The Production of Gunpowder in Pennsylvania During the American Revolution

began a search for the supplies necessary to carry on an armed conflict.* One of the critical items they sought was gunpowder; and, if the finished powder was not available, they gladly settled for saltpeter and sulphur, two of the ingredients needed to manufacture it. In their first efforts the Americans turned to known sources both at home and abroad. Committees of Safety collected existing stores, not only to acquire supplies for their own use but also to prevent them from falling into unfriendly hands.¹

This collection of existing stores was an important source of gunpowder and its ingredients, but it was only one of the ways in which the colonists planned to supply themselves with powder. In 1775 and 1776, Americans had high hopes that they could produce much of their own gunpowder, and Pennsylvanians took a prominent role in that attempt. These efforts were encouraged by the close working relationship between the Pennsylvania government and the Continental Congress. Pennsylvanians were also fortunate in having the

^{*} I would like to acknowledge the assistance of Professor Eugene S. Ferguson, Mr. Robert A. Howard, and the Eleutherian Mills-Hagley Foundation.

¹ In the first few months of the war one county, Lancaster, and the city of Philadelphia collected 3,184½ pounds of gunpowder, and other counties followed suit. Samuel Hazard, ed., *Pennsylvania Archives*, Series 1, V, 111; *Pennsylvania Archives*, Series 2, XIII, 293; Samuel Hazard, ed., *Pennsylvania Colonial Records*, X, 301.

A seminal article, Orlando Stephenson's "The Supply of Gunpowder in 1776," American Historical Review, XXX (1924-25), 271-280, is the basis for many later comments on American gunpowder production during the Revolution. Stephenson's article includes a computation, based on unnamed sources, of the amount of powder produced and collected in the colonies, and the amount imported from abroad. His figure for the amount collected in Pennsylvania is 4,000 pounds; if the figures given above are any indication, this would appear to be too low. Both Stephenson's computations, and his thesis, that the gunpowder produced in the colonies had no effect on the war, may be questioned.

most famous and, possibly, the only operating powder mill in the colonies—at least until May, 1775. The encouragement given to this mill, and Pennsylvania's other attempts to produce a domestic supply, was characteristic of American enthusiasm for home production. This enthusiasm faded, however, as the war dragged on and production faltered. Inflation, the lack of raw materials, political squabbles, destruction of the mills by the British and by accident, and the willingness to depend on foreign imports hindered the development of the Pennsylvania mills. The one thing that did not seem to be lacking was technological know-how and ability.

Because of limited production facilities at the outset, the colonists also pursued ways of obtaining gunpowder and supplies of saltpeter and sulphur from abroad. Although George III, in October, 1774, had forbidden the exportation of gunpowder to the American colonies, it did not take long for the colonists to find ways around this edict. The Pennsylvania Committee of Safety, and committees in other colonies, appropriated money and appointed merchants to import supplies. From May to June alone, in 1775, the Pennsylvania Committee spent £20,300 (plus £4,000 for freight) to procure arms, ammunition, and medicine from Europe; during the same period they were able to spend only £8,200 in America for the same purposes.²

Powder mills had operated in the colonies during the seventeenth and eighteenth centuries, but they fell into disrepair after the French and Indian War. In 1774 the only significant mill in the colonies was located on Frankford Creek, just north of Philadelphia.³ The Frankford mill, which belonged to Oswald Eve, began operation just prior to George III's proclamation forbidding the exportation of powder to the colonies. This led some to hope that "the said Proclamation will be rendered ineffectual by a manufactory of Gunpowder, which has lately been set on foot in this Province, the materials of which may be procured in great perfection, and at an easier rate than they can be imported from Great Britain, among

² Pa. Col. Recs., X, 350-351.

³ A survey of Eve's land is in *Pa. Col. Recs.*, XII, 668-669. Charles C. Smith, "The Manufacture of Gunpowder in America," *Massachusetts Historical Society Proceedings* (March, 1876), 248-256; Arthur Pine Van Gelder and Hugo Schlatter, *History of the Explosive Industry in America* (New York, 1927), Chp. 1.

ourselves."⁴ That statement was more propaganda than fact, for the materials needed to produce powder, especially saltpeter, were neither abundant nor cheap.⁵ Nevertheless, before 1777 an impressive number of new gunpowder mills and saltpeter refineries were built in southeastern Pennsylvania.

Oswald Eve's mill became celebrated throughout the colonies. Both inquisitive tourist and anxious patriot, eager to learn the mysteries of making powder, visited his works. In November, 1775, the Massachusetts Committee of Safety sent Paul Revere to Philadelphia to inspect Eve's mill. John Dickinson wrote Eve, at the behest of Congress, that New England had a great deal of saltpeter "in Consequence of which they desire to Erect a Powder Mill & Mr. Revere has been pitched upon to gain instruction & knowledge in this branch. a Powder Mill in New England cannot in the least degree affect your Manufacture nor be of any disadvantage to you." Eve evidently agreed and opened his works to Revere, and to others as well.

One of his visitors was Charles Willson Peale. Peale's experiments with saltpeter and gunpowder gave him some insight into what he observed. He visited Frankford in January, 1776, and recorded the fullest description we have of Eve's mill.⁸

Peale did not mention the kettles or tubs in which Eve mixed his ingredients, but he did note "something of the sifter kind fixed as bolting cloths are commonly. . . ." This contained a number of balls

- 4 "Extract of a Letter from a Gentleman of Philadelphia, to a Member of the British Parliament, Dated December 24, 1774," in Peter Force, ed., American Archives, Series 4, I, 1066.
- 5 Gunpowder is composed of four ingredients (saltpeter, sulphur, charcoal, and water) which are mixed together, not chemically combined, in the ratio of about 100 parts saltpeter (also called niter) with 18 parts charcoal and 15 parts sulphur (also called brimstone). The Essays Upon the Making of Salt-Petre and Gun-Powder, published by the Committee of Safety of the Colony of New York (New-York: Printed by Samuel Loudon, 1776) provides a good description of eighteenth-century procedures for making gunpowder and saltpeter. More recent works include Oscar Guttman, The Manufacture of Explosives (London, 1895); Van Gelder and Schlatter (mentioned above); and, Norman B. Wilkinson, Explosives in History (Chicago, 1966).
- ⁶ Dickinson to Eve, Nov. 21, 1775, Revere Miscellaneous Manuscripts, Massachusetts Historical Society.
 - 7 Petition of Oswald Eve, Mar. 22, 1776, American Archives, Series 4, IV, 464.
- 8 Charles Willson Peale Diary, 1775-1776, American Philosophical Society, entry for Jan. 20, 1776.

about the size of a small fist. Although Peale did not have time to examine the use of it, this probably was used to prepare the sulphur and charcoal prior to mixing. As Henry Wisner explains, the saltpeter, sulphur, and charcoal "are to be made as fine as possible, so as to be sifted through a gauze sieve, or fine boult, as fine as common flour." Eve and the other powder makers had to refine, grind, and sift their ingredients to obtain the purity needed to produce a dependable powder.

Eve had constructed his mill so that much of the work was done by water power. The ingredients were intimately mixed, or incorporated, in the stamping mill, where a

Great wheel turns 2 smaller, the axis of which is a long piece of timber, in which are fixed pieces to lift up pieces of Oak Scantlin confined in frames to move up & down falling into an oval mortar. Cut in a large piece of timber there was several of these mortars, according to the length of the shaft, & 2 pieces falling into ea[ch] mortar.

To granulate his powder Eve had "Three sifters moved by cranks, these sifters made of withs [small twigs]..." After graining, the powder was tumbled in a barrel to give it roundness. In Eve's mill "the same axis that moved the shaft had a whirl for a band to carry round a barrel to give the grains roundness." For the final process, drying the powder, Eve had a dry house with two square stoves. As a precaution against explosions the doors to the furnace were in a separate room, and the powder hung in trays near the ceiling. This was an uncomfortable operation, for, as Peale noted, the room was "exceeding hot."

Although Eve may have sold powder to Congress or to the Pennsylvania government prior to this, the first recorded delivery of Frankford powder was on August 16, 1775. From that date until the end of the year, Eve delivered 1,949½ pounds of gunpowder; this included 250 pounds of damaged powder sent him to be remade. After the first two months, when 575 pounds and 350 pounds of powder were made, Eve's monthly production did not exceed 250

⁹ Henry Wisner, "An Excellent Method of making Gun-power" [sic], in Essays Upon the Making of Salt-Petre and Gun-Powder, 37.

¹⁰ The damp gunpowder was pressed through a series of increasingly finer sieves or sifters made of withes to produce the grains of powder.

¹¹ Pa. Col. Recs., X, 306; for the following figures, see ibid., 341 ff.

pounds in 1775. One problem may have been in securing the materials, especially saltpeter, necessary to carry on production.

To remedy this deficiency, Congress recommended that the various colonies gather saltpeter and sulphur and send it to manufacturing centers.¹² Pennsylvania, Delaware, Maryland and New Jersey were to send their supplies to Philadelphia.¹³ Congress urged even distant South Carolina to send its saltpeter to Philadelphia, since Pennsylvania had the mills to manufacture it.¹⁴ At the same time, Congress encouraged the individual colonies to appoint persons "to collect earth from which nitreous salt may be extracted, and to manufacture it into salt petre."¹⁵

Pennsylvania did not take long to adopt Congress' suggestion. It was thought that any large town could supply enough nitreous wastes to make saltpeter and that Philadelphia would be a leading producer. The Committee of Safety of York suggested that "one kettle will make 50 or 60 lb p^r week, and there is doubtless materials in the City & Liberties to employ ten, which would furnish one Powder Mill at least with Salt-petre." 16

On July 3, 1775, the Committee of the City and Liberties of Philadelphia voted to undertake a local saltpeter manufactory. But more was involved than they had thought. Although the works got underway, they came to a temporary standstill in October for want of money and the necessary skill. Production began in earnest only after the Committee of Safety of York sent one of its experienced saltpeter makers, Baltzar Moody, to instruct the Philadelphians, and when the Pennsylvania Committee of Safety took over management of the works. 19

In addition to assuming this operation, the Pennsylvania Committee decided to encourage others to manufacture saltpeter as well. The Committee resolved to pay five shillings for each pound

¹² Worthington C. Ford, ed., Journals of the Continental Congress, III, 345-348.

¹³ American Archives, Series 4, II, 346.

¹⁴ Robert Gibbes, Documentary History of the American Revolution, Consisting of Letters and Papers Relating to the Contest for Liberty, Chiefly in South Carolina (New York, 1855), I, 117.

¹⁵ Worthington C. Ford, ed., Journals of the Continental Congress, III, 346.

¹⁶ Pa. Arch., Series 1, IV, 668.

¹⁷ American Archives, Series 4, II, 1533.

¹⁸ Pa. Arch., Series 8, VIII, 7308.

¹⁹ Pa. Arch., Series 1, IV, 668; Pa. Arch., Series 8, VIII, 7367-7378.

of saltpeter made in Pennsylvania within twelve months.²⁰ A later resolution changed this offer to niter, another term for saltpeter, made in Pennsylvania from January to April, 1776, with payment to be one-fourth in gunpowder and the other three-fourths in money, still at five shillings per pound.²¹ At the same time, the Committee began a program of education with the printing and distribution of handbills, in English and German, on how to make saltpeter.²² It urged county Committees of Safety to send people to Philadelphia to be instructed at the saltpeter works and then to act as teachers in their own districts. A number of counties responded by establishing model works and providing demonstrations.²³ During 1775 and 1776, these efforts produced tangible results as enthusiastic patriots delivered amounts of saltpeter varying from ten ounces to 400 pounds.²⁴

Not all were so successful. The Committee of Safety of Carlisle appointed Jonathan Kearsley to teach others how to make niter and to carry on a saltpeter works.²⁵ But neither his knowledge and zeal, nor the elaborate works he constructed, could overcome the lack of niter-impregnated soil. On March 30, 1776, Kearsley wrote the Committee of Safety:

I have been employ'd five Weeks with three men, two weeks making Ready and gathering earth, three weeks boiling, &c, the earths I have yet got are so lighty impregnated with Nitrous particles that I have as yet got but 15 lbs of Salt Petre. I have 14 Tubs, 4 Boilers containing upwards of 200 Gallons, Besides Receivers, ashers, Stand [Stamp] Collectors, &c.²⁶

Kearsley was just one of those who became discouraged when readily available materials disappeared and government encouragement ceased. The colonial gunpowder manufacturers relied more

²⁰ Pa. Arch., Series 8, VIII, 7368. A resolve to encourage saltpeter production the previous June evidently had little effect (Pa. Col. Recs., X, 280). For the effectiveness of the bounty system, and the result when it was discontinued, see Monte A. Calvert, "The Search for a Domestic Source of Saltpeter for Use in Making Gunpowder, 1620-1920" (M.A. Thesis, University of Delaware, 1961), 6-10.

²¹ Pa. Col. Recs., X, 441.

²² Ibid., 443; Pa. Arch., Series 2, XV, 470.

²³ Pa. Arch., Series 1, IV, 706; Pa. Arch., Series 2, XV, 354-355; Pa. Col. Recs., X, 499 ff.

²⁴ Pa. Col. Recs., X-XI, passim.

²⁵ Pa. Arch., Series 1, IV, 706.

²⁶ Ibid., 727.

and more on imported niter, much of it coming through Philadelphia.27

As with saltpeter, the colonists also sought a domestic supply of sulphur. After collecting available supplies, the Committee of Safety placed an advertisement in the Philadelphia newspapers requesting information on sources of sulphur ore and on people with the knowledge to refine it.²⁸

One response came from Thomas Bedwell, a local tradesman.²⁹ He proposed to refine crude sulphur at the rate of twenty shillings per hundredweight of refined sulphur, the Committee paying for the construction of a furnace and the transportation of the sulphur. Then, leaving the Pennsylvanians to make up their minds, Bedwell traveled to Connecticut and offered his services to that colony as well.³⁰ When both colonies accepted his terms, Bedwell formed a partnership with John Walters to run the Pennsylvania refinery and began operation sometime in April.³¹

Their Pennsylvania refinery ran smoothly until January, 1777, when inflation and Walters' lack of foresight hampered their operation.³² The cost of fuel was high in Philadelphia, and Walters had waited for the price to fall. When this did not happen, and available supplies were depleted, he was forced to ask the Committee of Safety for permission to cut wood from the barracks' lot so that the refinery could continue to operate.³³

In its search for sources of sulphur ore³⁴ the Committee considered several sites in Pennsylvania, but the most promising ores appeared

²⁷ Henry Wisner to New York Committee of Safety, Mar. 28, 1776, in American Archives, Series 4, V, 1421.

²⁸ Mar. 14, 1776; Pa. Col. Recs., X, 514-515. On March 30, the Committee offered to pay four shillings per hundredweight for good sulphur produced in Pennsylvania during the next six months. Pa. Col. Recs., X, 530.

²⁹ Ibid., 519.

³⁰ American Archives, Series 4, V, 1624-1625; ibid., VI, 879.

³¹ Pa. Col. Recs., X, 549.

³² Pa. Arch., Series 1, V, 182. As with saltpeter statistics, those for sulphur are sketchy, and are scattered throughout Pa. Col. Recs., X.

³³ Pa. Arch., Series 1, V, 182.

³⁴ Sulphur ore is generally found in pyrites, metallic sulphides, of which iron pyrites were the most important, containing from 25 to 39 per cent sulphur. Pyrites are widely distributed and supplied half the world's sulphur for many years. Extraction of the sulphur from the ore was by roasting. *Encyclopedia Americana* (New York, 1961), XXVI, 3; *Encyclopedia Britannica* (Chicago, 1891), 9th ed., XXII, 634.

to be in New Jersey.35 Elias Boudinot found one lode about ten miles from Elizabethtown, assayed the ore, found it promising, and proposed to hire men to mine more.³⁶ The Pennsylvania Committee sent samples of this and other ores to John Walters, who in early 1777 concluded: "I have made essays on Oars brot from all parts within five Hundred Miles, and find none so rich as what is found about Bordentown in ye Jerseys, which besides has the advantage of lying open to the Day, and being in prodigious Quantitys."37 With sulphur ore from these mines and imported crude sulphur, Bedwell and Walters continued their operation until the British occupied Philadelphia. After the enemy's evacuation of the city the following spring, the sulphur works did not resume production and the Pennsylvania powder mills had to rely on sulphur imported from other colonies or from foreign countries. However, all this was to come later, since in 1775 the colonists' hopes for a domestic supply of raw materials were high and the construction of powder mills had begun.

It was not long before other Pennsylvania mills joined Eve's in producing gunpowder for the American cause. In August, 1775, the same committee that approved the powder made at Eve's mill inspected that made at George Lush's works at Norriton.³⁸ Eve's and Lush's powder must have been acceptable; in fact, nearly any powder would have been welcome. During these months the American troops before Boston were almost destitute of ammunition. The situation was such that Washington wrote the neighboring colonies requesting powder, pleading that "No Quantity, however Small, is beneath notice." The output of the American powder makers could not be overlooked.

Although the Pennsylvania Committee inspected Lush's mill in August, its first recorded delivery was made on September 11, 1775.40 In October, Robert Towers, Commissary of Military Sup-

³⁵ Pa. Arch., Series 1, IV, 719-720, 723.

³⁶ Ibid., 727.

³⁷ John Walters to Council of Safety, Feb. 27, 1777, in Pa. Arch., Series 1, V, 245.

³⁸ Pa. Col. Recs., X, 301.

³⁹ John C. Fitzpatrick, ed., *The Writings of George Washington* (Washington, 1931-44), I, 386. Comments on the shortage of powder during the early months of the war are found in a number of sources, and particularly in Washington's writings.

⁴⁰ Pa. Col. Recs., X, 332.

plies, sent Lush 1,000 pounds of damaged Bermuda powder belonging to Congress and a small parcel belonging to the Philadelphia government.⁴¹ Two weeks later Lush returned 500 reconstituted pounds.⁴² From the amount of output, evidently neither Lush's nor Eve's mill was a very large enterprise. Although the figure is undoubtedly low (production prior to August is not recorded), existing records indicate that Eve and Lush supplied 2,352½ pounds of powder to Congress and Pennsylvania in 1775.⁴³

Whatever the amount, it was needed. On January 11, 1776, the Secret Committee of Congress made a contract with Eve and Lush to manufacture gunpowder for one year. 44 Congress would furnish the saltpeter, but the powder makers would have to supply the sulphur and charcoal, and pay half the cost of cooperage. Eve and Lush were also to pay for transporting the saltpeter from Philadelphia to their mills and for returning the finished powder. For this they were to receive \$8.00 for each 100 pounds they produced.

This government contract encouraged Eve to expand his mill; by late March he claimed to be making about 2,200 pounds a week.⁴⁵ If Lush's mill had a low output (which seems likely) this may have been true, for on March 3, 1776, Joseph Reed wrote Washington that "The two [mills] near this city deliver 2,500 pounds per week, and are now in very good order."⁴⁶

Congress and the Committee of Safety of Pennsylvania realized that the output of these two mills could not supply the growing need. If Washington was to drive the British from Boston and maintain forces in the middle and southern colonies, more powder was necessary. To increase production they decided to encourage the construction of several new mills. On January 17, 1776, the

⁴¹ Ibid., 365.

⁴² Ibid., 382.

⁴³ *Ibid.*, 306 ff. A Committee of Safety memorandum shows transactions with Congress involving a little more than 9,000 pounds of powder in July and August. *Pa. Arch.*, Series 2, I, 552.

⁴⁴ Pa. Arch., Series 1, IV, 696.

⁴⁵ American Archives, Series 4, V, 464.

⁴⁶ William B. Reed, ed., The Life and Correspondence of Joseph Reed (Philadelphia, 1847), I, 164. Lush evidently hoped to produce more. John Hancock wrote Washington, Jan. 16, 1775, of the Pennsylvania contract with two powder makers, one expected to produce nearly a ton a week, and the other one, a half ton. Jared Sparks, ed., Correspondence of the American Revolution being Letters of Eminent Men to George Washington (Boston, 1853), I, 122.

Pennsylvania Committee placed an advertisement in the Philadel-phia newspapers requesting that "Such persons as are willing to erect Powder Mills in this Province within fifty Miles distance of this City, are desired to apply to the Committee of Safety, who will lend them Money, on Security, if required, for that purpose, and give them other Encouragement." This ad and the Committee's other efforts produced results. By February 8, it received six proposals from people willing to erect powder mills. Encouraged by this response, the Committee consulted Congress and sought its support (as well as its saltpeter, since Congress controlled the large supplies imported into the colonies). Congress was only too willing to cooperate.

Three of the proposals received by the Committee were from residents of Bucks County—John Flack of Buckingham Township, William Thompson of Warwick Township, and Henry Huber of Lower Milford Township.⁵¹ Other proposals to erect mills came from Doctor Robert Harris of Delaware County and Thomas Heinberger of Chester County.⁵² George Lush proposed to increase his production, not by enlarging his present mill as Eve had, but by erecting two new mills.⁵³

A Doctor Vanlier, of Gloucester, New Jersey, offered to convert his fulling mill to the manufacture of gunpowder during the summer, if he had suitable encouragement.⁵⁴ This conversion of existing mills to other purposes was common in colonial times.⁵⁵ The same basic system of waterwheel, shaft, and gears powered the pounding devices used in fulling, tilt, and powder mills, or the grinding devices found in snuff and flour mills. This provides at least a partial answer

⁴⁷ Pa. Col. Recs., X, 459.

⁴⁸ Ibid., 479.

⁴⁹ Thid.

⁵⁰ Richard Smith Diary, see entries for Feb. 8-9, 12, 1776, in Edmund C. Burnett, ed., Letters of Members of the Continental Congress (Washington, 1921-36), I, 342-343, 346.

⁵¹ Pa. Arch., Series 1, IV, 709-710.

⁵² Ibid.

⁵³ Ibid., 709.

⁵⁴ Ibid., 710. The Committee of Safety appointed a subcommittee, on Jan. 25, 1776, to consider plans to erect suitable works, "or engage any mill or mills already erected for other purposes to convert them to make powder." Pa. Col. Recs., X, 467.

⁵⁵ Grier Schutz, "Flax Seed Mills," Papers of the Bucks County Historical Society, IV (1917), 725-726.

as to how powder mills suddenly came into being, and who had the ability to build them. Any good millwright could erect a powder mill and construct the basic machinery, or convert an existing mill (such as Vanlier's fulling mill) to the production of gunpowder.

On February 10, the Committee contracted with all but Dr. Vanlier (who must not have received "suitable encouragement") and John Flack on the following terms:

- I. To lend up to £150, on good security, to each person who proposes to build a mill; the Committee to be repaid in either money or work.
- 2. To supply at once, 50 pounds of saltpeter, and more in proportion to the powder produced each week.
- 3. To pay \$8.00 for each 100 pounds of powder delivered; the Committee finding only the saltpeter and paying one-half the expense of tight casks.
- 4. To give a ten percent allowance for refined saltpeter; the powder makers to return good powder in proportion. This saltpeter was to be manufactured so that at least 146 pounds of powder were returned for each 100 pounds of saltpeter delivered.
- 5. To pay a premium of \$100 to the first, \$50 to the second, and \$30 to the third powder mill to deliver one ton of powder each.
- 6. To give preference to the above mills in supplying saltpeter and material for twelve months; the powder makers to produce the powder on equal terms with other people.

In return, the powder makers were not to sell their powder to anyone except the Committee.⁵⁶ In March, Jacob Lorch, of Philadelphia County, also contracted with the Committee to produce powder.⁵⁷

The mills these men constructed were similar in appearance and operation to Oswald Eve's mill in Frankford. John Ladd Howell, who was directed by the Committee of Safety to tour the mills and examine their condition, provides a good description of some of them⁵⁸ in a report dated June 3, 1776.⁵⁹

⁵⁶ Pa. Col. Recs., X, 482.

⁵⁷ Letters of the Members of the Pennsylvania Congress, IV, 73, Historical Society of Pennsylvania.

⁵⁸ Owen Biddle to John Ladd Howell, May 29, 1776, Stewart Collection, Glassboro State College. Howell was to prove the powder made in these mills and encourage the workers to greater effort. He also was to find out: (1) if the mills were in operation, or when they would begin; (2) how many pounders they had in their stamping mills; (3) how many dry houses were erected; (4) how many pounds they could make per day; (5) what quantity of saltpeter and sulphur had been delivered to them; (6) if the conveniences at the mill were good or not.

⁵⁹ The following descriptions are in *Pa. Arch.*, Series 1, IV, 765-767.

One of the men Howell visited was Thomas Heinberger, who was listed as a powder maker in his original proposal. Heinberger's works were in Windsor Township, Chester County, on a stream emptying into French Creek.⁶⁰ His stamping mill, housed in a building thirty-six by thirty feet, was powered by an overshot water-wheel whose diameter was sixteen feet. This wheel turned two shafts, each working eighteen stampers.⁶¹ Heinberger also had a dry house, eighteen by twenty feet.

The Committee of Safety had contracted with Heinberger on February 23, 1775, and had advanced him £150 to erect his mill. On May 9 he received an additional £100 and 2,000 pounds of saltpeter; one month later he received a load of sulphur. Heinberger should have been ready to start production, but when Howell visited his works they were far from finished—the stamping mill was not floored or the dry house plastered, and the powder maker's house and the refining house had not been started. Heinberger hoped to begin production in ten days, but Howell doubted if he would meet that deadline.

Another mill which got off to a slow start was Henry Huber's on Swamp Creek in Bucks County.⁶² Huber had received an advance of £150 to begin work on February 23, but when Howell arrived little had been accomplished. The stamping mill, which was to measure twenty-three by fifteen feet, was barely underway, and the dam and race were not finished. Howell believed that unless more hands were employed the mill would not be in operation before the first of July. Evidently the pace of construction increased after his visit since there was a delivery of half a ton of saltpeter and fifty pounds of sulphur on June 15, and more in early August.⁶³

Dr. Robert Harris was more prompt. His mill on Valley Stream (Crum Creek), twenty-five miles from the city, began production in late May.⁶⁴ In the first week of production Harris claimed to be

⁶⁰ Heinberger's mill was about thirty-three miles from Philadelphia and two miles from Young's forge. Pa. Arch., Series 1, IV, 709-710, 766.

⁶¹ Each shaft, 22 feet in length, lifted the stampers, which measured 4½ inches square by 9 feet long. The two mortar trees were 20 feet long and had basins 12 inches by 9 inches by 16 inches deep. Pa. Arch., Series 1, IV, 766.

⁶² This was thirty-seven miles from Philadelphia on the road to Bethlehem.

⁶³ Pa. Col. Recs., X, 604, 665. For deliveries of saltpeter to him in September and December, see Pa. Arch., Series 1, IV, 732; and, Pa. Col. Recs., XI, 49.

⁶⁴ Harris' mill is described in *Pa. Arch.*, Series 1, IV, 761; and, Robert Harris to Committee of Safety, May 29, 1776, Stewart Collection.

able to make 400 pounds of powder a day, and had no doubt that he could produce a ton each week.⁶⁵

When Howell saw it, Harris' stamping mill was twenty by thirty feet, and was powered by a twelve-foot waterwheel. Although Harris thought his wheel rather small, he noted that it was supplied with plenty of water all year. This was an important consideration in an age when the lack of an adequate water supply in the summer months (when streams dried up), or in the coldest winter months (when the water froze) brought production to a halt.

At any rate, Harris' waterwheel powered eighty stampers, which fell three times for each turn of the wheel. This wheel also worked a stamper for preparing sulphur. Harris' graining equipment was housed in his stamping mill, it being "most handy to the stampers." This arrangement seems to have been a common practice. A stone storeroom for the saltpeter and sulphur, and a refinery for the saltpeter completed his works.

Several of Harris' buildings were not finished. His dry house, twenty by fifteen feet, was neither floored nor plastered, and "The sides of the Mill House, & Gable Ends of that & the Drying House being enclosed by Boards not sufficiently seasoned, are very open. . . ." Howell thought that this would have a bad effect on the powder, but Harris disagreed. Harris argued that since he meant to dry his powder in summer by the sun, he could finish the one room as conveniently as possible, and, if need be, finish another in the fall.

Howell's report did not include a description of William Thompson's and Jacob Lorch's mills, or the new mills built by George Lush. Thompson's mill, on Neshameny Creek in Bucks County, was either not very large or was not long in operation. On February 3, Thompson, promising to begin production in five weeks, had received an advance of £100 to construct his mill.⁶⁶ But he did not receive his first ton of saltpeter until May 30, and his next load did not come until October 16, 1776.⁶⁷ Except for another supply of saltpeter delivered in November, and £50 paid him the following January, Thompson and his mill disappear from the records.⁶⁸

⁶⁵ Robert Harris to Committee of Safety, May 29, 1776, Stewart Collection.

⁶⁶ Pa. Arch., Series 1, IV, 710.

⁶⁷ Pa. Col. Recs., X, 589, 756.

⁶⁸ Ibid., XI, 12, 90.

Lorch's mill went into production sometime in June, and throughout 1776 and the early part of 1777 he received saltpeter and sulphur from the Committee.⁶⁹ But these deliveries were not frequent enough; on March 14, 1777, Lorch petitioned the government for more material.⁷⁰

George Lush attended the Committee of Safety with the other prospective powder makers on February 3. He informed the Committee that he had rented two sites on which to construct powder mills.71 One was to be on a stream called Stoney Run, in Philadelphia County, fifteen miles from town; the other was on a stream called Mill Creek, then owned by John Roberts, about ten miles from town. With these mills he hoped to produce 2,400 pounds of powder a week. Lush agreed to enter a contract on the same terms as that which he made with Congress, provided it was for one year. Another mill, erected by George Hubner of Northampton County, joined these works. Unlike the others, however, Hubner's agreement was with the Northampton Committee of Observation, and he delivered his powder to Easton rather than to Philadelphia.72 Hubner agreed to return 140 pounds of powder for every 100 pounds of saltpeter he received, and was paid £3 per hundredweight of merchantable gunpowder.

Since it was uncertain if the private mills would be ready in time, the Committee of Safety of Pennsylvania also undertook a state-owned and operated gunpowder mill.⁷³ With Congressional approval, on February 16, 1776, the Pennsylvania Committee resolved to erect on Congress' account a powder mill capable of manufacturing four tons of powder a week.⁷⁴

The Committee selected Clement Biddle to find a suitable millsite, purchase the land, and supervise construction.⁷⁵ On February 22, the Committee also appointed Captain Joseph Cowperthwaite to help Biddle, and gave them £1,500 to purchase the land.⁷⁶ A

⁶⁹ Ibid., X, 600 ff; ibid., XI, 26 ff.

⁷⁰ Pa. Arch., Series 2, I, 716.

⁷¹ Ibid., Series 1, IV, 709.

⁷² Ibid., Series 2, XIV, 620.

⁷³ Committee of Sasety Memorandum (n.d.), in ibid., I, 472; ibid., Series 8, VIII, 7388.

⁷⁴ Pa. Col. Recs., X, 488.

⁷⁵ Ibid., 489.

⁷⁶ Ibid., 489, 491.

week later they viewed a tract in Chester County, and in mid-April preparations were begun.⁷⁷ By the end of the year the state had invested £6,200 in the Continental Powder Mill.⁷⁸

The government works were larger than the mills built by private individuals.⁷⁹ The stamping mill was 102½ by 31 feet 8 inches, and was powered by two waterwheels located in the center of the building. Each breast wheel was eighteen feet in diameter and five feet wide. A fourteen-foot shaft connected the waterwheels with a main gear, these in turn powered three shafts working the stampers which incorporated the powder in the six mortar trees.⁸⁰ In June, Howell reported that one end of the powder mill was nearly finished and would make 3,000, or perhaps 4,000, pounds of powder a week.

The graining mill, unlike those in the private mills, was in a separate stone building, thirty-seven and a half by twenty-seven and a half feet in size. A waterwheel, ten feet in diameter, powered twelve sieves (three feet in diameter) for graining the powder, a bolting cloth, and stampers for preparing the sulphur and saltpeter. This wheel revolved five times a minute, and for each revolution the pounders struck six times. When Howell visited the mill the walls were up but the building had not been roofed.

The works included a saltpeter house and four drying houses, all measuring twenty-one by twenty-seven feet, and a powder master's house. On June 3, the workers completed the saltpeter house and were ready to set twelve kettles, with a combined capacity of 1,300 pounds of niter. They had three of the drying houses nearly completed while the fourth lacked only shingles. The worker's also had begun construction of the powder master's house. These mills were to begin production by June 25, but heavy spring rains filled the races and carried away the dam, setting back the operation two weeks.

⁷⁷ Ibid., 489, 543. The Continental Powder Mill was located on French Creek, four miles from Phoenixville, and eight miles from Valley Forge.

⁷⁸ Ibid., 549 ff.

⁷⁹ John Ladd Howell visited the Continental Powder Works on his tour for the Committee of Safety. His description is in *Pa. Arch.*, Series 1, IV, 766; see also Gunpowder Papers, Stewart Collection.

⁸⁰ Each mortar tree was 28 feet long and contained twelve mortars measuring 12 inches by 12 inches by 17 inches deep. Two stampers, four inches square by 12 feet, incorporated the powder in each mortar.

The Continental Powder Works got underway soon afterwards, shortly before new problems arose. In December, the threat of British raids induced the Council of Safety to order the powder and military supplies at French Creek and Norriton removed to Lancaster. ⁸¹ After this threat blew over, the Council ordered the construction of barracks and stationed a company of militia there. ⁸² These barracks and a powder magazine completed the works on French Creek.

Pennsylvania's efforts early in the war were impressive. Eight mills operated by private businessmen in contract with either the Committee of Safety or the Continental Congress joined the one mill at the outset of hostilities (Oswald Eve's). In addition, the state government had built and operated the Continental Powder Works for Congress. Thus, in a little more than a year Pennsylvanians established nine new gunpowder works.

This promising start was not sustained in 1777. The Pennsylvania Council did not renew the bounties which they had paid for saltpeter, and saltpeter, always scarce, became even harder to obtain. An accidental explosion destroyed one mill, and the British army, moving on Philadelphia, razed others, as well as forcing the relocation of American supply depots. The decision to construct their powder mills within a fifty-mile radius of Philadelphia, and the sulphur and saltpeter works in the city, proved disastrous for Pennsylvania's gunpowder production.

It is interesting to note that just after Pennsylvania gunpowder mill construction ended two Frenchmen came to America to help "in reforming the practise of powder making, and disseminating the knowledge of that art throughout those states. . . ."83 Nicholas Fouquet, who had been employed at the Régie des Poudres, the French governmental powder agency, and his son Mark arrived in November, 1777, at Congress' request.84 Although the Fouquets met with Congress, then in exile at York, the Frenchmen did not tour the Pennsylvania mills. Instead, the Fouquets traveled through New York, Rhode Island, Massachusetts and New Hampshire. For

⁸¹ Pa. Col. Recs., XI, 49, 64.

⁸² Ibid., 58 ff.

⁸³ Journals of Congress, XV, 1164.

⁸⁴ Ibid., 1152-1154, 1164.

two years they visited powder manufactories, wrote treatises on gunpowder and saltpeter production, and, before leaving, left models of a powder mill. But powder remained scarce, and events in Pennsylvania made it even more difficult to make up the deficiency.

One of the greatest blows to production came with the destruction of the Continental Powder Mill. On the morning of March 10, 1777, Peter DeHaven was standing about 300 yards from the stamping mill when two explosions racked the mill, lifting the roof from the walls. So A fire broke out following the explosion, and a man who was in the building at the time died from his burns the next day. Several workers, possibly fearing further explosions, refused to combat the blaze.

DeHaven was convinced that a plot had been hatched among some of the workers to destroy the mills. He was especially suspicious of a Mr. Peck and his men,

as they have yoused Several odd Exprestions, and thay had Gon Sum Distants from it at the Time it Hapned and Runn to the next neighbers house & Did not Come back till Wee Sent out a Gard for them. Mr. Peck Seem to Say at first, that all his Men Where killed; Secondly, he Said that he had Seen the Men Going to the Graining house; that & Sum other Reasons Give Me Som Reson to think [they] have Sum knowledg of it.86

For a while he thought Colonel Peter Grubb, owner of Cornwall Furnace, also was implicated: "The first Day of this instand, Col. Peter Grub Was at the Powder Mill, Sumwhat in Drink; he Damned the Powder Mill, and told Col. Dewese Let us Blow it to hell... he and Mr. Peck Seemed verry Great, & he Lodged With Mr. Peck that Knight." But a full hearing exonerated both the workers and Colonel Grubb, "there being insufficient proof to imprison them on the suspicion of firing the mill..."88

No matter who was to blame or what the cause, the mill never went back into production, and after the Battle of Brandywine

⁸⁵ At some point in the latter part of 1776 Peter DeHaven took over the management of the Continental Powder Works, continuing in charge until the works were dismantled. DeHaven's letter notifying the Council of State of the destruction of the mills, and the testimony taken at the hearing on the explosion are in Pa. Arch., Series 1, V, 255-257, 261-262.

⁸⁶ Ibid., 255.

⁸⁷ Ibid.

⁸⁸ Pa. Col. Recs., XI, 184.

Washington ordered the remaining stores removed.⁸⁹ By April, 1779, the ground on which the powder mill had stood was "entirely waste, open and unclosed, and of no use to anyone except as a common."⁹⁰

Three other mills—Huber's, Harris', and Thompson's—went out of operation by early March, 1777, so that by the end of 1778 only five mills were producing powder in Pennsylvania. The mills that remained had checkered careers, as did their owners.

While George Lush's were in operation in early March, he was desperate for saltpeter. Then, in December, Cornwallis raided Lower Merion Township and Lush's works, capturing the proprietor, who was later released. Which of Lush's mills were destroyed and which remained in production is not known, but at least one of his mills continued to produce powder until the end of the war. As before, much of his business involved the remaking of damaged powder for Congress. From October to December, 1781, Lush returned 3,187 pounds of remade powder.

Jacob Lorch's mill also continued to operate throughout the war. In mid-June, 1779, he was paid for 4,453¾ pounds of powder at the inflationary rate of £60 per hundredweight. Lorch, too, was involved in the remaking of damaged powder; from March to June, 1780, this included 4,615 pounds delivered to him, of which he returned 4,458¾. S As late as November, 1782, Lorch was supplying the government. S

The Frankford mill fell to the British when they entered Philadelphia in September, 1777. Oswald Eve evidently stayed at the works and cooperated with the British. For this the Supreme

⁸⁹ Fitzpatrick, Washington, IX, 214.

⁹⁰ Pa. Arch., Series 1, VII, 315.

⁹¹ Charles R. Barker, "Old Mills of Mill Creek, Lower Merion," Pennsylvania Magazine of History and Biography (PMHB), L (1926), 7.

⁹² The British took Lush prisoner in retaliation for the American arrest of the Tory Christopher Sower; when Sower was released, so was Lush. After the war Lush filed a claim for £2,412 in damages. Edward W. Hocker, Germantown, 1683-1933 (Germantown, 1933), 117-118.

⁹³ National Archives Microfilm Publication, M859, roll 65, frame 28.

⁹⁴ National Archives Record Service (NARS), M853, roll 40, June 21, 1779, Account with Jacob Lorch.

⁹⁵ Ibid., roll 37, frames 34 ff.

⁹⁶ Ibid., roll 36, frame 77.

Executive Council of Pennsylvania attainted Eve a traitor, and he had to flee the city when the British left the following spring. As they did with all traitors, the state confiscated Eve's property and sold it at public auction. In 1781, Captain John Eve (whether or not a relative of Oswald is unknown) bought Eve's estate for £108,000, Continental money, plus a yearly ground rent of fifty-four bushels of wheat payable to the University of Pennsylvania. Body John Eve continued to make powder at the Frankford works, but not on the scale that Oswald had. There are no records of sales by John Eve to the state or Congress, but in April, 1782, he did sell 350 pounds of powder to the New Jersey government.

After 1777, data on Thomas Heinberger's and George Hubner's affairs are rather sketchy. Heinberger made some powder in 1778, and a little (1,193 pounds) in 1780, but that is all the records show.¹⁰¹ George Hubner evidently had a large contract with Congress, but the only figures available are those for July and August, 1780, when he delivered 2,900 pounds.¹⁰²

Since the records are incomplete for the amount of powder the Pennsylvania mills made during these years, any figure would be pure speculation. Evidently these mills could produce when materials were available, or when damaged powder needed to be remade. One thing is certain—their scale of operations never reached that of the Continental Powder Mill, and there was no second effort to build new mills or to repair those which had been damaged.

It is important to remember that at the outset of the war the colonists proved not only willing but able to undertake and carry out what were then complicated industrial processes. As with the transfer of technology in the nineteenth century, their knowledge came from a variety of sources—immigrants, dictionaries and en-

⁹⁷ Eve later made a claim against the British government for the loss of a plantation near Frankford of 200 acres with a powder mill, buildings, and other improvements which he valued at £5,000 currency; he also put in a claim for four acres in the Northern Liberties, with a distillery and other buildings valued at £1,475. "Extracts from the Journal of Miss Sarah Eve," PMHB, V (1881), 20; J. Thomas Scharf and Thompson Westcott, History of Philadelphia, 1609-1884 (Philadelphia, 1884), I, 420.

⁹⁸ Pa. Col. Recs., XII, 668-669.

^{99 &}quot;Notes and Queries," PMHB, XXXIX, 225.

¹⁰⁰ Revolutionary Documents, no. 118, New Jersey Archives.

¹⁰¹ Pa. Arch., Series 1, VI, 540; NARS, M853, roll 37, frame 43.

¹⁰² NARS, M853, roll 37, frames 74, 96; see also ibid., roll 33, frame 221.

cyclopedias, the importation of technicians, and travel and observation. But technological know-how is not enough; nor is the availability of a large market. The adaptation of a complex technology depends on a number of needs and conditions. While the Americans satisfied some of these, others, equally important, were not overcome.

One problem, evident from the start, was the scarcity of saltpeter. Efforts to produce an adequate domestic supply ultimately failed. It would have been small comfort to know that France suffered similar setbacks and difficulties in also trying to produce saltpeter.¹⁰³

While the quality of American gunpowder appears to have been no worse than that imported from abroad (opinions of the soundness of American powder varied with the interest and bias of the observer), 104 the quantity which could be produced was limited. Except for the Continental Powder Mill, most Pennsylvania mills were small in scale, and thus low in output. Their combined capacity was notable, however. The standard reference for American gunpowder production during the first two years of the war has been Orlando Stephenson's "The Supply of Gunpowder in 1776," which concludes that the Americans produced only 10 per cent of the powder used by the army. This appears to be too low since Stephenson does not count gunpowder made in America from imported saltpeter. (This is equivalent to saying that E. I. du Pont's powder, made in Delaware after 1804, was not American powder since he made it with saltpeter from India and sulphur from Sicily.) Using Stephenson's figures, and disregarding the ultimate source of the ingredients, American mills actually produced 34.6 per cent of the gunpowder used during the first two years of the war, 105 with Pennsylvania furnishing an important amount.

As the war ground on, the excitement and cooperation evident at

¹⁰³ Robert P. Multhauf, "The French Crash Program for Saltpeter Production, 1776-94," Technology and Culture, XII (April, 1971), 163-181.

¹⁰⁴ There were fewer complaints about the quality of powder than there were about the quality of other war material and they were directed at both domestic and imported powder. There were, however, complaints about specific mills (Oswald Eve's was one), as well as blanket condemnation of colonial gunpowder. Waldo G. Leland, ed., Guide to Materials for American History in the Libraries and Archives of Paris (Washington, 1936), I, 120.

¹⁰⁵ Stephenson, "The Supply of Gunpowder," 277.

its outbreak faded, and the state and congressional committees proved less willing to work together. By 1777, the Pennsylvania Supreme Executive Council thought the burden of doing Congress' business too heavy a task and asked to be relieved. Another problem that came with the passage of time was the increase in costs due to inflation. The price of powder rose from £3 per hundredweight in 1776 to £75 or £90 in 1780. The lack of circulating hard cash and high prices hurt Pennsylvania's efforts to encourage saltpeter and gunpowder production.

Fighting against one of the great industrial nations of its day, Americans were aided by the other leading industrial country, and could rely on it for much needed material. The impetus to develop domestic industries, which at first seemed so important, faded as reliance on imports became the accepted procedure. Nevertheless, Pennsylvania gunpowder production played a vital role in the early years of the war. When need and distribution were measured in the hundreds of pounds, the output of Pennsylvania mills, and that of her sister colonies, was significant.

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106 Pa. Arch., Series 2, I, 503-504. 107 NARS, M853, roll 33, frame 209.