Eli's First Two Thousand

Stephen D. Marvin

On December 8, 1765, in the town of Westborough, County of Worcester, Colony of Massachusetts, a baby boy was born into a prosperous farming family named Whitney. He was the first born; his parents christened him Eli. This little boy was, in manhood, to play a significant role in the development of the American industrial revolution and would be, in a very real sense, an innocent contributor to the confluence of factors which would culminate in the American Civil War.

If Eli Whitney was not a precocious child, he was, at least, very energetic, bright, and eager, and early exhibited unusual mechanical genius. When he was fifteen or sixteen, he started a nail manufacturing business and, since nails were at a premium during the Revolution, the venture proved to be extremely profitable. When the war ended and the bottom fell out of the nail market, his "machinery" and special tools were just the thing for manufacturing ladies' hat pins, and the excellence of his product resulted in a near monopoly of this trade.

It was not until he was twenty-three that Eli was able to overcome all parental objections to college and entered Yale University in April 1789. Graduating in 1792, he then aspired to continue his studies in the field of law. The problem he faced was trans-cultural and timeless: he didn't have the money. Faced with this complication, Eli accepted a position as a private tutor with a family in Georgia and sailed for Savannah on the same ship in which the widow of General Nathaniel Greene was returning. He apparently struck Mrs. Greene so favorably that he was invited to spend a few weeks at her plantation, Mulberry Grove, before he took up his tutorial duties.

Eli's Georgia experiences were overwhelmingly unfortunate; yet, in a very real sense, they were essential to the later pattern of his life. Hardly had he arrived at Mulberry Grove than he received information that his patron-to-be had employed another tutor, leaving him "down and out" at the Greene plantation without resources, contacts, or friends, with the exception of the Greene family. The world was a very different place in those days, and Mrs. Greene, having taken a liking to him, invited him to live in her home and pursue his studies of the law as he desired.

And so in the late summer or early fall of 1792, while attending a reception at Mulberry Grove for a large number of gentlemen from Augusta and the upper country of Georgia, Eli first heard about the problem of cleaning

upland green seed cotton and that all the lands which were unsuitable for the cultivation of rice would yield large crops of cotton—if there were only some way to clean it. The inevitable followed. Mrs. Greene provided space for a workshop and encouraged his efforts. By Christmas, Eli had built a prototype and by April of 1793 he had completed a marketable gin. On the 27th of May, he formed a partnership for the manufacture of cotton gins with Phineas Miller, a neighboring planter to the Greene plantation.

At that time, the market was glutted with all those items which could be grown or produced in the climate and soil of Georgia. Consequently, the economy of the state was severely depressed. The cotton gin suddenly opened to the planters boundless potential for wealth. It also made inevitable the demand for large numbers of slaves to work the fields.

The subsequent story of the cotton gin is a shameless saga of thievery, deceit, political rapacity and patent infringement at every level of southern state society, extending even into the halls of Congress. There were a few honorable acts, but only a very few. Suffice it to say that by late 1797, Eli began to cast about for a new business in which superior ingenuity and uncommon energy could lead to success and fortune, the hopes for such an achievement through the vehicle of the cotton gin having dimmed to extinction.

So, what was he to do? Eli certainly could not regard his Georgia days as a financial success, but there were a number of intangibles drawing from the experience which, if not susceptible to being deposited in a bank, still represented immensely valuable experiences and background for the high risk business he finally decided to

pursue. By 1795, Eli's factory had constructed thirty gins, and he had developed a work force, gained considerable manufacturing acumen and experience and was actively involved with all the multitudinous aspects of managing and directing an industrial establishment. Attendant to this was his developing familiarity with means of finance, sources of materials, and matters of transportation. Furthermore, he was early-on forced to meet, deal and negotiate with government functionaries of all statures at both state and national levels. He came to know the patent process intimately, and in so doing came under the eye of Thomas Jefferson, who, as Secretary of State in 1793, had the additional duty of processing patents. Almost without fail, Eli made a highly favorable impression on those with whom he dealt or who came to know him. Consequently, there were few in the spring of 1798 who had had a better practical business grounding than Eli Whitney. His predilection was for manufacturing, and it was from within this field that he selected as his next career one of the most treacherous and complex areas of industrial endeavor: the manufacture of military weapons on contract with the United States Government!

No one could ever say that Mrs. Whitney had borne a stupid son, yet here he was about to embark on a most complex manufacturing effort, in a really big way, and without any knowledge of or practical experience in the armaments industry. Eli was far too smart not to have done his homework, so what might he have learned up to this point about the arms industry of this era?

With the exception of the British Brown Bess Short Land pattern musket (Figure 1), the American Revolution was overwhelmingly fought with cast-off, obsolete or obsolescent arms of European manufacture: Dutch, German, Spanish, the British Brown Bess Long Land pattern (Figure 2) and most especially, the French muskets of 1763 and 1766, particularly the latter (Figure 3) which, because the preponderant numbers delivered to the Colonies had been constructed at the Royal Arms Manufactory of Charleville, came collectively to be referred to as "Charleville" muskets.

Since the Charleville holds such a revered place in the genealogy of American military muskets from 1794 to 1814, a word to two about it is appropriate at this point. The classic form of this musket is first discernible in the French model of 1763, but does not fully emerge as a US pattern candidate until the advent of the model of 1766. Between these two arms there are very significant differences in size of lock plate, the construction and location of the frizzen, and the nature and design of the barrel bands. These differences are so marked as to eliminate the 1763 as a progenitor arm. The 1766, on the other hand, is very close to the "Charleville" image, with the exception of having been manufactured originally without a lower band spring and with the bayonet lug under the barrel. Between 1766 and 1774, no less than four different models of muskets were manufactured, with the model of 1773 being the first to be manufactured with band springs to the rear of all three bands.

Increasingly these days, one finds reference to a "Model 1768" which allegedly differed from the 1776 essentially by introduction of a lower band spring and which, by virtue of this change, assumed the image of the pattern selected by the American authorities. Short of being able to identify such an official French model, the "1768" form may well have been achieved in the period between 1771 and 1773, during which time it is a matter of record that the French arsenals overhauled and modernized some 470,000 earlier muskets. These arms formed the bulk of the older weapons in store in 1777 and served as the quarry from which the arms shipped to the Americans were drawn.

In mid-eighteenth century, France and England were the preeminent arms manufacturers of the world and possessed extensive infrastructure and numerous traditional guild-trained armorers. Even so, it was an agonizingly slow, individualistic process which was bereft of any semblance of "mass" production or interchangeability. The majority of French arms were manufactured at three Royal armories: Maubeuge, St. Étienne, and Charleville. In England, arms were manufactured as complete weapons by contractors and were also assembled in large numbers from extensive stores of pre-manufactured parts stockpiled in the Tower of London. Although these systems carried the germs of ordered effort and the efficiency of localizing labor, they were squarely founded on the ancient patterns and techniques of the gun makers' guilds as they had emerged from the middle ages. Master craftsmen using primitive hand tools produced individual parts: barrels, stocks, mountings, and that most complex and daunting part of the complete arm, the lock. The lock, itself assembled from a number of separate parts, each the product of a different workman, was fitted together in the soft state, disassembled and suitably marked for identification and then hardened before final reassembly. That it was a most constipated system is born out by a situation occurring during the Napoleonic Wars when Britain found herself with 200,000 musket barrels which could not be assembled into muskets for want of the necessary stocks, locks and fittings.

There were, however, keen minds working on the related problems of mass production and of interchangeable parts. France seems to have been the leader in the early studies in these fields and sample arms

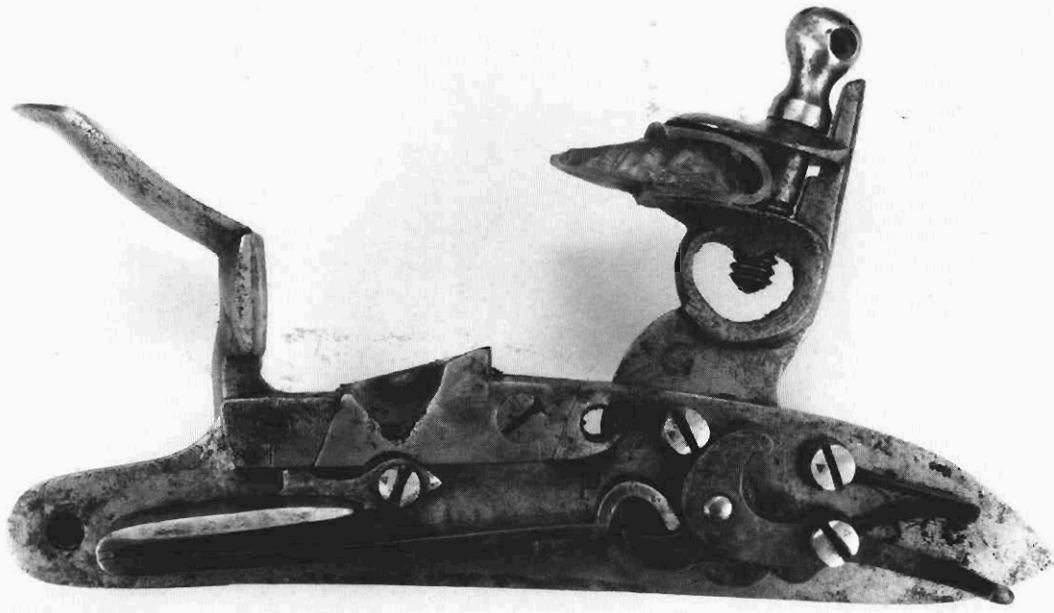


Figure 4. Internal lock parts, Whitney 1801 improved musket.

were made with interchangeable parts as early as 1717 and again in 1785. In that latter year, Thomas Jefferson reported from Paris to the American Government on a French concept that muskets might be made so nearly alike that they could be repaired by untrained individuals using only basic armorer's tools and stores of standard spare parts.[1] Jefferson, in 1789, sent a case of six officers' muskets constructed in accordance with this concept to John Jay.[2]

Before we examine these late Eighteenth Century concepts, it is necessary to observe that uniformity in gun work was then, as now, a comparative term and that in 1785 it meant within a thirty-second of an inch or more whereas it now means within a half-thousandth of an inch. In 1785, interchangeability of military small arms generally entailed a great deal of filing and fitting and then an uneven joint when fitted, whereas it now signifies slipping in a part, turning a screwdriver and having a close, precise, even fit.[3]

In the modern sense, a milling machine is a device that guides the piece to be worked into rotary, multiple-toothed cutters; the cutters are not guided by or on the work piece.[4] Irrespective of the ingenuity which may have been exercised in the late Eighteenth Century, general accounts of machinery can be interpreted to identify little more than metal saws, drills, boring and slabbing machines, hollow mills and simple lathes, all of which were of most rudimentary design.[5] There were no milling machines as industry now thinks of them.

What was it, then, that so excited Jefferson that he made specific and official reference to it and subsequently obtained for the United States Government samples of the product of the system. Jefferson served in France from 1784 to 1789, first as an assistant to Benjamin Franklin and John Adams and then as Franklin's successor as Minister to France. During this period, he came to know and closely observe the work of Honoré Blanc. What he saw was, as he stated in his August 30, 1785, report:

> He presented me with the parts of fifty locks taken to pieces, and arranged in compartments. I put several together myself, taking pieces at hazard as they came to hand, and they fitted in a most perfect manner...he effects it by tools of his own contrivance, which at the same time abridge the work....[6]

Thus by virtue of the foregoing and the subsequent shipment of six of the products of this system, it is established that Blanc's muskets were not only known but also were physically present in the United States by 1790.

As the 1790s dawned, France found herself surrounded by hostile powers. War was clearly inevitable and war meant vastly increased demand for firearms. On March 19, 1791, a report on Blanc's work was submitted to the French Academy of Sciences by a committee of its members. The importance of the report was underlined by the scientific eminence of its authors: La Place, one of France's leading theoretical physicists; Coulomb and Borda, who were amongst the most skilled experimentalists. The report was based upon the *Very Important Memoire on the Manufacture of Arms of War Presented by M. Blanc, Superintendent of Three Manufactories of Arms for the Use of the Artillery to M. de la Tour du Pin, Minister of War.*[7]

The report is extensive and all encompassing, but of particular note are the sections devoted to the manufacture of the musket lock (Figure 4.) Forging was an essential

precursor to the manufacture of all iron parts, each of which was prepared at a forge to rough shape and then trimmed in dies so as to reduce the necessity for further removal of metal to a minimum. The lock plate was forged with projections (later to be removed) which helped in indexing and locking it to a hardened filing jig, to the exterior dimension of which the plate was reduced by filing. It then was clamped to another very thick, hardened plate which carried all of the thirteen holes which had to be drilled. This was in modern terms a "drill jig." The holes were first drilled undersize, then bored out or reamed to be of proper diameter and in complete perpendicularity to the surfaces of the plate; thereafter, those requiring threads were tapped.

The tumbler was similarly forged and its large and small pivot surfaces turned on a rudimentary lathe. It was then reduced to proper thickness by "machining" its flat surfaces with a hollow mill which slid along the already turned pivot surfaces and "milled" away the flat surfaces which its toothed face contacted. Having been thus thickness sized, the piece was clamped between two hardened filing jigs of the exact desired shape and filed to this form. The finished exterior shape of the tumbler and its notches was then achieved by forcing it through a hardened die made specifically for this final sizing role. The last, but not least, important step was preparing the square arbor of the tumbler by the use of filing jigs to insure squareness and proper angular orientation with the tumbler notches.

Similar operations of an equal or lesser degree of complexity were executed on the rough forgings of the remaining nineteen parts associated with the lock plate itself.

The authors of this report observed that the Blanc system was accomplished by depending entirely upon the employment of dies, molds, gauges, and mandrels which were used in the manufacture. They also noted that subsequent heat treatment did not seem to alter the form of the pieces and consequently should not adversely affect the efficiency of the operation. The accuracy of the system depended quite obviously upon the accuracy of the equipments devised by Blanc to carry out the various operations. But was it possible, they asked, to make second and third sets of replacement tools and machines which were perfectly similar? They believed that it was and cited a demonstration where in a tumbler made by Blanc with a replacement set of tools and fixtures was interchanged with that of a lock assembled from parts made earlier on different but identically designed machinery.

If this 1791 report of the Academy of Science represented the state of technology in France, it needs to be observed that a related concept was at that very time being developed and presented in England. This was Samuel Bentham's *Methods and Means of Working Wood, Metal and other Materials*, set forth in the English patent granted to him in 1793.[8] Whereas Blanc's system was put to the experiment and its product actually evaluated by the authors of the Academy's report, Bentham's concept was just that: a conceptualization. This does not imply that it was a "drifty, off-the-wall" theory—it was anything but that, and it presaged actual industrial practices and techniques far beyond those used by Blanc and which are used to this day. Bentham's patent described not only varying types of rotary cutters—contour, hollow, slitting, "T", dovetail, slabbing and planing—but went on to conceptualize implementation of his system. Here he dwelt upon the use of movement limiting stops; upon devices for clamping and steadying the work piece; and use of power as the means of bringing the piece into contact with the cutter and controlling its movement through the milling operation. Not lost upon him, or left unclaimed, were the advantages of such equipment, taken as a complete process, in the making of a series of duplicate pieces with a minimum of dependence on the individual workman and in the shortest possible time.

Lengthy as the foregoing has been, it has been necessary in order to sense the scope and nature of industrial processes known and existing in the last decade of the Eighteenth Century. It is also very likely that by this time detailed knowledge of this technology had reached the United States.

Arms contractors throughout history have thrived only when the international climate has deteriorated and particularly when the party(s) to the worsening climate have found themselves unprepared. Such was the state of affairs in the United States during the last decade of the Eighteenth Century.

The Colonies emerged from the Revolution with large stockpiles of arms in varying degrees of disrepair. They also emerged, as they had entered, with no "industrial complex." The war was over, the armies were disbanded, and the support personnel (in our area of interest, the armorers and the artificers) set adrift. Only a small cadre remained. During the next seven or eight years, the stockpile of muskets was gradually overhauled, repaired, preserved or rebuilt. It is of interest to record that in 1790, as part of this rebuild program, the United States Government budgeted funds for procurement and installation of band springs into arms found to be without them. As an aside, there are heretics who hold the not altogether baseless opinion that the overwhelming majority of those few arms surviving today for which Revolutionary provenance is claimed are, in fact, products of the 1783 to 1794 overhaul and rebuild programs. Major storage sites for these "war reserve"

muskets were established at New London, Virginia; Carlysle Barracks, Pennsylvania; Schuykill Arsenal, Pennsylvania; West Point, New York; and Springfield, Massachusetts. This store of British Brown Bess, French Charleville of 1763/1766, assorted German, Dutch and Spanish muskets was not replenished except from the overhaul/rehab program, and as the seventeen-eightys and early seventeen-ninetys rolled by, the numbers of on-hand, ready-for-issue arms of reasonable quality began to dwindle.

For a time this was a "not-to-worry" condition. Britain sulked at home, doing all she could to make life for her erstwhile Colonials as difficult as possible. France was our "friend" and was held in the highest esteem. Military activity, as such, was focused upon the Indian problem and there were enough reserve arms to cope with this threat, such as it was perceived to be.

Then, on July 14, 1789, the Bastille fell. The revolutionary experience of the Americans identified with the French Republicans resulting in enthusiastic support and such gestures as incorporating the Phrygian or "Liberty" cap device into our coinage and as a proof mark on certain musket barrels. Not unexpectedly, this Revolutionary honeymoon did not last long, for with the advent of the Directory, the commerce of the United States began to come under mounting harassment by naval vessels of the French Republic, until a state of near war began to emerge. Nearly one thousand American ships were captured or detained and the frigate *Constellation* fought two heavy actions with French men-of-war. A reluctant Congress grudgingly began to appreciate the sad fact that there was to be no escape from foreign interference and that unarmed weakness was an irresistible temptation for the powers of Europe.

First rumblings of this had come early in the 1790s as England's quiet but unceasing and well orchestrated fomenting of the Indians along the western and northern frontiers resulted in relentless and savage attacks on the settlements. In the face of this growing pressure, on January 4, 1792, the Secretary of War, Henry Knox, authorized General Edward Hand of Pennsylvania to contract with gun makers of Lancaster County for 1,000 rifles. These contracts were in implementation of President Washington's decision to raise a batallion of riflemen to assist the settlers along the frontier in defending themselves against the terror.[9] The first rifles of this procurement were specifically obtained to arm the riflemen raised for Anthony Wayne's campaign against the Indians. These weapons represent the first Federal contract for arms.[10]

On April 2, 1794, Congress authorized the purchase of 7,000 muskets for the safety of the country while simultaneously directing the establishment of two national armories, Springfield and Harpers Ferry. There has been much controversy over this musket purchase, since there is almost no documentation extant on the subject. Was it the intent of Congress that these arms be imported from Europe? Existing freight bills dated in the spring of 1799 record shipment of very nearly the authorized number from England and Germany.[11] Yet in a War Department letter dated December 12, 1795, Timothy Pickering specifically alludes to contracts having been made and being executed for 7,000 muskets within the United States.[12] His comment is not merely a passing remark but dwells on specifics such as "French arms" for the pattern; on the inability to contract with assurance in Europe, and the need to retain the skills pool in the United States.[13] One of the American contractors who has been associated with the 1794 contracts was Own Evans.

On March 28, 1797, the General Assembly of the Commonwealth of Pennsylvania authorized the purchase of 20,000 muskets with which to arm its militia. The largest single contract was concluded with the English firm of Thomas and John Ketland on November 15, 1797, through their Philadelphia office, for 10,000 stands. It was not lost upon the Federal Government that the British Government promptly refused to grant permission for the export of these muskets and forced the summary cancellation of the entire contract.

By now, Congress was in a mild uproar. In short order, it authorized a military force of 80,000 men, recalled General Washington from his retirement, and placed him at the head of all the armed forces. Unfortunately, the remaining contents of the various arsenals were not sufficient to the crisis. There followed a spasm which has been repeated over and over again in our history. The torpor and reluctance to sustain a creditable defense structure was overtaken by a mad scramble to secure arms to meet the impending emergency.[14]

On May 1, 1798, Eli write to Oliver Wolcott, the Secretary of the Treasury. It was a most interesting letter. Seizing upon the "emergency" as a patriotic reason for putting the manufacture of cotton gins aside, he offered his work force and apprentices as well as his facilities to be employed in the manufacture of 10,000-15,000 stands of arms. He wrote:

> I am persuaded that machinery moved by water, adapted to this business, would greatly diminish the labor and facilitate the manufacture of this article. Machines for forging, rolling, floating, boring, grinding, polishing, etc. may be made use of to advantage....There is a good fall of water in the vicinity of this town [New Haven] which I can procure, and could have works erected in a short time. It will not answer, however, to go to the expense of erecting works for this purpose unless I could contract to make a considerable number....I shall be able to procure sufficient bonds for the fulfillment

of a contract of the kind above mentioned and will come forward to Philadelphia, immediately, in case there is an opportunity for me to make proposals.[15]

The result of this application was a Federal contract for 10,000 muskets at $13.40 a stand. Eli also obtained a loan for $10,000 from the Bank of New Haven, the loan being underwritten by ten of the most responsible citizens of New Haven.[16]

Before we proceed further, it would be illuminative to examine the structure of the contracts of 1798 which underlay the procurement of these arms.[17] The contracts were let under the general purview of the Secretary of the Treasury, Oliver Wolcott, with compliance, review, and administration lodged under the direct surveillance of the Purveyor of Public Supplies, Tench Francis. There were, in fact, two different contracts. The first was the unique, handwritten, six article Whitney document concluded on June 14, 1798, and the second was a standard, printed, five article contract which implemented the Congressional Act of July 5, 1798, and under which twenty-six contractors bound themselves to deliver anywhere from 200 to 3,000 stand of muskets. A rough side by side comparison is instructive and is best examined in sequential order of paragraphs.

Paragraph I: Both contracts addressed total numbers to be produced and stipulated that the manufacture was to be in the United States. The Whitney contract required delivery of 4,000 stands in fourteen and a half months and the remaining 6,000 stands twelve months thereafter. The standard contract required delivery of one-third at the end of eight months, one-third within the next six months, and the last third within the next four months, for a delivery span of eighteen months.

Paragraph II: Both documents specified point of delivery and decreed that the arms were to be made after the Charleville pattern. Included were general terms as to proof of barrels, hardening and tempering of various parts, and stipulated provision of two patterns. This paragraph was essentially the same for both contracts.

Paragraph III: Both contracts specified the ground rules for proofing the barrels; the number of barrels to be made ready for proofing before calling for an inspector; the location of the prooving operation, and established the United States Government as being fiscally responsible for the wages of the inspectors, the cost of powder and ball, and all other expenses of prooving and inspecting.

Paragraph IV: Addressed the matter of stocks. Whitney's contract spoke only to the use of walnut. The remaining contractors were authorized to use either walnut or, as a substitute, maple. Whitney's contract provided for provision by the Government of 10,000 walnut blanks to be delivered at Philadelphia at twenty-five cents each. The second contract provided for the same Government supply but only in the event the contractor could not obtain his own blanks.

Paragraph V: Was the same for both contracts and specified the price to be paid for each prooved and inspected musket: $13.40. This was the concluding paragraph for the non-Whitney, standard contracts.

Paragraph VI: No other contract contained such a provision. This was a most favorable, interesting and, for Eli, vital portion of the agreement, since it specified not only the payment schedule for the muskets but provided for initial advances or, in modern terms, "start-up" funding. The schedule was as follows:

- $5,000 immediately upon signing the contract.
- $5,000 upon presenting evidence of progress in building the factory.
- $5,000 upon completion of the first one thousand stands.
- further advances at discretion of the Secretary of Treasury in proportion to progress made in execution of the contract
- $13,400 upon completion of the second thousand and thereafter as one thousand increments of muskets were delivered.

It is revealing of just how liberal the government was to be in making advances to note that the final balance due to Eli in 1809 upon completion of the contract was only two thousand four hundred and fifty dollars.[18]

Contemplation of Eli's letter to Oliver Wolcott and the foregoing brief analysis leads to some interesting observation on these contracts. At the outset, one must remember that Springfield had been a public arsenal and overhaul workshop with buildings, powder magazines, and developed water power since early in the Revolution; that the United States Government had spent some $150,000 since July 16, 1793, towards making it a national armory and had after two and a half years only been able to manufacture 245 muskets up to the end of 1795! The average cost of a Springfield musket worked out to be $14.30.[19]

Further, one must take note of the fact that very few of the contractors had any previous experience in the manufacture of arms and were without any form of factory or capability for such an extensive industrial effort. There were also almost no skilled workmen available who were trained in the techniques of arms manufacture, since the few who were so experienced were almost, to a man, employed at Springfield.

Objectively, then, these contracts envisioned the near impossible, and it is of little wonder that most of the contractors failed and were either financially ruined or

found the business so unprofitable that they abandoned their contracts after furnishing only a very few arms.[20]

How did it come about then that Eli Whitney succeeded? Good luck? Some, but not in substantial measure; important and powerful friends and acquaintances both in and out of government? Most assuredly, for his universal reputation for intelligence, honesty, sincerity, practicality and hard work was a priceless asset. Access to funding? Without question, and he drew heavily from both the government and civilian sources for this. But all this is not enough in the face of having no experience in the arms industry, no factory, and no trained workmen, UNLESS—unless he knew (or thought he knew) something about which no other contractor was aware; unless he had conceptualized some way to accomplish this end: a system, in other words! Eli Whitney had to have been convinced that in spite of all the clear pitfalls, he was privy to a methodology that would make the venture feasible.

There are several ways by which we can infer the foregoing attribution of a system and there is no better place to look than to his letter to Oliver Wolcott: "Machinery moved by water...."; "Machines for forging, rolling, floating, boring, grinding, polishing, etc.... ."[21] These words indicated that the proposal was for a large operation encompassing a number and diversity of water powered machines heretofore unheard of in America and, for that matter, of such a scope as to have given serious pause in Europe. If we examine the word "float" we find further evidence. A float was a single-cut file having very coarse teeth and was specifically intended for use on wood and soft metals. The teeth were cut into the body of the tool instead of being in the form of a raised burr as ordinary file teeth are.[21] From this single word"floating," it can be inferred that prior to his letter to Wolcott, Eli had the concept of a power-driven multi-toothed cutting tool.[23]

So, were such ideas original with Eli or were they drawn from the reservoir of preceding and contemporary technology? We have already dwelt upon the system of Honoré Blanc and touched on the patent of Samuel Bentham. We also are aware of the presence of examples of Blanc muskets in the United States by 1790 and the existence of Jefferson's detailed reports on this system. We know also that it was to Secretary of State Jefferson, in his role as Supervisor of Patents, that Eli first presented his patent papers on the cotton gin. Further, it can be assumed with reasonable certainty, in light of Jefferson's early interest and subsequent procurement of the 6 Blanc muskets, that he would have been aware of and closely followed matters pertaining to the Academy of Sciences' 1791 report on the Blanc system, and in all likelihood was in possession of copies by 1792 or 1793 obtained through

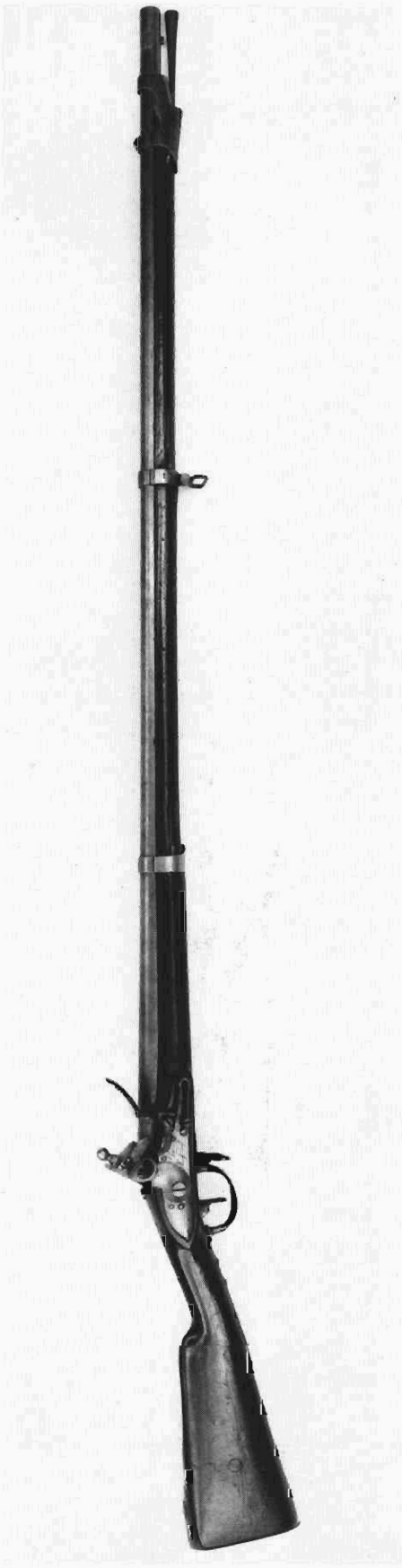


Figure 5. Model 1777 French infantry musket as modified in year IX (1800-1801) and year XIII (1804-1805).

diplomatic channels. Add to this Eli's entré to and careful cultivation of men in such positions of authority, and his stature in their eyes, and it is not at all unreasonable to reach the conclusion that prior to 1798 he had seen and studied a copy of the Academy of Science's report on Honoré Blanc and his system and probably Bentham's patent as well.

There are further tantalizing bits of information relevant to Eli's sources of inspiration. On October 9, 1798, well before Whitney had raised the first building for his armory, Oliver Wolcott, to whom the initial overture had been made, sent him:

> a pamphlet on the manufacture of arms which has been put into my hands and request you to inform me truly and candidly whether the performance appears to you calculated to afford instruction to the workmen in this country.[24]

The wording of this letter seems to indicate that the "pamphlet" was of foreign origin, that it contained material on a radically different process of arms manufacture, and, being in the form of a pamphlet, implies that it was a document prepared for wide distribution. It is probably safe to assume that it had also been brought to the attention of the Superintendents of Springfield and Harpers Ferry. Might this have been publication of Blanc's system?

Whatever the content of Wolcott's pamphlet, official government interest in French arms had continued through the course of the 1790s, for James Madison, who was very close to Jefferson and therefore would have known his interest in French arms manufacture, had sent an example of the improved model of the French musket, the Model of 1777 (Figure 5) to this country during his service in France as Ambassador from 1794 to 1796. We know that an example of this arm had come to Whitney's attention, and that its superiority over the 1766 pattern struck him forceably.[25]

Finally, we can establish a clear thread from Whitney to the Blanc system through a letter between two of the guarantors of Whitney's 1801 $10,000 loan from the Bank of New Haven, Elizur Goodrich and Simeon Baldwin:[26]

> Our friend Mr. Whitney is here....We last evening waited upon Mr. Jefferson, in pursuance of a previous appointment. He had, while in France and England, by direction of his government particularly attended to the manufacture of arms. On a very critical survey and examination he did not hesitate to say, that he had in no instance, seen any work or specimens equal to Mr. Whitney's excepting in one factory in France in which the owner had defined the various parts of his muskets, on the principles of Mr. Whitney, that Mr. Whitney equalled his specimens....[27]

The reference to "one factory in France...." is revealing, and though there seems to be an inversion of whose principles underlay whose work, certainly the "France Connection" appears to be clearly identified. The foregoing letter was written on January 8, 1801, nine months before Eli delivered his first five hundred muskets.[28]

So there we seem to have it. Eli has his contract for 10,000 stands of muskets three weeks before Congress authorizes procurement of any muskets at all. He has a conceptual plan of attack. He has his start-up funding. And he is, without doubt, the possessor of a soul full of hope. He also has not the faintest idea of the long road that lies ahead, or of the pitfalls and detours which would have spelled disaster to most men of the time.

The next two brief letters are essential to an understanding of the form of Eli's first one thousand muskets:

> 15th June 1798
>
> The Secretary of the Treasury will thank Mr. Hodgdon to deliver or cause to be delivered to Mr. Eli Whitney one of the muskets manufactured in the United States, by Mr. Evans.
>
> TREASURY DEPARTMENT
>
> 15th June 1798
>
> Mr. Harris will please deliver the above musket and also a box if in store which was received with two muskets from one of our posts.
>
> SAMUEL HODGDON[29]

The musket was obviously considered to be of the Charleville pattern and since Congress had not yet authorized procurement of any of the 1798 contract muskets, this Evans musket had to have been from an earlier agreement. It is unknown whence Evans received the pattern for his musket. It obviously was a Charleville, as can be seen in Figure 6. There is however, one significant difference between a Charleville and the Evans "pattern' musket: the pan. The Charleville's pan is iron, faceted and detachable. The Evans musket's pan is also iron, it is faceted, but it has been forged as an integral part of the lock plate. One authority has speculated on the origin of this Evans "pattern" and concluded that it was one of the "assembled" muskets delivered during 1797.[30] The argument against this is the fact that these muskets were assembled using either residual supplies of Revolutionary War French locks (both new and refurbished) or with complete, finished Charleville-type lock plates with detachable pans of Ketland Manufacture (and so marked on the inside), stamped UNITED STATES in two lines on the outside surface of the tail of the plate. The Evans lock is clearly and deeply marked US and EVANS which simply could not be done on a hardened plate without annealing. It is highly unlikely that the assemblers would have gone to such ends for the miniscule unit price they received for the assembly job, and it would have required a blank plate as well. Recalling that

Timothy Pickering, writing in 1795, had referred to 7,000 muskets after the French pattern being made under contract in the United States, it would appear that the Evans "pattern" originated from this source, the contracts of 1794. Where, how, or why the integral pan was substituted will always remain obscure.

Much has been made of this pan business, because one of the long held misconceptions of what Eli's first muskets looked like incorporated a detachable, faceted, iron Charleville pan. There was very good reason for the French pan: it made replacement of worn, eroded and pitted pans very easy, not entailing scrapping the entire lock plate. It also made forging and finishing the lock plate much more economic, simpler and easier. It was an entirely logical, simple and efficient feature. Knowing Eli's penchant for efficiency and labor-saving techniques, one can almost hear him when he received his pattern and found himself "locked-in" from the outset to a more expensive, more complex operation on the lock.

Eli was now "up against it." The dreaming, the politicking, the research were over, he must now "stand and deliver." There was land to be purchased; buildings to be erected; machinery to be made, much of which had yet to be designed; raw materials to be stockpiled from many different sources; and workmen to be assembled and then, almost without exception, taught a trade in which up to that point they had had absolutely no experience.

A tract of land on Mill River between Mill Rock and East Rock some two miles northeast of New Haven, which had once been a grist mill site, was purchased. Here a waterfall of moderate extent offered the promise of the necessary power to run the machinery. The buildings at the base of Mill Rock subsequently erected to house the superintendent and workmen came to be known as Whitneyville.[31]

The real world began to close in on Eli, and the harbinger of near disaster came in the unexpected, early onset of a protracted, savagely bitter winter. Suddenly, the contractual (and highly optimistic) fourteen month period during which the plan had been to erect the factory, install the machinery, train the men, and manufacture 4,000 muskets went from barely feasible to pathetically inadequate. The situation became so desperate, that on May 31, 1799, Eli wrote a long letter outlining the unending series of setbacks which made it impossible for him to meet the contractual calendar and restating his faith in the quality of his system and its eventual complete success.[322]

The letter is too long to include in this paper, but the following highlights will serve to convey a sense of the frustration and growing desperation which must have assailed Eli as the clock wound down on his contract. The

Figure 6. Evans Model 1794 U. S. contract musket. Whitney's pattern.

impact of the winter was "horrendous":

- unable to dig, construct, and complete the waterworks, flumes and drainage.
- unable to obtain or procure ox teams for heavy construction work due to scarcity of forage.
- suppliers of tools, mill irons, and other heavy iron work unable to deliver due to their own waterworks freezing solid and damage to their water power system.
- inability of iron suppliers to deliver because ground was too hard to dig the ore, to permit erection of charcoal smelters, or to cut wood, and absence of ox teams to procure the raw materials or to deliver the finished product to Whitney.
- the barrel maker in Salisbury, Connecticut went bankrupt.
- too many other "disappointments" to mention.

Yet with disaster on every side, with all of his best conceived plans terribly askew and behind schedule, the indomitable will of the man shines through, He is exhausted; he finds he can depend on no one; his subordinates are unable to direct or lead the work force; there was no branch of the effort that would proceed well unless he was present. But he still finds his enthusiasm for what he is creating growing. He sees his waterworks nearing completion, His metal working machinery is nearing readiness. He has sixty "good men" engaged and under training and the prospect of obtaining more as he may need them. He knows he can perform but he needs indulgence as to time and must avoid pecuniary embarrassment in an early stage of the business." (He clearly had his eye on the second $5,000 advance.) He closed by seeking an appointment with Wolcott so as to lay before him his "whole plan and manner of executing the different branches of the work."

We now know only that Eli's plea was heard, appreciated and the government's patience (and purse) extended. It was not to be the last time. Meanwhile, his armory continued to take shape and production procedures to evolve. The thrust of the scheme was, in simplified form, something as follows: the component parts of the musket were to be carried through the manufacturing process in lots: tens, hundreds or thousands of each. In the various stages of progress, they underwent successive operations by machinery which very significantly reduced the time and labor expended and, of equal importance, permitted the development of form and dimension by workmen of small skill and with little or no experience. Many parts passed across the benches of several workmen in succession, frequently returning several times and at odd and varied intervals to the same men. Each performed some single and simple operation by machinery or by hand until the part was finally finished. The degree of precision of the work was such that, in the later stages of the process, when the various parts were being assembled, the adaptation one to the other and of the entirety into a complete musket could be accomplished with a reasonable amount of adjusting and fitting.[33]

This industrial process had the beauty of employing workmen of ordinary capacity who could quickly acquire sufficient dexterity to perform a branch of the work. It was a process which did not produce a craftsman and was totally destructive to the elder concept of the all-around master. In fact, it was Eli's preference to hire and train new and inexperienced workmen rather than to fight the prejudices, habits and resistance to change which frequently characterized armorers who had learned the trade under the classic apprentice system.[34]

So passed the 18th Century and there were still no Whitney muskets. Then, world and domestic politics intruded, once again, into the equation. In Europe, Napoleon came to power in France and cordially welcomed the new embassy sent by President Adams. With the ensuing treaty between the two countries passed the threat of war and with it the pressing need for arms. To this was added the move of the national capitol to Washington in the summer of 1800 and the transfer of responsibility for arms procurement from the Treasury Department to the War Department. Eli must have watched this last development with growing trepidation, for by June 1, 1801, he had still not delivered a single musket.

Then on June 15, 1801, almost three years to the day that he had received his contract, the shoe was dropped!

War Department 15 June 1801

Gentlemen:

The business of the contracts for fabricating small arms for the use of the United States entered into the by Treasury Department having been transferred to this department and it appearing that the time stipulated for the delivery of the muskets to be fabricated under your contract has some time since expired, you are hereby notified that if the number contracted for shall not be ready for delivery on or before the 31st of August next no part of them will be received after that time unless very particular circumstances should exist to justify an indulgence of a further period of three months or until the 30th of November next, which in all events will be the latest date at which arms will be received. If you conceive such circumstances to exist in your case, you will be pleased immediately to state them for my consideration.

I am very respectfully your obt. servt,

Henry Dearborn[35]

Eli Whitney and fifteen other contractors each received a copy of this "bomb"; the other eleven original contractors

had long since given up the business as a losing proposition.

Eli always seemed to be at his best when his back was up against the wall and he was, assuredly, in deep trouble this time. Once again his "old black magic" which we know so well worked. His friends in the upper levels of the government, appreciating his mechanical genius and business ability, recognized the long term importance to the United States Government and the arms manufacturing industry of his efforts and not only did not cancel his contract but agreed to advance him an additional $10,000 through a loan from the Bank of New Haven and permitted him to proceed with his contract.

And so, on September 26, 1801, thirty-nine months after first signing the contract, Eli delivered 500 muskets, inspected by Noble Orr, to Timothy Phelps.[36] Nine months later, on June 15, 1802, he delivered a second parcel of 500 muskets, this time inspected by Decius Wadsworth, to Timothy Phelps.[37] He was on the way.

These first thousand muskets, (Figure 7) were close replicas of the Evans pattern and clearly exhibit the full Charleville silhouette; they are made with an integrally forged, faceted, iron pan just like the pattern. It was not until Robert Reilly's fine book, *United States Martial Flintlocks*, was published in 1986, that the first correct description of the lock of this first pattern musket was placed before the arms collecting world. Theretofore, both Hicks and Fuller had illustrated by drawing or picture a Whitney arm of similar outward appearance but with a shorter barrel, slightly different lock plate and trigger guard, and a detachable pan. Both authors believed these specimens to be examples of Eli's first production. While there may be an explanation for the differences which appear in the arms exhibited in the Fuller and Hicks studies, the fact is that Eli delivered precisely what he had contracted to produce: a near copy in all respects of the Evans version of a Charleville musket.

Now, it may be recalled that this paper has speculated on Eli's reaction to the pattern musket he had received. He could not have been overjoyed with the additional manufacturing complexities which the integrally forged pan represented. If we have drawn any insights on the man at all, we assuredly have perceived that he was resourceful, and it is a good wager that he had long racked his brain on how to get around this pan business.

While we are in this speculative mood, there is an even larger area of rumination to be explored: why the Charleville was the "sainted" pattern of all good things in shoulder arms? Its image brooded over American musket procurement from 1794 until 1814. We will never know. It was asserted to be the best arm of its class during the

Figure 7. Whitney Model 1798, first type (first 1000) musket.

Revolution. With no disrespect to the Gallic musketphile, this is open to debate. It did possess one definite advantage over the Short Land pattern Brown Bess: the barrel is retained in the stock bed with bands rather than pins, which made disassembly for cleaning much simpler for the soldier and safer for the stock. The Charleville cock is double-necked whereas the Brown Bess cock is of a graceful goose- or swan-neck form. Potentially, the French cock is therefore stronger. With these exceptions, the Brown Bess seems to be an altogether sturdier, more rugged arm. Given the fact that the powers-that-were did not agree with the foregoing and selected a French arm (and in those days of emotion-charged politics, "French" may be the real answer) why did they not select the Model of 1777? (Figure 5). At the time of the Revolution, this was the most modern of the French shoulder arms, while the arms which France provided the Colonies were the updated but obsolete or obsolescent "war reserve" weapons stored in the royal arsenals. So far as we know, no 1777 arms were shipped to the Americans, though it is known that the French troops at Yorktown under the command of Rochambeau were equipped with this musket.

The Revolution had ended in 1783, and it is very hard to believe that those who should know were not well aware of the existence and of the marked superiority of this musket over the updated 1766. Even if we accept the inconceivable and assume that there was total ignorance of the virtues of the model 1777 in 1794 when those early contracts which Pickering discussed were let, we have seen that Madison had sent home a specimen of the arm in 1794-1796. The 1777 musket was here in the United States; it had been so for a long time; and its existence had to have been known at the time of the 1798 contractual furor. One might also ask the question "if not the 1777, why then wasn't the 1795 Springfield specified as the pattern for the 1798 contacts?" After all, by the time of the 1798 contracts, Springfield had manufactured some 3,500 stands.

Eli was in no position in 1798 to argue with the framers of his unique contract over the generic model to be used. In 1801, however, he was now experienced in all the aspects of his new trade. While it stretches the imagination to accept that he was unaware of the 1777 before the 1801 examination of a specimen cited by Hicks,[38] nevertheless, he was reported most impressed, and this impression was shortly to be turned into inspiration.

The summer of 1801 had been traumatic. With ruin facing him upon receipt of Dearborn's termination letter, the activity at the armory could only have been characterized as being desperate in nature as every fibre was stretched to finish the first parcel of 500 muskets. "That Bloody" pan could only have contributed to the delays, problems, and complexities. Allegedly, Eli had offered as part of his counter to the termination notice, to incorporate improvements into his muskets inspired by his examination of a model 1777. Here was the way out, and it is submitted that the pan was the number one candidate. By going to a detachable pan, he could at one and the same time keep the musket under the mandated umbrella of the "Charleville pattern" yet incorporate at least one improvement inspired by the 1777 and do so in fairly short order. It would still take time to do this, and it is further submitted that the first few were assembled with detachable iron pans in complete keeping with a Charleville pattern currently being accepted. With the tools ready, the processes established, and the foundry set up, the merits of cast brass over cast iron would not long have been missed, especially after finishing an indeterminate number in iron. The "change order" went out to the factory, brass was substituted and appears in the parcel of 500 muskets delivered on September 6, 1802. The few precursors, equipped with iron detachable pans, would have been included in the parcel accepted in June 15, 1802, the last of the original iron pan pattern.

The detachable iron pan has until recently been a matter for speculation; then in February of 1992, out of the mists, emerged a 1798 Whitney musket in full, original compliance with the Charleville model, including a faceted, detachable iron pan. The author owned that wonderful musket for nine months and handled it (fondled it is a better phrase) for a brief hour on November 1, 1992. It was destroyed in a catastrophic fire seven days later, but it existed; and if there was one, there may have been more that survived and still live.

On September 6, 1802, and again on March 31, 1803, Eli delivered parcels of 500 muskets each, both inspected by Robert Orr. The government receipts for this second group of 1,000 muskets bear the cryptic comment "with brass pans."[39] Figure 8 is an example of this musket. It is in full congruity with the construction of a Charleville with the exception that its detachable, faceted pan is brass. With this musket, Eli has broken out of the lock manufacturing nightmare imposed upon him by the Evans pattern. He is still making a musket of the "Charleville Model" as stipulated in his contact, in fact it is more "Charleville" than was the Evans pattern. There is some question as to whether he got the idea for the pan material (brass) from his examination of the French 1777 musket. There can be no doubt whence he drew inspiration for the nature and design of the pan: the 1766 Charleville. It is believed that Figure 8 is the first time that one of these second thousand Charleville pattern muskets has been illustrated, or, at least, correctly identified and done so on purpose! At this point it is appropriate to examine, side by side, Eli's pattern, the

Evans, and the two direct descendants of this pattern. Figure 9 shows the complete muskets; Figure 10 is a study of the three locks; and Figure 11 permits examination of the left sides.

Figure 8. Whitney Model 1798, second type (second 1000) musket.

Figure 9. Whitney second 1000 (left); Whitney first 1000 (center); Evans musket (right).

Referring to the Reilly work previously cited, therein is to be found brief reference to a 1798 Whitney musket of "a second type....changed by including a detachable, faceted, brass pan."[40] There is also one of his beautiful, photo-like drawings of the lock of this "second" type. James Hicks illustrated in Volume I of his work, his candidate for a Charleville pattern Whitney musket.[41] The drawing is by André Jandot, who has the same magic talent as Reilly for superbly accurate line drawing. This musket's lock is identical in form to the Reilly lock, though the material used to make the pan is not specified. The Hicks' musket has a 42¾ inch barrel and a 10½ inch trigger guard pointed only on the forward end, which varies significantly from that of a Charleville. Finally, in Claud Fuller's volume on Whitney there is illustrated a musket, the differences of which were the source of Fuller's ruminations (42¾ inch barrel and shorter, 10½ inch trigger guard, pointed only on the front end) on why there were divergences from the Charleville

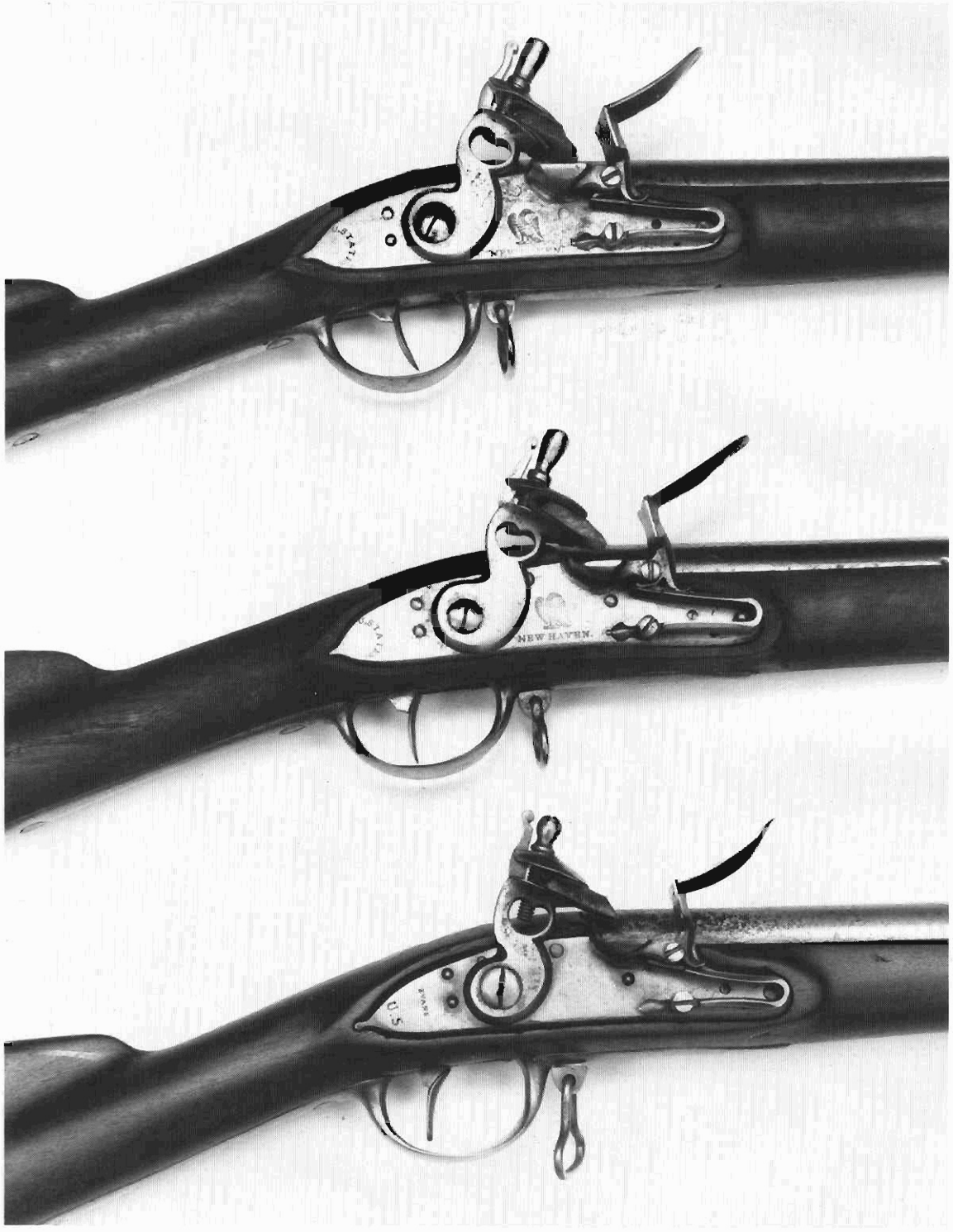


Figure 10. Whitney second 1000 lock (top); Whitney first 1000 lock (center); Evans 1794 lock (lower).

pattern. The detachable iron pan lock is identical in design to the foregoing two locks. Examination of these three locks, however, reveals that all three have a plate which differs from the 1766 pattern in the shape of its rear end and in location of the screw ends protruding between the cock and the pan. Figure 12 depicts this lock. None of these arms is an example of one of either the first thousand with iron pans or of the second thousand with brass pans. If these three locks (and two muskets with 42¾ inch barrels and shortened 10½ inch front end only pointed trigger guards) are not examples of the 1798 Whitney-Evans-Charleville pattern muskets, what might they be? We must wait a bit before we try to answer this, while we look at the final form taken by Eli's first two thousand.

The chain of events set into motion by Henry Dearborn's letter during the summer of 1801 now truly began to come together and the clear influence of the French 1777 musket emerged in full. Eli's 1801 agreement

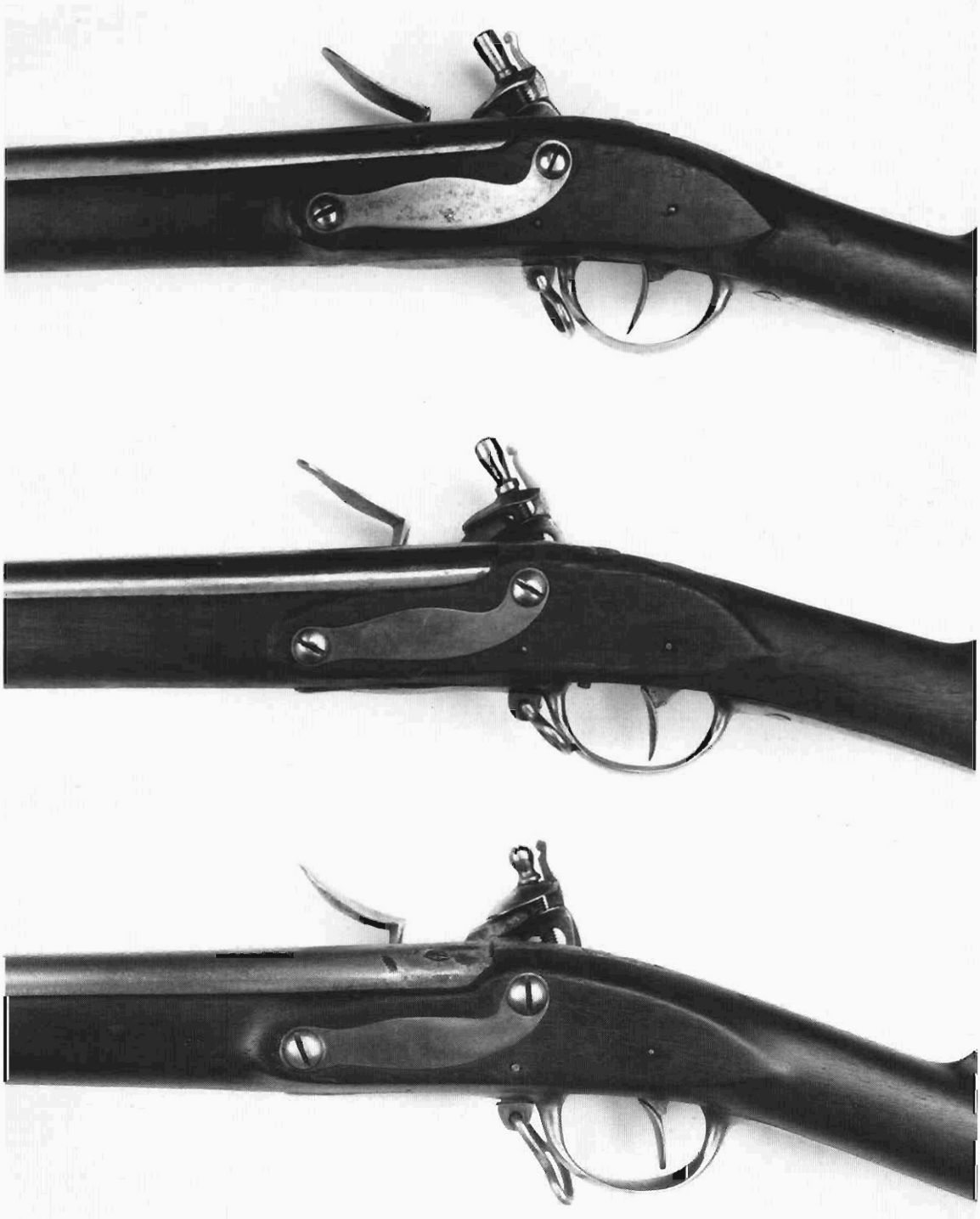
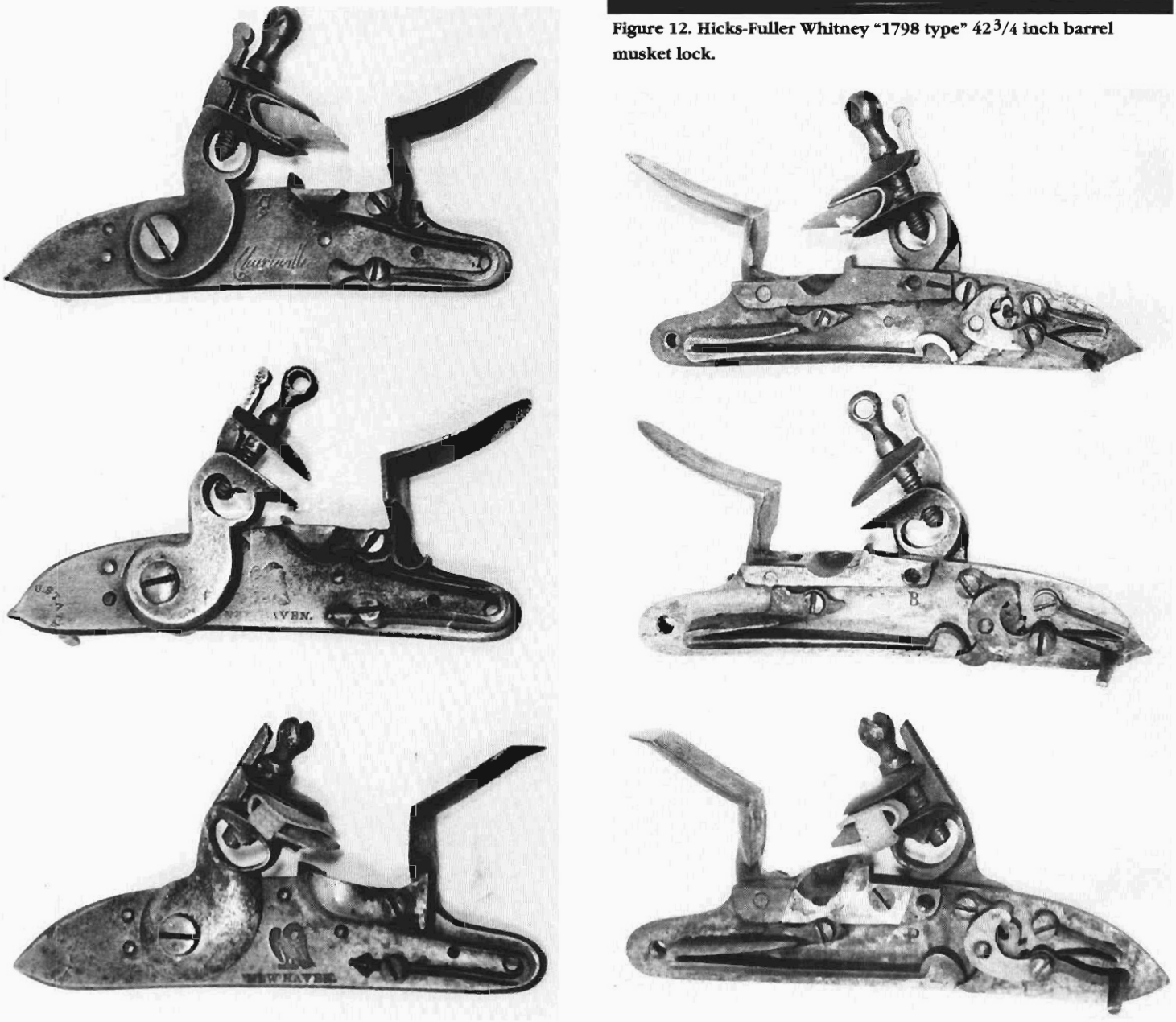


Figure 11. Whitney second 1000 left side (top); Whitney first 1000 left side (center); Evans 1794 left side (lower).

with the government is purported to have included approval of his proposal to incorporate improvements patterned predominantly after the lock of this musket into his production. Figure 13 is a comparative study of Charleville, Whitney 1798 I, and Whitney 1801 improved locks. From this date seems to draw the current appellation of "1801 improved" to the balance of Whitney's 1798 contract—a matter of 8,000 muskets. The date is a bit misleading, for it was not until July 11, 1803, that the records documenting the delivery of 500 muskets, inspected by Robert Orr, bear the annotation "with brass pans and other alterations complete."[43] This comment appears on each of the remaining deliveries until completion of the contract on January 23, 1809.

The sources of inspiration for Eli's 1801 improved 1798 musket, Figure 14, deserve attention at this point. Figure 5 is the French infantry musket Model of 1777 as modified in French Republican Calendar years IX (1800-1801) and XIII

Figure 12. Hicks-Fuller Whitney "1798 type" 42 3/4 inch barrel musket lock.



Figures 13, 13a. Exteriors and interiors of Charleville (top); Whitney 1798 first 1000 (center); Whitney 1801 improved (lower) locks.

(1804-1805). Figure 15 is the side-by-side comparison of the 1777 and Whitney muskets. Figure 16, permits a close examination of the French 1777 improved an IX and the Whitney improved locks. It is clear that this improved French musket, figure 5, was not the pattern: aside from the stock, the frizzen, the bands, the barrel length, the ramrod, and the finger ridges to the rear of the trigger guard differ markedly. Yet this musket differs from the original unimproved 1777 essentially only in the abandonment of a frizzen with a forward tilting top, and the addition of band springs to all bands. The barrel length of the Whitney musket is 42¾ inches; to find a 1777 with such a barrel one needs to turn to the 1777 Dragoon musket with its 42¾ inch barrel. So it would seem that Eli had an unimproved 1777 Dragoon musket to examine and serve as his source. Perhaps fortified in his decision by the fact that the Brown Bess short Land pattern also had a 42 inch barrel, he copied the Dragoon barrel. He retained the original Charleville stock form and stock furniture, reducing the band spacing to suit the shorter barrel. He modified his Charleville trigger guard to a simplified but close copy of the 1777 trigger guard, Figure 17. Finally, he copied closely the lock assembly, retaining a simpler-to-manufacture flat lock plate contour and mounting thereon the unmodified 1777 lock furniture which included the frizzen with the older forward tilting tip. That was it! And that was the way the last 8,000 muskets went out. The delivery price, by the way, was increased ten cents per musket!!

It is now time to grapple with the Hicks-Fuller-Reilly musket. Figure 18 is the Fuller piece. It closely resembles the Hicks specimen. We can see that it has the appearance of a 42¾ inch barreled Charleville. Both arms have shorter (10½ inch) trigger guards, pointed only on the forward end, Figure 17; both have Charleville lock furniture. In Reilly's drawing of the lock the pan is reported to be of brass; Fuller's is iron; Hick's is unknown. All three lock plates are identical to each other and to the plate of the 1801 improved musket. The trigger guards are also identical to that of the "improved" arm. These differences not withstanding, it is not hard to see how Fuller and Hicks, writing half a century ago, might have been misled into wishfully thinking that they were looking at one of the first two thousand muskets. When dealing with the 1798 contract pieces, diversity has always been the norm, with significant variation in barrel lengths, lock plate shape, lock furniture design, and trigger guard shape and dimensions.

Collectors love to use (and frequently misuse) the term "transition," but this is what we might be looking at here. Significant to a transitional attribution is the fact that shorn of the cock, pan, and frizzen, these are 1801 improved muskets. It takes no stretch of the imagination to see Eli with an early batch of near complete improved

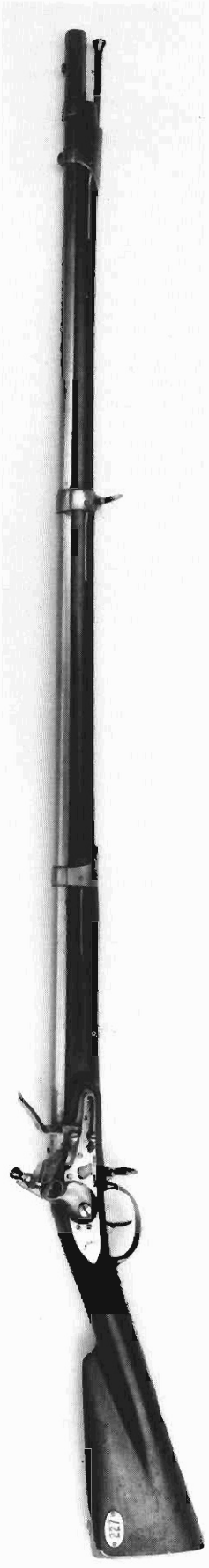


Figure 14. Whitney 1801 improved Model 1798 musket.

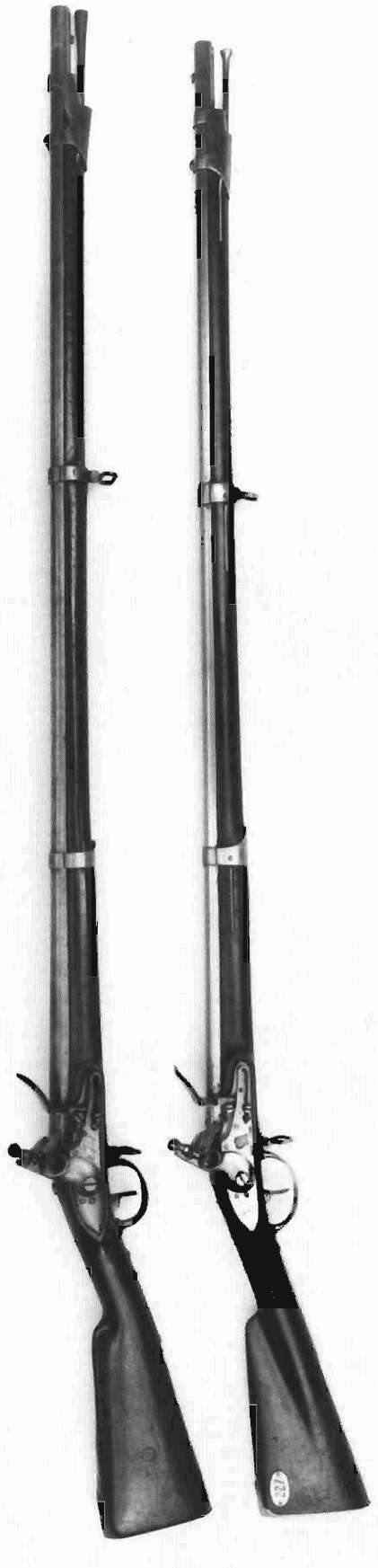


Figure 15. French Model 1777 improved an IX and an XIII, (left) and a Whitney 1801 improved Model 1798 musket.

muskets short of fully finished "improved" lock parts. The temptation to complete them out of remaining stocks of older lock furniture and to get on with the operation would have been a natural route to take. This practice became a favorite indoor sport at Springfield. If this is in fact close to the truth, then these muskets would be at the interface between March 31, 1803, and July 11, 1803, when the full metamorphosis from the 1766 "updated" Charleville to the original 1777 inspired Eli "improved" musket first occurred. They would have been included in the parcel of muskets accepted on July 11, 1803. The pan material is of critical importance and should be brass.

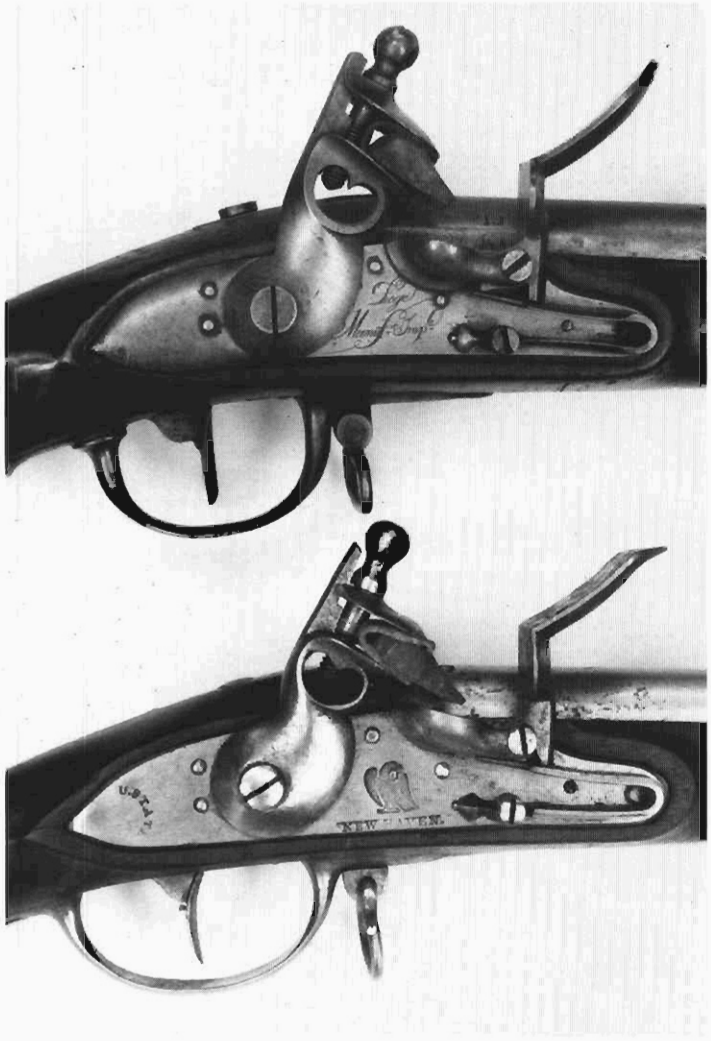


Figure 16. French Model 1777 improved an IX (top) and Whitney 1801 improved Model 1798 (lower) locks.

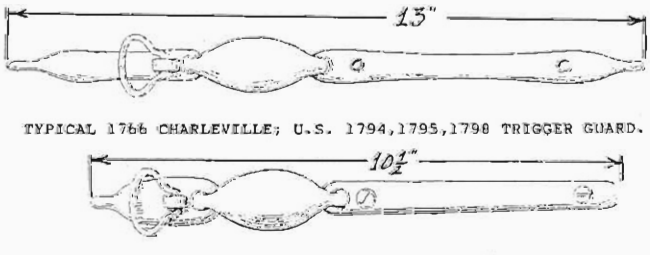


Figure 17. Typical Charleville (top) and Whitney 1801/French 1777/ Fuller-Hicks "1798" trigger guards (lower).

Now, there is one serious note of caution to be struck with such an attribution should you be called to make one. Examination of the Fuller musket reveals an iron pan and finial on the frizzen spring which does not correspond to the finials found on the early Whitney muskets. These deviations may signal, at best, a workmanlike reconversion performed before more recent study had established proper form and material for the frizzen spring and the pan. At worst, one must also recognize the possibility of an inadvertent but totally erroneous restoration; a backward "Charlevilleizing," so to speak, of a percussion conversion of a fully developed 1801 improved musket. It is for this concern that the Reilly lock with its detachable, brass, Charleville type pan assumes such importance and lends strong credence to the existence of such a musket.

With this we have exhausted the saga of Eli's first two thousand muskets, pursued their mutations and seen him finish his contract in 1809, eleven and a half years after he first received it. Eli looms in the mists of myth over the American Industrial Revolution. He has been lionized as fathering the interchangeable parts concept in arms manufacture. This is really not the case. Eli's process was not an interchangeable parts process and any interchangeability achieved right off the production line was pure accident. He has been credited with inventing and employing the milling machine in the production of his 1798 muskets. This is not the case either. Edwin Battison conducted a high magnification examination of the various parts of an 1801 improved musket and could find evidence for the use of the hollow mill and the circular slitting saw and nothing more.[44] Neither of these is a true milling machine in the modern sense of that word, and both of these devices had been in use by clock makers, Russian cannon founders, and Honoré Blanc for decades prior to Eli's use of them.

This is not an attempt to denigrate a great man. Eli Whitney established the basis for the mass production of industrial products with an unskilled labor force not trained under the old guild-hall system. He pioneered in the field of applying power to operate a wide variety of machinery to expedite and facilitate industrial production. His ideas, innovations, and technical improvements in small arms foretold similar advances in the Federal armories by fifteen years. He pioneered in the establishment of that great network of private armories owned by Simeon North, Lemuel Pomeroy, Nathan Starr, Asa Waters and Henry Deringer.

All of this he did, AFTER he had invented the cotton

gin: an accomplishment which has, for its century, been equated in social and economic significance to James Watts, invention of the steam engine.

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Figure 18. Hicks-Fuller Whitney 1798-1801 improved "transition" musket.