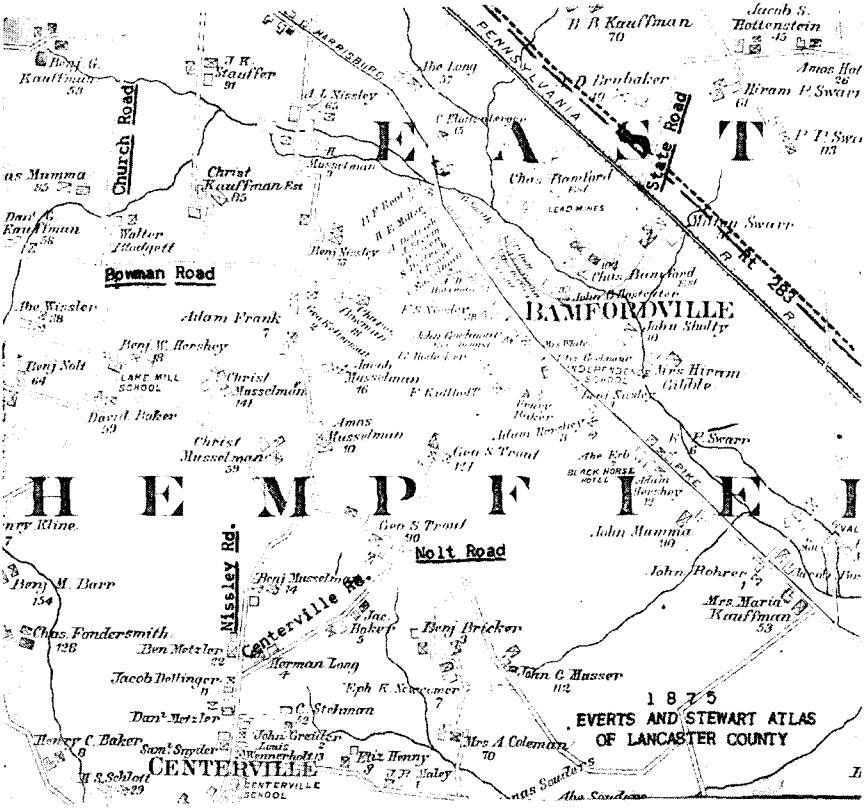
Lead and Zinc Industry in Lancaster County

by John W. W. Loose

Lancaster's role in the lead and zinc industry is another piece of hidden history. Persons travelling the Old Harrisburg Pike or the newer highway (Route 283) between McGovernville and Landisville would never recognize the quiet little hamlet of Bamfordville as a center of lead and zinc production during the fifth, sixth and seventh decades of the nineteenth century. Today nothing of this industry remains other than a water-filled pit, and a grove of trees among which are bits of crumbling brick from the old smelting furnace stack.

In the late 1940s when the writer was an undergraduate student, field trips to the site were yielding fragments of tube retorts, condensers, bits of slag, fused refractory material, and bricks. Not even these remain to testify to that singular industry. To the geologist the limestone in which the veins of ore were found is the Ledger dolomite of Lower Cambrian age, and it overlies fossiliferous Lower Cambrian Kinzers shale, and underlies Elbrook limestone of Middle Cambrian age. The Bamfordville area is not the only place in Lancaster County to have lead ores; however, it is the only mine for there is evidence of being worked and of its ores being processed for the market.

According to a report given in July 1876 by E. Gybbon Spilsbury, Superintendent of the Bamford Works, to Persifor Frazer, Jr., Assistant State Geologist, the ore deposits were worked as early as 1845 with indifferent results. In 1873 Charles Bamford and his brother of Cheshire, England, purchased the mines and sufficient land on which he erected buildings and machinery for the winning of the ore as well dressing, roasting and smelting the ore. During the early days of the mine, from 1845 until the panic of 1857, the mine was worked for white oxide of lead. A Mr. Tamlin was employed to develop the mining property, following which Mr. Spilsbury, an experienced lead-zinc mine engineer and manager, was placed in charge. Some time after 1877 Mr. Spilsbury submitted a detailed report that contrasted in many ways with the 1876 report,

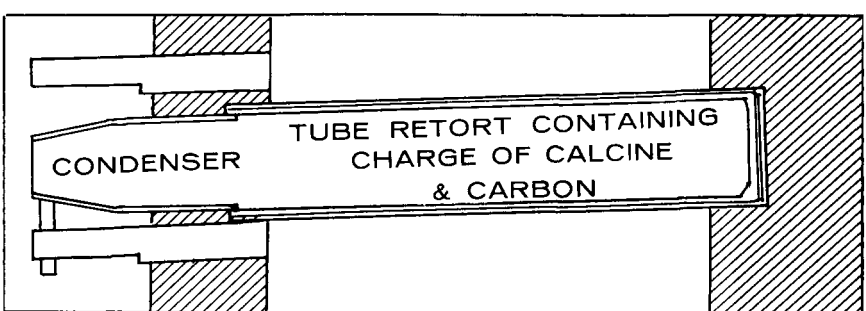


owing possibly to increased efficiency in operations of the works and the depressed state of the zinc market.

In 1876 shaft No. 1 nearest the smelting works and railroad had been sunk 30 to 40 feet deep, while No. 2, located about 50 feet south of the first opening, had been sunk approximately 70 feet deep. Additional small shafts were dug for mechanical purposes.

After the ore was removed from the veins it was crushed in a Blake crusher, and then in a finer crusher after which it was dressed in six jigs and three buddles. Two of the buddles (machines that wash out finer particles by shaking an inclined trough through which is passed water) were connected in line with the fine crusher, while the third was hand-fed. The coarser material was conveyed directly to four jigs from the crusher, and the remaining two jigs were hand-fed. The dressed ore was sorted by screens, then roasted and reduced by the Belgian process.

The calamine was roasted in a reverberatory furnace after which it was crushed in a special crusher used only for that purpose and for clay preparation for retort manufacture. The crushed calamine then was stored, either in a pure state or with a mixture of the blende. The retorts were four feet eight inches long and eight and one-half inches in diameter. The condensers were conical, and were about 15 inches long. Coal dust and powdered ore were put into the retorts which then were placed on shelves in the furnaces and heated by bituminous coal. The smelting works had four zinc fur-



Powdered anthracite coal and roasted ore were placed in the tube retorts which were arranged on shelves in the furnaces and heated by bituminous coal fires. The molten metal flowed into the condenser where the cooler temperature caused solidification.

naces, with each furnace holding 56 retorts and condensers. There were two single hearth and two double hearth furnaces. The general average daily yield of spelter in 1876 was about 1500 pounds which commanded in 1876-1877 from 7.5 to 11 cents per pound. It appears the average daily income from spelter amounted to approximately $135.00 in 1876.

The anthracite coal dust used for the retorts was hauled to the works from the Landisville station of the Reading and Columbia Railroad at the rate of 50 cents per ton for hauling and two dollars for the coal dust per ton. Three carts were employed under contract for this purpose. The bituminous coal used for heating the retorts was obtained from Clearfield County, and cost $4.25 per ton delivered to the works.

Steam power was furnished by an engine having a 13-foot flywheel and operating at an average pressure of 60 pounds. Of the works personnel twenty men were miners, five were enginemen, and the rest were crusher operators, furnacemen, and cart drivers, a to-

tal of 80 persons. The wages paid the workmen were by contract, proportioned to the amount this obtained, and it amounted to $1.50 to $2.00 daily. Outside hands got approximately $1.35 daily, while furnacemen received $5.00 for a shift of 24 hours. Engineers' wages were from $1.50 to $1.75 daily.

The Spilsbury report issued after the cessation of the Bamford operations in 1877 follows:

This mine is situated in East Hempfield Township, on the line of the Pennsylvania Railroad, about five miles West of Lancaster.

The deposit occurs in the form of two parallel bed-veins in the lower Silurian Limestones, near their line of contact with the shales of the same epoch, although so far as developed, the actual line of contact has always been found barren. In this respect the deposit differs from a very similar one in Sinking Valley, Blair county, where the contact lines between the shales and the Limestones are quite productive.

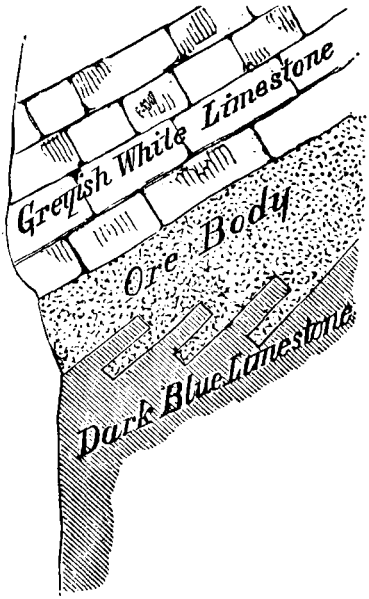
The veins at the Bamford mine are most unmistakably "**bedded** veins, and not fissures or gash veins. They are conformable both to the stratification and dip of the enclosing rocks, their general course being about 74° 35' east of North, and dipping at an angle of 18° from the vertical," (i.e. the dip is N. 15° 28' W.—72°.) "The roofs or hanging walls are, in each case, well defined and regular, although the Limestone of the hanging wall has a decidedly brecciated appearance, is partially decomposed, of a whitish grey color and highly siliceous. It is full of seams and cavities, some of the latter attaining the dimensions of small caves, being from 15 to 20 feet long and equally broad, with a height of from 4 to 6 feet. All these seams and openings are completely filled in with a dark red sandy loam, differing in that respect from the Limestone caves of the Lead and Zinc regions of Missouri and Illinois, which are invariably filled with mineral. In none of the cavities examined in this mine have I ever found a trace of mineral.

This broken and dislocated appearance of the upper Limestone bed is not only apparent on the surface, but extends down at least so far as the bottom of the pump shaft, which is 110 feet.

The foot wall, although having a generally regular dip, conformable to the hanging wall, is not so uniformly smooth, but has the appearance of a series of layers, between which the ore bearing limestone of the vein has been intercalated, sometimes to a depth of eight or ten feet. The annexed sketch will better explain this peculiar appearance: (See illustration on next page.)

The limestone forming the foot wall differs very materially from that of the upper beds, being less siliceous, and of a dark blue, and in places almost black tint, and having a very close and compact fracture. I have noticed in places in it small druses lined with calc spar, and frequently filled with Oligiste iron ore." (specular.)

The minerals contained in these veins are the sulphides of zinc and of lead. From the surface down to the permanent water level, a depth of about 18 feet, these minerals have been oxidised by atmospheric influences, and are replaced by calamines and carbonates of lead. The gangue is a limestone, slightly crystalline in spots, but generally very similar to that composing the foot wall. The Galena is chiefly found in bunches, or little strings, running along on or near the hanging wall, whilst the Blende thoroughly impregnates the whole



of the vein matter in greater or less proportions. A remarkable feature in the Galenas from this deposit, is the vast difference between the percentages of silver they are found to contain. Specimens taken from one bunch or pocket, will run up to $2,000 of silver per ton, whereas adjoining pieces would perhaps contain only a couple of dollars to the ton. By the eye it is impossible to distinguish any difference between the two minerals, but nevertheless the difference is most probably due to the presence of minute crystals of Tetrahedrite. The average value in silver per ton may be taken as twenty-two dollars.

The Blende occurring here is of a bright golden color, known as rosin blende. It is very pure—the only impurities I have ever found in it being a slight trace of iron and cadmium, and mechanically mixed with it a small percentage of lead. The average of fourteen analyses, made at different times on these Blendes, gives:

Zinc	65.87 per cent.
Sulphur,	32.28 per cent.
Iron,	.81 per cent.
Lead,	.34 per cent.
Cadmium,	.07 per cent.
Total	99.37 per cent.

The percentage of Blende in the vein varies considerably, but the average of a year's working shows about 17 to 18 per cent."

These veins have been traced on the property for a distance of about half a mile, and ore has been found in an excavation made on the side of the Petersburg Township [State Road] road, just beyond the Pennsylvania railroad. About a mile and a half further north-east, another deposit of calamine was cut through in building the Lancaster Branch of the Reading and Columbia railroad. At that point considerable ore has been taken out, but owing to the desultory manner in which the mining was done, and also from the fact that there is no outcrop here, the soil being fully fifteen feet deep, it is impossible yet

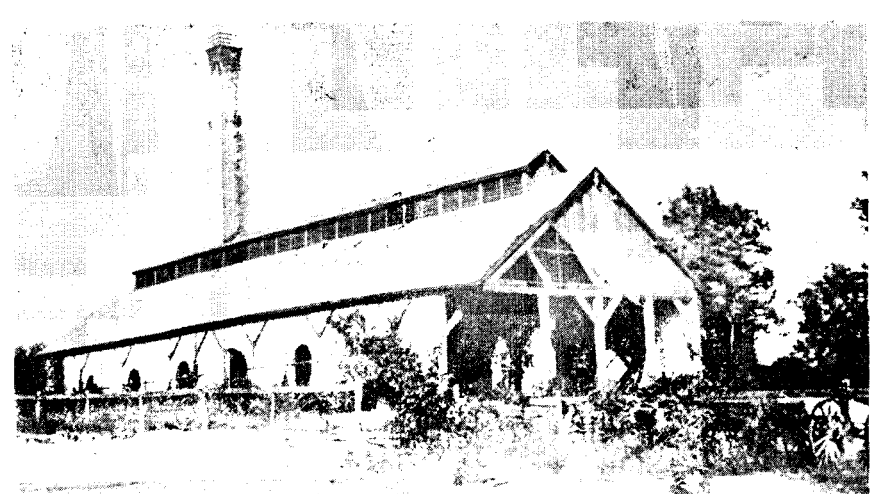
to form any correct idea regarding the extent or character of the deposit. It was at first generally supposed to be a continuation of the Bamford veins, but closer examinations prove it to be too far to the northward, and it must either belong to some other belt, or it may be an independent deposit.

At the Bamford mine, both the veins have been opened upon and worked down to the 75 foot level, and the south vein has been cut at the 110 foot level.

The north vein has been opened on a length of over 300 feet, had an average width of 12 feet, and has been worked out to a depth of 50 feet, and cut and explored on the 75 foot level. Below the 50 foot level, however, it was found everywhere to be perfectly barren.

The south vein, which was the most regular and the most profitable, has now been worked out to the 75 foot level, and on a length of over 400 feet. The average width is from 14 to 18 feet. Although in some portions the ore was very rich, still the average amount of zinc in the vein never exceeded 12 per cent., and no ore was ever pure enough to treat without a previous concentration, excepting, of course, the surface deposits of calamine. The richest ore occurred at about fifty feet from the surface, and from there down to seventy-five feet. At the 110 foot level, although the vein is well defined, there is little or no ore in it, at any of the points where it has been opened, and what little ore is in it, appears in strings, and not disseminated, as above.

These deposits were discovered as early as 1845, and have been worked off and on with varying successes since then. It was not, however until 1873, that the present extensive surface and underground workings were inaugurated. The property at that time changed hands



Bamford Zinc and Lead Smelter, as it appeared about 1888 after being abandoned some years earlier. The brick stack survived in a ruined condition until the late 1940s. Smelting furnaces were located along the walls of this building. Ore buggies can be seen among weeds at right.

for the enormous sum of $100,000 cash, and the purchasers at once set to work to spend another hundred thousand in building smelting-works, before making any effort to develop the underground capabilities of the mine. In 1874 it became evident that no successful operations could ever be carried on here which were not based on a thorough mechanical preparation of the ores, owing to the fact, as stated above, that the whole vein mass was merely Limestone, impregnated with minute crystals of Blende. The present dressing floors were therefore erected on the Hartz system, and proved a most perfect success, and they are today, probably, the most complete and efficient in any of the Eastern States. The capacity of these floors is from forty-five to fifty tons per day.

The calcining and smelting is carried on in furnaces of the Belgian style, adapted to the burning of anthracite coal.

The cost of producing metal from such very low grade ores was necessarily high, though by very great care and economy the average cost for the year 1877 was not over five cents per pound. By the introduction of some more economical pumping machinery this might be lessened perhaps to 4¾ cents, but even at those figures there is no encouragement to resume operations, even if it were proved that the veins become again metalliferous at a lower depth. Subjoined is a detailed account of the cost of production, based on the capacity of the dressing floors for at least forty tons per day. Every item is from actual working, and taken off the books of the concern.

Cost of Manufacture.

Mining 40 tons ore, @ $1.50,	$ 60.00
Hoisting and carriage to floors,	2.00
Dressing 40 tons, yield 26.63 clean ore,	20.00
Two engineers, @ $1.50,	3.00
Two tons coal for engine, @ $2.80,	5.60
Labor in roasting, $1.00 per ton,	26.63
Fuel for roasting 26.63 tons, @ $3.80,	101.19
Labor to reduce 24 tons calcined ore,	148.50
Fuel for reduction furnaces, 25 tons, @ $2.80,	70.00
Coal for reduction in retorts, 7½ tons, @ $1.50,	11.55
Fifty-four retorts, @ $0.72 each,	38.88
Condensers used, 180, @ $0.02,	3.60
	490.95
Add wear and tear, and management, 10 per cent.,	49.10
TOTAL,	$530.05

The zinc produced, at the lowest estimation, would be 10,800 lbs., which, at 5 cents per pound, would equal $540, leaving a slight balance on the right side.

The spelter manufactured here was very pure, and acquired considerable reputation for its good qualities. Subjoined is an analysis of it:

Zinc,	99.687
Cadmium,	.034
Lead,	.262
Copper,	trace.
Iron,	.017
	100.000

E. GYBBON SPILSBURY.[2]

Some accounts suggest the Bamford works were started up in the 1880s for a short time but no evidence has been found to substantiate such a claim.[3]

The Lancaster Lead Company, a New York Corporation headed by John C. Mallory, in 1863 issued a prospectus in which it stated its new mine near Marticville (known to us today as the Pequea Silver Mine) "promises to be one of the most valuable mines of the Atlantic States." The company was capitalized at $250,000 with 50,000 shares of stock at $5.00 par. Much of the work visible at the Pequea Silver Mine apparently was done around 1863 by the Lancaster Lead Company. Excerpts from the prospectus follow:

> The Lancaster Lead Mine is situated at Marticville, Lancaster Co., Pa., and promises to be **one of the most valuable mines of the Atlantic States.** The occurrence of lead ores in almost all of the States has long been known, and most of the lead ores have been tested by Professor Booth, of Philadelphia. There are very few of them, whatever may be their geological relations that have not some silver, and **this is an indication of great value in lead mines.** It seems to be a rule, not only in gold and silver but in lead, that the metal is found in deposits, workings and isolated quantities, from the breaking up of veins, and these are soon exhausted. **It is, however, to the veins themselves that we are to look for a perpetual supply.** The ledges, beds, and veins of auriferous quartz, from which the floating gold is derived, **penetrate the rocks to such depths that they may be regarded as altogether inexhaustible.** It is the same with veins producing copper, in which gold is a constituent, and the same principle applies to lead that carries silver, and in which the metal is procured by regular mining.
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> The common ore, from which nearly all the lead of commerce is obtained, is the sulphuret called galena—a combination of 70.55 per cent of lead and 13.45 of sulphur. It is a steel grey mineral, of brilliant lustre when broken. The ore very frequently contains silver, in the form of sulphuret of that metal, and may be profitably separated when it contains 8 ounces of silver to the ton; ores of this character are known as argentiferous galena, and they have been discovered in the southeastern section of Pennsylvania, running through Chester, Montgomery, and Lancaster counties. The general course of the veins is east and west, and silver has been found in them ranging from 10 oz. to 16 oz. per ton, which gives also 80 to 82 per cent of lead, according to the following analysis by Professor Joy, the coarser grained galena giving the most, and the finer grained the least.
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> These veins, coming upon the lands of the Lancaster Company, which are situated in Marticville, Lanc. Co., a little to the right of Pequea Creek, were opened under the direction of F. P. Herington, well known as an experienced and highly skilful mining engineer, on the 9th Nov. last, and on the following day a considerable amount of pure loose lead was taken out. A few days subsequently, two 6-inch veins were struck. These run parallel with each other, 7 feet apart, and two more were struck on the following day. All these have a dip of 35 degrees, and were evidently converging. A thin sheet of lead running through a soft place in rock, became more regular, strong and perpendicular. As the works progressed, the lead became more abundant, and the work more facile. The severity of the winter in that region retarded the work to some extent; but, as the spring appeared, the veins were more promising, and the product greater, with somewhat decreased expenses.

On the 24th of March, the workmen were employed on the top drift, 10 feet wide, 22 feet deep from the surface, embracing three veins, vix., the two north veins, 2 feet apart, and the foot wall vein, which is 10 feet south from the north wall of the north vein. The surface or top of this drift is sandy soil, 4 feet in depth, and the remainder of the drift is limestone rock, 18 feet to the bottom of the drift. As fast as this body of sand and rock is removed, the ore is taken out (of a purity of 80 to 82 per cent) of the three veins, which are

Fragments of tube retorts and condensers found at site of Bamford Works by Millersville State College students on field trip in 1946. In photo at left, student is holding a conical section of a condenser. Girl in right photo is holding matching fragments of a tube retort. No evidence of the furnace survives today.

nearly perpendicular, dipping slightly to the north. These veins are one to three inches wide, converging to unite in one vein 3 to 6 inches wide, thus decreasing the expense, and affording a product sufficient for fair dividends on the company capital. On the 9th April a shaft was sunk 30 feet west of the drift. On the 20th April the Engineer wrote:

We are now sinking the third shaft, out of which we took yesterday a considerable quantity of pure lead ore. We also took lead ore. We also took lead out of the drift.

On the 23rd, he wrote:

We are now sinking the 4th shaft. We still continue to find the sheets of pure lead ore in the sand, and a considerable quantity in the rock. We are also driving the upper drift, and are taking out more or less each day. The vein continues in the drift, and looks more favorable.

The progress of the works is now daily improving in productiveness and the receipts of the company's lead in the city have already commenced. The price of freight from the mines to Philadelphia, by railroad and canal, is 18 to 25 cents per 100 pounds, and the lead is

of so pure a quality that it is sent down at once rather than to smelt at the mines, to diminish the cost of transportation. At the same time the market value of the mineral increases prodigiously. **The demand for the lead, not only in the cities,** but all over the world, **has greatly increased** in the last few years, not alone from the expansion of the arts, **but for military** purposes. In the eastern States the rapid development of water works, in the dwellings and factories, as well as for farm purposes, have vastly increased the demand for this metal. In illustration of this, influence upon the demand for lead, became very great.

The operations of the Lancaster mines have thus far been eminently satisfactory. It is now six months since the works were commenced, and the object of the Engineer has been hitherto thoroughly to test the value of the mines, by exploring all the various veins, leads, and depositories, both near the surface and in depth, by means of a series of drifts, cross-cuts and other necessary explorations. This has been satisfactorily accomplished, and a large amount of ground has been laid out for advantageous working, as soon as the most available points for work are decided upon. Most of the ground that has been drifted or sunk sustains the conclusion that **a good paying mine can be worked at little expense.**

The future production of course depends upon the continued richness of the veins, as we have pointed out in the former part of this scetch, **it is a well known fact that veins such as those we are now working are seldom ever known to give out. The company may, therefore, took confidently forward to a continued increase of production.**

The high hopes of the Lancaster Lead Company failed to materialize, and the Pequea Silver Mine joined the list of geological curiosities. Occasionally efforts are made to work the mine, but such endeavors have not gotten very far. The most recent proposal to use the mine for a limestone quarry was thwarted by the local residents who objected to the probable noise, dust and traffic of trucks.

APPENDIX A

Title to Bamford Tracts

Lancaster County Office of Recorder of Deeds:

Book P–10–454. John H. Swarr to Charles Bamford of Park Road, South Birkenhead; and Edwin Bamford of Raby Hall Bromborough, Cheshire, England, 31 March 1875, for $15,000, two tracts (1) 95 acres, and (2) 3¾ square perches. Christian Hershey was previous owner.

Book P–10–457. John Huber to Charles and Edwin Bamford, 31 March 1875, 7 acres.

Book C–Misc.–425. Lancaster County Mining Company to Charles and Edwin Bamford, 31 March 1874, agreement to erect smelting furnaces at mines of Lancaster County Mining Company. Company was headed by Daniel Herr, Edward J. Zahm, and Jacob Shenk. It would appear the original purpose was to have the Bamford Brothers erect the works for the local firm.

Book I–19–481. Charles Bamford's Devisees, et al, to Annie M. Minnich, wife of James L. Minnich, 27 September 1906, for $12,500,

the Swarr and Huber tracts purchased in 1875. The devisees were Anne Hawke and the Hon. Harold Brooke Hawke, her husband, of Lutterworth, Leicestershire; Emma Jane Cunliffe and Walter Cunliffe, her husband, of Waylake, Cheshire; Alfred Charles Bamford and Henry Samuel Bamford, trustees under the Will of Edwin Bamford, deceased of Emma Jane Cunliffe; Alfred Charles Bamford (in his own right) and Mabel Josephine Bamford, his wife, of West Kirby, Cheshire; Henry Samuel Bamford and Hilda Bamford, his wife, of Plumton Hall, Neston, Cheshire; Elizabeth Ann Cott and Arthur M. Cott, her husband, of Ashby Magna, Leicestershire; Evelyn Nora Bamford, of Llandudus, Caernarvonshire; Frances Mary Barnalie and Henry Edward Barnalie, her husband, of Llandudus; and Edna Elizabeth, of Ilandudus, only children of Edwin Bamford II, son of Edwin Bamford.

APPENDIX B

In the United States, the first zinc was produced in 1835 at the Arsenal in Washington, D.C. The United States Government, seeking to establish definite standards of weights and measures, imported workmen from Belgium and built a small spelter furnace at Washington to make the zinc necessary to form the brass desired for the standard units of weight and measure. The zincite ore was obtained from northern New Jersey.

The first American attempt at the commercial production of zinc occurred at Newark, New Jersey in 1850. A Belgian zinc furnace was built for the smelting of franklinite (zinc-iron-manganese ore) but was not successful because of the high iron and manganese content of the ore. In 1856, a distilling furnace of the Silesian type was built at Friedensville, Penna., which also failed owing to the quality of the ore. The first successful commercial furnaces for zinc production in the United States were built in 1860 at Lasalle, Illinois, and South Bethlehem, Pennsylvania. The latter used the Belgian furnace.

After 1854 the American or Wetherill process evolved in which the zinc oxide is reduced by carbon, followed by distillation of the zinc and immediate burning of the vapor. The first large furnace [built similar in design to the Bamford furnaces] was constructed in 1872 at LaSalle, Illinois, and it had 408 retorts. In the 1880s considerable scientific work was being done on hydrometallurgy of zinc. Improvements in roasting ores were discovered, and the electrolytic process was first tried.

from **Historical Background of Zinc Manufacture,** by H. D. Carus, President, Matthiessen and Hegeler Zinc Company, LaSalle, Illinois, courtesy of the Zinc Institute, Inc., 292 Madison Avenue, New York, N. Y.

NOTES

[1] Persifor Frazer, Jr., "The Geology of Lancaster County," **Second Geological Survey of Pennsylvania** (Harrisburg, Pa.: Board of Commissioners for the Second Geological Survey, 1880) pp. 196-198.

[2] **Ibid,** pp. 198-203.

[3] B. L. Miller, "Lead and Zinc Ores of Pennsylvania," **Pennsylvania Topographical and Geological Survey Bulletin,** M-5, 1924, pp. 49-53.