

TECHNOLOGY TRANSFER AND THE EVOLUTION OF ORDNANCE ESTABLISHMENT IN BRITISH-INDIA: 1639-1856

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There was a constant military interaction and upgradation of technologies between the East India Company (hereafter EIC) and its opponents in South Asia in order to reduce the technological lead of the other. Technological diffusion among the princely states occurred through the mercenary of European personnel, the EIC in turn had to regularize and systematize its military production through the construction and maintenance of the ordnance establishment (comprising of factories, magazines and arsenals) in British-India. The present essay is an attempt to trace the development of the ordnance establishment from the seventeenth century till the 1857 – uprising. The ordnance establishment of British-India manufactured gunpowder, small arms and various types of cannons, mortars and howitzers. The EIC found out that India had abundant supply of saltpetre and large number of domestic animals and buying saltpetre in India was much cheaper than importing this commodity. EIC constructed its first gunpowder mill in Bombay in 1669 AD but by 1741, the powder manufactured in this mill was considered superior than the quality of powder imported from Europe. The demand for gunpowder and guns during the Second Anglo-Maratha War helped greatly the expansion of gunpowder and artillery manufacturing capacity of the EIC's ordnance establishment. Construction of a string of arsenals and maintenance of the magazines along the probable routes of military deployment and especially at the critical strategic nodes increased the operational range of the EIC's army.

Key words: *Bighā*, Cossipore, East India Company (EIC), Flint, Flintlock, Gunpowder, Howitzer, *Khalsa*, *Maund*, Mortar, Saltpetre, Sonaut rupee, Sulphur,

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The colonialism in South Asia was mainly based on the superior military technology in the hands of the British. Technology infused with ideas and bureaucratic strategies, according to me, produced historical changes. The opponents of the East India Company (hereafter EIC) in the subcontinent were equally dynamic powers and continuously adapted and adopted new technologies in order to reduce the technological lead of the British. Technological diffusion among the princely states occurred through the medium of mercenary of European personnel. The EIC on the other hand had to regularize and systematize its military production. This resulted in the construction and maintenance of the ordnance establishment (it comprised of factories, magazines and arsenals) in British-India. The present essay traces the development of the ordnance establishment and its impact on Indian society from the seventeenth century till the outbreak of the 1857-uprising.

MILITARY HARDWARE PRODUCTION IN THE PRINCELY POLITIES

From seventeenth century onwards, firearms became more important than cavalry in the conduct of warfare. And this was a global trend.¹ Let us take a quick snap shot regarding the nature of handguns and artillery used in pre-colonial India. The Rohillas fought as infantry and were armed with muskets. The barrels for matchlocks were prepared by forming bits of iron into rods which were as thick as the finger. Then, they were twisted and three or four of them joined together. Another band of iron one third of an inch thick was welded to it. Then, it was formed into a band which was twisted and beaten into a solid cylinder. Finally, a hard steel chisel bored it.² Stephen Peter Rosen claims that Indian musket barrels were better than British barrels because they were made with spiral rather than longitudinal welds. Hence, they were stronger and less likely to burst and were able to take a larger gunpowder charge and shoot twice as far as the European muskets.³

In course of time, the matchlocks were replaced by the lighter, more reliable rapid firing flintlock muskets whose powder was ignited by a spark produced through the action of flint on steel. The new guns were lighter and did not require any rest and the rate of fire further improved with the use of paper cartridges. In 1696, the Swedes introduced this weapon. The Dutch, English and the French armies adopted flintlocks by 1700s. The flintlocks were made more effective by replacement of the plug bayonets (which hindered firing), by ring and socket bayonets which allowed firing with the blade in place.⁴ Jadunath Sarkar

tells us that the Mughal Emperor Shah Alam's infantry was equipped with flintlocks. Sarkar continues that in 1759, the Rohillas had flintlocks.⁵

In 1750, India produced 200,000 tons of iron, which was about the same as in all of Europe in that year excluding Russia. And the Indian iron production was largely devoted to shipbuilders and gun makers. Rosen asserts that qualitatively Indian steel was better than British steel because surface iron ore was better than that available in Europe. Indian bronze was not as good as British bronze but Indian brass was better than European brass and made better artillery barrels. Probably, the problem lay with the doctrine and organization of warfare.⁶

The Afghans and the Persians conceptualized the artillery not as an independent battle winning arm but as a subsidiary system within the dominant paradigm of cavalry warfare. Hence, they developed light mobile artillery known as camel swivel guns (*zamburaks* or *śutarnāls*) for supporting cavalry charges. The camel swivel gun included the driver and the gunner sitting on the same camel. From the Afghans and the Persians, the use of *zamburaks* passed on to the Mughals. The Sikhs continued to use *zamburaks* (which fired 1-pound shell) till the Second Anglo-Sikh War (1849).⁷ The *zamburak* functioned as the near equivalent of the British Army's horse artillery gun.

Before the Battle of Third Panipat (1761), the Maratha artillery could not be aimed properly in the battlefield,⁸ due to lack of elevating screws. Sadashiv Rao Bhau's guns were made of brass (cast bronze) and were mounted on teakwood carriages.⁹ Cast iron was cheaper, harder and more enduring than bronze. In England, cast iron guns were manufactured as early as 1543.¹⁰ Deficient bellows was the principal hurdle behind manufacturing cast iron field guns by the Indian powers. Hence, the Indian rulers used European experts in order to establish European style foundries¹¹ and to cast guns for the princely armies. Before the Second Anglo-Maratha War (1803-5), the *Peshwa* (hereditary Prime Minister of the Maratha Confederacy) had 40-pounder guns which were cast by a Portuguese in Pune. The carriages of such guns had wheels made of solid teak. After the First Anglo-Maratha War (1774-83), Benoit De Boigne, a Savoyard was hired by the Maratha sirdar Mahadji Sindia for modernizing his military apparatus. Sangster, a Scotch used to cast field guns in Agra for De Boigne.¹² Boigne also appointed Perron, a French, who was an artisan skilled in operating the cannon foundry.¹³ Use of European mercenaries for their technical skill seemed to be a global trend. During the early decades of the nineteenth century, the Muslim ruler of Egypt also

utilized European advisors for making gunpowder and firearms.¹⁴ The Agra Fortress under De Boigne became a depot for arms and munitions.¹⁵ Sindia's Gwalior Arsenal cast huge brass guns.¹⁶ De Boigne's contingent was equipped with 3, 6 and 12-pounder guns. The guns constructed at Mathura and Agra had elevating screws. These guns were modelled on the French pattern and in quality were equivalent to those possessed by the EIC.¹⁷ Iqtidar Alam Khan asserts that besides copying European military technology, the Marathas also resorted to limited improvisations. The Maratha gun makers attempted to cast bronze casings around the wrought iron barrels in order to raise the strength of wrought iron barrels to the level of those cast in bronze, thus economizing on the use of copper which was in short supply and costlier as well.¹⁸

Iron cannon balls were manufactured at Gwalior where there were iron mines and saltpetre and sulphur were imported from Bikaner to Agra where gunpowder was manufactured. In the Battle of Delhi (11 Sept. 1803) during the Second Anglo-Maratha War, the Marathas used round, chain and grape shot against Lord Lake's army.¹⁹ The grape shot was introduced in West Europe during the fifteenth century. It consisted of small round shots packed in nets and sacks and bore resemblance to cluster of grapes.²⁰ And the muskets manufactured in Sangster's arsenal in finish and durability were equivalent to the British products.²¹

Like the Maratha Confederacy, the *Khālsā* Kingdom from the second decade of the nineteenth century also went to a great length in modernizing its military apparatus. The Kashmiri artisans at Lahore manufactured muskets and pistols. By 1837, *Khālsā* infantry was capable of volley firing. Ranjit Singh manufactured cannons with the help of the French officer M. Court. Grape firing by the Sikh guns caused lot of casualties among the EIC's troops in the Battle of Ferozeshah (21-22 December 1845). The Sikh guns were heavier in metal than the similar caliber guns possessed by the EIC's Bengal Army.²² However, the Sikh gunners lacked adequate training.

The cavalry branch of the Indian powers remained conservative. The cavalry of the indigenous powers did not adopt the wheellock and flintlock on a large scale. Most of them used matchlocks. However, certain cavalry units maintained by the EIC were equipped with advanced handguns. For instance, the sowars of the 1st Punjab Cavalry carried carbines.²³ In the final instance, the EIC's forces not only had better materials of war but the ordnance establishment ensured a systematic supply of military hardware.

MANUFACTURE OF GUNS, GUN CARRIAGES AND GUNPOWDER

The ordnance establishment of British-India manufactured gunpowder, small arms and various types of cannons, mortars and howitzers. Gunpowder was made by mixing together under pressure, saltpetre (nitrate), sulphur and charcoal in the following proportion: 75 percent, 10 percent and 15 percent respectively. The nitrate functioned as an oxidizer in the burning reaction.²⁴ Saltpetre occurred as nitrogenous materials rotting in the ground and was converted by bacteria to form nitrates. High temperature and humidity in India accelerated the decomposition process. India had abundant supply of saltpetre or potassium nitrate due to huge demographic resources and use of large number of domestic animals especially in Orissa and in the Ganga Valley. The earth of the Ganga Valley was richly impregnated with saltpetre in a natural state which was extracted by lixiviation, evaporation and crystallisation. In Bengal, saltpetre was gathered in large masses wherever it effloresced on the soil especially during the rainy season. In India, the men from the '*loneā*' and the '*nuniā*' castes collected the saltpetre rich earth and undertook its initial treatment to refine it by boiling it in water before it could be used for making gunpowder.²⁵ The EIC found out that buying saltpetre in India was much cheaper than importing this commodity. Bengal also supplied saltpetre to the other two British presidencies. To give an example, in 1696, a ship named Josia Ketch belonging to the EIC transferred 700 bags of saltpetre from Bengal to the Bombay Presidency.²⁶ In 1689, one Daniel Chardin bought saltpetre from Bengal for selling it to Britain. The authorities at Fort St. George complained that this should not be allowed in future as Madras was suffering from a shortage of saltpetre supply.²⁷

In 1752, Lieutenant-Colonel Caroline Frederick Scott had the contract of supplying gunpowder to Fort William.²⁸ The EIC encouraged the contractors to supply them with saltpetre or made advances to the *āssāmis* who were required to furnish saltpetre to the EIC's officials. While providing contract for supplying saltpetre, advertisements were issued at Kolkata and Patna and invitations were issued to the Indian merchants to come forward for supplying the EIC with saltpeter. The saltpetre was stored in gunny bags, each of whose cost in 1779 varied between 8 to 12 Annas.²⁹

Refined saltpetre increased the charge of the gunpowder. Hence, the EIC was interested in acquiring refined saltpetre for its own use. In 1779, Dr. Bryant Higgins, a chemist who was employed by the Board of Ordnance at Britain in his

report stated that the saltpetre supplied by EIC from Bengal and Patna were unrefined and was not suited for making good gunpowder. In 1782, the Supreme Council informed the Board of Trade that refined saltpetre must be acquired. The Agent for the Manufacture of Gunpowder found out that on refining the weight of the saltpetre was diminished by about one-fourth. In 1783, the EIC entered into an agreement with a chief at Patna for supplying refined saltpetre. The wastage of Patna saltpetre due to refining was about 27%. The expense of refining a *maund* of saltpetre exclusive of the charge for the boiling pots came to about 12 Annas. In September 1782, 12 copper boilers were sent to Patna. On 19 November 1782, the EIC's Resident at Patna sent to the Board of Trade a proposal for contracting for the investment of saltpetre in its refined state at a cost of Sicca Rs 5.5 per *maund* (excluding the wages of the factory servants and the *gomastās*) which will be delivered to Kolkata. One *maund* was equivalent to 80 pounds and the *gomastās* were Indian agents of the British traders. In December 1782, the Board of Trade informed the Supreme Council that if the price of labour, firewood and copper boilers were taken into account then the cost of refining saltpetre came to about Sicca Rs 3 per *maund*. The sub-export warehousekeeper at Patna was in charge of refining the saltpetre. The price of saltpetre at Patna was Rs 3 Anna 12 Pice 3 per *maund* and the charges of transportation to Kolkata was Anna 8 Pice 10. The total price including transportation charges came to about Rs 4 Anna 5 Pice 1.³⁰

During 1783-84, the contractor at Patna supplied 44,800 *maunds* of refined saltpetre. The contractor charged Rs 5 Anna 8 for per *maund* of refined saltpetre supplied. In addition, he charged Rs 14,173 Anna 5 as wages of the factory servants and the *gomastās*. The contractor made a profit of Rs 1 Anna 8 per *maund* of saltpetre supplied.³¹ During November 1791, Jagannath Prashad, a Hindu businessman close to the *Nawab* of Awadh provided the EIC with 6,300 *maunds* of saltpetre and by boats transferred it from Awadh to Kolkata. Prashad had several Indian agents who collected the saltpetre from different villages on his behalf.³² With the passage of time, the volume of saltpetre bought by the EIC rose. Table 1 gives an account of the saltpetre bought by the EIC in India during the period between the Fourth Anglo-Mysore War (1799) and the Second Anglo-Maratha War (1803-5).

The EIC found that it was easier and cheaper to acquire the other commodities necessary for making gunpowder from India. In 1819-20, sulphur

was sent from England for the manufacture of gunpowder. However, the material deteriorated during storage. So, it was decided to use the local product. Sulphur was procured from the Indian *bazars* at the price of Rs 2 Anna 12 per *maund*. Due to increasing demand, the price rose to Rs 5 Anna 8 per *maund*. By 1822,

Table 1: Value of Saltpetre bought by the East India Company in India between 1798-1808

Date	Value of Saltpetre bought in Sterling Pounds
1798-99	2,26,742
1799-1800	4,10,928
1800-01	2,28,250
1801-02	96,880
1802-03	1,56,596
1803-04	2,39,170
1804-05	1,29,192
1805-06	2,17,769
1806-07	1,86,896
1807-08	1,79,932

Source: Appendix no. 10, Account of Sales for ten Years, from 1798-99 to 1807-08; distinguishing India and China, and the species of goods from each, *Parliamentary Papers, Colonies, East Indies* (Shannon: Irish University Press, 1971), p. 243.

Fort William had a huge stock of sulphur and it met the demands of the other two presidencies.³³

In 1669, the EIC constructed a gunpowder mill at Bombay. During 1673, the powder mill at Bombay always maintained 2,000 barrels of gunpowder.³⁴ In 1741, the gunpowder manufactured in this mill was considered superior than the quality of gunpowder imported from Europe. Preparation of gunpowder required pulverizing which meant the initial mixing of charcoal and sulphur. In this process, the charcoal was broken down into particles and got mixed with sulphur. The quality of powder was dependent on how well this was done. Initially, the labourers used stone mortars for pressing the various components of gunpowder. During February 1745, the gunpowder mill at Bombay was expanded and the numbers of stamps were raised from 2 to 4. In 1768, buffaloes were used for turning the machinery used for pressing gunpowder. Mule driven mills for grinding the ingredients of gunpowder were already used in the Portuguese Gunpowder Factory at Goa from 1630 onwards. In 1779, the output of the Bombay Powder Mill rose by about 1,000 barrels per season.³⁵ Still demand outstripped supply. In December 1786, Bengal supplied Bombay Presidency with 1,500 barrels of gunpowder.³⁶

The EIC also took steps for manufacturing gunpowder in Madras. In 1639, Fort St. George was constructed at Madras. Originally, the village known as Madrasapatam was 230 miles south of Masulipatam. The Madrasapatam village was between River Elambore (Coum) and the sea. The land was granted by the Naik of Chingleput. Andrew Cogan was the leader of the party which established the settlement. The initial establishment comprised of a couple of writers, some European surgeons and artificers and an Indian powder maker along with 25 armed guards.³⁷ In 1690, Fort St. George was still not self-sufficient as regards the production of gunpowder. Gunpowder was still imported from Britain.³⁸ However, Fort St. George took steps to augment the production of gunpowder. In April 1690, 50 *pāgodās* were advanced to the powder maker for manufacturing gunpowder which would be supplied to the garrison. In July 1690, for the same purpose, another 50 *pāgodās* were given to the powder maker.³⁹ The demand for gunpowder rose when the EIC was engaged in fighting the *Nawāb* of Carnatic, Marathas and the French in the Madras Presidency. On 19 December 1753, the dispatch from the EIC to Thomas Saunders, one of their official at London noted: 'As it is very dangerous to send large quantities of gunpowder from Europe, and as with the necessary skill it can be made just as well in India, send an exact model of a powder house and mills with a minute description, and William Bishop to be Superintendent of the powder works on sterling pounds 100 a year with pay as a First Lieutenant of the Military.'⁴⁰

The 'experts' for manufacturing gunpowder were always imported from Britain. In a letter dated 9 May 1764, India House at London informed Fort William:

As a person well versed in the method of making gunpowder is extremely difficult to found, Mr... Walton has been for three or four years qualifying himself in that manufacture and has offered his service to proceed to your Presidency next season when he will be fully master of the whole process to give you good assistance in this particular branch. As an encouragement to Mr. Walton we shall appoint him a factor upon the Bengal establishment to rank next after the lowest factor upon the list at the time of his arrival.⁴¹

The demand for gunpowder soared during the Second Anglo-Maratha War. This, in turn witnessed the expansion of gunpowder manufacturing capacity of the EIC's ordnance establishment. On 4 May 1804, 1,000 barrels were sent to Ishapore Powder Work which was manufacturing gunpowder. The warehouse supplied 1,000 pounds of saltpetre to Ishapore. The Allahabad Manufactory also

started manufacturing gunpowder.⁴² On 26 April 1804, L. Hook, Secretary to the government wrote to Captain A. Greene, Secretary to the Military Board: 'I am directed by the governor-general in council to acknowledge the receipt of your letter and to inform you that His Excellency approves of the military board having authorized Captain Taylor, Agent for the Gunpowder at Allahabad, to proceed immediately in the construction of the two additional boring houses.'⁴³ Between 1798 and 1805, the ordnance establishment of Bengal Presidency supplied the Cape of Good Hope with gunpowder worth 11,164 sterling pounds (freight charges not included). The factories making gunpowder generally pursued production policy on the assumption of three years' consumption in peacetime.⁴⁴

As early as 1672, gun carriages were manufactured in Fort St. George at Madras and the iron works for these carriages were imported from Britain. In 1744, timber from Tellicherry in the Malabar Coast was used for manufacturing the gun carriages. In 1748, John Gray, the Master-Carpenter in Madras was in charge of manufacturing gun carriages. In 1782, axles for gun carriages were manufactured at the Fort William Arsenal. The EIC established 4 gun carriage factories: Cossipore (1801), Seringapatnam (1802), Bombay (1810) and Fatehgarh (1816). In 1801, there were 19 forges at the Cossipore Gun Carriage Agency. In order to meet the extraordinary demands during the Second Anglo-Maratha War, a temporary gun carriage factory was established at Khidderpur near Kolkata. By March 1805, this factory manufactured 235 carriages. By 1830, the Gun Carriage Factory at Fatehgarh was producing carriages, limbers, swivel collar iron bars, swivel yokes for the bullocks and ammunition wagons.⁴⁵

During the First Anglo-Burma War, Cossipore manufactured Royal Pattern Black Trail Gun Carriage. The timber yard at Chitpur provided Cossipore Gun Carriage Factory with seasoned timber (teak or *Sissoo*).⁴⁶ In 1830, Cossipore while producing gun carriages faced a problem in acquiring good timber. Major L. Taylor the Garrison Engineer at Fort William in a letter dated 21 June 1830 informed Lieutenant-Colonel R. Rickett, Superintendent Engineer of the Lower Province:

There is great difficulty in obtaining wood from the agency yard at Cossipore. Initially we procured some timber but after cutting up they proved to be unworkable for our purpose. It caused much additional expenses. There is the difficulty of procuring hackeries to carry such heavy timber, several of them having broken down, the hackery men being unwilling to undertake the job. The military board should give permission

to Captain Hutchinson to cut up the timbers and to supply me with wood in the half wrought state.⁴⁷

Rickett argued that the timber ought to be cut at the Agency Yard at Cossipore.⁴⁸ On 6 July 1830, John Craigie, Secretary of the Military Board replied to the superintending engineer of the Lower Provinces: 'I am directed by the military board to acknowledge the receipt of your letter no. 535 dated the 28th ultimo, and to acquaint you in reply, that the board deems it expedient to adhere to the arrangement at present in force which required executive officers at the presidency to indent for the whole timber. The board observes that if the garrison engineer will attend at the Cossipore Yard to ascertain that the timbers selected for him are of good quality; the evils he complains of would not occur.'⁴⁹

The most important duty of the ordnance factories was to manufacture guns. The first brass gun was manufactured at Cossipore in 1756 just before the Battle of Plassey (1757). In 1765, India House sent to Fort William a brass 3-pounder field gun which was lighter than the older patterns.⁵⁰ The authorities at Fort William were supposed to study this new gun before embarking on manufacturing guns on their own establishments. In 1770, Captain Glass established a foundry in Patna where casting of brass 3-pounder guns and 10-inch mortars was done.⁵¹ Frederick of Prussia first introduced howitzer whose fire trajectory was higher while ordinary cannon's fire trajectory was flat. Hence, howitzer was used to fire at the enemy when the friendly troops were engaged in close combat with the enemy. The curved trajectory of a howitzer was also useful for firing behind the enemy lines. A mortar was a small howitzer and had a far steeper trajectory. Generally, a mortar was a short piece with a large bore and a chamber and was primarily used to fire shells from a high angle. Whereas a mortar had a fixed quadrant elevation of 45 degree (the range was adjusted by altering the weight of the charge), the howitzer was able to fire at variable elevations and also horizontally against troops in the open. Generally, howitzers were more mobile than mortars but were approximately twice as heavy for the same bore. The mortars and howitzers were used in siege operation in an anti-personnel role in order to kill the defenders inside the forts.⁵² In 1804, in order to make up the shortfall of guns, the EIC bought eight 4-pounder guns which were brought to India by the Danish ship Hanna.⁵³ Bronze 3-pounder guns were produced at Fort William from 1809 till 1821. Bronze 4.5 inch mortars (range was 900 metres) were manufactured at Fort William by Major J.D. Sherwood, Commissary of Stores at Fort William (1816-37) from 1816 onwards. Captain George Hutchinson

was appointed Superintendent of the Fort William Foundry. He moved it to Cossipore about 8.6 km north of Fort William. The Cossipore Foundry in 1834 under Hutchinson produced 3-pounder guns which had a range of 1 km. In 1840, Archdale Wilson was put in charge of the Cossipore Foundry, and supervised the casting of the guns. Wilson continued to remain as the Superintendent of Cossipore till 1845. Under his supervision, bronze 4.5-inch mortars were manufactured at Cossipore from 1841 onwards.⁵⁴

Along with heavier guns, new types of guns were being manufactured thanks to the import of machinery from Britain. During the Peninsular War, the British Army found out that the brass ordnance was unable to fire as many rounds as the iron ordnance. Rapid firing by the brass ordnance resulted in overheating of the muzzles which then started to droop.⁵⁵ The foundry at Fort William was capable of making only brass guns. But, in 1834 due to the new plant imported from Europe, the foundry at Cossipore acquired the capability of casting iron cupolas for manufacturing iron guns. This foundry had 2 steam engines of 10 and 12 horsepower respectively, 6 gun lathes, 1 trunnion lathe, 2 mortar lathes, 2 screw cutting lathes and 7 other lathes. Thus, we see that steam power was replacing the animal power used for driving the machinery. Between 1840-50, Cossipore produced 12, 18, 24 and 32-pounder iron guns, 3, 6 and 9-pounder brass guns, 8-inch 4-pounders, 8-inch 5-pounders and 10-inch iron howitzers, 12-pounder brass howitzers (for mountain warfare) and 24-pounder howitzers.⁵⁶

In 1853, Cossipore manufactured 92 iron guns, 17 brass mountain howitzers and 34 brass guns.⁵⁷ In 1856, Cossipore manufactured carriages for 32-pounders and 24-pounder guns, elevating screws for 24-pounders, 12-pounders, 9-pounders and 6-pounder guns. During 1855-56, Cossipore manufactured 139 brass guns. In the next year, output rose to 146 pieces. In 1856-57, the total number of brass guns manufactured by the ordnance factories numbered to 415.⁵⁸

From guns now we move to hand held firearms. The Redcoats carried flintlocks. In 1696, Fort St. George sent 1,000 flints to Fort St. David.⁵⁹ In the 1740s, the wooden ramrods were replaced by iron ramrods.⁶⁰ During the Second Anglo-Maratha War while the EIC's troops had Brown Bess muskets, the French trained Maratha infantry was equipped with matchlocks and fusils.⁶¹ Percussion cap was introduced in 1839. It reduced misfires from 40% to 4%.⁶² In 1844, a percussion cap factory was added to the Bombay Powder Mill.⁶³ Henry Steinbach, a Prussian mercenary officer in the *Khālsā* Army noted that the muskets used by

the Sikh soldiers were inferior and incapable of throwing a ball to a significant distance. Further, quick and repeated firings resulted in bursting of the barrels.⁶⁴ Such sort of defect was unknown among the hand held firearms manufactured and maintained by the EIC's ordnance establishment in the subcontinent.

EXPANSION OF THE ORDNANCE ESTABLISHMENT IN BRITISH-INDIA

The British constructed a string of arsenals and magazines for storing and distributing military equipment for its various detachments in the field. The arsenals had workshops for repairing military equipment and laboratories for manufacturing ammunition. The magazines were used mainly for storing gunpowder.⁶⁵ These arsenals and magazines were located along the probable routes of military deployment and especially at the critical strategic nodes. Construction and maintenance of the magazines increased the operational range of the EIC's army. The arsenals and the magazines supplied the regiments with arms and munitions both during war and peace. During the Second Anglo-Maratha War, ammunition for the EIC's detachment serving in Rohilkhand was brought from the magazines at Aligarh (50 miles south-east of Delhi) and Fatehgarh. During the First Siege of Bharatpur (1804), the EIC's force acquired battering guns from Fatehgarh and Aligarh and the cannon shots from the magazines established at Agra (60 miles east of Bharatpur), Dig and Mathura (40 miles north-east of Agra on river Jamuna).⁶⁶ In 1822, for the troops operating south of river Narmada, shots and shells were stored at the Nagpur Magazine.⁶⁷ In 1830, the 3rd Local Horse Regiment was deployed in Saugor for internal security duties. During the month of June, the Deputy Commissary at Saugor was ordered to provide the regiment with the following articles: 3,200 balled cartridges for pistol, 320 pistol flints, 500 pounds of lead, 87 musketry pistols and 500 pounds of gunpowder.⁶⁸

The military department took care in maintaining and expanding the arsenals, magazines and the manufactories. The EIC from the very beginning spent lot of money to protect their arsenals and magazines. Between 1639 and 1643, the EIC spent 4,150 sterling pounds for fortifying Fort St. George. In February 1756, the redoubt at Perrin's Point known as the Bagh Bazar Redoubt was completed at a cost of Rs 29,000.⁶⁹ In 1801, 20 *bighās* of land was purchased from Mr. Thornhill at a price of about *Sikkā* Rs 5,000. Captain Preston of Military Engineering Service at a cost of Rs 20,000 constructed gunsheds and building, and it came to be known as Gun Carriage Agency Cossipore. Another Rs 20,700 was spent for importing the machinery for the plant.⁷⁰ In 1822, land worth *Sikka* Rs 5,289,

Anna 12 and Paise 10 around Ishapore Powder Works was bought for expanding the establishment. In 1822, construction of sheds for ordnance bullocks and a *puccka* flat roof verandah to the house of the gunpowder agent of Allahabad and a wall around the old burial ground cost Sonaut Rs 5,366, Anna 13 Paise 8.⁷¹ One sonaut rupee had 165 grains of silver compared to 174 grains in the *Sikkā* rupee. In 1822, at a cost of Sonaut Rs 2,734, Anna 1 Paise 6, a temporary gun shed with storerooms was constructed at Mhow in central India. In 1822, *Sikkā* Rs 23,010 Anna 12 Paise 7 was spent for repairing and expanding the buildings of the gun carriage agency at Cossipore.⁷² In 1830, a *pukkā* road was constructed inside the DumDum Magazine for better drainage.⁷³ During 1830, at Fort William 13 carts and 2 bullocks were maintained for transportation of guns and ammunition. The monthly expenditure came to about *Sikkā* Rs 185, Anna 11 and Paise 6.⁷⁴ In April 1830, Sonaut Rs 58, Anna 9 and Paise 8.5 were spent for repairing the gun shed at Shâhjahânpur.⁷⁵ In 1830, a new powder magazine was constructed at Dinapore at the cost of Rs 4,000. The capacity of this new magazine was to hold 2,600 barrels of powder. And the superintendent engineer of the Lower Province was ordered to repair the old magazine.⁷⁶ In 1841, an aqueduct was constructed within Fort William Arsenal at a cost of Rs 6,072 for continuous supply of water in order to extinguish any fire, if it broke out. After six years, for repairing the reservoirs and aqueduct of Fort William Arsenal, Rs 449, Anna 2 Paise 6 was expended. An explosion of gunpowder on 5 January 1847 destroyed the number 3 mill house of Ishapore. For reconstructing the mill house at Ishapore, the EIC had to spend Rs 892, Anna 1 Paise 4. For repairing the woodworks and palisades of the Allahabad Fortress including the manufactory, the EIC from 1847 onwards had to spend annually Rs 13,550. In 1847, Rs 707 was spent for constructing a redoubt around the Ambala Magazine.⁷⁷

A sort of quasi-military industrialization which British-India underwent strengthened the genesis of the military-fiscal organism. This also gave rise to a bureaucracy. The *Rāj* kept a detailed account of the correspondence between various officials engaged in military production. On 24 June 1830, W.H. Oakes from the military accounts office at Fort William informed the secretary and accountant of the military board: 'I beg to annex copy of a charge of Sonaut Rs 543-3-6 against Captain Sommerville Executive Officer brought forward in the cash account current from 1 May 1828 to 30 April 1829 of the agent for gun carriages at Cossipore and to request you to forward to this office any receipt (or copy thereof) granted by Captain Sommerville for the above sum or a statement

showing the particulars of the account.’⁷⁸ Major W. Battaine, the Principal Commissary of Ordnance, informed Lieutenant-Colonel John Craigie: ‘I have the honour to enclose a bill for pay to the extra magazine men employed in the arsenal of Fort William for the month of May last, amounting to Sonaut Rupees 500, Anna 88 and Pies 4, which I beg you will be pleased to lay before the board to be passed.’⁷⁹ The governor-general’s council also kept a tab on the minutest detail regarding the labourers. And all the relevant information was recorded on paper. Extra artisans were employed temporarily in the arsenals to tide over emergencies for meeting extra production output. On 25 June 1830, the governor-general informed the military board that the superintendent and director of the Fort William Foundry was authorized to entertain 6 extra artisans for cleaning the new machinery recently brought by two ships of the EIC.⁸⁰

Some elements within the British ruling class were against military industrialization of British-India. They wanted to import state of the art military hardware from the West, while some politicians and British officers wanted to pursue the programme of limited military industrialization within India. On 15 February 1765, India House accused the Fort William authorities that the gunpowder which had been manufactured by them and sent to London for inspection was of bad quality. Its charge was quite low. They pointed out that the charcoal used was bad and the brimstone and saltpetre used were not properly refined. India House warned that gunpowder cannot be sent from London due to lack of shipping facilities and moreover even when the shipping space was available then also sending ships laden with gunpowder made them very vulnerable to fire by accidents. Hence, Fort William should take all possible steps for improving the quality of gunpowder and should appoint a board which would supervise the cost, quality and quantity of gunpowder manufactured.⁸¹

In 1811, the court of directors pointed out that the guns manufactured at the Fort William foundry were inferior to those manufactured in Europe. So, the court of directors wanted to close the manufactory. However, the military board disagreed and argued that the guns manufactured at Fort William were equal in quality if not better than those manufactured in Europe. In 1818, when the Third Anglo-Maratha War ended, due to the insistence of Governor-General Lord Hastings several pieces of ordnance manufactured in the ordnance factories at India were sent to Britain and it was found out that the specimens were much better than the products churned out by the Royal Arsenal at Woolwich.⁸²

In 1822, 11,186 barrels of defective gunpowder was manufactured at Allahabad Ordnance Factory.⁸³ It provided grist to the mills of the lobby which wanted to import military hardware from Britain. But, the court of directors ordered the EIC's officials that they should encourage manufacture of military hardware within India as a cost cutting measure. The court of directors in a letter dated 30 September 1829 informed the Bengal Presidency: 'The cost of supplying all the stores from England is prohibitive. So, you must try to obtain as much as possible from the subcontinent. It would be cheaper. You should purchase and manufacture some goods in India.'⁸⁴ The penny-pinching Governor-General Lord Bentinck, agreed with this proposal. However, the court of directors warned that there should be no compromise on quality. The military board was ordered to enquire and inform the court of directors if the military hardware produced in India though cheaper, were inferior in quality to the products manufactured in Britain.⁸⁵

Some officers tried to obstruct military industrialization in British-India. Brigadier A. Macleod, Commandant of the Artillery on 6 July 1830 wrote to Bentinck: 'As regards the court of directors' letter, we must judge Indian manufacture with regard to quality and price, it might be a case of false economy. We demand special shells for the 9-pounder field guns and Royal Pattern cavalry swords.'⁸⁶ In 1830, some military officers claimed that the brass 24-pounder howitzer (meaning 5.5-inch) and the 9-pounder field pieces and their carriages manufactured in India, were indeed defective. While firing, due to the thrust of recoil, their carriages burst. The governor-general replied that further tests were required with proper carriages before a decision could be taken. The select committee of artillery officers at DumDum was ordered to find out the requisite proportion of the metal used in the gun and the charge of powder.⁸⁷

In 1739, at Geneva, a Swiss gun founder named Maritz invented the boring machine. By using a lathe driven by horses, Maritz bored guns from solid castings. The previous method was casting the piece hollow on a core.⁸⁸ This new technique was adopted by the ordnance establishment of British-India. Captain G. Hutchinson, the Superintendent and Director of the Fort William Foundry in a letter dated 3 July 1830 replied to the secretary of the military board: 'I have the honour to inform you that the brass cylinders cast in the foundry agreeable to the Board's order of the 8th December last, and reported ready for delivery in my letter number 292 of the 26th February last, are still in the foundry, they are quite

perfect without a single flaw and are bored and finished according to the dimensions stated in Mr. Edwardes' letter to the commissary general.'⁸⁹

Some sort of research and developmental activities were undertaken in the British-Indian ordnance establishment in order to maintain the technological lead. The military board came into existence in 1786.⁹⁰ All the inventions connected with carriages and improvements of artillery and guns of every description came up before the military board. The commandant of the artillery, chief engineer, the auditor general, the adjutant-general and the quarter-master general were members of the military board. The commander-in-chief of India was the president of the military board.⁹¹ In 1830, for the artillery personnel a laboratory was opened at the Dinapore Powder Magazine.⁹² In the same year, Captain Hutchinson of the Bengal Engineers visited Vienna for the purpose of studying gun manufacture and erected the first steam machinery at Cossipore.⁹³ In April 1847, the Allahabad Powder Magazine was supplied with lightning copper conductors on the plan designated by Professor Faraday and approved by the British government at the cost of Rs 1,462 Anna 5 Paise 7.⁹⁴ In 1802, shrapnel shells were invented and were used in the Peninsular War.⁹⁵ Captain W. Olperts of the Bengal Artillery invented a metallic fuze which was carried ready and fixed and was set in the field for any distance very easily. This made the use of shrapnel shells easier.⁹⁶ During the First Anglo-Sikh War, at the Battle of Sobraon (10 February 1846), against the *Khâlsâ* Army, Littler's force had 2 iron 8-inch howitzers with shrapnel shell ammunition filled in 4.5 oz balls.⁹⁷

The British were always conscious of maintaining firepower superiority over their indigenous opponents. So, the military officials took care to upgrade their artillery regularly and to store the latest pieces in the arsenals and magazines. With the passage of time, the guns became heavier and their ranges increased. In July 1830, the military board decided that 6-pounders (effective range 500 yards) and 5.2-inch howitzers should be replaced by the 9-pounders (effective range 800 yards) and 24-pounder howitzers. And those new guns should be kept stored in the Katak Magazine. The magazines and arsenals at Mewar and Nimach were ordered to maintain 12-pounder brass guns.⁹⁸ It is to be noted that during the First Anglo-Sikh War (1845-6), the EIC used 8-inch howitzers.⁹⁹ Horse artillery guns were introduced in the British Army in 1793 and in the Bengal Army in 1800. In 1803, the EIC had 3-pounder horse artillery guns. But, in 1846, the EIC had 6-pounder horse artillery guns, and each of them weighed 4.5 cwt.¹⁰⁰ The 9-pounder field artillery of the EIC during the Sikh Wars was drawn by

bullocks.¹⁰¹ Nevertheless, during the Battle of Ferozeshah, quantitatively and qualitatively, Sikh artillery was superior than the artillery deployed by the EIC's force.¹⁰² However, the bane of the *khālsā golundazs* was the absence of tactical doctrine and training.

CONCLUSION

Initially, the EIC was interested in acquiring the components of gunpowder from India. The process of acquisition of sulphur and saltpetre involved subcontracting to various Indian social groups. The Indian merchants and the various communities associated with manufacturing saltpetre made hay as the EIC's demand for gunpowder rose. From late eighteenth century two lobbies emerged within the British ruling elite: while one group was for buying the state of art military products from Britain, the other lobby was for manufacturing the military goods in the ordnance establishment established in British-India. By the first half of the nineteenth century, the British-Indian Empire was dotted with arsenals and magazines which aided the operation of the army for protecting and expanding the frontiers of the Empire. With the passage of time, small manufactories became transformed into full fledged factories. Gradually, the factories upgraded and diversified the items of production. Throughout the period under review, the flow of firearms technology was from the West to the 'East'. While in the princely states, the diffusion of military technology was from French sources, in the case of the EIC's ordnance establishment, the source of diffusion was Britain. The technical designs for most of the products were obtained from Britain. Only minor innovations occurred within the ordnance factories of British-India. After the collapse of the princely states, their ordnance establishments were emasculated by the British. Due to lack of shipping facilities, the supply of hardware from Britain was uncertain and inadequate. Hence, the ordnance factories of British-India despite the charges of churning out second grade products at higher cost, continued to function and remained operational in the nineteenth century.

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