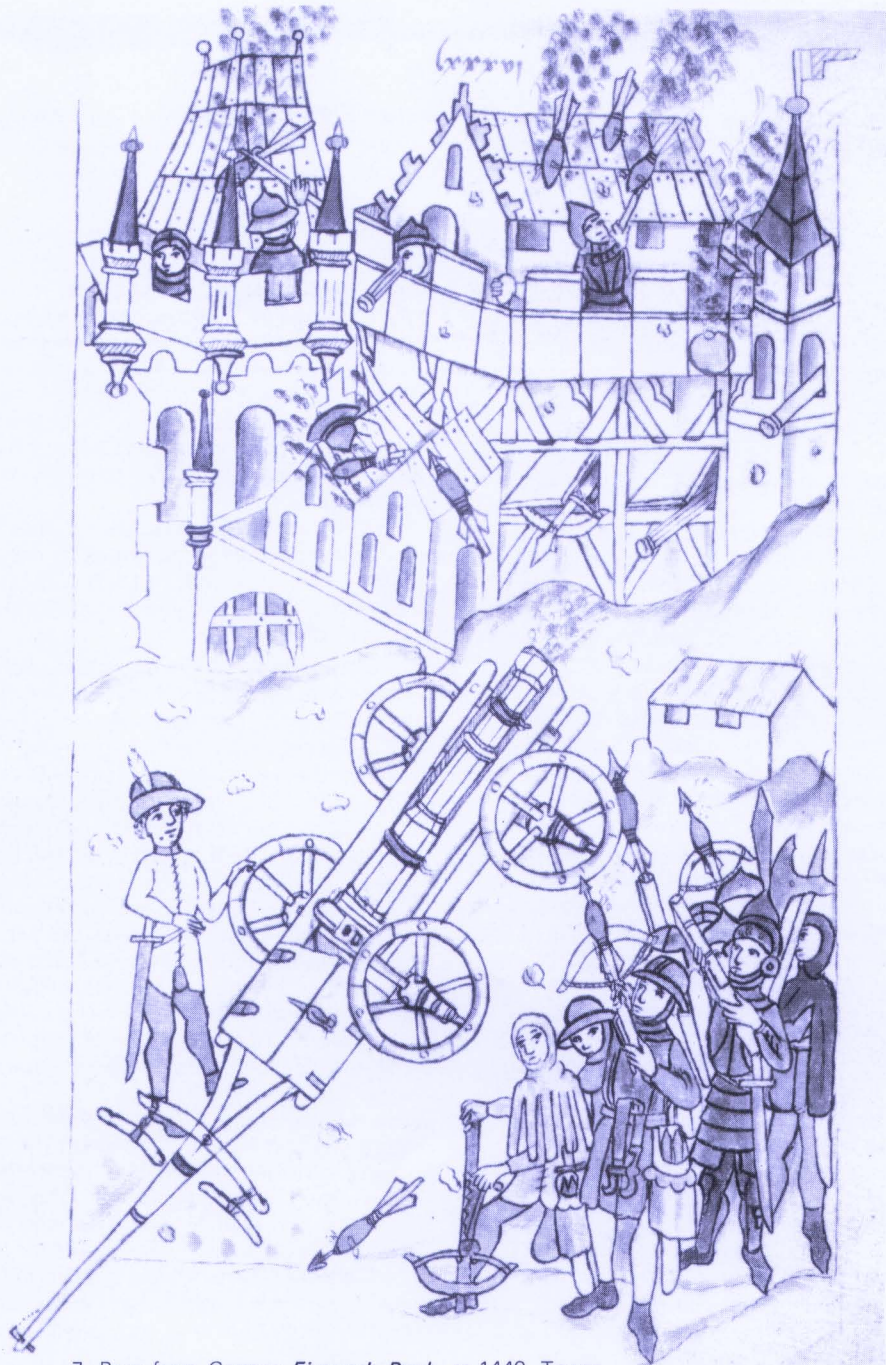


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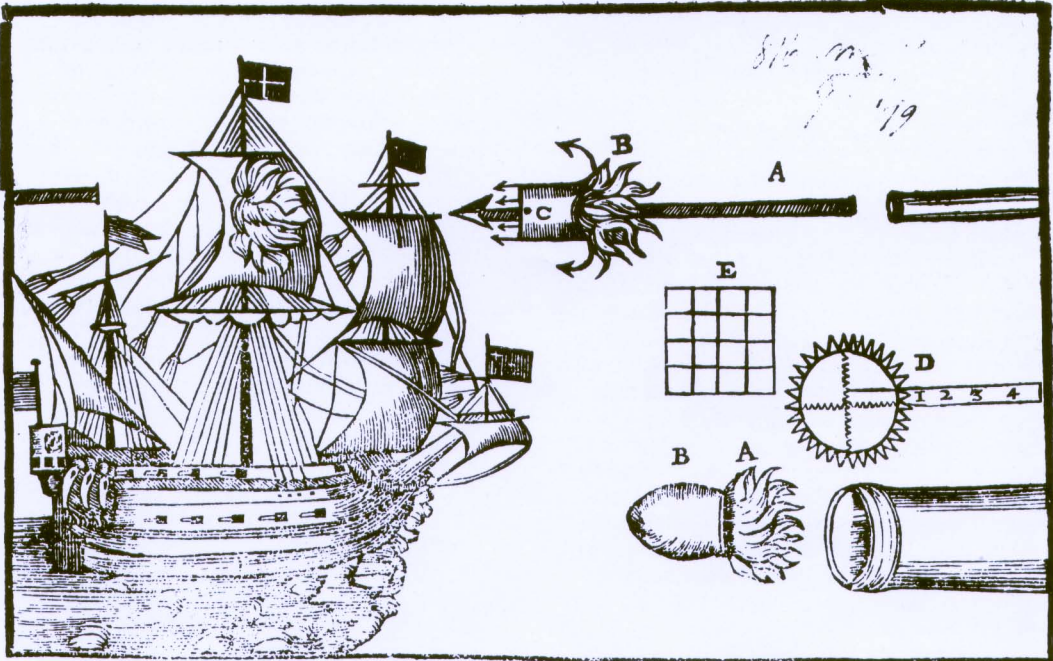
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7. Page from German *Firework Book*, ca.1440, Tower
Armouries, London.
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9. John Legg's fire-shot and fire arrow. (Reproduced by kind permission of the British Library)

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The Society of Archer-Antiquaries



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Fire Shafts and Musket Arrows

from the fifteenth to twentieth centuries

by Arthur G. Credland

Introduction

Attempts to attach combustibles to an arrow shaft may be almost as old as the bow itself. One can well imagine early man wrapping grease-soaked plant fibres or strips of cloth around an arrow either in order to attack his enemies by burning their thatched huts or perhaps as an aid to hunting by setting vegetation on fire so as to drive wild animals into his clutches. The ability to set fire to a distant object is clearly a valuable one and after the invention of Greek fire and gunpowder in the Middle Ages the possibility of producing a more effective and reliable fire arrow greatly increased.

The numerous military manuals circulated in the sixteenth and seventeenth centuries take for granted the value of combustibles attached to a variety of missiles and offensive weapons including the fire pike or lance as well as arrows launched from bows, crossbows and muskets. Plain arrows were also shot from muskets singly, and in bundles from artillery pieces. Both musket arrows and fire shafts seem to have been particularly recommended for service at sea.

Fire Arrows and Musket Arrows

The latter part of the sixteenth century was a period of intense debate as to the usefulness of the bow on the battlefield. Except for the county militias it had been all but put aside in favour of the arquebus and musket but the most ardent advocates of the bow would have wished to discard powder and shot in favour of England's once all-conquering arm. Others took a more balanced view and considered that it was a weapon which could be usefully employed alongside its rivals. Sir Thomas Wilford, Colonel of the Kent regiment and High Marshall of Normandy during the French campaign of 1589 gave as one of the bow's uses "to shoot arrows with wildfire, to burn a gate or drawbridge, to fire thatch or shingled houses".¹

An anonymous pamphlet was published in

1628 with the express intention of promoting the use of fire arrows on the field of battle. Entitled *A New Invention of Shooting Fire-Shafts in Long-Bowes* it advised the use of bowmen mingled with bodies of musketeers so as to both protect them and maintain the offensive whilst each rank moved in turn to the rear to reload their guns.² A constant barrage could be kept up, especially important when being pressed by the enemy cavalry, by shooting over the musketeers' heads and at the same time they were protected by the musketeers. Similarly the archers might be placed amongst the pikemen to help break up a cavalry attack and disable the opposing musketeers:

"Bow-men placed behind a parapet, a stand of pikes, or mannuple of musquettiers, may showre down such incessant drops of fire, like Sodom's raine, upon an enemie, as well not only among the pikes, and rout the horse, but altogether disable the musquettier."³

The composition of the fireshaft is given as follows:

"How to make and Shoote Fire-shafts out of the Longe-bowe.

Let the Fire-shafts have one end feathered and shaped after the manner of an ordinary arrow, and the other end fitted with a pipe of latten,⁴ ten inches long or more at discretion, a bearded⁵ head of iron fast glued into it, with a socket of wood, and a touch-hole made close by it, with some little reserve to stop the arrow from piercing so deepe into a mans cloathes, the flanques of a horse, or other marke of easie passage, as to choake the fire. The shaft may be made fast within the pipe (if men so please) with hard waxe; which melting as the pipe groweth hote will make it very difficult to draw the arrow from where it lights.

Arrowes to make a blaze by night, as also those that are to shoote into the sailes of a ship or an enemies tent, must have the touch-hole within an inch of the shaft, and

the holder *c* fall under gravity and drop into the arrow groove. The lever *b* is united by pegs with the wooden arm *a* as well as with the arrow holder *c* and pivots around them at the same time pulling the holder backwards and forwards on the wooden arm. The string is pushed out of its resting place *d* by the action of the lever.

Notes

1. *Le Tcheou-li* trans by E. Biot in 1851.
2. This sounds like the opposite of what one would expect but presumably the light weapons were hand-held crossbows suitable for skirmishing and self-defence whereas the heaviest weapons would be employed as a sort of field artillery, mounted on carts or other wheeled platforms.
3. *ie.* the forward curve exhibited by the composite bow when the string is taken off and tension removed. One imagines that the light crossbows would include both weapons with the more slender types of composite bow and simple bows of bamboo or other timber.
4. The thread probably trailing behind from the rear of the shaft and serving the same function as feathers.
5. *ie.* a chested arrow.
6. *ie.* with a cylindrical stele.
7. This is in fact the trigger.
8. The other 'tooth' *c'* is part of the ear-shaped piece *c*. The two teeth are the equivalent of the 'fingers' of the revolving nut in a European crossbow.
9. Here the author is in a complete muddle. The upper lever is in one piece with the left-hand tooth and is the setting lever or 'regulator'. The lever extending downwards is the trigger. The writer probably means the casing which encloses the components of the lock when he refers to the 'barrel'. Only the bronze lock of the crossbow is illustrated in the figures above, the grip, the stock and the bow are not shown.
10. The small hole *f* at the lower end of the trigger is probably for attaching a trip wire so that the weapon can be used as a trap. Crossbows were used for example, to guard the entrances of royal tombs against would-be robbers; *g* is merely the leading edge of the trigger shaped for comfortable handling.
11. Aiming would have been easy and the 'regulator' sometimes bears horizontal calibrations which enable it to be used like a gunsight to gauge various degrees of elevation.
12. This lock is no doubt the same as the others illustrated above only the artist has shown it in strict profile so that only one 'tooth' is visible.
13. The trigger lever is missing.
14. The pegs are the cotter pins holding the parts within the bronze casting. Fig.6 if it is accurate may show a type with a much reduced 'regulator'.

the reserve a little above the touch-hole, to stay the arrow whilst the marke takes fire. The pipe must be filled with this mixture bruised very small and hard ram'd in; Gunpowder and salt-peeter a like proportion, and brimstone half so much, with some small quantity of camphir (if men please) to make it operate more strongly where the marke is wet. If the mixture burne too quicke, add brimstone; if too slowe, add powder.

To stop the touch-hole, that the mixture runne not forthe, and to take fire when you meane to shoot seeth (*i.e. boil*) cotten-candlewicke in vinegar and gunpowder bruised very small; and when it is thoroughly soaked and well dryed, take a small quantity (rolled a little in the former mixture) and stop the touch-hole therewith.

The Fire-shaft being made, and filled in this manner, take the Bowe with a match well lighted into your left hand, after the manner of Musquettiers, then hold the Arrow ready nocked in the Bowe, after the manner of Archers. Lastly give fire, returne your match, and deliver the arrow."⁶

Also recommended by the same author is the combination of bow and pike⁷ originally advocated by William Neade.⁸ The latter demonstrated his invention to King Charles I in St James Park in 1624 and ten years later was granted royal letters patent. This gave Neade and his son, sole rights for the next fourteen years, both for the manufacture of the combined bow and pike and the teaching of its development, though the inventor was soon complaining that despite the expenditure of funds amounting to £600 that "by the evil example of the City of London the service is now wholly neglected". The reference is of course to the city trained bands but despite this pessimism there is some evidence of the existence of companies of soldiers armed with bow and pike some years later. An incident at the beginning of the Civil War in 1642 outside the city of Hertford is recorded as follows:

"... at the entry of the town stood the whole Traine band in a full body placed in a warlike equipage. The Court of Guards where he was demanded the word, which was Prevention: having given it them, he was by them conducted to the second watch, being a *company of Pikes with Bowes*

and Arrowes; they conducted him to the Captain, who demanded by what authority he had brought his forces to the town."⁹

The frequency with which a particular weapon or tactical manoeuvre appears in the numerous manuals and pamphlets of the period cannot be taken as a real indication of their military value or the degree to which they found acceptance in active service. The text of these works is often a strange mixture of ideas borrowed from the Greek and Latin authors, practical suggestions derived from the writer's own experience and more or less outlandish speculations. Some of the advice is quite distinctly eccentric; our anonymous author suggests that the archer should endeavour to improve his aim by shooting at the tied bull usually baited with dogs!¹⁰

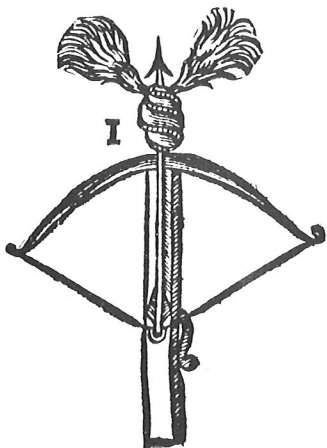
Thomas Smith's *The Complete Soldier*, also published in 1628, recommends both fire arrows and fire pikes: the reference to *rack* or *gaffel*, in the paragraph here quoted, clearly indicates the use of a crossbow, as illustrated on the same page. (Plate 1a)

"To burn the sailes of ships a prettie distance off, or to fire thatched houses, corne-stacks, or any combustibile matter apt to burn, when as you cannot come to the same, it is good to make certain strong bowes, to bend either with a rack or gaffel, or otherwise, and to shoot out of the same strong arrowes armed with wild fire, and headed as the draught I showeth (Plate 1b): the composition is to be made as is taught to arme Pikes with fire-work, which arrowes may do great good for divers services."¹¹

There are scarce references in the late sixteenth and early seventeenth century to *slurbowes*, for shooting fire arrows and "brasse balles of artificiall fire".¹² The origin of the name is mysterious and there is no clear indication of the precise nature of the weapon. It was apparently spanned with a *bender* which implies a bow fixed to a stock, in fact a kind of crossbow and though often considered to be a crossbow fitted with a barrel like of a gun the evidence does not support this.¹³ It would be extremely dangerous to insert a grenade with lighted fuse into an enclosed tube since, with the very unreliable fuses of those days, it would be liable to explode prematurely before the bowstring was released. Equally the fuse might be snuffed out by being placed in a confined

the said starres may bee seene, you may learne in the seuenteenth Chapter of the Art of Nauigation, written by *Martin Curtis*, who sheweth the same in such a plaine and easie manner, that any vnlearned man hauing a sharpe wit may vnderstand the same.

To burne the sailes of ships a prettie distance off, or to fire thatched houfes, corne-stacks, or any combustible matter apt to burn, when as you cannot come to the same, it is good to make certaine strong bowes, to bend either with a rack or gassel, or otherwisc, and to shoot out of the same strong arrowes armed with wild-fire, & headed as the draught I, sheweth: the composition is to be made as is taught to arme Pikes with fire-work, which arrowes may do great good for diuers seruices.



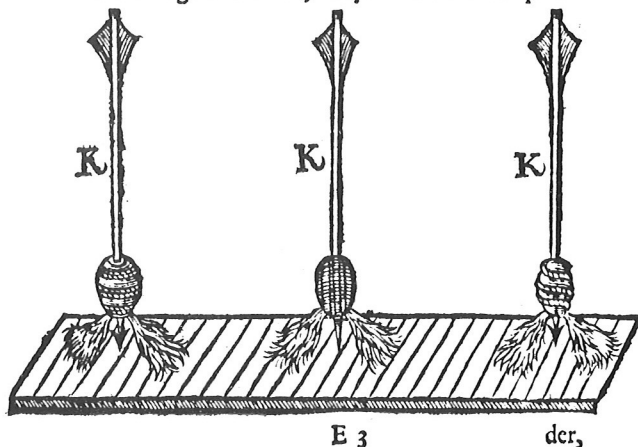
1a, b. Thomas Smith, *The Complete Soldier*, 1628. (Reproduced by kind permission of the British Library)

space with a restricted circulation of air. The illustration in Smith though schematic shows merely a conventional steel crossbow and we may perhaps conclude that the slurbow of earlier writers was simply an ordinary military crossbow modified to some degree for shooting fireworks.

A crossbow illustrated by Dubay may well be such a slurbow.¹⁴ The conventional string is replaced with three interlinked metal rods looped on to the nocks of the steel bow. From the forward end of the stock extends a narrow metal trough ideal for supporting the inevitably point-heavy fire arrow whilst the metal 'string' would be immune to burning in case of accident. It is spanned with a lever; two hooks

To burne bridges, wooden gates, &c. or to doe diuers other militarie seruices, if you can come to anoint the same with some such liquid composition as I haue shewed for the coating of fire-worke, melting in the same a good quantitie of bruised brimstone, and sticking in the same arrowes of wild-fire made in proportion as the draught K, sheweth, the which may be made of the selfe like receipts, as is taught to arme pikes with fire-worke, which will vndoubtedly set the same a fire, for the receipt is so forcible that it will burne in the water.

To charge trunkes to shoot little bals of wild-fire, either to offend or defend, you must charge the same with two inches of good powder, and then with a bal of wild-fire a little lower than the concaue of the trunkes, bored through crossewise, and primed full of fine pow-



at the end of a rigid forked extension to the long handle rest on the fulcrum (placed well behind the release nut) and the paired hooks of a hinged portion pivoted at the top of the fork engage the string. Smith goes on to describe firearrows shot from muskets and longbows both for sea service and for creating general confusion on the battlefield:

"It is good eyther for service on sea to burne the sailes of shippes, or on the land for disordering men in battellray being neere, or for diuers other military seruices, to haue certaine short muskets of an inch or very near an inch bore, out of which you may shoot eyther chained bullets, or half a score of pistoll bullets, or halfe a

It is good eyther for seruice on sea to burne the sailes of shippes, or on the land for disordering men in battell-ray being neere, or for diuers other militarie seruices, to haue certaine short muskets of an inch or very neere an inch bore, out of which you may shoot eyther chained bullets, or halfe a score pistoll bullets, or halfe a dozen harquebus bullets at one shot; or you may shoot out of the same fire-arrows made with strong shafts fethered with horne, or with common feathers, glewed & bound on with threed: when you are to shoot a fire-arrow out of any of these peeces, you must not giue the peece her full loading of powder, but rather $\frac{2}{3}$ parts thereof, and then put in a close wad after the powder, and put in the arrow close to the said wadde, firing the same at the other end without the mouth of the peece, as you see the



draught

dozen harquebus bullets at one shot; or you may shoot out of the same fire-arrows made with strong shafts fethered with horne,¹⁵ or with common feathers,¹⁶ glewed and bound on with thread: when you shoot a fire-arrow out of any of these pieces, you must not give the peece her full loading of powder, but rather $\frac{2}{3}$ parts thereof, and then put in a close wad after the powder, and put in the arrow close to the said wadde, firing the same at the other end without the mouth of the peece, as you see the draught: (Plate 2a) which being well fired, you may discharge the same at your pleasure. The string made fast to the end of the fire-worke, is to keep the

draught: which being well fired, you may discharge the same at your pleasure. The string made fast to the end of the fire-worke, is to keepe the arrow streight in his passage, being shot eyther with or against the winde.

For the like seruice aforenamed, it is good to haue certaine strong bowes to shoot fierie shafts, something stronger and longer than ordinarie shafts: for making the fire-worke fast to them, the which being fired and discharged out of the bow by a skilfull Archer, hauing a strong arme, will doe excellent good seruice for diuers occasions, as by the draught hereunder you may see.



I

2a, b. Thomas Smith, *The Complete Soldier*, 1628.
(Reproduced by kind permission of the British Library)

arrow straight in his passage, being shot eyther with or against the wind.

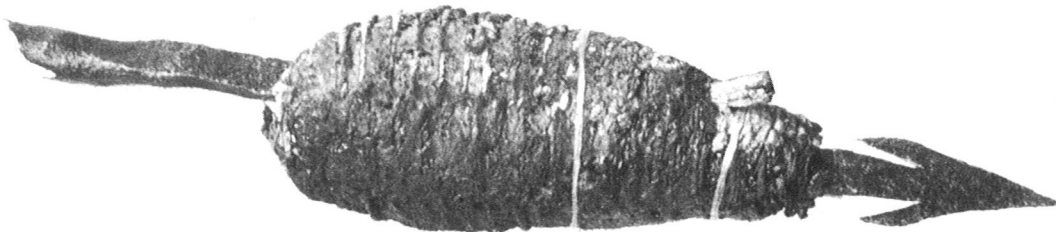
For the like service aforenamed, it is good to haue certaine strong bowes to shoot fierie shafts, something stronger and longer than ordinary shafts: for making the fire-worke fast to them, the which being fired and discharged out of the bow by a skilfull Archer, hauing a strong arme, will doe excellent good service for diuers occasions, as by the draught hereunder you may see."¹⁷ (Plate 2b)

The ingredient of the fire-work is the same as that applied to the firepike which was employed to defend or attack a ship or a breach in a fortification:¹⁸

"Powder bruised 8 parts;
 Peter¹⁹ in Roch,²⁰ one part;
 Peter in meelee, one part;
 Sulphur in meelee, two parts;
 Rozin roch, three parts;
 Turpentine, one part;
 Linseed oyle, one part;
 Verdegrease,²¹ ½ part;
 Bole armoniacke²² 1/3;
 Bay,²³ 1/3 part;
 Colophonia,²⁴ 1/6 part;
 : and if you think good, you may put
 thereto of Arsnick 1/8 part: then coate the
 same over with this liquid mixture molten
 in a pan or coating pot (to wit) Pitch,
 foure parts; linseed oyle, one part;
 Turpentine, ½ part; Sulphur, one part;
 Tarre, 1/3 part; Tallow, one part. And
 assoone as this is cold, bore two holes in
 each of the same an inch deepe, with a
 sharpe iron or bodkin, filling the same with
 fine bruised powder, putting in everie hole
 a little sticke of two or three inches length,
 which are to be taken out when you would
 fire the same. This composition will burn
 furiously. If you please you may make
 fast to the same receipt on your pike certain
 light pipes of yron or brasse of six or
 seven inches length, being pistol or caliver
 bore, as the draught B showeth placing the
 touch-hole thereof close to the canvas,
 boring the said canvas thorow, and priming
 the same with fine powder, and upon the
 same paste a little paper and then coate the
 same as above is said."²⁵ Canvas material
 encloses the mixture and is tied in a bundle
 with *marlin* cord.²⁶

A portion of a fire-arrow, the foreshaft
 bearing its bundle of 'fire-work', is preserved in
 the collection of antiquities at Alnwick Castle
 in Northumberland. It was one of a number

recovered from an old timbered house near the
 High Bridge, Lincoln, and though no associated
 items by which it can be dated are recorded²⁷
 a close similarity to the illustrations given by
 Smith does suggest that this rare surviving piece
 is of seventeenth century origin and most
 probably a relic of the Civil War. (Plate 3) The
 iron foreshaft is 10½ in. long overall prepared
 from a bar with maximum width of 7/16 in.
 and approximately 5/32 in. thick. The narrow
 head measures 2.1/8 in. from the point to an
 imaginary line passing through the tips of the
 twin barbs and has a maximum width of one
 inch. At the distal end the metal is flattened
 and developed into a socket some 1¾ in. long
 for the insertion of the wooden shaft of the
 arrow, now missing. Immediately behind the
 barbed head is a mass of combustible material
 wrapped in thin canvas, measuring 5¼ in. long
 and with a maximum diameter of 2½ in., bound
 by two ply cord matching the two stranded
marlin referred to by Smith. There are twenty
 two turns of cord caught up in three longitu-
 tudinal 'braids' spaced at roughly equal
 intervals. At the forward end of the bundle a
 wooden peg is inserted through the canvas and
 this was presumably removed to allow access
 of air to aid combustion or was replaced by a
 fuse when the arrow was ready to be used.
 (*vide supra*, Smith) The outside of the canvas
 and the cord has been thinly smeared with a
 dark slightly resinous substance. During recent
 conservation of the arrow the combustible
 filling has been revealed as dark grey in colour;
 though now compacted it readily crumbles into
 a fine powder. The bulky nature of the fire
 arrow illustrated by Smith is clearly borne out
 by this item and is in distinct contrast to the
 light and elegant fire-shafts of Indo-Persian
 origin. (Plate 4) Made from cane and averaging
 28 in. several examples in the Simon Archery



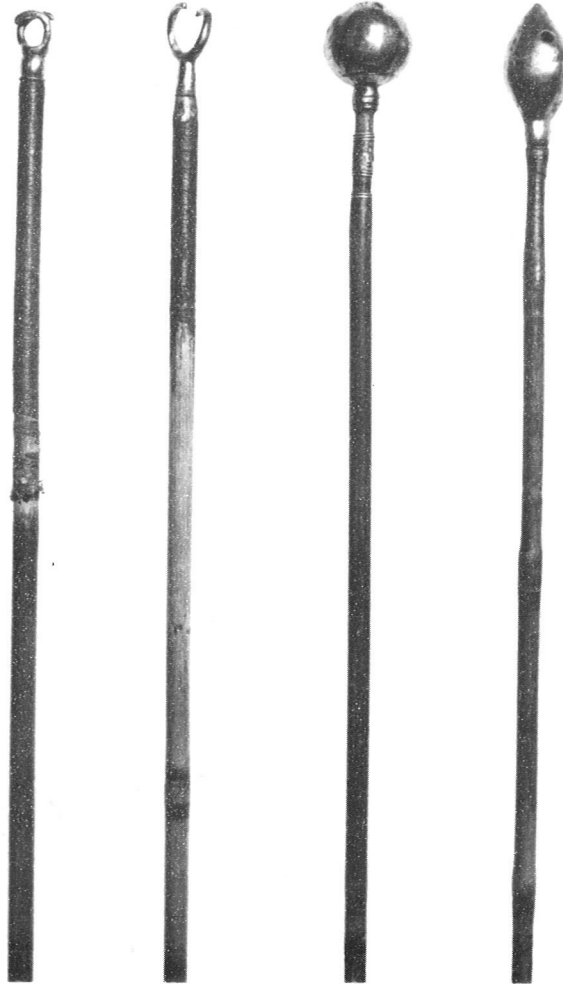
3. Head of fire arrow at Alnwick Castle, Northumberland.
 (Reproduced by kind permission of His Grace the Duke
 of Northumberland)

collection at Manchester can probably be dated to the eighteenth or early nineteenth century. Two of them have 'corkscrew' tips around which strands of tow or rag could be wound and the others have a hollow iron head, spherical (1.1/8 diam) or pear shaped (max diam. 1.5/8 in.) which could be filled with flammable material. Pant tells us that "in the early medieval period some arrows were headed with hollow brass balls perforated with three or four holes which were filled with inflammable composition".²⁸

There are a number of fireshafts preserved in Swiss museum collections which are generally ascribed to the fifteenth century. In several instances they are complete with wooden shafts and flights which indicate they are incendiary crossbow bolts (*brandbolzen*).²⁹ The examples in Berne are each approximately 18 inches overall including the metal foreshaft of about six inches in length. Average weight is less than three ounces. All seem to have the same small barbed head and rectangular section to the foreshaft seen in the Alnwick specimen.³⁰ The combustible material is similarly wrapped around with cloth and fastened with cord. The socket is rather broad so as to accommodate the relatively thick shaft of the crossbow bolt. Two further examples, in Geneva, (foreshafts only) have similar dimensions, slightly less than seven inches long, with sockets of about half an inch in diameter.³¹ (Plates 5, 6) These are large enough to accommodate the shaft of the crossbow bolt but the shafts of longbow arrows, certainly as used by the military in England in the sixteenth century, were of a similar thickness. In both examples the incendiary bundle is wrapped in a thin cloth or gauze and bound with twine. A slip of wood is inserted at the proximal end and this would have been removed when the shaft was ready to be lit and shot from the bow or crossbow. A fifteenth century date is certainly possible for all of these projectiles since we find close parallels in manuscripts of the period. The German *Firework Book*, preserved in the Tower Armouries and dated ca.1440, includes many illustrations of crossbowmen shooting fireshafts. (Plate 7) The major difference between these and the surviving specimens is that the incendiary material occupies almost the entire space between the arrowhead and the fletchings. We can probably put this down to artistic licence since the

resulting bolt would have sat very uneasily on the top of the crossbow tiller.

Thomas Smith's namesake Capt. John Smith, most famous nowadays for his connection with Pocahontas the Red Indian princess, was the author of a number of historical works as well as an important manual of seamanship entitled *A Sea Grammar*, published in 1627. In it he refers to both fire arrows and fire pikes: evidently even the latter were occasionally used at sea: "*Fireworkes* are divers, and of many compositions, as *Arrowes*



4. Indo-Persian fire arrows.
(Reproduced by kind permission of the Simon Archery Foundation, Manchester)

trimmed with wild fire, to sticke in the sailes or ship's side, shot burning. *Pikes of Wild fire*, to strike burning into a ships side to fire her."³² He was acquainted with Robert Norton and supplied a laudatory verse printed at the beginning of *The Gunner*, 1628. Earlier Norton had written a dedicatory verse for Smith's *Generall Historie of Virginia, New England and the Summer Isles*, 1624, a chronological history of the English settlements in north America and Bermuda.³³

Fire-pikes or lances were certainly put to practical use and are reported in use at more than one siege during the Civil War, for example at Cirencester in 1642:-

"He thus gotten to the house, with a fire-pike in his hand, both troubled their shooting from the windowes, and by and by set fire to the house, and some stacks and ricks by it."³⁴

Warburton's *Memoirs of Prince Rupert* includes another description of this device in the hands of the attacking Royalist forces at Bristol in 1643. "Ours, thereupon, helping over one another, fell presently to fling down the work with their hands, halberts and partisans, as they could, to let in their fellows. In the meantime, Lieutenant-Colonel Littleton, *riding* along the inside of the like with a fire-pike, quite cleared the place of the defendants."³⁵ A little later, "Captain Clerk, Ancient (i.e. *ensign*) Hodgkinson, and some others, running upon them with fire-pikes, neither men nor horses were able to endure it. These fire-pikes did the feat."³⁶

From 1600–5 John Smith was in the service of the Holy Roman Emperor and in the wars with the Turks he seems to have been acknowledged as something of an expert on 'fire-works'. These included earthenware pots filled with gunpowder and covered with pitch in which a quantity of partially quartered

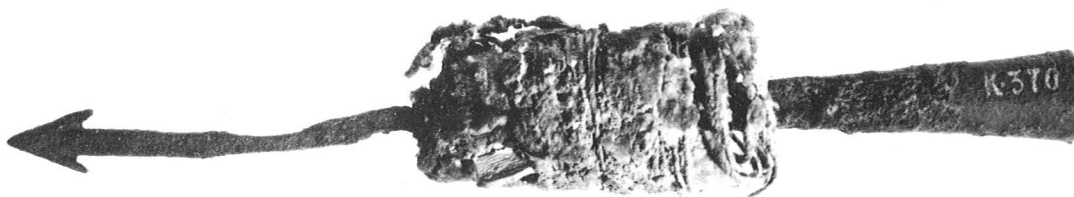
musket bullets were stuck, as well as a form of firelance:-

"advised of a pretty stratagem by the *English Smith*, which presently he thus accomplished; for having accommodated two or three hundred trunks³⁷ with wild-fire, upon the heads of lances, and charging the enemy in the night, gave fire to the trunks, which blazed forth such flames and sparkles, that it so amazed, not only their horses, but their foot also; that by the means of this flaming encounter, their own horses turned tails with such fury, as by their violence overthrew *Jeremy* and his army, without any loss to speak of to *Meldritch*."³⁸

The Compleat Gunner, published in 1672, is a compilation from various sixteenth and early seventeenth century authors and contains a comprehensive account of the fire lance and its preparation closely following Thomas Smith's description:-³⁹

"To Arm Pikes to defend a Ship or any other place.

To arm pikes to defend a ship, or breach, or to enter the same, or to stick in the sides of a ship, or other place, take string canvas, and cut it in length about a foot, or 14 inches, and six inches high in the center, and let the ends be both cut taper-wise, then fasten the canvas at both ends with strong twine, and fill it with this receipt. Powder bruised 7 parts, Peter in Roch 1 part, Peter in meal 1 part, Sulphur in meal, two parts, Rozen Roch three parts, Turpentine 1 part, Verdigrease ½ part, Bole-armonick 2/3 part, Bay Salt 1/3 part, Colophonia 1/6 part, Arsnick 1/8 part, mix them very well together, and try them in the top of a Brass Candlestick, when the fire doth burn furiously with a blew and greenish colour, then fill the Canvas, and roul it over, being first armed with strong



5. Head of fire arrow, Geneva, K.370.
(Reproduced by kind permission of the Musee de l'Art et d'Histoire, Geneva)



6. Fire arrow, Geneva, K.371. The shaft and incendiary head do not originally belong together. (Reproduced by kind permission of the Musee de l'Art et d'Histoire)

twine all over, with this liquid mixture molten in a pan, Pitch four parts, Linseed Oyl 1 part, Turpentine 1/3 part, Sulphur 1 part, Tarr 1/3 part, Tallow one part; and as soon as this is cold, bore two holes in each of the same next the Iron an inch deep, with a sharp Iron Bodkin, filling the same with fine bruised powder, and putting in every hole a little stick⁴⁰ of two inches long, which are to be taken out when you would fire the same: this composition will burn furiously.

And remember you cut off the staff some three inches from the work, and put thereon a brass socket of five or six inches long, and then cut the end of your staff to fill the socket, for when you fire your mark, you may stick it in the side of the ship, and pull the staff out again, so will not the work be so easily avoided, as when the staff was on, and hangs at length, because the very weight of the staff, and length thereof will be a means to weigh down the work, or that the enemy may come, and thereby pull it out, or beat it off quickly; let the composition and work contain in weight about 7 pounds, then will it do execution, and work a better effect, then if it were of less weight, by much, by reason the composition else would be wasted, before it comes to effect its Execution."

The Chapter is completed with a paragraph recommending fire arrows shot from crossbows, following Smith virtually word for word:-

"To burn the sayle of ships a pretty distance, or to fire thatch'd houses, Cornstacks, or any other combustible matter apt to burn, when you cannot come to the same; it is good to have certain strong cross-bows to bend with racks or Gaffels, and so shoot arrows armed at the heads with Wild-fire, made of the composition as above, and about three inches in length, and one inch and a half in Diameter, tapped as afore in all points: or you may

have long bows, but then let your Arrows be also longer, which for divers services may do great good."

Fuller's *Worthies* includes the following paragraph in his description of the Royal Navy: "If they be windward of a ship, they have arrows made to shoot out of a bow with fire-works at the end, which, if striking into the enemy's sails will stick there, and fire them and the ship."⁴¹

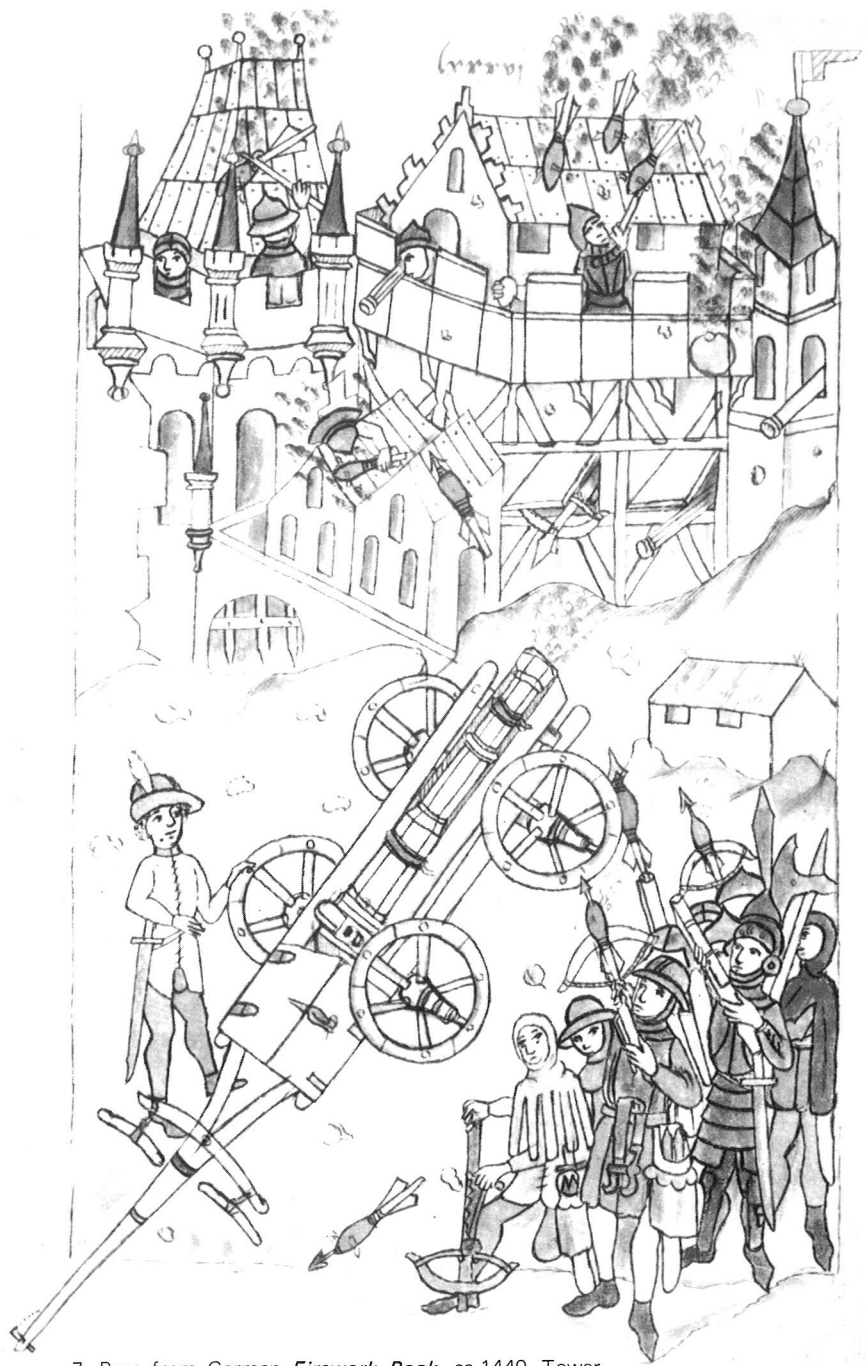
The author served as a chaplain with the royalist forces and the work though published posthumously in 1642 was compiled and written during the troubled times of the Civil War and interregnum.

Whilst various ways of setting ships on fire were being considered, methods of preventing this were not neglected. In 1625 William Beale was granted a fourteen year patent for just such an invention:

"... *William Beale of London* Goldsmith hath by his owne Studie and Industry with greate chardge and long Practise, brought to Perfection a newe Invention by him lately found out, howe by the use of and applyinge of certen compounded Stoffes and Waters, called or known by the Name of Cement or Dressing for Shippes as well the Bulkes, Huelles and Bodies of Shippes, and other vessels, as their Masts, Decks, Tackles, Sayles and other Furnitures, may be preserved in fight at Sea from Burninge or Consuminge by Wild-fyer or Gunpowder, and also have by the like Meanes such Shippes and vessels, as are bound for long voyages, may without Sheathing or other like Charge, be preserved from Hurt by the Seaworme or Barneacle ..."⁴²

Beale was to receive 40 shillings per annum from the crown for the duration of the patent and was permitted to dig for "the necessary 'Myneralls and native Materialls' throughout England and Wales" on commons and wastes or by agreement with the landowner as appropriate. At the siege of Lyme, Dorset, in 1644 John Rushworth records that "from the first fort they shot Granadoes and Fire-arrows into the Town".⁴³

A number of other incidents during the Civil War also indicate the use of arrows as



7. Page from German *Firework Book*, ca.1440, Tower
Armouries, London.
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of the Environment. Crown copyright reserved.)

offensive missiles though whether shot from a bow or a musket is uncertain. James Wintone claimed a pension for "being wounded in ye righte hande by an arrowe", in a skirmish at Hathersage in 1647.⁴⁴ At the siege of Devizes by forces under the command of Fairfax and Cromwell the following incident took place: "I having the guard by the riverside, and standing by Sir Jacob Astley, a bearded arrow stuck into the ground between his legs. He plucked it out with both hands, and said 'You rogues you missed your aim'."⁴⁵

In September 1643 during yet another siege, that of Gloucester, a note with false information designed to undermine the morale of the garrison was shot into the town:

"In the afternoon a paper was shot upon an arrow into the towne, the contents whereof was this; these are to let you understand your God Waller hath forsaken you, and hath retired himselfe to the Tower of London, Essex is beaten like a dog, yielded to the King's mercie in time, otherwise, if we enter perforce, no quarter for such obstinate traiterly rogues. From a well wisher."

The Roundhead garrison replied in like manner:

"Waller no God of ours, base rogues ye lie, Our God survives from all eternity:

Though Essex beaten be as you doe say,
Rome's yoke we are resolved nere to obey;
But for our cabages which ye have eaten,
Be sure ere long ye shall be soundley beaten.
Quarter we ask you none if we fall downe,
King Charles will lose true subjects with

the towne.

So saith your best friend, if you make
timely use of him

Nicholas Cudgel you well."⁴⁶

Again the weapon used to propel the arrow is not stated but we may recall a much earlier occasion when a *crossbow* was suggested as a means to shoot a message into Calais under siege by the French in 1557.⁴⁷

The occasional opportunistic use of the bow or crossbow is quite understandable under siege conditions when every conceivable weapon would be pressed into service. The defenders especially cut off from supplies might be expected to resort to primitive or obsolete devices. Of the armies in the field during the Civil Wars only the Scottish highlanders who came south to support the parlia-

mentary cause carried the bow as a regular part of their arms:

"Some carry only a sword and targe, others muskets, and the greate parte, bow and arrow, with a quiver to hold about six shafts, made of the mane of a goat or colt with hair hanging on, and fastened by some belt or such-like so it appears almost a tail to them."⁴⁸

There is however no eyewitness account that they used their bows on English soil though the Scots employed them to great effect during the covenanting campaigns north of the border. Before Charles I alienation of the Scots he had himself been aware of the usefulness of their skill with the bow and in 1627 ordered a levy of two hundred highland archers. They were sent under the command of Capt Alexander McNaughton to aid Buckingham in his expedition to relieve La Rochelle then under siege by the forces of Cardinal Richelieu.⁴⁹

The highlander retained the bow as part of his armoury until the latter half of the seventeenth century.⁵⁰ In contrast the last time *English* archers made a significant contribution on the battlefield was at Pinkie Cleugh well over a hundred years previously.⁵¹ The national weapon, victor of Crecy and Agincourt, was largely discarded during the reign of Elizabeth though the events of the Armada and threat of invasion re-awakened an interest in the weapon. Amongst the musters and train-band soldiers of the provinces some, even at the beginning of the reign of James I were supplied with "a cote and bowe and a shiffe of arowes and a quiver".⁵²

The arrow shot from a musket seems to have made its appearance more or less simultaneously with the adoption of the musket as the standard missile weapon in place of the bow. In this way, although the bow itself was discarded the arrow still remained as a potential substitute for the projectile, a lead ball, normally shot from the barrel of a gun. Musket arrows were included in the inventory of equipment aboard the vessels of the royal navy at the time of the Armada. In a postscript Sir Francis Drake writes "Forgett not 500 musketts and at least one thousand arrows for them".⁵³ They were also amongst the supplies listed by the Chamberlain of Norwich during preparations for the possible Spanish invasion, "item to Willm. Fforde Ffletcher, for a dozen arrowes fethered and heds for musketts, and a case for

them XVd".⁵⁴ Though the usual musket arrow seems to have been provided with both fletchings and a head Sir Francis Bacon describes a variety with only a sharpened wooden point called a *spright*:-

"And it is certain that we had in use at one-time for sea-fights short arrows, which they called sprights, without any other heads, save wood sharpened which were discharged out of muskets and would pierce through the side of the ships where a bullet would not pierce."⁵⁵

Sir Richard Hawkins carried musket arrows during his voyage in 1593 and gives us a lengthy description of their efficiency:

"Michael Angell demanded for what purpose served the little short arrowes which we had in our shippe, and these in so greate quantitie. I satisfied them they were for new muskets. They are not as yet in use among the Spaniards, yet of singular effect and execution, as our enemies confessed: for the upper worke of their shippes being musket prooffe, in all places they passed through both sides with facilitie and wrought extraordinary disasters: which caused admiration, to see themselves wounded with small shott, when they thought themselves secure; and by no means could find where they entred nor come to the sight of any of the shott. Hereof they proved to profit themselves after, but for that they wanted the tampkins, which are first to be driven home before the arrow be put in; and as they understood not the secret, they rejected them as uncertaine, and therefore not to be used: but of all the shot used now a-dayes, for the annoying of anemie in fight by sea, few are of greater moment for many respects, which I hold not convenient to treat of in publique."⁵⁶

The tampion, (*tampkin*) of wood or leather is essential because the arrow does not completely fill the bore. Without it, most of the energy of the expanding gases would be dissipated through the space between the shaft and sides of the barrel. The fletchings would give a degree of stability but, being shot from a smooth-bore weapon would not impart any spin. Again the presence of the tampion helps to reduce the chance of the fletchings being seriously burned.

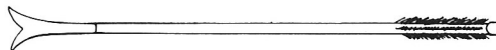
Both Bacon and Hawkins emphasise the small size of the musket arrow and since long-bow arrows were twenty-eight inches or more

in length, the musket arrow must have been two feet or less. An account of the assault on the fort at Brill hill (Bucks.) in 1643 in which these missiles were used describes them as "some arrowes about halfe a yarde in length, and some three inches in the head which the rebels shot out of their muskets to make sure work of it". The following month the Royalist newsheet, *Mercuricus Aulicus*, has a further reference to musket arrows:-

"not withstanding they had sent Propositions to His Majesty as if they did intend and desire a Peace did more than prepare themselves for battell by making Arrowes to be shot out of Muskets, Carbines and Pistols, and a new kind of great ordnance to be more easily carried, and discharged more frequently than any hitherto invented."⁵⁷

The headless variety were presumably inserted right into the barrel of the gun, without any part of the shaft or head protruding. Those arrows with barbed heads and furnished with incendiary material must have been somewhat longer than 18 or 21 inches or the butt of the arrow would not have rested in direct contact with the powder charge and wadding. Alternatively they may have been shot from muskets with barrels cut down from the normal length of four feet or more.

Robert Thoroton in his *Antiquities of Nottinghamshire* published in 1677 refers to Gervase Wylde of Nettleworth, a hamlet of Mansfield, who was for sometime a merchant in Andalusia. At the time of the Spanish invasion threat he was back in England and made captain of a ship against the Armada of 1588, "where he made use of Arrows with long steel heads shot out of muskets, some of which he left at Nettleworth, where he lived to a great age, 93". John Throsby in a reissue of this work in 1797, entitled *A History of Nottinghamshire*, records that the Rev. Mr Wylde, rector of St. Nicholas in Nottingham, had in his possession three of these musket arrows. They were eighteen inches long with oak shafts and forked heads as indicated in a reproduction of a sketch made by the antiquary in 1795. (Plate 8) Three



8. Gervase Wylde's musket arrow used at the time of the Armada, 1588; re-drawn after Throsby.

fletchings are indicated and a nock, a semi-circular concavity rather than a deep slot, probably of horn. The forked head means that they could only have been shot from a musket with a greatly reduced barrel.

A Royal Commission report of 1599 giving a list of all munitions in the royal stores and aboard the warships in the fleet includes a large quantity of musket arrows, "Musket arrows with 56 to be new feathered, 892 shefe, 13 arrows and a case for demi-culvering".⁵⁸ Evidently bundles of arrows in a container, comparable to case shot, could be fired from an artillery piece. A demi-culverin had a 4½ inch bore and usually shot a 9lb iron ball.

Robert Norton in 1628 describes the use of the *arquebus à croc* for shooting arrows:

"Now for the Harquebuse a crocke, being in these days seldom used but at sea, where especially, with an arrow, it is a very galling, and serviceable peece, and may safely be discharged 300 times in one day, or 25 times in a houre: his leaden shot weigheth but 3 ounces, and it is charged with two ounces of powder, and by reason of the length thereof, might be also accompted of this kind (i.e. of the *culverin* class) but that it is a hand-gunne and so appertaineth not properly to this discourse."⁵⁹

The *arquebus à croc* had a metal lug on the underside of the barrel which hooked over a parapet or the bulwarks of a ship so as to absorb the recoil. It was a hand gun in the sense that it was not mounted on a carriage and was light enough to be man-handled by a single operator.

Fire arrows and arrows projected from a gun were not a unique preoccupation of the English and we have notice of a Dutchman named Adolf Sleeveocht who invented a type of incendiary arrow to set fire to the sails of enemy ships. Propelled from a blunderbuss, five of these missiles, as Admiral de Ruyter himself reported, set fire to two British men-of-war in 1653. Secret orders were given to every Dutch vessel carrying these weapons, to throw them overboard if capture seemed likely.⁶⁰

A wagonful of 'musquet arrowes' was part of the baggage the surrendered Parliamentary force near Lostwithiel was allowed to take with them in 1644 during the campaigning in Cornwall,⁶¹ but the idea evidently lapsed into obscurity following the Restoration for in

1693 one Samuel Pitman petitioned the crown regarding his invention of "some sort of arrows or darts to be shot out of guns with gunpowder, and prays for letters patent for the sole use of the same".⁶² On the 2nd September the affidavit of William Digges referred to several "notable experiments" of the invention and the Attorney General was in favour of a patent being granted.⁶³ Despite this no patent was in fact registered but Pitman obtained preferment and was commissioned captain in Col. Thomas Farrington's regiment of foot.⁶⁴ In 1696 he was made governor of Hurst Castle, Southampton.

Sometime in the reign of Queen Anne the idea of fire shot and fire arrows was again revived and John Legg petitioned parliament to support his *new* invention:-

"Proposals for serving the Royal Navy with Fire-shot and Fire-arrows: To the Honourable the Commons of England Assembled in Parliament. The Humble Proposals of John Legg, Engineer, relating to his new invention of fire-shot and fire-arrows, which being shot out of a piece of ordinance (*sic*), paterrero, or musket, initially sets the enemies ships sides, sails, and rigging, etc. in a flame. It was in the reign of Queen Elizabeth that fire-ships were first invented, and had a prosperous effect on the Spanish Armada, which stratagem is so well known, that our enemies have found out ways to keep them off, and avoid their being burned by them. Now these *fire-shot*, and *fire-arrows*, in their place, will do as great, if not greater, mischief to the enemies ships, sails and rigging, when at sea, and where we cannot make use of fire-ships; and with but a small charge to the nation.

And by the invention, every ship in the Navy may be able to defend themselves, and take or destroy the enemies ships that shall engage them, although more in number, by putting them in a consternation, seeing their ships sides, sails and rigging in a flame.

If this honourable House shall think fit to encourage so useful and necessary an invention as *fire-shot* and *fire-arrows*. It is humbly proposed that Her Majesty be addressed, that Her *Royal Navy* may be supplied and furnished with the same, by the inventor, who will make and deliver in,

what quantity shall be required, before the fleet can put to sea.

Be pleased to note upon the Fire-Arrows, that the pin at C gives way and the shaft B flyes through the sail, and leave the head B flaming in the sail. The flash at the muzzle of the gune gives it fire.

Note also, that the fire-shot consists of two parts, the solid part B flyes through the ships side, and the Cap A remains burning in the hole." (Plate 9)⁶⁵

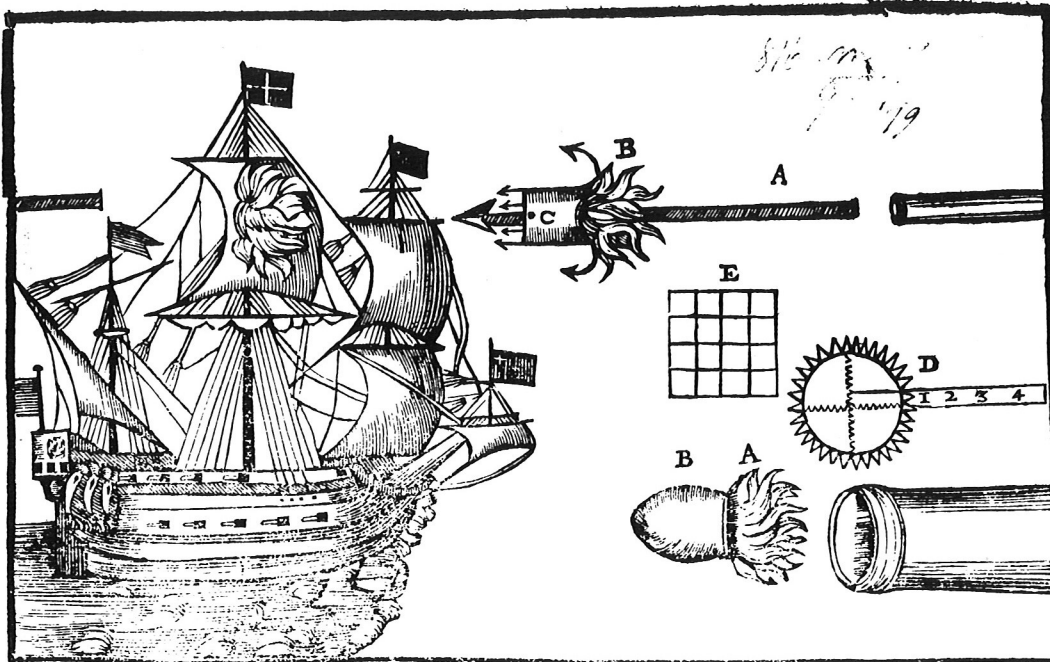
Falconer's *Universal Dictionary of the Marine* published in 1780 describes the fire arrows currently in use which were shot from a musketoon, (a shot-barrelled shoulder gun of large bore) or from a small swivel cannon:-

"Fire arrow (*dard à feu*) is a small iron dart furnished with springs and bars, together with a match, impregnated with powder and sulphur, which is wound about its shaft. It is intended to fire the sails of the enemy and for this purpose is discharged from a musketoon or swivel gun. The match being kindled by the explosion, communicates the flame to the sail against which it is directed

where the arrow is fastened by means of it's bars and springs."⁶⁶

John Norton, sometime captain in the 94th regiment, was a considerable authority on ballistics and made a number of inventions in the military field. These included an oblong, iron-pointed, rifle ball "stated to act with an increased momentum equal to double the calibre of the rifle, to exceed in effect the leaden bullet, and to facilitate the rapidity of loading",⁶⁷ and rifle percussion shells designed to explode on impact "thereby obviating the necessity of a fuse".⁶⁸ The latter were considered suitable for Mr Perkins steam gun, as well as airguns, and rifled firearms of all kinds. In addition a percussion arrow to be shot from a rifled steam gun:-

"Those parts of the arrow where feathers are usually placed, fit into the grooves of the rifle, whereby the arrow is made to revolve during its flight, its range to be nearly doubled, and the accuracy of flight greatly superior to what it would be if discharged from a gun not rifled."⁶⁹ Examples of all of these, or models of them, were displayed at the Adelaide Gallery, in the 1830s, along with the Newton's hand grenade



9. John Legg's fire-shot and fire arrow. (Reproduced by kind permission of the British Library)

for home defence. He was a keen archer and in 1831 became Vice-President of the Royal Toxophilite Society on whose shooting ground he demonstrated such diverse weapons as a pellet bow, a bow made from whalebone and a boomerang.⁷⁰

The Lowther Arcade was established in 1832 by Jacob Perkins as a place for the demonstration, chiefly by means of scale models, of all the latest novelties of science and invention.⁷¹ The most popular attraction was Perkins own steam gun which, connected to a high pressure steam generator, could project a stream of up to 420 musket balls per minute. At a pressure of about 700lbs psi the lead balls were completely flattened against an iron plate fixed one hundred feet away. If the pressure was raised to 840lbs psi the musket balls disintegrated on impact.⁷²

Whilst in all the preceding examples the musket arrow is an instrument of destruction this was not always the case and John Murray perfected a method of throwing a line in order to save lives from a shipwreck.⁷³ Murray's shipwreck arrow was also displayed at the Lowther Arcade and is described as follows:-

"Intended to be discharged from the shore, or from a boat, to which a rope may be fastened, so as to effect communication with the shore. An apparatus, for illuminating the arrow for night service is attached."⁷⁴

A pamphlet published in 1831 is a comprehensive record of his experiments which had begun in the Isle of Man in 1817.⁷⁵ In its developed form the arrow, of hickory, ash, or lancewood, was a harpoon-like projectile eighteen inches long and three-quarters of an inch in diameter. Shod at the butt end with copper to prevent the shaft being scorched by the propellant charge a leading line was tied to a ring which slid along a narrow bar the full length of the shaft. Behind the barbed head a cylinder packed with a mixture of potassium chlorate and 'sugar candy' was ignited by means of a phial of sulphuric acid to provide illumination for rescues at night. The overall weight of the missile including flare and whip cord line, was 2lb 1oz and this could be shot from a common blunderbuss with a 16 in. barrel and 1.1/10 in. calibre a distance of nearly one hundred yards using two drachms of

powder. The shipwreck arrow could also be shot from a three pound swivel gun. Demonstrated "at a number of ports on the east coast" Murray's apparatus was offered for sale by John Blanch, gun-maker of 26, Silver Street, Hull.⁷⁶ Offered "To Shipowners, Captains and Philanthropists" the advertisement in the *Hull Advertiser* for the 13th February, 1835, relates that "The apparatus consists of a short gun, with a set of iron arrows, to one of which is to be attached a line to be thrown from the ship to the shore. ... The prices for the best finish, including gun with patent breach, percussion lock and set of four arrows £5.50. Second finish with patent breech and percussion lock and arrows £4.10s. Third class £4.0s."⁷⁷

Murray's invention seems not to have attracted a great deal of support and Blanch himself emigrated to Hobart, Tasmania in 1836.⁷⁸ Captain Manby's mortar was the standard life-saving equipment kept on the east coast stations at this period.⁷⁹ This device was soon to receive strong competition from a life-saving rocket devised by Alexander Gordon Carte, ordnance store keeper at the Hull Citadel.⁸⁰ Made available for sale in 1836 this modified Congreve rocket was by 1851 established from Spurn to Sunderland and Whitburn in Co. Durham.⁸¹

We can end with another idea (there is no evidence that it found practical employment) from the fertile brain of John Norton which places our subject firmly in the modern era. In 1854 Norton registered a patent for "Signalling on Railways by means of Cross Bow and Explosive Projectiles".⁸² To quote from the specification:

"This invention relates more especially to a system or contrivance whereby the guard of a railway train is enabled to signal to or communicate with the engine driver in case of accident or for other reasons. The guard or other official who is to make the signals, is supplied with a cross-bow or other similar impulsive apparatus, as well as with a number of explosive missiles or projectiles of a peculiar kind. These projectiles or shot are composed of stiff paper tubes, or of sheet iron, or other matter, the paper or case material in each case being sufficiently

rigid to withstand the shock of the cross-bow firing. This tubular case is filled with Hall's gunpowder or other explosive agent, such, for example, as is used in Captain Norton's fog signal, that is chlorate of potash and sulphuret of antimony. This forms what may be termed a charged arrow, and its head, or the part next the bow string, has one or two heads of Bell's lucifers or other frictional explosive matter attached. With this arrangement, when the shot or arrow is discharged, the friction generated during its passage along the bow shaft or stock ignites a fuse composition communicating with the exploding charge. In this way the guard can shoot his signal in the direction of the engine driver, the explosion being made to occur at any determined distance in front of the driver, so as to command his attention in the most peremptory manner by a mimic display of lightning and thunder. A few grains of coarse emery powder are attached by means of glue to the front of the cross bow stock to cause the certain ignition of the fuse composition."

The specification also offers a number of variants both in the nature of the missile and the means of propulsion. Instead of an exploding arrow one with a whistling head, ("of the kind used by the Malays"?) and both types may be shot from a rifle or musket. Alternatively they might be shot from the elastic gun patented by R.E. Hodges in 1849.⁸³ Examples of the latter which partakes of the nature both of cross-bow and catapult are preserved in the Tower Armouries and in the Vokes collection at Havant in Hampshire.

The possible use of fire arrows even in modern warfare were realised by the men of the U.S. Special Forces serving in Vietnam. Here the bow and crossbow made a re-appearance for clandestine missions and arrows with thermite heads were targeted against native huts and enemy munition dumps.⁸⁴ During the second world war the bow occasionally made its appearance and the value of fire arrows for irregular actions was apparent to some individuals at least. After the B.E.F. retreat to Dunkirk the imminent threat of invasion from across the

Channel led to the setting up of a network of resistance groups in Britain intended as a guerilla force to fight the Germans if they had succeeded in occupying Britain. Captain Peter Fleming (brother of Ian Fleming the author of the James Bond stories) was in charge of the Kent section the first to be established:-

"Fleming had packed the big barn ... from end to end and from floor to roof with explosives, ammunition and weapons — including half a dozen longbows for which he had indented through Auxiliary Units (cover name for the resistance organisation) supply channels. He hoped to teach his men to use the bows to hurl incendiary charges into German petrol dumps and to pick off sentries quietly. Fleming himself could kill a deer at a hundred yards with a bow and arrow, but his plan to train Resistance people to use such weapons never got very far."⁸⁵

Acknowledgements

I am indebted to His Grace the Duke of Northumberland for permission to publish the fire arrow preserved at Alnwick Castle and Mr Colin Shrimpton of the Northumberland Estates was most helpful during the course of my investigations. Mr Alan McCormick, the Castle Museum, Nottingham, brought to my attention the unique drawing 'from life' of a sixteenth century musket arrow. M. José A. Godoy of the Musée d'Art et d'Histoire, Geneva, provided photographs and details of fire arrows in his care and Mrs Wendy Hodgkinson, Hon. Curator of the Simon Archery Foundation the illustration of Indian fire shafts.

NOTES

1. Sir Thomas Wilford, *A Military Discourse*, London, 1734, pp 21–22.
2. Anon, *A New Invention of Shooting Fire-Shafts in Long-Bowes: wherein besides the maner of making them, there is contained a briefe Discourse of the usefulness of them in modern Warres by Sea and Land. Published by a true Patriot for the common good of his native country of England*, London, 1628; Printed by H.L. for John Bartlett, at the Gilt Cup in Cheapside.
3. *ibid* p.6.
4. A brass alloy.
5. ie. a barbed head.
6. *A New Invention*, etc. (*op.cit*) p.12.
7. *ibid* p.5.
8. William Neade, *The Double-Armed Man, By the*

- New Invention: Briefly showing some famous Exploits atchieved by our British Bowmen, with several Portraits proper for the Pike and Bow*, London, 1625, (Printed by I. Grismand, at the signe of the Gun In Pauls Alley).
9. *A Perfect Diurnall of the Proceedings in Hartfordshire, From the 13th August to the 29th (1642). Wherein is declared how the Earle of Bedfords troops searched the Lord Capels house ... Also how they searched Sir Thomas Fanshaw's house.* Printed for W M, September 1st 1642. William Russell, fifth Earl of Bedford was a parliamentarian supporter at this stage of the war.
 10. *A New Invention (op.cit)* p.5.
 11. Thomas Smith (of Berwick upon Tweed, soldier) *The Complete Soldier. Containing the Whole Art of Gunnery with certaine newe and more rare additions concerning fireworks*, London, 1628, see p.36. The general title page is so printed but the volume is in two parts each with a separate title; the *Art of Gunnery*, dated 1600; and *Certain additions to the book of Gunnery with a supply of fireworks*, 1627.
 12. 'The Observations of Sir Richard Hawkins Kt. in his voiage into the South Seas, Anno Domini 1593', *Hayluyt Society Publications*, no.1, 1847, pp. 185–6: The work was written some thirty years after the events described and published posthumously in 1662.
 13. A.G. Credland, 'Crossbow Guns and Musket Arrows', *Journal of the Society of Archer-Antiquaries*, Vol 20, 1977, p.5, et seq.
 14. Pierre Dubay *Arc at Arbalete*, Lausanne, 1978, p.27. A crossbow of this design would be effective as both a device for shooting fire arrows and as a bow trap. The iron links would be resistant to decay when left for long periods in the open and the trough would support the arrows with large heads, forked or otherwise, usually used in these latter weapons.
 15. Resistant to burning.
 16. Natural feathers themselves are highly resistant to catching fire and tend merely to scorch and smudge; creating a terrible stench in the process!
 17. Smith *op.cit* p.34.
 18. Fire pike or lance; see below.
 19. ie. Salt petre (potassium nitrate).
 20. In crystalline form, not ground down into a powder or meal?
 21. Basic acetate of copper.
 22. ie. Bole armeniac; an astringent earth brought from Armenia.
 23. *Bay* salt ie. salt derived from evaporated sea water and imported from the Bay of Biscay; this would be sodium chloride with various other halogen salts of sodium, potassium and magnesium.
 24. Greek pitch; a resin formed from the distillation of turpentine with water.
 25. Smith, *op.cit*, p.29.
 26. A two-stranded line used for lashing etc; hence marline spike.
 27. J.C. Bruce, *A Descriptive Catalogue of the Antiquities of Alnwick Castle*, 1880, p.186, inv. no.902.
 28. G.N. Pant, *Indian Archery*, Delhi, 1978, p.180.
 29. Dr R. Wegeli *IV Fernwaffen – Inventor der Waffensammlung des Bernischen Historisches Museums in Bern*, 1948, pp. 41–2 inventory nos. 2022–2026. Sample dimensions:- no. 2022, overall length 462mm; length of foreshaft 152mm and weight 105 gr; no. 2024, overall length 480mm, length of foreshaft 166mm, and weight 51.5 gr.
 30. Though this is somewhat larger overall.
 31. Musee d'Art et d'Histoire, Geneva; inventory number 370, length of foreshaft 174mm; width of head 11mm, diameter of socket 15mm; and weight 60gr; inventory number 371, length of foreshaft 165mm, width of point 10mm, diameter of socket 13mm, and weight, 80gr. The latter has been married with the shaft of a crossbow bolt (invent. Arm. 920) which does not belong though it is practically certain that the foreshaft did originally form part of such a bolt.
 32. Capt. John Smith, *A Sea Grammar*, London, 1627. See the reprint edited by K. Goell, London, 1970, p.87.
 33. *ibid*, see introduction.
 34. Anon. *A Particular Relation of the Action before Cyrencester ... taken on a Candlemas Day, 1642 by part of His Majesties Army*, 1642.
 35. Eliot Warburton, *Memoirs of Prince Rupert and the Cavaliers* Vol.2, London, 1849, p.251.
 36. *ibid* p.252.
 37. Trunks, ie. tubes or cylinders; this was the usual name at this period for the blowpipe too.
 38. *The Travels and Adventures and Observations of Capt. John Smith, 1593–1629*; originally published in 1630 this extract is taken from the reprint which appears in Churchill, *A Collection of Voyages and Travels*, London, 1732, p.341. For an illustration of a fire-lance in action see Charles Ffoulkes *Arms and Armament*, London, 1945, p.142 where an illumination is reproduced from *Bib.Nat* (Paris) 7239 fol.72 a manuscript of the late fifteenth century or early sixteenth century.
 39. *The Compleat Gunner*, London, 1672, pt.3, Ch.15. Acknowledged on the title page are Casimir (Simenowicz) the Polish author of the *Great Art of Artillery*; Uffano (of Ypres) author of the *Treatise on Artillery and its Use*, Brussels, 1613, Don Diego (de Alava y Viamont) author of *The Perfect Captain*, Madrid, 1592; (Henry) Hexham, author of *The Principles of the Art Militarie*, London, 1637–1640; and others. It also forms the third book of Thomas Venn, *Military and Maritime (sic) Discipline*, London, 1672.
 40. These sticks will of course prevent the contents being lost while the lance is not in use. When it has been ignited their removal allows an access of air to aid combustion.
 41. Thomas Fuller, *Worthies of England*, Vol.2, London, 1840, p.119. This work was originally published at the Restoration, a year after Fuller's death in 1661.
 42. *De Concessione Privilegii Willielmo Beale*, AD. 1625, An.1, Car.1, 1st August (at Southampton). A William Beale, goldsmith, lived in Honey Lane, All Hallows parish, London.
 43. John Rushworth, *Historical Collections*, London, 1721, p.678. On the next page there is the following entry: "May 12. This day they shot in divers balls of wild-fire, but did not hurt, only fell into a house."

- John Rushworth (1612?–1690) son of Laurence Rushworth of Acklington Park, Northumberland was appointed solicitor to the town of Berwick on Tweed in 1638. At the reorganisation of the parliamentary army he was appointed secretary to the general and the council of war. He accompanied Fairfax through the campaigns of 1645–6.
44. Rev. J.C. Cox, *Three Centuries of Derbyshire Annals*, Vol.1, London, 1890, p.160.
 45. See a transcript of John Gwyn's writings in *Military Memoirs — The Civil War*, ed. by P. Young and N. Tucker, London, 1967, p.52. Gwyn (or Gwynne) was a retainer of the household of Charles I and employed in training the royal family in military exercises. As a result he was appointed a captain in the Kings Regiment of Guards.
 46. John Dorney, *A Briefe and Exact Relation of the Siege laid before the City of Gloucester*, London, 1643. Reprinted in J. Washbourn *Bibliotheca Gloucesterensis*, pt 2, 1825; see p.224.
 47. *Acts of the Privy Council*, 1556–8, p.233.
 48. Quoted by S.R. Gardiner, *History of England, 1603–42*, London, Vol.10, pp 27–8.
 49. D. Gregory, 'Notices Regarding Scottish Archery', *Archaeologica Scotica*, Vol.3, pp.243–54.
 50. A great clan battle fought in 1688 between the Laird of Macintosh and McDonald of Keppoch was probably the last large scale encounter in which the Scots used their bows. See D. Gregory, *Archaeologica Scotica*, *op.cit.*
 51. W. Patten, *The Expedition into Scotland of the most worthily fortunate Prince Edward, Duke of Somerset uncle of the most noble sovereign Lord, the Kings Majesty Edward the VI ... made in the first year of his Majesty's most prosperous reign*, London 1548. Under the command of Lord Protector Somerset the English forces engaged the Scots on the 10th September, 1647, south of Musselburgh. There were archers present in both the Scots' and English armies.
 52. Cox, *op.cit.* p.160.
 53. *Calendar of State Papers (Domestic) Elizabeth*, 1588; 30th March at Plymouth. The inventory, ca. 1430 of Schlochau Castle, stronghold of the Teutonic order, included "arrows for backcrossbows and also for arguebuses"; see B Rathengen *Das Geschutz in Mittelalt*, Berlin, 1928, p.646. The two earliest recorded illustrations of guns depict arrow-firing cannon and appear in an English manuscript of Walter de Milemete dated 1326–7, see T.F. Tout *Firearms in England in the Fourteenth Century*, London 1968.
 54. *Norfolk Archaeology*, Vol.1, p.11 and p.19.
 55. Sir Francis Bacon, 'Expt Solitary touching attraction by similitude of Substance *Sylva Sylvarum*, Century VIII, 1627.
 56. Sir Richard Hawkins; see note 12.
 57. See *Mercuricus Aulicus*, January and February 1643; British Museum, Thomason collection of Civil War tracts, E 246, items 16 and 26 respectively.
 58. *Archaeologia*, Vol.13, p.397 etc.
 59. Robert Norton *The Gunner*, London, 1628; see chapter 12 (p.56) entitled "Of Culverings, or the second Kinde of Ordnance with their several sorts". Norton (d.1635) learned his craft of engineer and gunner under John Reinolds, master gunner of England, and in 1637 was granted the post of engineer to the Tower of London for life.
 60. De Jonge, *Het Nederlandsche Zeewesen*, I, 658f, Haarlem, 1858; quoted by Arne Hoff, *Dutch Firearms*, London, 1978, p.192.
 61. Richard Symonds, *Diary of the Marches of the Royal Army during the Great Civil War*, London, 1859, p.66 (ed. for the Camden Society, vol.74). Symonds (1617–92?) was present at Cropredy Bridge, Newbury, Naseby and the relief of Gloucester.
 62. *Calendar of State Papers (Domestic)*, William and Mary; 24th August 1693.
 63. *ibid*, 2nd September, 1693.
 64. *ibid*, 1694–5; 25th May, 1694.
 65. British Museum; shelf mark 816 m.7 (96). John Legg may have been a kinsman of William Legge (1609?–72) who had served abroad in service with the Dutch and Swedish armies and in 1638 was commissioned to inspect the fortifications at Hull and Newcastle. Appointed Lieutenant of Ordnance in the first Scottish war he was to attach himself closely to Prince Rupert. His eldest son George Legge (1661–91), admiral and commander in chief was created Baron Dartmouth in 1682 and the latter's son William Legge (1672–1750) became first Earl of Dartmouth in 1711. A demonstration was made at Blackheath on 29 April, 1687, of "bombs with two mines, mortars of 300 weight; one with nine cylinders, to shoot as many bullets; as also a fiery hot bullet to burn ships". These may have been connected with Legge's inventions; see Narcissus Luttrell *A Brief Historical Relation of State Affairs*. London, Vol.2, 1857, p.401.
 66. William Falconer, *Universal Dictionary of the Marine*, London, 1780.
 67. *Society for the Illustration and Encouragement of Practical Sciences*; The Adelaide Gallery, 16th Edition, London, 1835, item 165, p.30.
 68. *ibid*, item 150, p.29.
 69. *Society for the Illustration*, etc; *op.cit.* item 168, p.30.
 70. A.G. Credland, 'The Pellet Bow — A Postscript', *Journal of the Society of Archer-Antiquaries*, Vol.21, 1978, p.6. In 1825 he published *A Lecture on Rifles and Rifle Projectiles*.
 71. Jacob Perkins (1766–1849), born at Newbury port, Massachusetts, arrived in London in 1819. The invention of the steam gun, patented in 1824 followed as a result of his experiments with high pressure boilers.
 72. The steam gun is described in the *Society for the Illustration and Encouragement of Practical Sciences* (1835) *op.cit.* pp.11–12.
 73. James Murray, often referred to as doctor or professor Murray, was born ca.1786 in Stranraer. A prolific scientific writer and lecturer he produced a rival design to Davy's safety lamp for miners. See the *Dictionary of National Biography*. Murray returned to Scotland and died at Broadstone, near Stranraer, in 1851, *Hull Advertiser*, 18th July, 1851.
 74. *Society for the Illustration and Encouragement of*

- Practical Sciences. The Adelaide Street Gallery for the Exhibition of Objects blending Instruction and Amusement, Adelaide Street and Lowther Arcade, west Strand*, London, 1836.
75. John Murray, *Invention of an Effective and Unfailing Method for forming an instantaneous communication with the shore in shipwreck and illuminating the scene in the dark and tempestuous night*, London, 1831.
In the earliest attempts he attached a whipcord to a musket ball but it continually broke owing to the abrasion against the sides of the musket barrel. See also 'New Arrow for Shipwrecks', *Imperial Magazine*, Liverpool 1822, p.290.
76. Son of the eminent London gunsmith of that name he occupied the Silver Street premises from 1833 until August 1835.
77. *Hull Advertiser*, 13th February, 1835.
78. He left Tasmania to settle in Melbourne, Victoria where he set up shop at the *Sporting Emporium* on the east side of Market Street. His wife, and several other people were killed in an explosion of gunpowder on the 17th December, 1839. See Edmund Finn, *The Chronicles of Early Melbourne*, pp.36-7, 437-8, 542-3.
Amongst the possessions of the Australian bush-ranger Ben Hall (1837-65) recorded at the Coroner's inquest over his death, were "Three revolvers consisting of one police revolver No.210, one revolver made by *Blanche (sic) and Son*, and one Tranters revolver with a Deane and Adams cylinder". (E.F. Penzig, *In Defence of Lives and Property*, Sydney, 1981, p.55.)
79. See *D.N.B.* Capt Manby was barrack master at Great Yarmouth.
80. Carte died aged 60 on the 23rd February 1853, at the Hull Citadel where he had been ordnance storekeeper and barrack master for twenty eight years; *Eastern Counties Herald*, 27th January, 1853. He never patented his rocket but John Dennett, engineer and surveyor of New Village, Isle of Wight registered in 1838, an invention for "*Improvements to war rockets and in the Methods and Apparatus for the applying the Powder of Rockets for the purpose of obtaining communication with vessels which are stranded, or in any other situations of danger; also an improved instrument and method for accurately pointing mortars for throwing shells, which may likewise be used for firing shot from mortars for the purpose of obtaining communication with ships.*" This patent (number 7759, 1838) develops the ideas of both Carte and Manby. Henry Trengrouse of Helston in Cornwall demonstrated a rocket fired from a musket in 1818 before Admiral Rowley and a government commission. See H. Trengrouse, *A Brief Description of and Directions for using Trengrouses Apparatus*, London, 1826.
81. See *Fifteenth Annual Report of the Rocket Stations established on the coast of Yorkshire for the Preservation of Life from Shipwrecks*, Hull, 1851; published by A.G. Carte at his manufactory, Hedon New Road, Hull. Carte was the inventor of the lifebuoy as we know it today, a canvas-covered ring of cork with rope handles.
82. UK Patent no.129 registered the 19th January, 1854.
83. UK Patent No.12, 623, 29th November 1849, "Obtaining mechanical purchases by means of resilient force of caoutchouc and application of such force to projectiles".
84. A.G. Credland, 'The Crossbow in Modern Warfare', *Journal of the Society of Archer-Antiquaries*, Vol.27 1984, pp.5-20.
85. D. Lampe, *The Last Ditch*, London, 1968, pp.84-5.