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On Her Majesty's Service

WASC-1533

Mus.

~~SP/C 2150~~

We wish our readers a Happy Christmas and success in 1985

PROFILE

Newspaper of the Royal Ordnance Factories

DECEMBER 1984

No 50

US Army Secretary to
sign deal in London

MORTAR CONTRACT WORTH MILLIONS

Two top
projects
in view



Just released are these dramatic photographs of two of the projects in which Royal Ordnance have teamed up with leading American companies, as reported on page one of our last issue. Above: the ROF/BMY International Turret and below: the Stingray gun and turret system produced in collaboration with the Cadillac Gage Company.



A £2.1 MILLION US order for the 81mm mortar and ammunition is due to be signed in London on Thursday December 13. It opens up a potential market for several thousand mortars and up to two million mortar bombs worth hundreds of millions of pounds. Production will be in the UK.

Signing the agreement at the Ministry of Defence are Mr Adam Butler, Minister for Defence Procurement, and the Hon. Dr Jay R. Sculley, US Assistant Secretary of the Army for Research, Development and Acquisition.

The initial order is for a pilot production batch of the well proven 81mm mortar which has been refined for US use under a joint contract. It includes several thousand mortar bombs with delivery starting early in 1985.

Negotiations to win the order began some eight years ago, and latterly negotiations have been in the hands of Dr Arthur Chaplin, DOF Ammunition, and his team. And with production in the UK it will be good news for the

Ammunition Division factories, and for Royal Ordnance Nottingham which makes the mortar.

The order clearly established the 81mm mortar as the finest of its type in the world, as the British Army and Royal Marines know, having used it operationally for many years.

This weapon has exceptional range which enables it to be used for tasks which, otherwise, would necessitate the use of field artillery. It has a high sustained rate of fire and remarkable accuracy.

High strength and ability to withstand extreme heat are among its notable features and yet it is light enough for a single unit to be carried in three one-man loads of which the heaviest weighs only 12.3 kg.

Apprentices receive MOD merit awards

Apprentices Graham Jefferson of ROF Birtley and David Pipkin of ROF Bridgwater were presented with Merit prizes in the annual MOD Apprentice Awards Ceremony last week. A third Merit winner, Andrew Shaw, is to receive his award at ROF Radway Green.

The presentations were made by Mr Tom King, Secretary of State for Employment, at the Ministry of Defence headquarters in Whitehall.

After the ceremony, Mr King toured a special exhibition of the work of apprentices from several

of MOD locations, and this included an impressive display featuring products made by the Royal Ordnance lads. Full details and pictures in January issue.

HISTORICAL HIGHLIGHTS

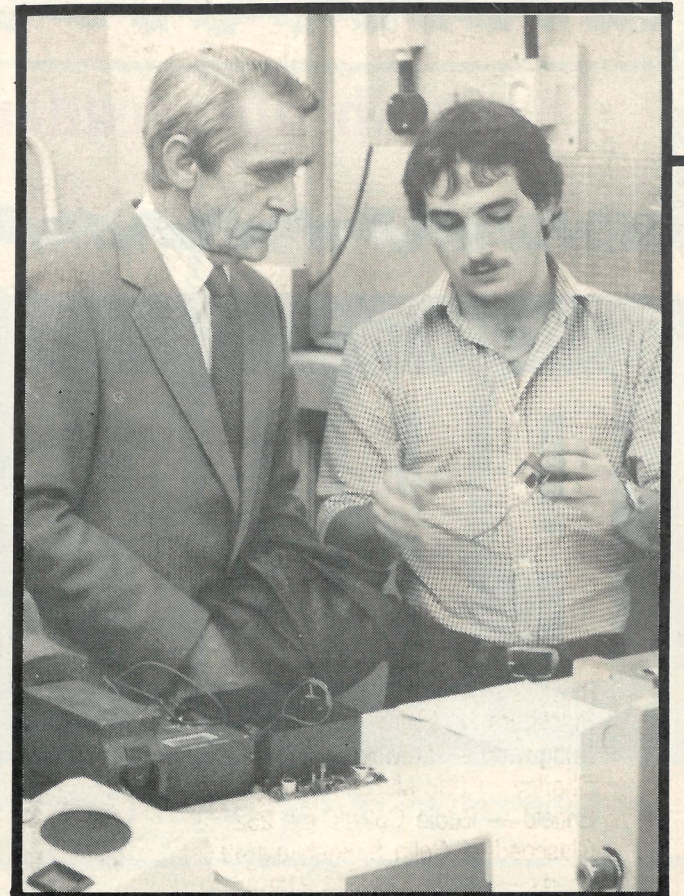
In a special 4-page pull-out supplement in this month's issue we look at the heritage of the Royal Ordnance Factories through a series of historic prints and photographs.

Shot Shop five shoot those winning goals



Birtley's Shot Shop team scorched to victory in the factory's recent five-a-side football inter-departmental competition. Twelve teams took part this year and were separated into three leagues of four. The winners of each league then played each other in a "round robin" competition to decide the overall winners. With Shot Shop taking the victors' laurels, the Case Shop were runners-up and the team representing FID were placed third.

Proudly displaying the rewards of their championships are the Shot Shop team of A Salmons, D Urwin, R Henderson, B Stell and G Mackie.



It was a time to renew old acquaintanceships when Mr Harry Butterworth, Managing Director Ammunition, went to Glascoed as guest speaker at the factory's annual Apprentice Prizegiving Ceremony.

Despite blustery weather visiting parents and friends were taken on a tour of the workshops, with apprentices acting as guides, and were shown samples of work completed during the year.

Prizes were awarded to the best first, second, third and fourth year apprentices and Awards were given to the Factory's 'Tom Nevard' entries. In addition 14 Completed Deeds of Apprenticeships were given

out and Russell Oliver, best first year apprentice presented Glascoed's former Director with a turned wood bowl surmounted by a brass ship's wheel nutcracker.

Other top young men in their respective categories were: Steve Hulme, best second year apprentice; Robert Evans, best third year; and Andrew Edwards, best fourth year.

In our photograph Paul Beaton, a first year electrical apprentice discusses with Mr Butterworth the finer points of an ultrasonic alarm detector. This device is Paul's own entry for this year's Tom Nevard competition run by the Ministry of Defence.

Day of awards as apprentices show results of their skills

First Aid league is launched in NE

A new First Aid League has been formed in the Tyneside area and the ROF Birtley team had the honour of playing hosts for the very first competition.

Aim of the League is to provide regular practice for First Aiders in a competitive environment, thereby increasing capabilities and experience. In turn, this will provide valuable benefits in maintaining high standards throughout the region.

Membership of the League is currently restricted to seven teams and each in turn will organise regular competitions. Sister Katherine Glendinning and the Birtley team are to be congratulated on a successful first event, which was also attended by Factory Director Mr J. O'Donovan, who has agreed to be a Vice-President of the League.

First Aiders at the Royal Ordnance establishments willingly give up their time to keep their life-saving skills honed to a keen edge. A dedicated band of men and women, they are ever-ready to handle any emergency both at work and outside.

Rousing farewells for Don and Arthur

Don Jones, and Arthur Ridout, long-serving employees at Radway Green, were given rousing send-offs by their respective colleagues when they retired recently.

A total of 43 years government service is Don's proud record. Born in nearby Congleton, he first joined the factory in February 1914 as a shop lad and within a few months had moved to the Laboratory which was to be his place of employment right up to his retirement, except for four years military service with the Black Watch regiment from 1943. Don became a Higher Scientific Officer in 1971.

His depth of knowledge, helpful advice and friendly persuasion were a hallmark of his service as well as his undoubted talent for telling humorous stories. He also boasts of being the most faithful, if not the only, supporter of Port Vale Football Club.

Don has unfortunately had to retire due to illness but we wish him better health in retirement.

The other stalwart, Arthur Ridout retired as Shop Manager of Radway Green's Toolroom. A native of Abergavenny, Arthur started his ROF career in 1948 at Blackpole near Worcester, transferring to Radway Green in 1951. He is an extremely keen gardener and lays claim to growing the largest tomatoes in Stoke on Trent!

In recent years Arthur has been a convert to golf and his greatest regret is not having taken the game up earlier in life. We wish him well on the greens of Keele Golf Course.



Arthur Ridout (in light suit and glasses, front row) lines up with his colleagues on the day of his retirement



Don Jones (in front of fire extinguisher sign) pauses for a photograph, with friends who gathered to wish him well

PROFILE

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Three receive their Birthday Honours

THREE of the Royal Ordnance Factories employees who were cited in the Queen's Birthday Honours this year, have now received their British Empire Medals.

They are: Mrs. Jean Moore, of ROF Radway Green; Mr. Eric Ingham, of ROF Glascoed; and Mr. Joe Bonney, who retired this year from ROF Birtley.

The presentations were made at a special ceremony in London last month by Mr Adam Butler, MP, Minister of State for Defence Procurement.

Jean Moore is a production worker at Radway Green and for most of her 22 years' service, she has been involved on machine work connected with the manufacture of small arms ammunition.

Apart from being a keen first aider and member of the factory first aid team, Jean is an active member of SWANS swimming club which assists handicapped children and adults. She is also on the Factory Support Committee for Stanfields Hospital, which is a local geriatric hospital.

She has a son, a daughter and a granddaughter, also has 2 cats, one of whom is named Bemy in celebration of her BEM!

Eric Ingham, who has clocked up 30 years' service is aged 54, and since 1972 has been the factory Fire Brigade Officer at Glascoed. He holds many First Aid certificates and is a qualified First Aid Instructor.

In addition to his work in firefighting and interest in First Aid, Eric has many other interests. He holds a

Glider Pilot 'C' licence and a judo brown belt, and plays solo baritone horn in the Cwmbran Youth Brass Band, of which he is also deputy conductor.

He is married and has two sons and two daughters.

Joe Bonney who is 62 retired last February after more than 40 years' service at ROF Birtley, where he began as a shop lad aged 16. He retired as a production worker. During the Second World War he served in both the Royal Artillery and the Middlesex Regiment and attained the rank of Regimental Sergeant Major.

Joe, whose wife Cecilia works at ROF Birtley as a messenger, is an active member of Birtley Parish Council. He is also a keen first aider, having been in the factory First Aid team. Under his training, the team won the MOD Annual Competition each year from 1978.

We take this opportunity of joining their colleagues in congratulating all three on being chosen for this honour.

When the other members of the ROF workforce cited in the Birthday Honours list have received their awards, PROFILE will bring you news and pictures of the events.



Mrs Jean Moore, of Radway Green, receives her BEM from Mr Adam Butler, MP, Minister of State for Defence Procurement



BEM for Glascoed's Fire Brigade Officer, Mr Eric Ingham



Mr Joe Bonney, who retired from Birtley earlier this year receives his BEM.

Medals mark their years of service

Four past and present employees at ROF Birtley have received Imperial Service Medals. The presentations were made by Mr J R O'Donovan, Factory Director.

James Foley; still serving after 30 years, came to Birtley in 1953 as a Setter but was made redundant 4 years later. He was away for 11 months and re-entered in March 1958. He worked in various shops and in January 1962 settled in the Large Shell Shop.

John Frazer Fenwick; first entered Birtley in January 1949 as a Labourer in the Large Shell Shop. Made redundant a year later, he returned to the factory in August 1950. After working in various shops he moved to the General Machine Shop in November 1961 where he took medical retirement after 34 years' service.

John McHenry; still serving after 44 years, started at Birtley in October 1939 as a lad, joining the RASC in 1942, he returned to Birtley in April 1947 and went to the Case Shop where he has remained ever since.

Joseph Killen, still serving after 31 years, is enjoying his third term at Birtley. Entering in April 1949, he was made redundant in December 1949 after 8 months in the Medium Shell. He re-entered in January 1953, only to be made redundant in February 1956. Re-entering in July 1957 he worked in the Case Shop for one year, then transferred to Development, where he has remained.



ISM recipients, from left to right, Mr and Mrs Joseph Killen, Mr and Mrs John McHenry, Mr J R O'Donovan (Factory Director), Mr and Mrs John Fenwick and Mr and Mrs James Foley

Joan follows Les into retirement

Les Hooper, who had already retired, returned to ROF Bridgwater to attend the presentation to his wife,

Joan, on the occasion of her retirement.

Les, born in Pontypridd, served with the RAF from

1938-46. He joined the ROF Bridgwater on demobilisation, but left in 1950 due to a reduction in establishment. Returning to the factory in 1966, from the atomic power station at Hinkley Point, Les became a driver and remained with that Department until his retirement.

Joan is London born, and first worked in the factory during the War. She returned to us in 1965 as a canteen assistant where she was working on her retirement.

We wish them both many years of happy retirement.



Skills of the apprentices

In the January issue our centre spread will be devoted to a selection of colour photographs showing examples of work by ROF apprentices which went on display for the annual MoD Apprentice Awards ceremony.

SALAMUT HARI CHRISTMAS

With this greeting in the native tongue of Borneo, PROFILE's Brigwater correspondent LAWRIE HIBBERT shares with us his memories of a Christmas Eve, 35 years ago, which he spent in a dugout canoe attempting to return from the jungle to his coastal base in time for the Yuletide celebration

I KNEW Sabah when it was North Borneo. In 1949, I worked on a logging operation based on Sabatik, an island that lay across the border with Indonesia eight miles from Tawau. Except for a narrow straight at each end of the island, Sabatik sealed Cowrie Harbour from the sea, forming a deep water haven sheltered from the worst of the weather.

Salt water fingers groped inland through the mangrove swamps forming estuaries for the many rivers that emptied the tropical rainfall from the jungle basin into Cowrie

Harbour. On most of these rivers were situated timber camps of the North Borneo Trading Co Ltd, run by Chinese or Malays on a contract basis. Rafts of logs were towed in by launches to the log pond on Sabatik, where they were trimmed, measured and prepared for shipment. I had the overall responsibility for these shipments and for conditions in the jungle camps.

It was nearing Christmas. I had been in the jungle for a couple of weeks camp visiting on the Surudong River near the Indonesian border. I had reached the village with my cook, Ngniew — a bow legged, squint eyed, whispy moustached, Orang Sungai (riverman), any Hollywood director would have typecast as a pirate. We expected to meet the launch which was to take us back to Tawau, but it was not there. When it

failed to show up on the 23rd I resolved to return by dugout canoe.

We left on the ebb at 2000 hours a reluctant departure as far as my superstitious crew were concerned. Ngniew sat in the bow, Amat in the stern while I sat amidships with our baggage and a biscuit tin full of sand to carry a small fire to make a brew. By the early hours of the morning we had left the nipah palm behind us and were flanked on both sides by mangrove, a sure sign we had reached tidal waters. Some of the trees were fantastically illuminated by thousands of beetles flashing their firey rumps, as though in celebration of the Christian season.

The mangrove was cleared soon after dawn. Three miles away we saw the MFV alongside the log Pagar beginning to pull away. I stood in the

Parhau and waved frantically, but to no avail. Ngniew blew on a conch shell, normally reserved to call the wind, but the sound did not carry to the boat. When we made our weary arrival the MFV was out of sight.

I had helped with the paddling during the night and it had been a hard pull across the Cowrie Harbour against the flood. None of us were in a fit state to continue, although the ebb was due at 0900 hours. We rested up for the rest of the day, leaving on the ebb at 2100 hours. A rain squall forced us to shelter in the mangrove as we neared Tawau, but by 0100 hours on 25 December we pulled alongside the wharf. I climbed up leaving Ngniew and Amat to sort out the baggage in the morning.

"Salamut malem Ngniew"
"Salamut Hari Christmas Tuan"



Radway Green's Factory Director, Mr Philip Thorpe, presents the six-a-side trophy to stand-in captain of the winning D Block team, Sam Trickett

Soccer sixes battle it out at lunchtime

This year's six-a-side football knockout competition at Radway Green was well contested with no fewer than 22 teams battling it out for a place in the finals.

Matches in this competition, which is organised each year by the factory Apprentice Association, take place during lunch breaks and have all been refereed by first year Apprentice Instructor Phil Yeomans.

The final of the 1984 round took place between a side representing the Boiler House and a team from D Block Cuppers. A close match was played in front of

a large and enthusiastic crowd but as the game progressed conditions deteriorated dramatically, with the last few minutes taking place in torrential rain and hail.

The destiny of the trophy for this year was decided by the only goal of the match which followed a clever "one-two" between Sam Trickett and Derek Pickerill of the "Cuppers," with Derek slipping the ball neatly past the approaching Boiler House goalkeeper Dieter Pattison.

Conditions were such that the presentation of trophies had to take place at a later date by which time D Block captain Dennis Cotton had unfortunately broken his ankle in an accident away from the factory.

Michael receives exam success certificate



Michael West, of ROF Leeds, is among a select band of people up and down the country who have just passed the final examination set by the Institute of Cost and Management Accountants (ICMA) and he is pictured here receiving his certificate from John Burnup, President of the Institute West Yorkshire branch



George Woodburn receiving his canteen of cutlery prize for winning the 5,000 metres in the MOD Sports Day. It was presented by Mr K. C. Macdonald, DUS POL (PE)

George wins again

George Woodburn, a painter at ROF Blackburn, is well known locally for his many successes in various running events from marathons downwards. This year he has added two more to this list, the first being in the summer when he won the 5,000 metres at the MOD Sports Day.

Then, more recently, George took part in Preston's Citizen Fun 14 Road race which was a half marathon that he completed in a winning time of 1 hour 20 mins 34 secs. As the race took place in sweltering heat, George did say that it wasn't exactly a lot of fun, but it was worth the effort as his chosen prize was a weekend in Paris.

Obviously he is a romantic at heart as he is taking the weekend to coincide with his wedding anniversary. Mind you, romance may have to take second place for a while as George, a member of Blackburn Harriers, is consider-

ing joining 28,000 other runners in a 10-mile road race from the Eiffel Tower to the Palace of Versailles while he's there.

Two centuries' service marked in ISM awards

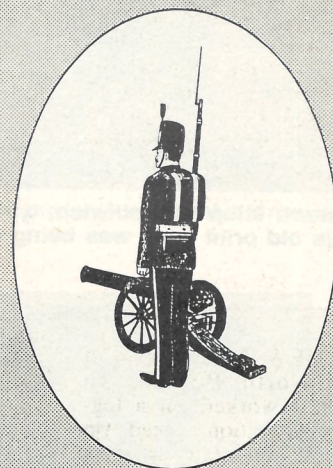
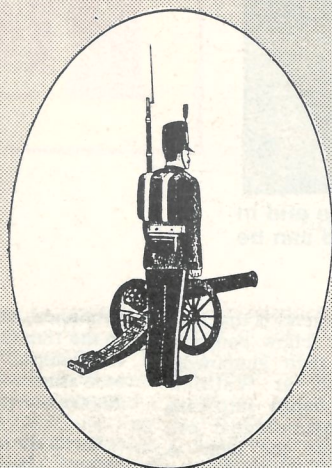
More than 200 years' loyal MOD service was recognised at Radway Green when the factory Director Mr Philip Thorpe presented Imperial Service Medals to five existing employees and one who had retired. The award ceremony was followed by lunch in the Canteen and then a tour of the factory which was found to be particularly interesting for

those wives who were able to attend.

The photograph below shows the Director (left) with the six recipients: Sam Hancock (retired PTO IV); Fred Mallett (general hand); Albert Ball (head gardener); Bill Wootton (leading hand examiner); Jack Allen (production worker) and Jack Harratt (Senior Storekeeper).



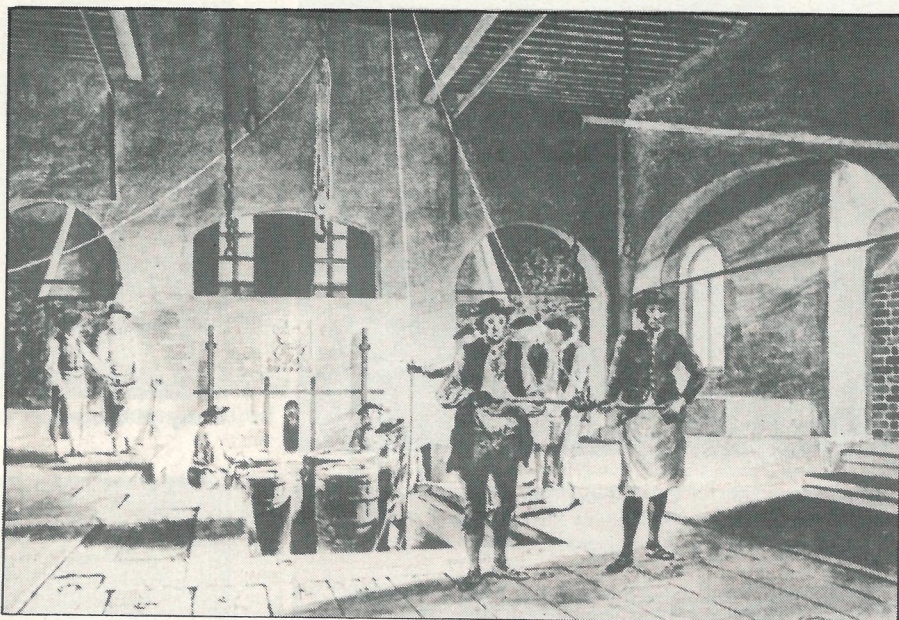
HISTORICAL HIGHLIGHTS



by Stan Taylor, MBE
Chief Training Officer, ROF Chorley

As the Royal Ordnance Factories approach incorporation as Royal Ordnance plc, Stan Taylor traces the history of explosives and the emergence and development of ordnance as he outlines the pedigree of our organisation. His extensive

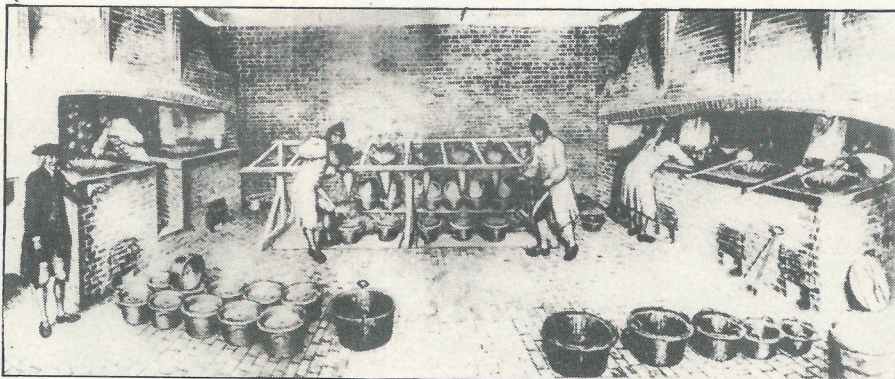
research for this commemorative supplement also brought to light a number of old prints, documents and photographs which serve admirably to illustrate a heritage of which we can be proud as we go forward to future success.



This is how it was done in the old days . . . a drawing from the Georgian period showing moulds being positioned prior to casting of barrels at Woolwich



A scene in the furnace room depicting the casting of cannon barrels in the furnace itself

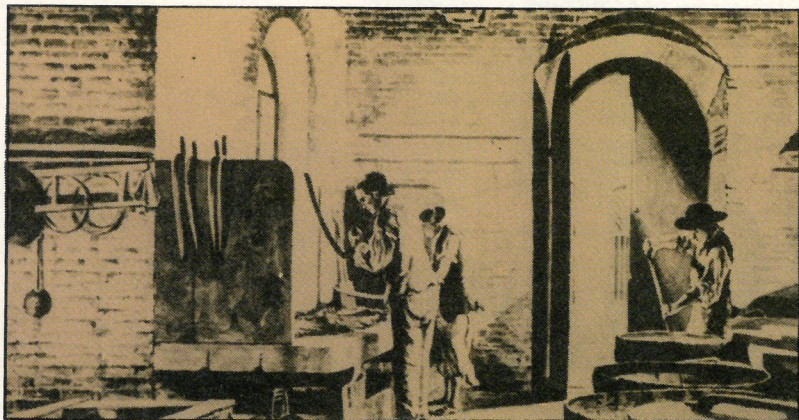


One of the earliest drawings of work at Woolwich Arsenal, then known as the Royal Laboratory, it shows munitions manufacture circa 1750



Believed to have been executed around the same time, this illustration shows the moulding of pellets at Woolwich

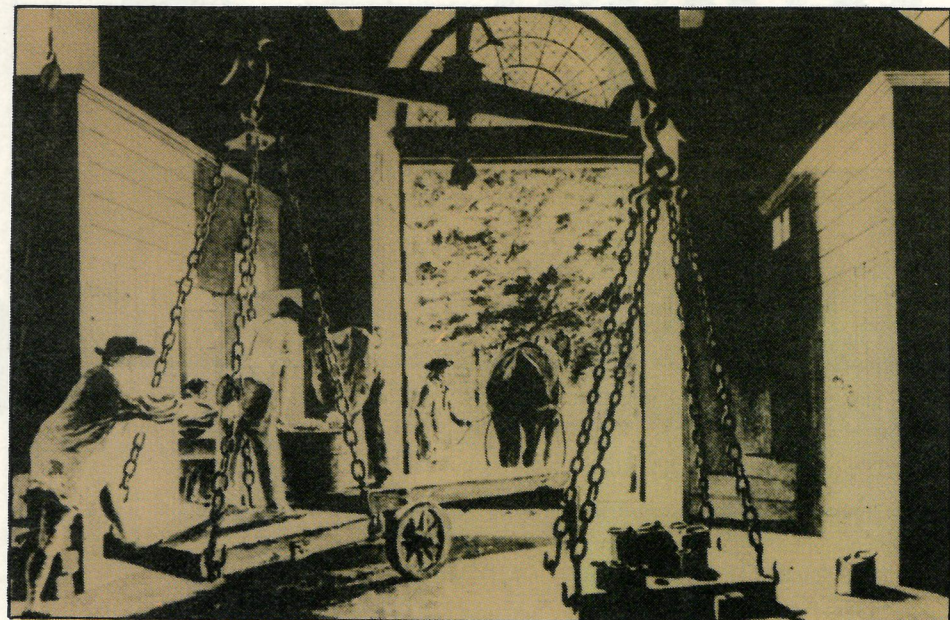
HISTO HIGH



Pattern shop at Woolwich, typical of the 18th and 19th Centuries. In this old print work was being carried out in preparation for casting



Convicts were used as cheap labour in ordnance manufacture and in this 1779 drawing of Woolwich, the hulks in which they lived can be seen at their moorings on the Thames



Powder was delivered by horse and cart, and here it is seen being unloaded in preparation for weighing

It would need volumes to cover a detailed history of the Royal Ordnance Factories' organisation coupled with that of the Explosives Research and Development Departments and the Royal Armament Research and Development Establishments. But as our organisation moves towards its change of status and we look to the future, it is an appropriate time to take a brief glance at the milestones along the path we have already travelled.

A protogunpowder was first discovered in China in the 9th Century. This quickly led to the development of primitive fuses and ballistics and the mixture was used in flame throwers made from hollow bamboo or paper tubes and the mixture lit by a fuse.

Legend has it that the first use of gunpowder was at the Battle of Crecy, in 1346, and that it was made by the Monks then in residence at Waltham Abbey! It is known from the accounts of the Clerk of the Great Wardrobe that saltpetre and sulphur were supplied to the King for his guns.

Yet another legend is that Guy Fawkes and his fellow conspirators purchased their gunpowder from the Mills at Waltham Abbey. This is hardly surprising for there is circumstantial evidence to support the idea. A Father Henry Garnett, the Superior of the English Jesuits, was living under the assumed name of Mr Meaze only two miles away at White Webbs, where the conspirators were frequent visitors, and they were there only a few days before November 5, 1605.

It is known from their confessions that there were at least three separate purchases of powder over several months and that it was stored in Catesby's house in Lambeth before being taken to a house rented by Percy, next to the House of Lords. The transport from Waltham to Lambeth after purchase was safely carried out by water.

But so much for legends. The first evidence of a connection between Waltham Abbey and gunpowder appears in the State Papers of 1561 when a contract for supply of saltpetre and sulphur is mentioned.

Experiment and development

continued, with particular growth in the 18th Century. By the Battle of Waterloo in 1815, production at Waltham Abbey had peaked to 20,000 barrels per year.

Methods of gunpowder manufacture changed little over the centuries until recent times. Whereas sulphur and nitre are reproducible ingredients, a mystery enshrined optimum specifications for gunpowder charcoal. Within recent years the application of modern analytical techniques has removed some of this mystery and anatomical feature and physical properties have been characterised.

By the year 1326 the discovery of the cannon had spread to Europe and the first recorded was known as the Milemete Gun, a vase-shaped barrel that fired an arrow type ammunition. Over the succeeding centuries further development through a series of projectiles from classic cannon ball led onwards to those sophisticated variants of artillery and tank ammunition of today, which fire through gun systems developed by the ROFs, are recognised as the best in the world.

The Royal Ordnance Factories were created from Her Majesty's

*Orders by the Chief Fire
Master of the Royal Laboratory
1 of March 1799*

*The People who may be employed in Driving of
Composition of all Descriptions are desired to keep
their Bodies in an Erect Position so as to be clear
of the Shoulders which will in a great Measure
Preserve them from the Fatal Consequences attending
upon Accidents*

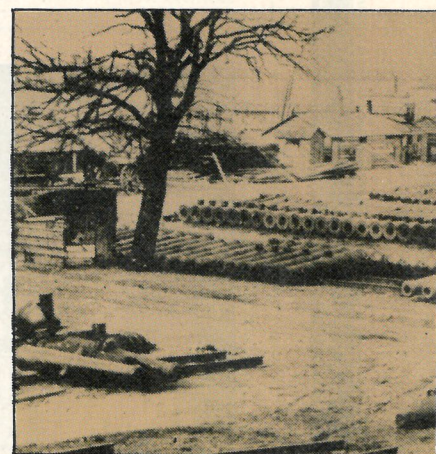
*Not to exceed the Undermentio
ned Quantity of Composition in
each Box when Driving*

Each Fuse Takes	Boxes
13 Inch Fuse 2.. 8	From 1.. 0 to 1.. 8
10 " " 1.. 8	" 0.. 12 to 1.. 8
8 " " 1.. 0	" 0.. 8 to 0.. 12
5 1/2 " " 0.. 8	" 0.. 6 to 0.. 8
4 1/2 " " 0.. 6	" 0.. 4 to 0.. 6
Hand " " 0.. 3	" 0.. 3 to 0.. 4
Portfire 3.. 8	" 1.. 0 to 2.. 0
Rocked of 1 " 6.. 4	" 1.. 8 to 2.. 0

Above: A far cry from today's rigid precautions, this safety regulation of 1799 "desires" those employed in transporting composition to "Keep their Bodies in an Erect Position"

Above right: A group of visitors watches as the men prepare the moulding pit and position the moulds ready for vertical casting.

Right: Old documents add much to the study of history and this letter in the hand of the famous William Congreve, which places an order for saltpetre production, gives a brief personal insight. In his closing paragraph he apologised for missing a meeting because he was unwell.



Early photograph showing open-air at W

Sir

I have received your Report relative to the experiments on Salt Petre and am to desire you will order 10th of the Fr. richmans Salt Petre to be pulverized by pounding and 10th to be done in the usual way by Evaporation. I should be glad to have the Poundd get ready and Have Dried by 12 O'clock to-morrow if Possible.

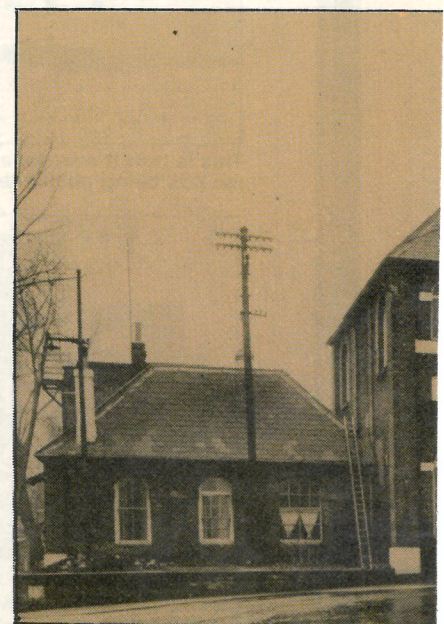
*I was taken so ill with a dizzings in my Head that it prevent-
ed me being with you to day, but I hope to be well enough to come
down to morrow*

I am Sir Your very humble Servant.

W^m Congreve

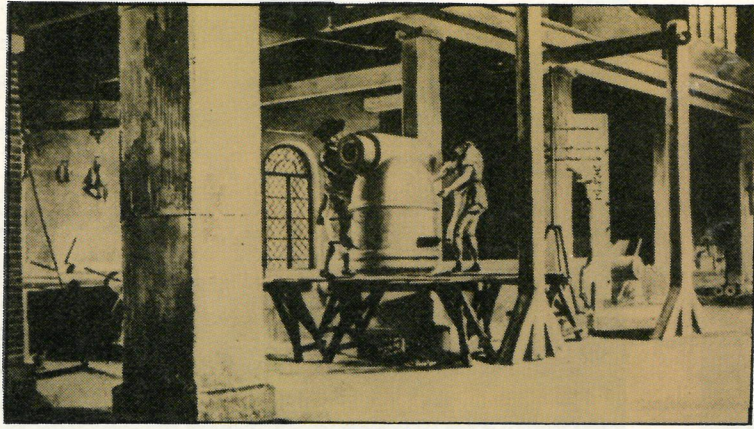
7th April 1786.

*Please to have another Report of the Experiments
made out against 12 O'clock tomorrow—*

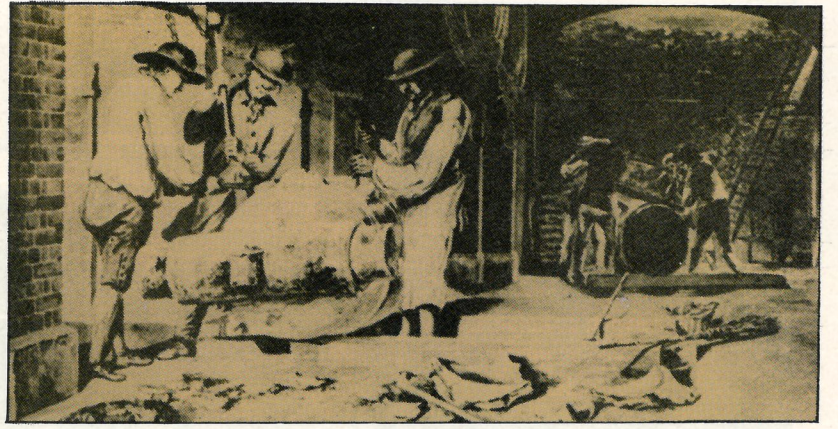


A scene that will be firmly fixed in the entrance to the Royal Foundry,

ORICAL IGHTS



Another view of production showing two halves of a newly-cast mortar being assembled at Woolwich



Cleaning off the moulding sand from a newly cast mortar

Ordnance Factories and the Royal Laboratories, Woolwich Arsenal. The World War II demand in the various combat theatres eventually necessitated a total of 48 Royal Ordnance Factories engaged in the production of Explosives, Guns, Tanks and Ammunition, employing some 300,000 people to meet the demand, without which the ultimate outcome of World War II could have been the reverse of the victory that was achieved.

Within two years the number of ROFs was reduced to 25 only, and between 1946 and 1958 a further 14 factories were run down, leaving 11 main ROFs plus two agency factories, one at Powfoot and the other at Featherstone, with an overall workforce of approximately 20,000.

Over the foregoing period various Governments placed responsibility for the ROFs from War Department to Ministry of Supply then to Ministry of Defence.

In 1968 the Government of the day appointed Sir John Malabar to examine the ROF's organisation and accountability with a view to removing some of the main constraints which inhibited

their commercial capability. The role of the ROFs was then reactive rather than innovative. Unlike manufacturers in the private sector, the organisation was not free to design and develop products which in its judgement and expertise would find a profitable market. In the main it had to organise and equip itself to respond to demands for products which were designed elsewhere and to exacting specifications.

The findings of the Malabar Committee, linked with those of the Raby Committee, that the ROFs should be commercially viable, were accepted by the Government of the day and resulted in the setting up of the ROF Trading Fund within the Procurement Executive. This gave the ROF Organisation command of the resources at its disposal and was more consistent with the commercial system of accountable management.

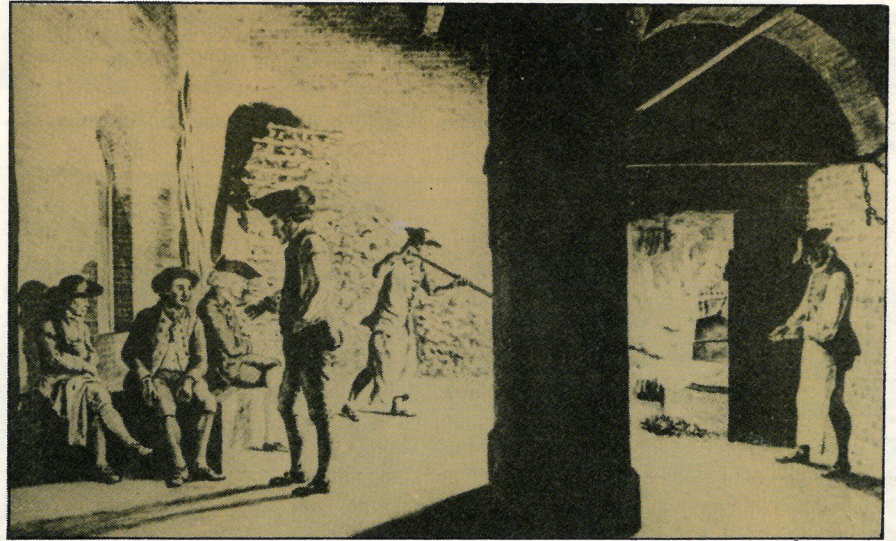
In July 1974 the Trading Fund was set up and the vote system of Government financing the factories ceased. The ownership of the ROF Organisation now rested with the taxpayer who is represented, and whose interests are safeguarded, by the Treasury. The Treasury, therefore, acting

on behalf of the taxpayer, can be regarded as the equivalent of a sole controlling shareholder.

The organisation moved quickly into its new role, with certain factories selected as prime contractors and a Central Control headed by MD/ROFs who was responsible to Government as the "accountable manager" for financial and technical aspects of the new organisation.

In the ten years of operation under the Trading Fund, with considerable re-organisation of existing staff within the factories to learn the expertise of procurement and sales techniques, the organisation has proved to be profitable — even against a highly competitive world market and a diminishing demand from the British Services.

The long history of the organisation and its forebears, the expertise of all employed in it (which in many cases included three generations of families) and their total dedication, have faced many changes but always the challenge has been met. ROFs have continued to retain the lead in quality and performance of defence equipment much envied by our competitors. This experience and dedication to lead from the front is the sure resolve for our future operation.



Stoking up the furnace prior to casting cannon barrels

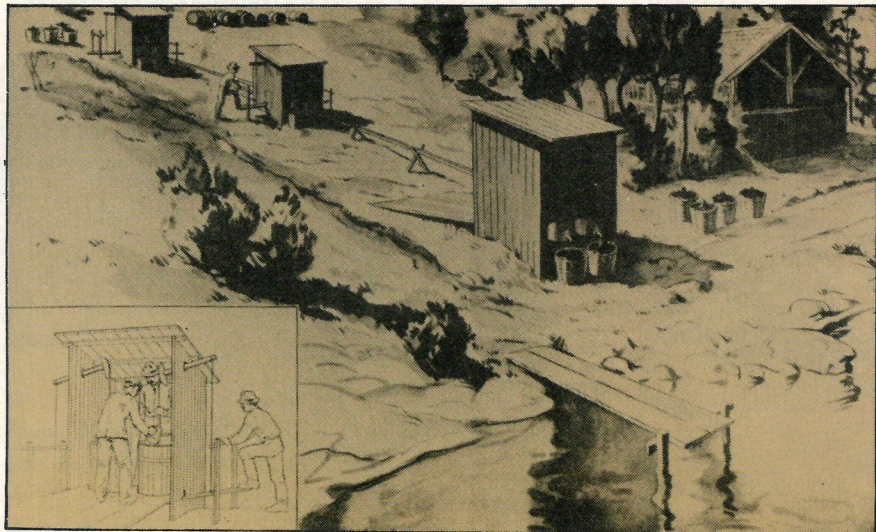
Expence of Particular Services in the Royal Laboratory at Woolwich in July 1776

	L. S. D.
Clerk	3-2-0
Feraman	3-6-9
Turning Wood Bottoms &c	5-11-3
Splicing the Modellers	13-7-0
Working at the Smiths Shops	5-3-6
Working in the Carpenters Shop	4-1-0
Turning Wheels	5-19-0
Mixing Composition	15-13-6
Staking Powder	13-9-6
Surveying and Counting Stores	23-11-0
Drying, Firing and Refrains	23-15-0
Quitting the Service Graps Shot	12-11-0
Watch	13-14-0
Sorting and Packing Stores	35-10-0
Pressing and Weighing Shells	29-16-0
Making Caps and Hoovers	27-18-0
Firing and Lapping Tubes	19-15-0
Making Quackmatch	13-11-0
Firing and Lapping Tubes	15-17-9
Firing and Cleaning Stores	14-14-0
Firing Case Shot	8-8-6
Total	£316-11-9

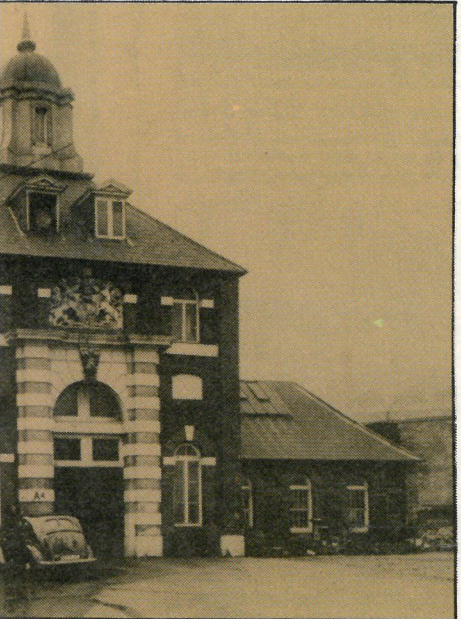
It is always fascinating to look at the prices of former times and this accounts sheet of 1776 gives a perfect breakdown of the cost of work performed at Woolwich, then known as the Royal Laboratory. In viewing it we have to remember that the total of £316 was a considerable sum in those days



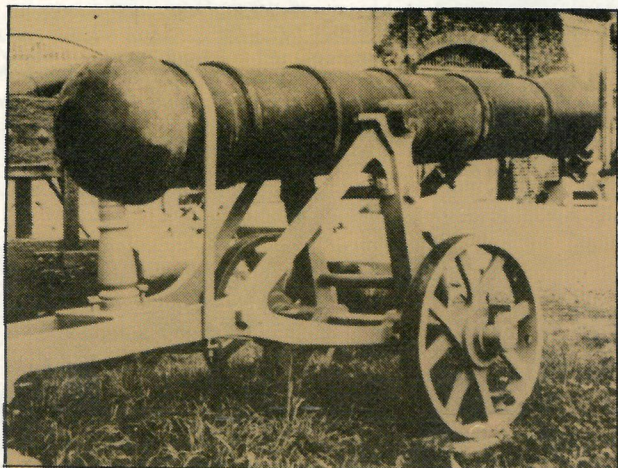
Storage of cannon barrels manufactured at Woolwich



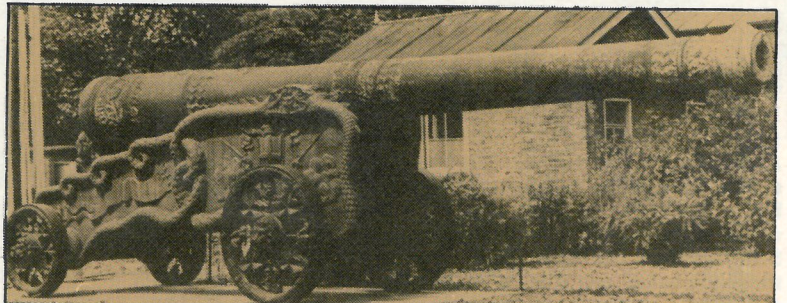
This is not an illicit distillery — the end product is much more volatile than hooch! In fact this is early production of nitro-glycerine, obviously without the stringent safety precautions maintained today



In memories of many, this is how the main building at Woolwich looked in January 1953



One of two Russian guns from the Crimea, the cascabels of which were sawn off to be melted down for production of Victoria Crosses. This gun is now on show at the Rotunda Museum of Artillery at Woolwich



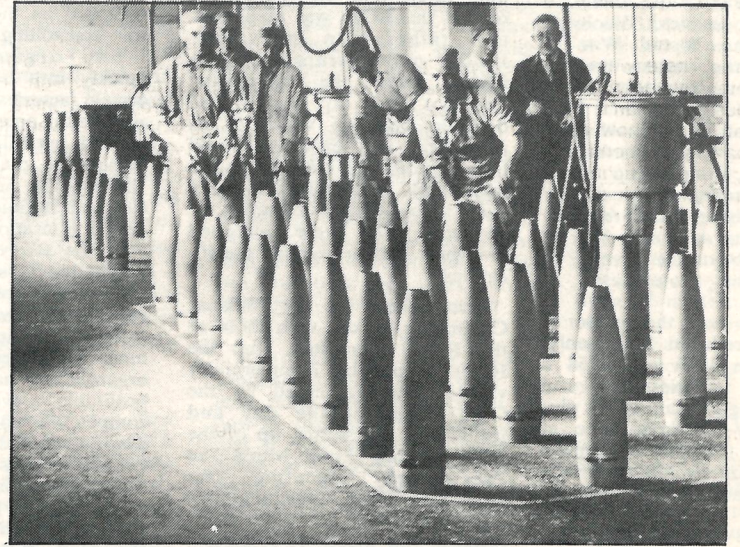
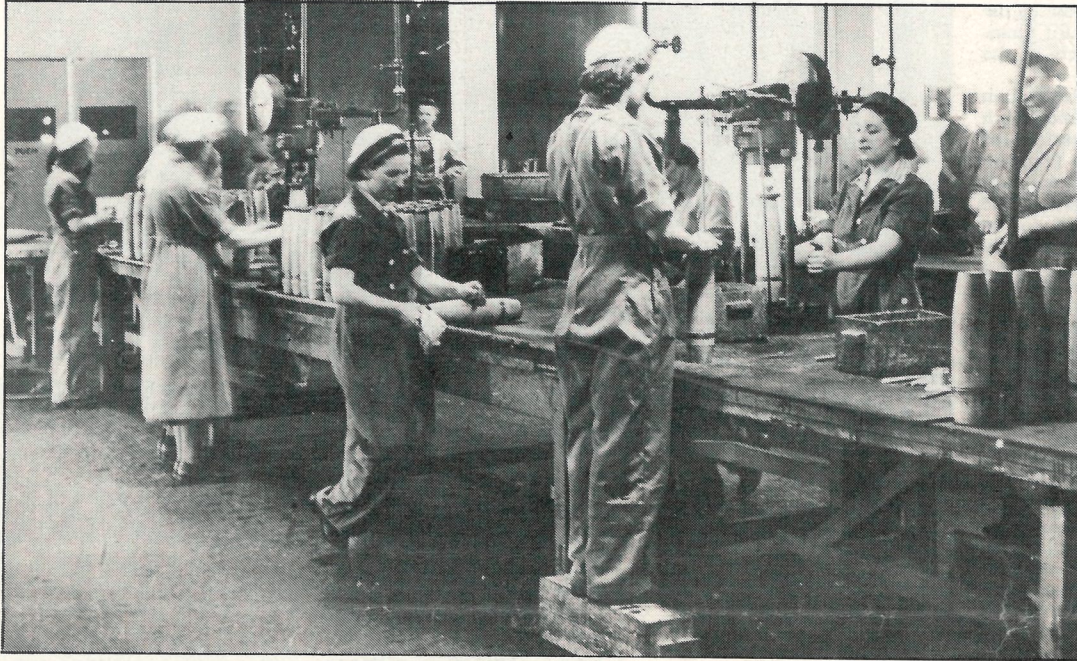
The Maltese Gun of 1607 was actually produced in France and owes its name to the fact that it was captured from the Maltese during the Napoleonic Wars. It has a barrel length of 20 feet and is now sited at Woolwich in Dial Square



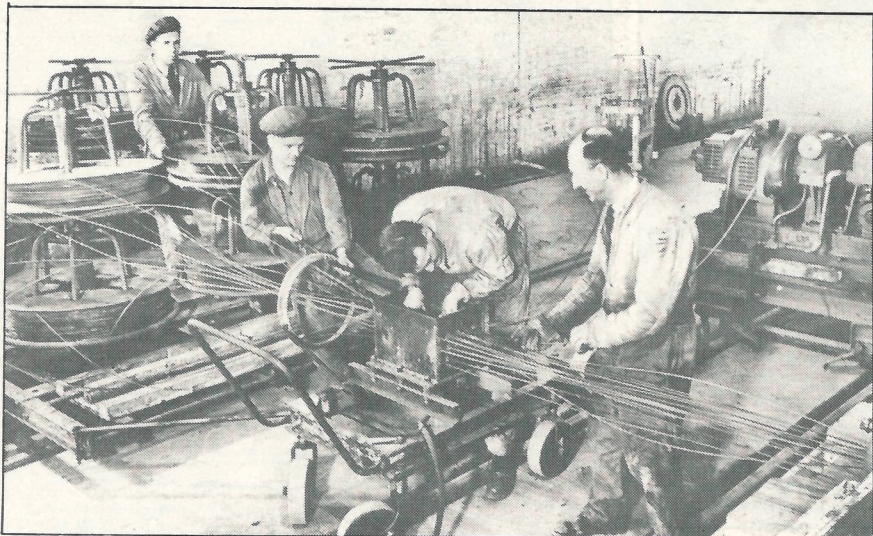
Above: We do not have a date for this photograph of the Woolwich main entrance, but the tramlines and the policeman's buttoned-to-the-neck tunic indicate that it could have been Thirties or Forties. At least we can date the building as being George IV (see plaques over side arches)



Above right: Directors and assistant directors of all the Royal Ordnance Factories in May 1949



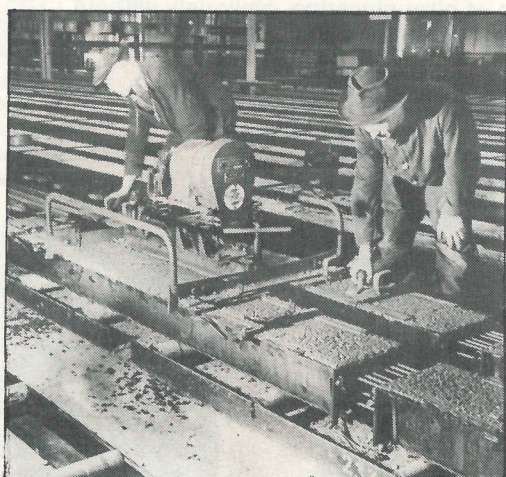
Above: Shell production at ROF Chorley in the Second World War
Left: When women were recruited into munitions factories to release men for military service — manufacturing 25-pounder shells at ROF Chorley between 1939 and 1945



Left: With the end of the war came a reduced need for munitions and many factories were awarded other contracts as the country built upon the peace time foundations. Here steel rod is being laid up for the production of reinforced concrete railway sleepers at ROF Chorley in 1948



Above: Concrete having been poured, the surfaces of the reinforced sleepers are being trowelled (left); this done, the castings are then vibrated to remove air bubbles and consolidate the mix. These three pictures are examples of how skills could be applied in a diversity of work to retain employment until munitions requirements and weapon development picked up again



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Sir

You will please to try the following Experiments comparatively betwⁿ M^r Alexander's and some of the Best of the Salt-petre which has been extracted from damaged Powder, and melted after the Venetian Method.

1st 10^{lbs} of each sort of Petre must be pulverized and after being thoroughly dried it must be exactly weighed, and then be put into a damp Place in Copper Pans.

2nd 10^{lbs} of each sort of Petre must undergo a further process of refining and all the impurities carefully be put up in Glass Bottles on which Labels must be put to distinguish whether they were found in M^r Alexander's or the King's Petre

3rd 10^{lbs} of each sort of Petre must be put into a damp Place in the lake just as it happens to be broke off, to make up the weight.

The remainder of M^r Alexander's Petre must be carefully put by for further experiments.

(signed) W^m Congreve
Deputy Comptroller.

27th March 1786.
P.S. When the Experiments are completed you will please to inform me.

Major Wood

Sir

You will please to order the Laboratory Boat to be at Westminster Bridge to morrow Morning at 8 O'clock or there about. The Coxswain must call at the Duke of Richmonds for a person who has some Salt Petre to bring to the Laboratory — which Person you will not suffer to examine any of the Work but you will please to order some of the People to get him a Lodging — I shall have the pleasure of seeing you on Friday Morning and am

Dr Sir
Your very humble servant
(signed) W^m Congreve
Deputy Comptroller.

5th April 1786.
Major Wood
Chief Firemaster
Royal Laboratory Woolwich

Two letters written by William Congreve in 1786 when he was Deputy Controller at the Royal Laboratory, Woolwich — one was to order a series of experiments with saltpetre, the other to arrange transportation by river from Westminster to Woolwich. Note the polite, if quaint, terminology of his security directive.

5 MINUTE FICTION

A DAY FOR LIVING

Short story by **JOE CHANCE** of **RSAF Enfield**

The sun shone down from a cloudless sky and although it was late in the day it was still hot.

The air was still; not a breeze to sway the trees or even rustle the leaves. It had been a long hot summer and it showed all around him, the leaves already brown. The grass he lay in was hard and sharp to his touch. He wondered how many hours of daylight were left before dusk came, bringing with it the coolness of the evening. He had no means of telling the time. There were those who could tell by the position of the sun, but he couldn't.

What he did know was that he was having to spend more time underground to escape his killers. To breathe the fresh air as he was doing now made him realize, but he knew that he would have to take more risks and do it more often if he was to keep fit and well.

He moved forward slightly and found he was out of the sun and shaded by the branches overhead. His eyes looked around once again searching for any movement but there wasn't any. He studied the trees ahead of him and he saw the birds. Starlings and a pigeon, or was it two?

He knew they would give him warning if anybody approached from that direction. They had done so many times before. What

was behind him didn't worry him because he knew that only 20 yards back was the entrance to his underground cave. He had dug the tunnel and made sure that it was well hidden in the thicket. He had worked through the nights when there was nobody to see or hear him. His body had ached for days afterwards, but he had been rewarded as he was now, that was the prize — to lie there in peace and tranquility. His eyes gradually closed and although he felt tired he dared not sleep — there would be plenty of time for that later.

Eyes closed, he gave up his mind to the thoughts that would come again as they always did. The memories of when he wasn't alone, but with his wife and family. A groan escaped from his lips as he remembered how the happiness he had felt when he was told he was to be a father was replaced by a feeling of loneliness and dread when the sickness came. One day everything was fine. His wife had just given birth to their first child — a son. He died the next day, his wife three days later.

God, would he ever forget? Of course he knew he wouldn't. He tried so many times, but it was impossible. He felt the tears

coming into his eyes and he squeezed them tight to stop them running down his face.

Would his wife have survived if she hadn't been weak through childbirth? He didn't think so. The sickness had not been swift, but it was sure. He had sat there by her side as her pains turned to spasms which had racked her body, till she was screaming in agony. Near the end she could not see him, her eyes were so swollen. He had gone for help, but there was none, everywhere he went they were dying, young or old it made no difference, it seemed the whole world was dying. On the third day he had gone to the next district but it was the same there and when he finally returned home, tired and shattered, he found his wife lying still and cold.

He had sat there just looking at her hoping it was a nightmare, but no. That had been two or three years before. He had waited for the sickness to take him but it hadn't. Why had he been spared? Why couldn't he have died with his family instead of living this non-existent life? There were a few other survivors but they kept to themselves for fear of dying.

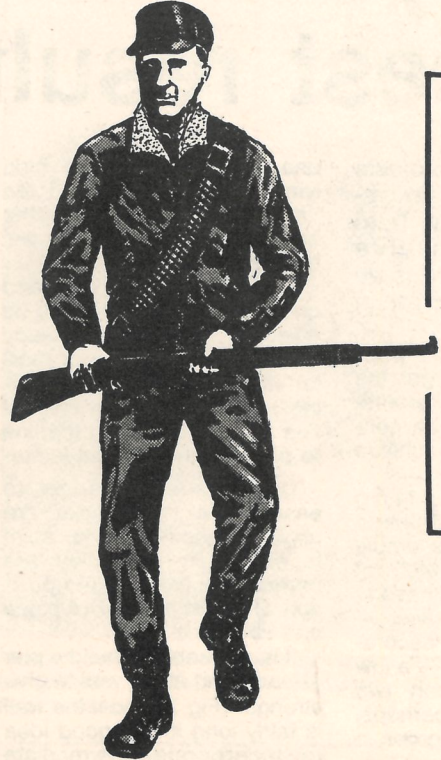
A sudden flutter of wings

brought him wide awake, his eyes blinded, trying to adjust to the light.

The pigeons had risen and wheeled away to the right.

Raising his head slightly he saw what had disturbed them. Walking slowly and carefully towards him was a gunman, rifle cradled in his arms across his chest. He recognised him immediately. Usually there were two, where was the other one? He spent precious seconds studying the man's features, the cruel lips, the searching eyes. As he raised himself to a crouch, ready to run, he realised in terror that the gunman had seen him. He turned and ran back to the tunnel entrance, panic rising in him, he ran faster as he neared the thicket. When he was almost there, he glanced sideways and with horror saw the other gunman, rifle pulled into his shoulder ready. God, he must have come from the other side. With blood pounding in his head he raced for the cover of the tunnel entrance.

He was a few feet away when he heard the report, and his legs gave way. He tried to crawl but found he couldn't. His body was going numb. He tried to scream but no sound came. The light was



Walking slowly and carefully towards him was a gunman, rifle cradled in his arms ... ready to run, he realised in terror that the gunman had seen him.

going fast, then blackness, then nothing.

The first gunman lit a cigarette as he casually walked up to where his victim lay. "Well, he

nearly got away again, Ted." Ted laughed, but made no reply. Chas looked at him and he too laughed. "Don't you ever get tired of rabbit pie?"

A FINE range of armoured fighting vehicles has made its debut under the Heller Humbrol brand. These kits are produced in France by Heller, the long established model manufacturers which, like Humbrol, are part of the world famous Borden group.

The kits are in 1/35 scale and among the first releases has been the **Gepard**, an anti-aircraft tank featuring 35mm twin ordnance with radar controlled target acquisition in a purpose-designed turret mounted on a Leopard hull. The tank is manufactured in Germany and known as a Flak Panzer.

My recent visit to the giant Lionheart exercise provided an excellent opportunity to inspect Gepards operated by the 1 Deutsches Korps and to make a subsequent comparison between the model and the real thing. The result is top marks to the kit whose detail and authenticity cannot be faulted in any way.

Moulded in olive green styrene for ease of paint cover, the parts boast some very fine detail and I am particularly impressed with the representation of the tank's suspension system and final drive.

The lower hull is not a single box-type moulding — instead the entire body has to be built up from individual plates with bulkheads provided for internal strength. This makes for more interesting and rewarding construction work and gives the modeller an insight into how the real thing is fabricated.

Tracks are moulded in flexible plastic (probably polyethylene) as two strips rather than two continuous belts, and when bringing the ends together it is necessary to use a heated screwdriver tip to burr over the ends of the location page. On the

same moulding spine are the towing hawsers.

You could have trouble painting the tracks and cables as this type of plastic is greasy and tends to resist enamels. The problem is easily solved by first priming them with Humbrol's vinyl upholstery paint to achieve a perfect key.

Belgium and the Netherlands are two of the NATO nations which operate Gepards and this is reflected in the choice of markings on the decal sheet and in the paint scheme advice. My only disappointment is that the German Army is not represented, however, it is simple enough to check the reference books and finish the model in German markings.

To complete a really praiseworthy model the manufacturers have even supplied wire lengths for the whip aerials, saving the modeller the tedious job of heat stretching sprue!

Length of the model is 220mm while width is 97mm.

Two more releases in this Heller Humbrol 1/35 scale series cover a pair of **AMX tanks**, the **30t anti-aircraft**

weapon system, and the **AMX 13t-75** which is equipped with a missile system in addition to its main tank gun armament.

The AMX 30t is moulded in sand-coloured styrene and provides a choice between French and Saudi Arabian markings and colour schemes. Beautifully captured detail is the overriding theme throughout all the mouldings, including the tracks, spare track links and hawsers (which again are in flexible plastic). The hawsers are particularly worthy of mention for the texture of the strands of steel cable has been represented with subtlety to match scale.

Offering a choice between Swiss and Israeli markings, the AMX 13t-75 is equally well produced and detailed, moulded in olive green styrene.

In the real thing the upper portion of the turret moves with the gun in elevation and depression and consequently a flexible seal runs around the gap between this and the turret bearing ring section. In the model this seal is represented in the moulding and gun elevation cannot be

altered. For the enterprising modeller it would be well worth scratchbuilding an articulated mounting (which will be concealed inside) and making a truly flexible seal either from linen or polythene.

The AMX 30t is 200mm long by 89mm wide while the AMX 13t-75 has a length of 187mm and width of 71mm.

Still on the subject of army equipment, from the same stable and in the same scale comes a delightful representation of the ubiquitous **Willys Jeep** complete with two-wheeled Bantam trailer. The markings provide a choice between American and British operated vehicles and, authentically, both have the large five-pointed white star surrounded by white circle for application to bonnet and canvas hood top surfaces. This emblem was a truly effective instant identification device, highly visible from the air.

The model features superb detail, which even extends to the engine compartment. Parts for a driver are included, but modellers who choose the British markings

will have to perform a certain amount of cosmetic surgery on this character. His helmet is Second World War American pattern, therefore it will be necessary to scratchbuild a typical Tommy's tin bowler. Alternatively you may decide to give the chap a beret, forage cap or field service cap. Additionally his battle blouse and trousers will need to go to the tailor's if you choose the British version.

The Jeep makes a satisfying construction project and is very useful for diorama work. Indeed, it deserves a purpose-designed diorama itself, perhaps also featuring an appropriate tank of the period.

AFVs and other military vehicles certainly provide a lot of scope for imaginative modelmaking, particularly at the finishing stage where weathering, oil stains, mud and sand can all be simulated to produce equipment that has seen service — so much more satisfying than pristine factory finish.

Turning now to the aviation side, the second release in Esci's new 1/12 scale cockpit series is now in the shops.

Following their excellent representation of the F-16 Fighting Falcon cockpit, reviewed in this column earlier this year, they have turned their attention to the F-104 Starfighter.

Those responsible have certainly done their homework, omitting nothing from this superb kit. In their quest for authenticity they have even produced harness straps as printed images on real fabric. These have to be cut out and then peeled from their cardboard backing. The card is siliconised for easy release of the fabric which has adhesive on its reverse side.

Although the straps are colour printed it is well worth toning them down in appropriate places to simulate use. Dry-brushing of the toning colours is advisable because if paint and thinners are allowed to saturate the fabric they will interfere with the adhesive.

The kit is fully supported by an excellent instruction sheet which also has educational value. Every instrument and control device is clearly labelled so that one can learn a lot about the complex array of equipment which the pilot has at his fingertips.

As one of my spare time activities I am an instructor to an Air Scout troop and this type of kit is invaluable for training purposes. Being three-dimensional it attracts the lads' attention far more effectively than a picture and is second only to the real thing.

I look forward eagerly to the further development of this series and hope that in time Esci will cover subjects such as Harrier, Tornado, Phantom and Jaguar.

Dimensions of the completed F-104 cockpit are: length 150mm, height (to top of ejection seat) 118mm, width 90mm.

MODELSCENE

New range of AFV kits superb in every detail

DO IT YOURSELF and save money!

Bricklaying: take it slowly and achieve the best results

THERE are many projects that the average householder shies away from because they involve bricklaying, but there is no great mystery or terror in this kind of work.

Certainly it requires skill, but the key is to forget the speed at which the professionals operate and be content to work slowly to achieve good results.

When attempting bricklaying for the first time it is advisable to tackle a simple job, such as a stretch of garden wall. It doesn't have to be a high boundary wall — just a straightforward, decorative but functional job — a low retaining wall between two levels of the garden perhaps, or a structure to border a patio.

Having decided on the location and dimensions, mark out accurately and then prepare the foundation, whose width should be twice the thickness of the wall. Cut a shallow trench, removing the topsoil until a firm base is reached. This will usually be about nine inches down.

Drive wooden pegs into the floor of the trench and level them using a line or board with a spirit level. The tops of these pegs should be about three inches below the ground surface. Next, fill the trench to the tops of the pegs with concrete (mixed as one part cement to six of ballast), level off and allow to set hard.

Cement mortar should comprise one part cement to three parts of sand and should never be made up in a larger quantity than can be used within two hours.

Drop mortar on to the foundation and spread it out to about 1/2-inch thickness. With a length of timber as a straight edge scribe a line along the mortar bed to represent the face line of the wall and then lay the first brick at

one end with its face side lying along the line and the "frog" uppermost. Tap the brick in place with the trowel handle.

Now take the next brick and one the end which will be adjacent to the one already laid, spread a portion of mortar (this is known as "buttering") before laying it. Repeat this all the way along the line to produce the vertical joints.

Use a straight edge to ensure that the bricks are aligned, and with the spirit level check that they are perfectly level. Tap into position any that are out of place and re-check.

It is advisable to build a pier at each end of the wall to give strength (Fig 7) and if the wall is fairly long it is a good idea to incorporate intermediate piers (Fig 8).

Having laid the first row you now have to ensure that the bond will be correct with the vertical joint lines staggered. The key to it all will be the first brick that you lay in the second row. Make a chalk or pencil mark midway along its length and when you lay it this mark will align with the first vertical joint of the first row.

Obviously there will be a gap equal to half a brick at each end of the second row, or in each end pier, and this will have to be made up with a half-bat produced by chopping a brick in half as explained in the section on cutting.

When ready to lay the first brick of the second row, use the trowel to cut, turn, roll and pick up a long sausage of mortar which should be laid on top of the first row. Deposit sufficient to fill the frog and produce the bedding joint. Lay the brick, tap into position, "butter" the next, lay and tap, and so on.

Complete the row and then check alignment and level.

Mixing mortar and storing dry cement

Having mixed the dry ingredients thoroughly and scooped out a reservoir in the centre of the pile, add water carefully so that after blending and turning until no dry material remains, you end up with the right consistency.

The mixture should be plastic — in other words, damp enough so that if you press the trowel into it the impression will be retained without the mortar crumbling. But it should not be runny under any circumstances.

Do make a note of the quantity of water used in the first (satisfactory) batch of mortar. This will make life much easier when you come to mix subsequent batches.

The builders sand which

you use should be clean and well graded so that it has grains of varying sizes but in equal proportions.

A word of warning... use new cement! You may have some left in a bag in the shed or garage, or indeed an unopened bag which you have been storing for months. Tempting though it is to use this rather than waste it, cement does go off and loses its properties over the weeks.

If you intend to spread your bricklaying project over several weekends, then it is safe to store your cement for such a short period. However, do not leave it to settle in the bag so that the grains consolidate.

To avoid this, pumble the bag (or bags) frequently.

Tools for the job...

It is essential to have the right tools for the job, so be sure to buy a bricklayer's trowel whose ten to 12-inch blade length can hold sufficient mortar for a brick's length. The smaller version pointing trowel is also a must.

In addition you will need a bolster and club hammer for cutting bricks, a long spirit level (3ft. or so), short spirit level, measuring tape, pegs and line, timber straight-edge, spot-board and hawk (as described in the November issue, and, if your wall is to turn a corner, a builder's square which can be made simply from timber. Also at hand should be any items needed for pointing, depending on the finish of your choice (see previous issue).

Additionally, use a small spirit level to test that this row aligns vertically with the first both along the face and at each end. As the wall grows it will be possible to check verticals with the long spirit level.

Also, when several rows have been laid take the straight edge from time to time and offer it up to the wall face diagonally at various points to check that there are no bulges.

Repeat the laying technique for each row until you have completed the penultimate one. If, for the top of the wall you have not chosen specials such as coping bricks, it will be necessary to finish off so that the frogs are not showing. To achieve this clean appearance lay bricks upside down, but make sure their faces are on the correct side. Laying procedure is the same, but with additional need to "butter" the frogs before laying.

All joints should be about 3/16in thick and pointing should be carried out before the mortar hardens. It is a good idea, therefore, to point as you go — say, when you have run out of mortar and before mixing the next batch. Working this way also helps to break the monotony of the laying operation.

Cutting the easy way

It looks so easy when a bricklayer taps all round a brick with the edge of the trowel and then, with one sharp blow, chops it cleanly in half. He is so skilled that he doesn't even have to measure it.

For the amateur this is probably the worst task, but it can be fairly trouble-free, providing certain procedures are adopted. First use a ruler and pencil to measure and mark the desired cut line on the face side. Place the sharp edge of a bolster on the pencil line and lean the handle slightly towards the waste part of the brick. With the club hammer give the bolster a sharp blow and the brick should break cleanly.

If the cut has irregularities, these can be cleaned up by chopping with the edge of the trowel. Where the cut is crooked the brick can still be used if its face is the right length.

Tougher bricks may need to be marked and cut from the back as well as the face side.

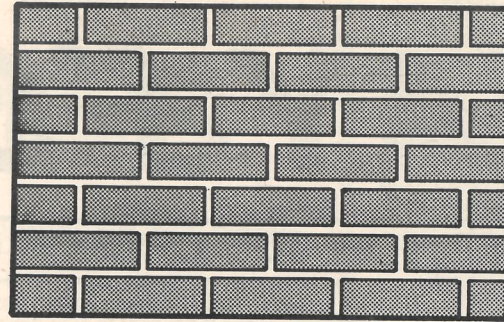


Fig 1. Stretcher bond — the most common, and very strong, it consists of identical courses with bricks laid lengthwise, vertical joints are staggered and alternate rows feature half-bats at each end, or headers at the corners

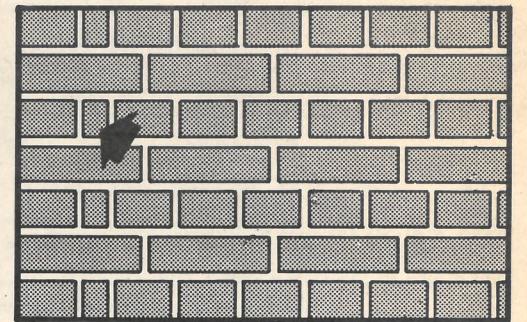


Fig 2. English bond — walls are twice brick width (225mm) and the pattern features rows of stretchers and headers alternately. Gaps in header rows are filled by queen closers as arrowed

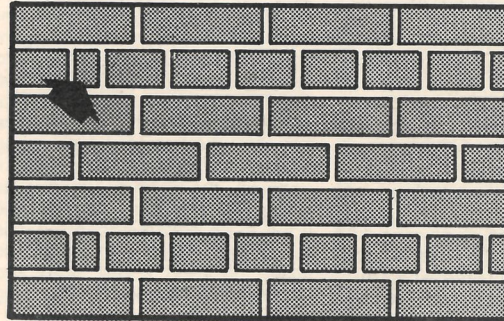


Fig 3. English garden wall bond — again, walls have to be 225mm thick. Although considered more decorative and less monotonous than English bond, this pattern is not so strong. Arrow denotes queen closers

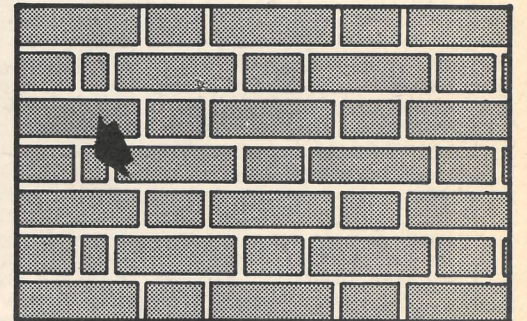


Fig 4. Flemish bond — double thickness wall again but with stretchers alternating with headers in every row. Gaps are taken up by queen closers (arrowed) which are bricks cut in half lengthwise

Bonding is the key to strength

If all the vertical joints in brickwork were to line up there would be no strength in the wall and this is why they are always laid to a pattern, or bonded, so that the joints are staggered. This way, those in one course line up with those in the next course but one.

The most common pattern is stretcher bond in which all the bricks are laid end to end and each straddles a joint of the course below. Every other course therefore finishes with a half-bat (half a brick) — at each end. Where each end is a right-angle corner the half is, of course, the end of a brick laid whole in the other wall.

English bond and Flemish bond can only be used in walls that are 225mm thick (double a brick's width). In the former two horizontally parallel rows of bricks are laid as stretchers then

the next row comprises "headers" — bricks laid across the two rows at right-angles — the next double row stretchers and so on.

In Flemish bond (again double thickness) each course is laid as one stretcher, one header, one stretcher... alternating all the way to the end. The diagrams illustrating these two types of bond show the insertion of a series of "queen closers" which have to be used to take up the discrepancy gap caused by these patterns.

A queen closer is simply a brick chopped in half lengthwise and laid like a header.

English bond is stronger than Flemish which serves as a more decorative pattern. Even less strong is the English garden wall bond, but its attraction is that it has less monotony than English bond.

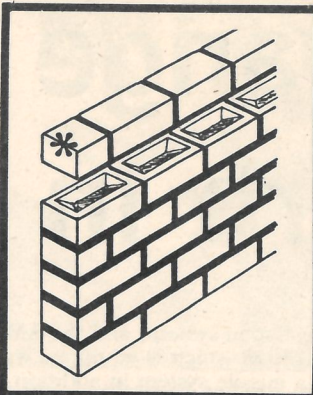


Fig 5: Capping the wall — the "frog" should face downwards. Asterisk denotes half-bat

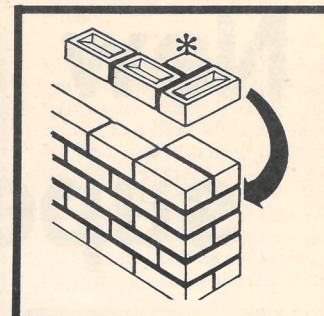


Fig 7: Strengthening pier at end of wall (asterisk denotes half-bat)

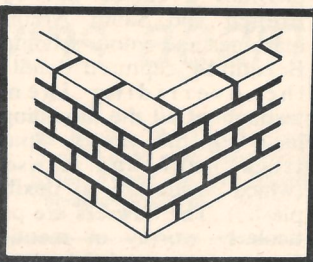


Fig 6: How the corners key in — alternate headers and stretchers

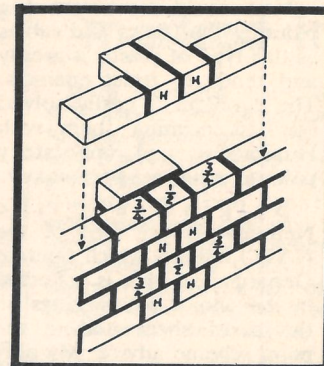


Fig 8: Intermediate pier keys in by use of headers. Gaps taken up by half- and three-quarter bats

A wide choice of bricks

Many types of brick are available, but to simplify matters let's break down the range into the three basic types: facings, commons and engineering bricks.

The first type is for visible brickwork and there are many attractive surfaces from smooth to textured and in a range of shades. They are tough and weather resistant.

Commons are cheaper, have no decorative finish, and are for non-visible brickwork. However

many of this type can be used to satisfaction where a rustic effect is desired.

Engineering bricks are hard and waterproof and designed for applications such as underground structures (manholes and culverts for example).

Before embarking on a project a visit to the local builders' merchants would give you an idea of what is available. You would also obtain helpful advice on the job you are planning.

Painless estimating

The British Standard brick size is 215mm long x 65mm high x 102.5mm wide. When estimating the quantity needed, add in the mortar joints and therefore base the calculations on a "working" size of brick of 225mm long x 75mm high and regard width as 112.5mm wherever this features in your reckoning.

Having established the desired length of wall, divide this figure by 225 to give the number of bricks required for one layer of course when laid end to end (stretchers) in a single thickness wall. Height of wall should be divided by 75 and the answer (numbers of rows) should be multiplied by the single row quantity.

The amateur usually feels happier with this method, but it is possible to multiply wall length by height to give area and divide by 60 — the number of bricks needed for one square metre.

Whichever method you choose, remember to add on ten per cent. to quantity to cover damage, wastage and cutting.

When planning a structure in brick, always endeavour to make the lengths multiples of 225mm and 112mm (working size brick lengths and half lengths). This saves unnecessary cutting to make up awkward discrepancies.

Your tips

If you have any tips on do-it-yourself projects which you would like to pass on to your fellow readers, why not drop us a line to the address on page 3.

THE CANNON AND THE IRONCLAD

Summer sailing trip reveals links between ordnance and warship development

Words by LAWRIE HIBBERT
Illustrations by DON LAVELLE
(both of ROF Bridgwater)

SAILING into Chapel Bay, Milford Haven, this August, a long bulk of metal of familiar shape caught my eye. I did not recognise it immediately for what it was, but something prompted investigation. I anchored in the bay and rowed the dinghy to the rocky shore. Scrambling over the boulders I discovered a 14-ft cannon, red with rust. I knew a fort had once stood guard over the bay, but natural overgrowth and dereliction had deterred the curious.

Mr Davies, a retired and enthusiastic historian who had made a special study of the defences of Milford Haven, informed me the cannon in question was a "12 ton Palliser Rifled Muzzle Loader (RML) cannon", that had been deliberately tipped over the cliff from the fort above. The name Palliser struck a chord, and I remembered the Palliser shell I had seen in the Conservancy Board Offices at Hakin, three years earlier. This is how my interest in Palliser began.

When you follow an historical trail, it never runs true and straight. It twists and turns, doubles back on itself and becomes confused among other trails. Evidence from different sources conflicts in quantity, type, year and place until you begin to wonder if you can trust historians and authors. You wonder if all their stories have been authenticated or have they been a little naive in accepting the fascinating stories of a local character who spins a good yarn and wishes it true. Then you find yourself making assumptions because your information is not complete and the proof has not been located.

The Palliser trail began like this: in the libraries, at first, I could find no reference to Palliser, but as the field of my investigation widened, the information flooded in, the story

became clearer, and dates slotted into place. I found I had entered an important period in history, when great plans were afoot and new ideas in ordnance and the naval fighting vessel were being developed. The Palliser story could not be told without relating it to the appearance of the Ironclads, the advent of steam and the treatment of iron to produce armour.

Steam and paddle

First hint of things to come came at the close of the 18th Century, when Robert Fulton built steam driven ships that worked. In 1813, when England was at war with America, he produced a steam warship, the *Demologos*, a twin hulled vessel with a paddle wheel between, armed with thirty 32 pounder shotted guns and four 100 pounder shell guns. Shot is generally in ball form and solid, while shell is hollow and filled with gunpowder, with or without a fuse. The poetic phrase, "Through shot and shell" in no way expresses the horrific mayhem unleashed on the crews as two vessels of the line closed for battle. The *Demologos* was not completed in time to prove itself in battle. John Stevens, an engineer from New Jersey designed a warship protected by sloped iron plates, but again cessation of hostilities shelved his plans. This is a common story in history, of war giving impetus to invention and peace curbing man's ingenuity by vacillating governments urging retrenchment. To be fair war always left them in debt and they did not have the money to squander on warlike projects.

At the time the Admiralty, proud of their Naval traditions and secure in their undoubted command of the seas, would not trifle with innovations. They were convinced that if any upstart nation came up with a good idea that threatened their supremacy, the industrialised might of the nation could outbuild them and the Navy outfight them. They scorned the use of iron both for the construction and protection of ships.

This obdurate attitude persisted until the Crimean War of 1854. Basically a land campaign, the Navies of England and France were, for a change, allies and mostly engaged in bombarding

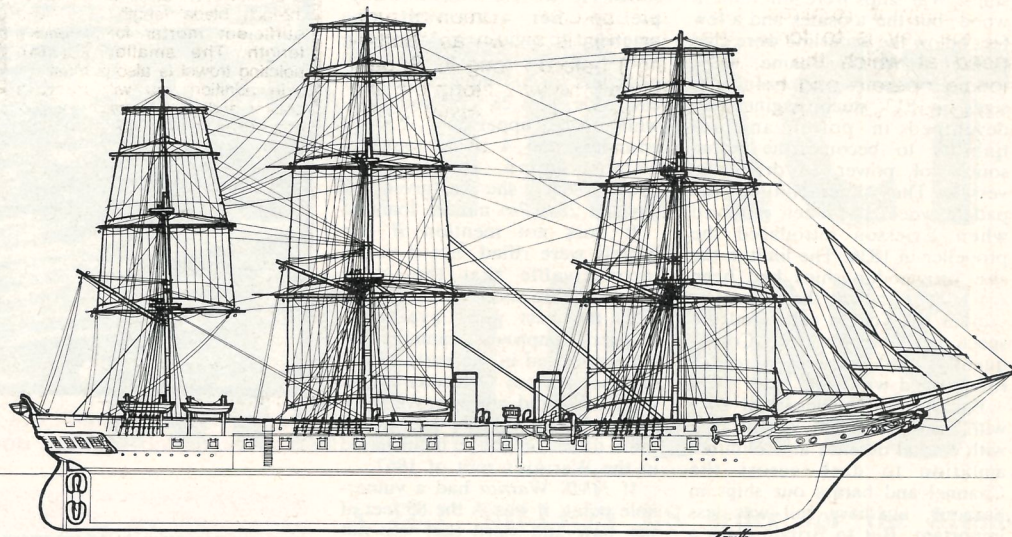
Russian Coastal Forts. The pride of the Navies, the 100 gun three-deckers were ill-suited to the task.

The French, under Napoleon III, harking back to General Paixhan's ideas of shell guns and iron covered ships, built three floating batteries; *Devastation*, *Lave*, and *Tonnant*. Each vessel was protected by four inches of wrought iron over 17 inches of timber, and armed with 16 x 56 pounder shell guns. These vessels anchored 800 yards offshore under the muzzles of the guns of Fort Kinburn at the mouth of the River Dneiper, and opened fire on the Fort. After four hours of bombardment, Fort Kinburn was wrecked and surrendered. The Russians, at point blank range, scored 200 hits on the floating batteries, killing two Frenchmen and injuring 25 mostly through stray splinters through the gun ports. This convinced the French that the next generation of ships of the line would be built in iron and armed with shell guns.

In reaching this conclusion, the French had overlooked the fact that their undoubted success against the Russian forts was in overcoming stone and concrete. The lighter explosive shells did not have the weight or velocity to penetrate the 4½ in. armour of the early ironclads. Gunpowder was still the only propellant — an explosive charge, in itself, not powerful enough to defeat armour. This could only be achieved with bigger guns and heavier shot.

During the American Civil War of 1862, a duel between *Monitor* (Union) and *Virginia* (Confederate) resulted in stalemate when both ships gave up the fight because their repeated hits made no impression on their ships. The Assistant Secretary of the Navy, Gustavus Fox, who watched the battle, came to the conclusion that the 11-in guns of the *Monitor* were not heavy enough and called for a heavier weapon. A 15-in gun was produced which proved effective against the Confederate ships in later battles.

The arrival of the Ironclad and the development of the monitors during the American Civil War, brought into focus a problem that was to confront ship constructors for many years to come. The contest between gun and armour. The guns became bigger and heavier and took longer to load; armour became thicker and heavier to the detriment of the ship's seaworthiness and its ability



Broadside view of *HMS Warrior*, the world's first fully armoured warship, which combined sail with steam power. Currently undergoing restoration, she will be ready to go on public display at Portsmouth in 1986

to support it. Everything was subordinate to the task of smashing a hole through armour plate. Clearly the end of the smooth-bore cannon was in sight. A new gun and ammunition were needed.

By 1860, both shot and shell fired from smooth and rifled bore muzzle-loaders were in use alongside each other. It was accepted that, if penetration could be achieved, the lighter shell was more destructive. In 1854, the year of the Crimean War, Captain W. Palliser took out a patent for "Improvements in projectiles for Ordnance generally having a centre of gravity forward. Helical projections are to be formed on the projectile to cause rotation."

From this description it is plain that Palliser was not talking about conventional shot — the cannonball. With spherical shot the weight is determined by the calibre of the cannon and cannot be increased without altering the shape of the projectile. The shot he proposed, "with a centre of gravity forward", clearly indicates an elongated form. It resembled a modern shell, but was stubby in length, about two to two-and-a-half times its calibre.

Chilled moulds

The early Palliser rounds were undoubtedly "shot" and were cast solid except for an elongated cavity towards the back of the shell. The cavity was a manufacturing need and not part of the shell design. The iron used was too hard to be worked with tools and had an iron bush cast into the base to enable it to be closed with a bronze plug. To harden them further and increase the penetrating power of the shot (made necessary by the appearance of the Ironclad ship) Palliser cast them in chilled iron moulds instead of the conventional sand. Unfortunately, uneven cooling of the shot caused minute fissures at the rear end resulting in disintegration of some rounds in the

barrel of the gun when fired. Some improvement was achieved by casting the shot vertically in sand, chilling only the nose.

At the time, the main advantage claimed by shot over shell was that it had greater penetrating power in oblique firing. However, comparative tests between the small cored shot and the larger cored shell (in thinner walls), fired at iron plates at angles of incidence between 60° and 65° failed to prove any advantage. As the thinner walled shell did not suffer from fissuring, large cored shot was approved. This solved the problem of fissuring.

Palliser rounds went into service in 1867 and became the standard other contenders had to meet. In the years to follow, all natures were developed from 4-in 17.72-in both shot and shell. Production of shell ceased around 1892, when the gunpowder was emptied out, replaced with sand, and renamed "shot".

When elongated rounds were first fired, they tumbled through the air and brought no advantage over cannon balls. The rifled cannon imparted a spin to the round which kept it steady through the air and increased its range and accuracy. To achieve this, Palliser shot was studded around the circumference to match the rifling in the gun barrel. Gunmetal studs were pressed into recesses undercut in the round.

The forts in the upper reaches of the Bristol Channel, were equipped with 7-in RML cannon cast at the Royal Gun Factory, Woolwich around 1868, and show three rifled grooves. The Palliser projectiles they fired had two sets of studs around the circumference. Both shot and shell were fired. The shells weighed 115lbs and contained a bursting charge of 2lbs 8ozs gunpowder. Alternatively, they could be filled with sand shot. The 9in Palliser Cannon installed at Chapel and Stock forts at Milford Haven fired 9in projectiles, 18in long weighing

246lbs and were studded with 12 studs to fit the six grooves in the barrel. In later years, Palliser shot became "studless" when driving bands were fitted. One of the shells dredged up from the Haven when Esso Oil Terminal was built, bore the legend, "Palliser R3 L4/71 RG Chill". This dates manufacture at April 1871.

Achieving increased velocity was another problem. With no alternative to gunpowder, this could only be obtained by increasing the size of the charge. Cannon were either cast iron or a combination of cast and wrought iron. It was impossible to make them strong enough without being too heavy and cumbersome. Many inventors tried and failed.

Rifling proposed

Again Captain W. Palliser of the 18th Hussars came to the rescue. In 1863, he proposed boring out existing cannon and fitting a rifled tube of coiled wrought iron. This was anchored in place by threading the mouth of the cannon and the end of the tube, and fixing it permanently by firing a heavy charge and shot. The idea was simple and attractive to Government because at little cost hundreds of cannon in forts ashore would be given an extended life.

A 68-pounder was bored out and sleeved with a Palliser tube. It was subjected to the standard form of destructive proof. Ten rounds were fired with service charge and shot. Then ten with weight of shot increased and so on in series of ten, each with heavier shot. Once the shot reached three times service weight, the loading was changed to double weight charge with service shot and the ten-round series repeated until the gun was firing double charge and treble shot. This was continued until the gun burst. Surprisingly, Palliser's gun went to round 107, the first

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with double charge and triple shot. This compared with the maximum endurance of a service 68 pounder of 76 rounds. For services to his country, Captain Palliser became a major within the year and eventually Colonel Sir William Palliser.

Breech loading, rifled barrels and improved ammunition would have developed whatever the political situation, but there is no doubt that the appearance of the Ironclads was the catalyst that speeded the process. Experience in the Crimea and the American Civil War had demonstrated the indestructibility of iron as a protective sheathing for wooden ships. War ships were still built in wood, but the topsides and a few feet below the waterline were clad in iron, hence their name.

Since Fulton's successful designs in 1813, steam engines had developed in power and reliability to become the prime source of power to drive the vessels. The vulnerability of the paddle wheel had been removed when Ericsson introduced the propeller in 1836. The limit in the size of wooden ships had been reached, restricting the amount of armour they could carry and the space available for coal. Consequently, most warships were still fully rigged with sail.

For America, concerned only with coastal defence, and France with coastal defence and a limited ambition to dash across the Channel and harass our ships in harbour, auxiliary sail was less important. But to Britain, with a world-wide Empire commitment, sail was necessary. Without it a collier was needed to accompany the vessel.

France was the first in the field of Ironclads with *La Gloire*. Built entirely in wood, her iron sheathing was added at completion stage. Faithful to the lesson she thought she had learnt in the Crimea, France equipped her new vessel with 34 x 16cm shell guns. When news of her construction broke in England there was uproar at the thought of our traditional enemy taking the lead in naval architecture. We responded in May 1859 by laying down the keel of the *Warrior*.

The Admiralty's confidence in the ability of their shipyards was sustained when *HMS Warrior* was launched at Blackwell in 1860 before the *La Gloire* touched the water. She was the first fully armoured ship in the world. Built entirely of iron, she was 380 feet long, 58 feet beam and displaced 9,210 tons. Her Penn's horizontal trunk single expansion engines developed 5,000 hp, which, transmitted through her single screw propeller, drove her through the water at 14.3 knots. Under sail and steam, her best speed of 16.3 knots was achieved on November 5, 1861.

The design concept of *HMS Warrior* was that her speed and firepower were capable of over-

whelming any ship then in existence. Her engines gave her the speed, her protection was in the 4½in iron backed with 18in of teak with a further ½in of iron to prevent teak splinters being blown about the ship's interior. This protection extended 21 feet above and six feet below the waterline along 213 feet of the ship's length, closed at each end by bulkheads similarly protected. All her armament was contained within this citadel.

Her guns were planned to be 26 x 68 pounders, 10 x 110 pounders and 4 x 40 pounders situated on her single gun deck and firing through ports in the traditional broadside manner. Before completion, her armament was amended to eight new Armstrong Screw Breech Loading 110 pounders on her main deck, four each side, plus 26 x 68 pounders, while on her upper deck, 2 x 110 pounders and 4 x 70 pounders were mounted. Re-fitting between 1864-7, she was given 4 x 8in and 28 x 7in muzzle loaders.

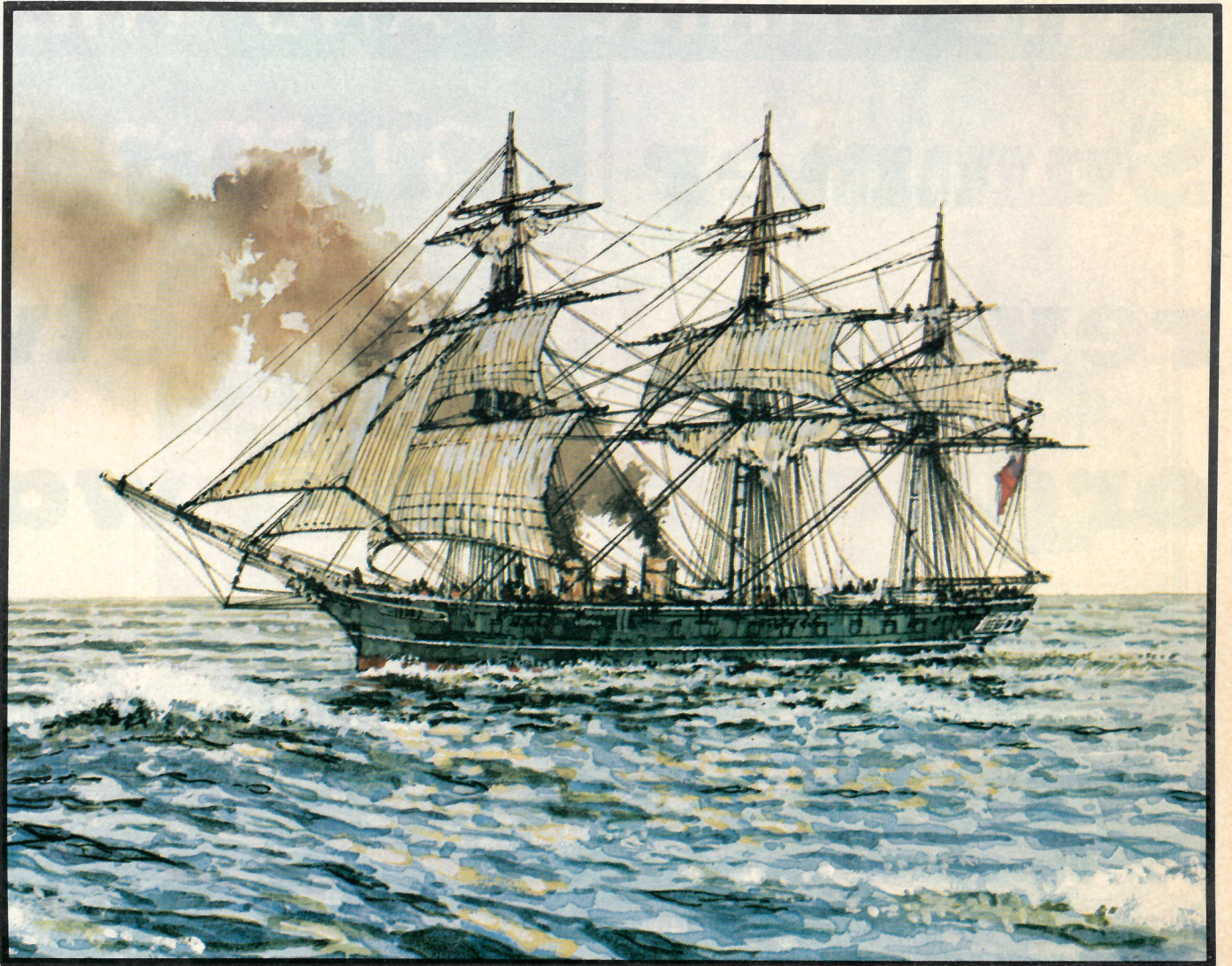
It does not mention if the barrels were rifled, but it seems inconceivable that the most powerful ship afloat was not fitted with the best guns available. Palliser's improved cannon had been accepted in the early 1860s, but the cautious Ordnance Select Committee did not approve them for service until 1869. This would seem to be too late to be included in the *Warrior's* refit of 1867.

If *HMS Warrior* had a vulnerable point, it was in the 85 feet of her bow and stern that was not armoured. To have done so would have made her less seaworthy and placed an intolerable burden on her iron structure.

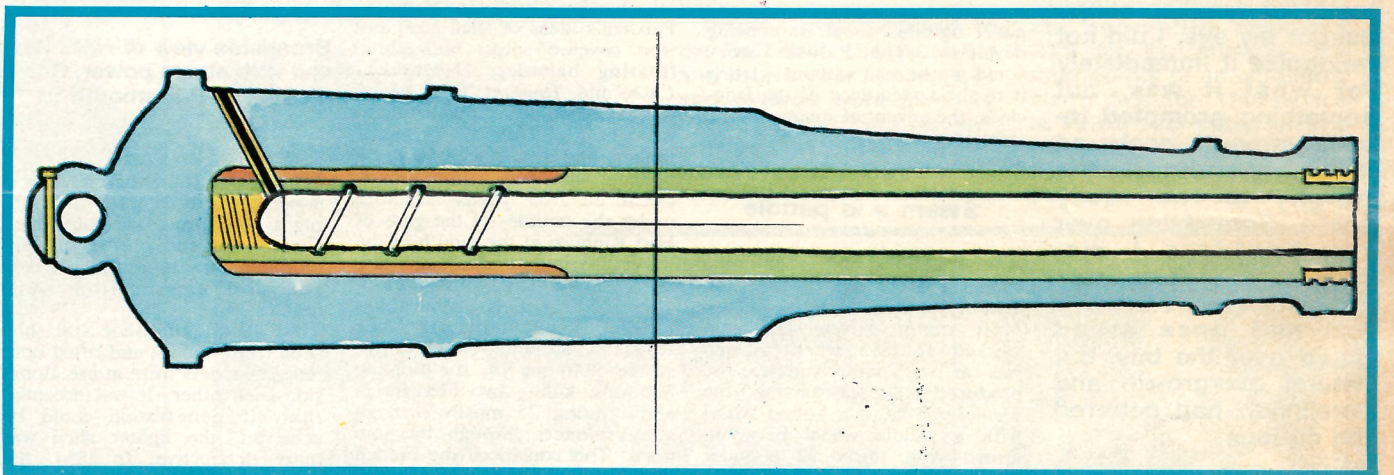
When she commissioned at Portsmouth in 1861, she joined the Channel Fleet and continued in Channel service until the late 1870s. For 14 years she was Guard Ship at Portland until 1881 when she became Training Ship for the Royal Naval Reserve on the Clyde. In 1904, she came to her final Naval Service as torpedo depot ship attached to *HMS Vernon*. Finally, she was cut down and used at Milford Haven near Pembroke as an oil pipeline pier where I first saw her.

This is my connection between Palliser Cannon and the Ironclad ship. I found them both in the Haven. The story of each began in the same decade, developing because of each other. It is the story of the Ironclad ship and man's inventiveness in combatting it. It is the story that continues to this day: armour versus the gun.

We have not lost the *Warrior*. The historic importance of this vessel has been recognised by the Maritime Trust as equal to *HMS Victory* and the *Cutty Sark*. A few years ago, she was rescued from her degradation and towed to Hartlepool where she is being restored. Hopefully, this sea-mark in Naval History will be ready for inspection at Portsmouth in 1986.

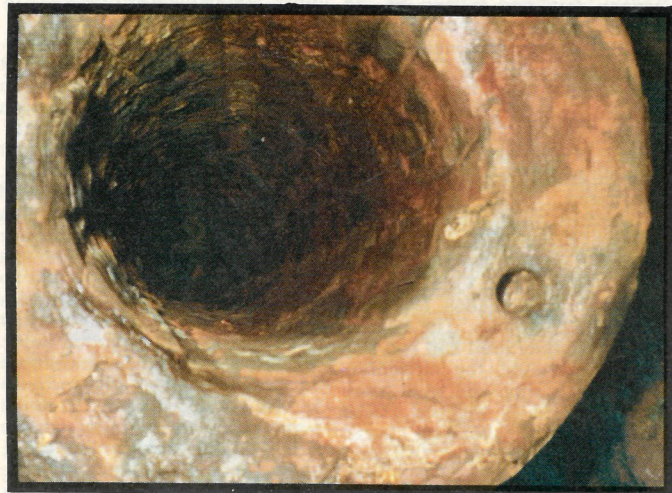


One can almost smell the tang of salt spray in Don Lavelle's delightful painting of the first fully armoured vessel, *HMS Warrior*, which was cut down to be used as an oil pipeline pier at Milford Haven. Rescued from this ignominious fate, she is now being restored to her former glory.



Two pieces of colour artwork by Don Lavelle which show: Above — cross-section through the structure of the 80-pounder (5 ton) cast iron cannon, bored out and fitted with a Palliser tube. This was the RML ("Rifled Muzzle Loader") in the nomenclature of the day. Right — section through the 12-inch, Mark 1 Palliser shot

Below: Resting place of the cannon which Lawrie Hibbert discovered among the boulders where a fort had once guarded Chapel Bay, Milford Haven



Lawrie Hibbert's photograph of the Palliser cannon clearly shows the grooves and lands of early rifling

