and rib. The screws were chased to any desired pitch (so a special die was not needed) and were an interference fit in the holes in the rib (which therefore did not need to be tapped). The nylon rib was flexible enough to accept the mal-alignment due to zeroing. To avoid backlash the screwheads were conical to match conical recesses in the housing and the free ends were riveted over spring washers. The housing was diecast with the space around the optic and a hole in the top to allow skylight to enhance the gtls. Its base had 45° faces to fit inside the M16 handle (in fact this dictated the 7 mm aperture as a larger one wouldn't go in). A M4 stud screwed into the housing matched the hole in the M16 handle; a domed nut and spring washer held it in place. Interfaces were designed and made for other rifles (including a very neat one for the G3 rifle).

This was put into production by Leafields Engineering but, despite considerable marketing effort, it wasn't sold in quantity (before its time). It was bought by GCHQ and others (Scott even sold one to a man in the Hilton bar at Gatwick who overheard his sales spiel) but never adopted by an army. At BAEE our potential customers could go to shoot on the Parachute Regiment's 30 metre range in Aldershot; we allowed the corporal in charge of the Ring Sights™, our weapons and ammunition to use these to shoot with in the evenings when the exhibition closed. He was a skilled shot and could shoot by moonlight "splitting the pupil"; you can look along the top of the optic injecting the graticule image into the lower part of the pupil while the upper part, and the free eye, sees the target - this improves night vision while still enabling good aiming. Not only that but he had trained himself to shoot off the eye's axis - this improves resolution (like seeing the Pleiades). Later on he was sent to the SAS but he had shown what could be done with our sight.

Much later this sight, the LC-7-40-M16, was adopted by Shorts as an alignment means for their STARSTREAK GW launcher and is still regularily ordered for this.

The basic optic was used for the EPC, a solid glass red dot sight. The PDR was made 8 mm square with a dichroic beamsplitter reflecting red preferentially (so giving better night vision), the graticule was a dot lit by a red LED powered by two hearing aid cells in a battery housing moulded into the optic housing. Dot brightness was automatically controlled by a photo-diode to match the scene lighting. The battery cap was also the switch; it could be switched on and off by hand or it could be put on, in the combat mode, so that it was permanently on until removal. The housing had a curved base to allow movement for zeroing. There were a number of weapon interfaces to be cemented to the pistol which then accepted the sight. The sight was aligned to the weapon while the cement was setting. It could be levered off when needed.

Over 100,000 were sold; mainly for pistols (you can holster the pistol with the sight in place) but also onto sub-machine guns (for example to the Channel Tunnel police). The sight can be used with night vision goggles; at night an untrained person can hit a man at one hundred metres. But the switch system was unreliable and numbers were returned.

Chapter Eight

Solid Glass Sights: LC-14 & LC-9

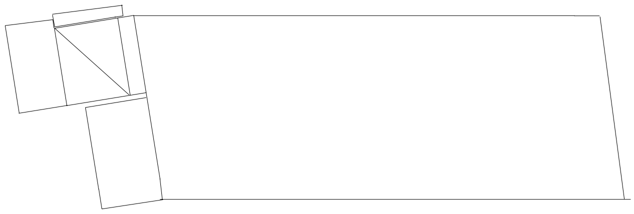
We started to design sights with larger apertures and less demanding parallax. The US M60 machine gun has a backsight between the carrying handle and the feed mechanism leaving very little room for a solid glass sight. Budden designed a new optic to match, the LC-14-46, which was short enough to go in the space. It was like the last LC-7 described, having no patch plate, and a PDR edged down from the round to suit the space above the graticule plate. The graticule plate was 14 mm x 9 mm which, since the equivalent focal length was 56 mm, provided 250 mils horizontally and 160 mils vertically.

We never got a customer for the M60 application. At BAEE one year there was a small arms demonstration every day on Ash Ranges. We fitted a small Smith & Wesson revolver (1 " barrel) with a LC-14-46 sight and it was demonstrated by the sergeant in charge of the range detachment firing at a figure target at 100 metres. He had taught himself pistol shooting with this combination and shot successfully. On the last day Scott took the target away as all six shots were within an A3 sheet of paper and the width zone was narrower than that of SA80 at the same range.

This optic came into its own when, in 1995, the Brits were buying Israeli rifle grenades fired from the muzzle of the SA80 rifle. The Israeli sight was an open one of plastic which melted when the rifle was fired at automatic. The UK MoD invited firms to propose alternative sights. We turned the LC-14-46 on its side, becoming the LC-9-46, thus giving enough mils elevation for a boresight mark, and range marks at 50, 100 and 150 metres. The workshop at the Infantry Trials & Development Unit at Warminster made a housing to fit on the SUSAT telescopic sight and competitive firing trials were done through the summer of 1996 (the range tables we were given proved to be wrong so much effort was used to establish the correct tangent elevations).

The MoD requirement was to get 80% hits on a 1.2 metre square at 50 metres; with the Ring Sight they got 100% hits on this square at 150 metres. So the LC-9-46 was selected to go forward, a gtls was fitted on a beamsplitter prism in front of the graticule for night use and Budden designed a housing clamped to SUSAT with two screws for zeroing. Optics were made, moulding tools for the housing designed and made, a pre-production run completed and acceptance trials done by ITDU; the sight was accepted (8" groups achieved at 150 metres) and 8,000 ordered and delivered by the infantry and other front line troops. The optic layout is shown in Figure 9 which is the view from the top. Further sights have been ordered by the British MoD.

Figure 9 LC-9 rifle grenade sight optic viewed from above



A special light probe with a curved front had to be used so that each range dot was lit at its elevation. The only problem was that light leaked out forwards from the tritium light source. This was due to using a cheaper tubular tritium light source with a diffuser which had optical contact with the light injector prism. Replacement of the tubular source with a flat one, and no diffuser, solved the problem as the phosphor is not in optical contact with the glass (the opposite to that described for the first LC-7 in Chapter 7).

There is no doubt that rifle grenade use is going to be changed by such sights. The maximum effective range will be increased; this may require more elevation than can be accommodated on the LC-14-46 and optics have been developed accordingly.

One of them is the LC-15-90 designed as a fallback sight for an all singing, all dancing computer sight for the Mk19 Automatic Grenade Launcher.

Chapter Nine

Solid Glass Sights: LC-40 & LC-31

After our success with the RC-25 and RC-35 which needed regular purging, filling with dry nitrogen and resealing described in Chapter 4 it was only natural to do solid glass replacements for these

So the lead and elevation were decided, the lead at 150 mils (left and right of course) and elevation at 100 mils. Parallax centre to out was to be one mil, a relaxation for automatic weapons from that used for single shot ones. Two optics were designed, like bigger LC-14s, with these parameters, the LC-40-100 for pintle mounted weapons, which need more eye freedom, and the LC-31-85 for weapons fired from the ground so needs to be lighter.

Matching housings and zeroing mounts were designed and put into production. The zeroing was on kinematic design principles one advantage of which was that the housing and mount did not need to be made too precisely so could be used as cast without machining.

The LC-31 has not sold well but it has now come into its own as a dry zeroing device for helicopter machine guns by fitting it with a spigot to go into the gun muzzle. For zeroing it is used as a pure collimator (with a cover over the PDR) but to check that the zeroing mark is parallel with the gun bore, the cover is removed, the LC-31 aimed at a distant mark with it at three o'clock; the LC-31 is rotated to nine o'clock and, if it is parallel, it should still be on the distant mark. If not the zeroing is adjusted till it is. This is now in service with all of the three UK services.

After a slow start the LC-40 has become appreciated. The RAF had funds left over after the Gulf War; they had machine guns firing sideways from helicopter doors; trying to hosepipe using tracer is pretty well impossible without a reference frame. So they had mounted a laser on the gun. But the factors to be allowed for aiming off include the speed and course of the helicopter, the angle of the line of fire with the helicopter course, the range and crossing speed of the target, the wind speed and direction. So a laser aligned with the gun doesn't help without some reference frame. We were asked for a sight with a red dot; we soon modified a LC-40 with a red dot but also provided a cartwheel graticule around it. They did trials and, as we expected, found that the red dot was superfluous and that they could fire a burst, observe the strike against the graticule pattern and do "burst on target" hitting the target with the next burst. Practice makes perfect, the gunner gets used to what aiming point to use for various conditions; in effect the LC-40 provides his brain with the information to programme it to choose the aim point.

The gunnery experts at RAF Odiham put their minds to work on what graticule pattern they really needed and came up with one with elevation and lead marks for ground targets and ellipses and radii for air targets. A boresight mark was included for alignment. This pattern has proved satisfactory.

The RAF had three 7.62 mm machine gun types used in this role - GPMG, M60D and the M134 Minigun. All needed sight mounts. For the GPMG we used the existing dial sight dovetail; for the M60D we did a modification to the existing handle; but the Minigun is electrically fired; if it jams the sight has to be taken off to clear the jam so its sight mount was more complicated. All have been satisfactory in service.

But the RAF did not only want to shoot by day; they wanted to shoot at night using their Ferranti Night Vision Goggles. So the graticule has to be lit, this lighting must not interfere with the gain control on the NVG so the brightness must be adjustable to match the light level of the night. We put a dichroic light injector in front of the graticule plate which transmitted the daylight but reflected diffused light provided by an array of five red LEDs cemented to the base of the injector. Power was provided by one of two 3.5 V lithium chloride batteries (the same as their NVG) through two rotary switches, one to select the battery in use, the other to control brightness. There were two levels of brightness for day, one as bright as possible for use if the ambient light needed enhancement, the other for twilight when the naked eye was still being used. The other levels were for use with NVG, the lowest current being a tenth of a milliamp.

But the light at night, especially in battle, can be too dim for NVG. The RAF had decided that they would light the target scene with a laser illuminator and had selected the laser to do it. So this laser, preset at a beam width of forty mils, had to be given a housing containing two of the batteries, a switch and a warnng LED, and this housing had to be mounted pre-aligned with its dovetail on top of the LC-40 (which also had a matching pre-aligned dovetail so that illuminators were interchangeable). There also had to be a pressel switch, mountable to suit the gunner, on a lead only plugged in when in the air. So now the RAF could engage targets by day, in twilight, in the dark and in the very dark. They bought a quantity which were introduced under a dispensation meaning that the usual rigorous testing was not undergone. The sights, mounts and and illuminators have proved themselves and more have been bought.

Meanwhile this sight had been tested by the Army Air Corps and by the Navy. The AAC bought six for their .50" M3M FN machine guns. This machine gun has a very high rate of fire. Its introduction with the sight was subject for the full approval for use in the LYNX helicopter so the proper procedure had to be carried out including vibration testing. In this it was found that there was a resonant frequency which caused the sight to swing, like an upside-down pendulum, from side to side (the interesting thing about this was that, because the axis of swing was parallel to the optical axis of the sight, the graticule image was undisturbed against the target scene). Simple modifications were done to the zeroing system amending the detent system; the repetition of the vibration test showed that the problem had been cured. The F100A was then issued and the sight, its mount and the illuminator could be used. This was going on as KFOR was being assembled for the Kosovo exercise in summer 1999; three sights had been sent out while the next three were modified and vice versa. Now all the RAF sights are to be brought up to the same standard even though there has been no trouble. And funds have been found for the Royal Navy to get sights too.

This same sight, with a mount to match the guns and the graticule pattern to suit the ballistics and the operational use, has been adopted by FN and GIAT on their cannon for surface to surface and surface to air use. The optic, again with a special graticule pattern, has been used by BAe as a putting-on sight for their Air Defence Gunsight. This computer sight, for updating conventional air defence guns, has a high magnification sight unsuitable for acquiring the target so it is supplemented with the unit power Ring Sight. And, since the computer sight requires power, but the gun doesn't need power to fire, when and if the power fails the Ring Sight can be used as a fallback sight.

The Royal Navy spend much money on keeping their RC-35s operational, mainly due to the need for all the purging (vital under sea conditions where the sights reman on the gun exposed to the full rigours of ocean conditions). They can replace the RC-35 with LC-40-100-NVG-RN-DTC for the maintenance cost of the RC-35. So we provided them with two sights for trial, first at Plymouth where, at the weekends, they took them off the guns and put them in a bucket of seawater. They then sent them on sea trials around the world. Meanwhile we had started to redesign the housing, electrics and mount interface as zeroing was to be done on existing mounts. We took the opportunity to get away from the original rotary switches using sealed membrane ones instead; we improved the battery pack and the electrics getting it slimmed down. The outcome is that the sight looks and behaves even better than the original. The Royal Navy will gradually buy it; Royal Ordnance have adopted it as a replacement for the RC-35 on their 20 and 30 mm cannon.

The Royal Navy had developed a trainer, OBVACT, which went on the RC-35 sight. They placed a development contract with Lockheed Martin Solartron for up-to-date replacement which was to mount on the RC-35. This is the Close Range Gunnery Trainer and we are developing an interface with the new LC-40-100-NVG-DTC. Since the parameters for naval gunnery are basically those for shooting sideways from helicopters, we are cooperating with Lockheed Martin to introduce a trainer for shooting sideways from helicopters which should cut the cost of training these gunners considerably.

In 1995 Peru fought Ecuador losing six aircraft to Ecuador's three. Peru improved their air defence by buying Russian IGLA anti-aircraft homing missiles fired from the shoulder. But these missiles have open sights, not useful at night, whereas the attacking aircraft can operate then. Delft, in Belgium, proposed that they should use the Delft MUNOS NVG with a sight to be developed by Ring Sights™. We used the LC-40 optic as the basis for this with a graticule lit by LEDs in a new housing clamped on to the barrel (the barrel is discarded after firing so the sight is unclamped and clamped to the next barrel). A quantity of this new sight, the Ring Sight™ LC-40-100-9K38 have been bought, but there have been no more hostilities to test the system (we had to modify the sight line to suit the short necks of the Inca men). Scott thought that he should make sure that the system was likely to work so we found when the AAC were going to fly helicopters at night without lights. He and Flack went down to Salisbury Plain for this; with NVG the night sky looks bright. a helicopter is dark and silhouetted against it so it is easy meat for the IGLA (or for a .50" HMG with a Ring Sight).

Like the LC-14 the LC-31 and LC-40 can be turned on their sides to give a sight with considerable elevation. We did this for a Heckler & Koch automatic grenade launcher but had to withdraw it when we did an exclusive deal with Saco Defense on the WC-30.

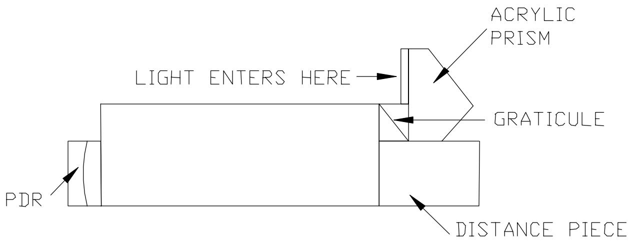
Chapter Ten

Solid Glass Sights; WC-30, XC-10 & YC-10

40 mm grenades are fired from automatic grenade launchers subsonically so need considerable elevation at maximum range. Saco Defense make and sell the US Mk19 AGL; at 2000 metres range the elevation required is 525 mils so even the LC-40 on its side cannot achieve this. Budden turned his mind to designing a solid glass solution.

The design was very different. It still used a PDR but this one was over 80 mm high and 30 mm wide. The layout is shown in Figure 10 which is the optic seen from above.

Figure 10 Layout of WC-30



The daylight enters from the target area as usual and is reflected around an acrylic prism with an ingenious shape onto a graticule curved to match the focal plane of the PDR. The PDR puts the graticule at infinity against the target scene. The gunner looks through an aperture on the rear of the distance piece and sees the graticule. He elevates the launcher until the chosen range dot is on the target (he cannot see all the range dots simultaneously due to the aperture at the rear; this keeps the parallax within the chosen limits). The range dots have lines either side to help burst on target and are numbered for range.

Who would buy this? AGL manufacturers were used to open sights for the basic one and computing sights, such as MUGS, for customers with more money than sense. We sent a sight to Singapore for their AGL but they had not tested it after a year. Meanwhile we had been in touch with Saco, they were more interested, Flack and Scott went out to Portland, Maine, and closed the deal giving them a sole licence for the world (less the UK). We put the sight into production and substantial quantities have been sold.

The advantage of the WC-30 over computing sights is that burst on target correction of fire is easy to use. The low muzzle velocity means that the wind has a great effect and, since the wind over the trajectory is not easy to measure, a computing sight may well be wrong. Range needs to be reasonably exact too so the computing sight needs a laser rangefinder (more expense). Saco asked for stadia lines to help range estimation which we provided for a standing man and the length of a tank. But it is better to give the launcher commander a handheld laser rangefinder; he chooses the target, measures the range and gives a fire order to the gunner (he can do this while the previous target is being engaged so the rate of engagement is speeded up). The gunner fires a burst, corrects the aim and goes to fire for effect. Meanwhile the commander is looking for the next target.

Like our other sights the WC-30 has to be lit for use with NVG. So there is a pack with a LED array, batteries and a switch (ON/OFF and brightness) which is put on in front of the light probe when required.

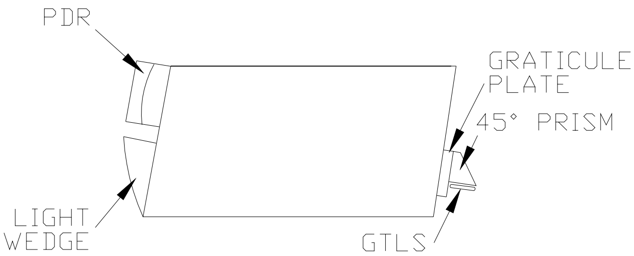
But the WC-30 is bulky and heavy weighing more than a kilogram. So Budden designed smaller optics to do the same job, the XC-10 and the YC-10. These have a much smaller aperture and are much smaller and lighter. However they are really only suited to shoulder fired launchers and not to pintle mounted ones like the WC-30.

Chapter Eleven

Solid Glass Sights: HC-10 & HC-14

The layout of the WC-30 was like that of the original solid glass sight shown in Figure 6 in Chapter 7 except that the PDR was inclined to see the graticule offset from the PDR. The graticule is at the opposite end of the prism to the PDR. Budden extended this principle to form what was named the HC range. The layout is shown in Figure 11 which shows the optic seen from the side.

Figure 11 HC type layout



Daylight enters through the light wedge, curved to get the light from above the target. Because the graticule is at the rear of the prism the light wedge has to be larger than the LC one (which is at the front) so that whatever the eye position the graticule is properly lit. This makes the prism higher in HC types than in LC. The graticule being at the rear means that it can be nearer to the optical axis of the PDR which helps with parallax keeping the focal length short. But with a rear mounted graticule lit from below the PDR the day pattern must be reflective; such a reflective pattern is not easily lit artificially so instead a separate transmissive pattern is used for low light and NVG use. A gtls was used to light this transmissive graticule. It could have been put directly behind the graticule plate but a 45ø prism was added; light (if any) from the sky goes through this prism, scatters off the tritium light source enhancing its inherent light and is totally reflected by the 45ø surface into the graticule (improving day/night takeover). This also makes gtls adequately accessible so enabling an armourer to replace it as the only tool needed is a little knife.

At the first European Small Arms Symposium Scott gave a paper on Sights and the Small Arms Designer in which he said that these designers did not understand sights and used the FN FAL (British SLR) as an example. This rifle, designed by Vervier, had open sights; the backsight broke my glasses when I fired the rifle (because it was too close to the eye) and the foresight was on the barrel connected to the stock by a pin which wore loose so the sight line became unreliable. In the audience was Andre Vervier, his son, who, despite my rude remarks (or because of them?), asked us to go to FN as the wooden mock-up of a Personal Defence Weapon had now become the P90. FN were proposing to use a run-of-the-mill Israeli unit power sight; this was replaced with the HC-14-62 optic in a plastic housing designed by FN.

Ten thousand were ordered. Production was organised by Ring Sights™ including getting the moulding tools made, the sights accepted by FN and marketed around the world. This was the first example, except for the EM2 rifle, of a small arm with a unit power sight built in properly from the start. Subsequent production orders have been placed.

FN chose the aperture of 14 mm; it suited the width of their PDW, and the position of the sight line, despite extra height of the optic and the plastic housing around the optic. But for other weapons a narrower aperture may be desirable. So we made the HC-10-62 which was the same length but much less high. Housings were made and marketed but without much success even though, with the height of the sight line above the barrel, a laser pointer can be put in between the rifle and the optic.

Chapter Twelve

Solid Glass Telescopic Sights

Not everyone likes the white graticule and lower light transmission of reflex collimator sights. They are used to the black graticule and good light transmission of traditional telescopic sights. John Barlow put a unit power telescopic sight on the EM2 rifle; this was the usual layout of four lenses with a graticule plate at one focal plane; four lenses are needed to provide an erect image of the target. But such an arrangement has vulnerable air gaps between the lenses and requires excellent manufacture if the scene seen through the sight is to match that seen around it.

Budden kept the principle of four optical components but made two of them reflective instead of refractive. He could then cement them onto a solid glass prism as in Figure 12.

Figure 12 MC type layout

The surface of reflector B is at the focal plane of lens A so, if a graticule pattern is cut into it, this appears black when focussed by reflector C and lens D. And, if a gtls is put behind it, the pattern is lit bright for low light and NVG use. Unfortunately, there is a spell in the gloaming when the target brightness matches the graticule brightness and the graticule cannot be seen. So the gtls has to be veiled until the rifleman decides to use it and unveils it. This can be avoided by the use of a dual graticule (like the HC-14); day and night patterns are cut into the reflective surface and the day one is given an opaque coat which keeps it black.

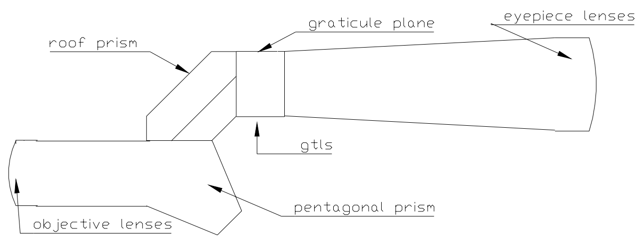
We made up prototypes, the MC-10, with an aperture of 10 mm so the overall height was 20 mm, the width 10 mm and the length 83 mm weighing, for the optic only, some 40 grams. So it is a robust, compact sight with very good light transmission (only two air glass surfaces). But it is more expensive than the reflex collimators so, though it is much admired, means that the reflex collimators are preferred.

Budden designed another solid glass unit power solution which erected the image in the way that traditional binoculars do with two right angle prisms. We made prototypes with a 10 mm aperture coming out 110 mm long and weighing 55 grams. But the dogleg shape, and the difficulty of lighting the graticule artificially, made this layout not militarily attractive.

The Steyr AUG rifle was designed to incorporate a x 1.5 telescopic sight of conventional design (unit power was too expensive). This sight has proved popular except that, having air spaces, it tends to leak and mist up; in addition there is no illumination of the graticule for low light use.

Budden designed a solid glass x 1.5 telescopic sight, the TC-12, to match the AUG one which included a means of lighting a night graticule. It is shown, diagrammatically, in Figure 13.

Figure 13 TC-12 layout from the side



The target scene is focussed by the objective lenses (diameter 12 mm) onto the graticule plane via pentagonal and roof prisms which invert it; the eyepiece lenses (diameter 17 mm) focus it for the eye, putting it the right way up. The eye distance is 60 mm.

The graticule is dual, rings and a dot for day use and an open T, lit by a gtls, for low light and night use. However, other graticule designs have now been made.

Like the other solid glass ones, the optic is potted into a housing with Dow Corning silicone rubber.

It is a beautiful sight.

Chapter Thirteen

What Now?

If Scott, in A5 in 1950, had been asked to provide a sight for the EM2 rifle he would have gone to Budden at the Admiralty Gunnery Establishment and we might well have started this whole unit power sight development decades earlier.

Since retirement from Government service Budden and Scott discussed what the services are likely to need and designed optics as a result (not to stated operational requirements). The services have not always recognised the needs straightaway but, in most fields, Ring Sights™ have been adopted. The exception is the replacement of open sights on rifles. Rifles have a long life and, since there are so many, cost a lot to update. But the operations in the Balkans are starting to generate requirements for better rifle sights and we hope to achieve success here too.

Now military and R & D establishments are considering what the Future Infantry Soldier is to have. Probably a helmet which displays, among other things, a graticule so that his weapon can be aimed. They think that this means a sensor (like a little TV camera) on each weapon. special to that weapon, plugged into the helmet. So the sensor must have the right graticule pattern for the weapon. Do such sensors have enough field of view for a 525 mils graticule?

Our solution is simpler, cheaper and more militarily useful. Put a Ring Sight on each weapon with, as usual, the graticule pattern needed by the weapon. View this, like we do now with NVG, with the sensor so injecting the graticule into the sensor. Only one sensor is needed per man which he puts on the weapon he is to use. The graticule is already zeroed to the weapon; the sensor does not need to be precisely aligned (especially easier for throwaway barrels like LAW80). And, if the helmet or its power supply fails, the soldier can use the Ring Sight with his naked eye. All simpler, all much cheaper. And, if magnification is needed, use a magnifying sensor (or a zoom lens).

When a thermal system is to be used, instead of having to afford a thermal sight for every weapon, put a thermal graticule, focussed by a reflector (no germanium!), on the Ring Sight aligned with the sight in production. This injects the weapon's graticule pattern into the thermal system. Since there is unlikely to be more than one thermal system per infantry section, it can be put onto the particular weapon expected to be used.

All these sensors, ambient light or thermal, can be used handheld for surveillance and quickly attached to the weapon of choice (no need for zeroing).

So there is life in Ring Sights™ in the years ahead.