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No. 50

THE BRITISH EMPIRE

INDUSTRIAL EXPLOSION

Britain Inaugurates the Modern Age

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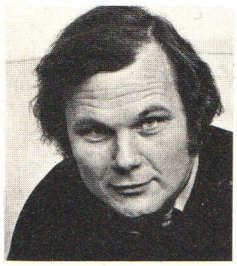

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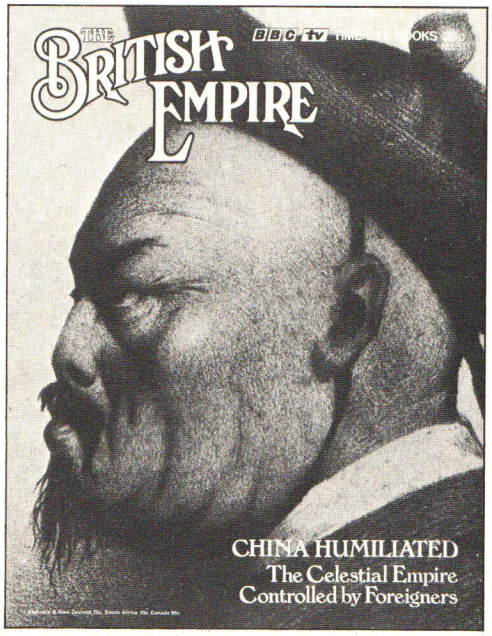
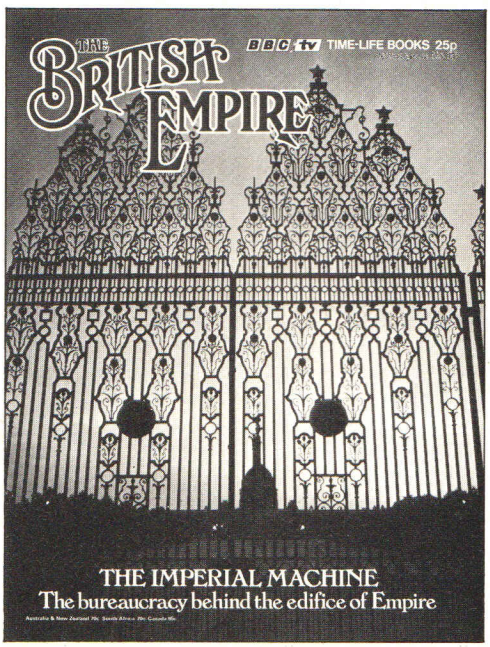
Published by Time-Life International (Nederland) B.V. in co-operation with the British Broadcasting Corporation.

Distributed in the U.K. by Time-Life International Ltd. and BBC Publications.

Printed in England by Jarrold and Sons Ltd. Norwich.





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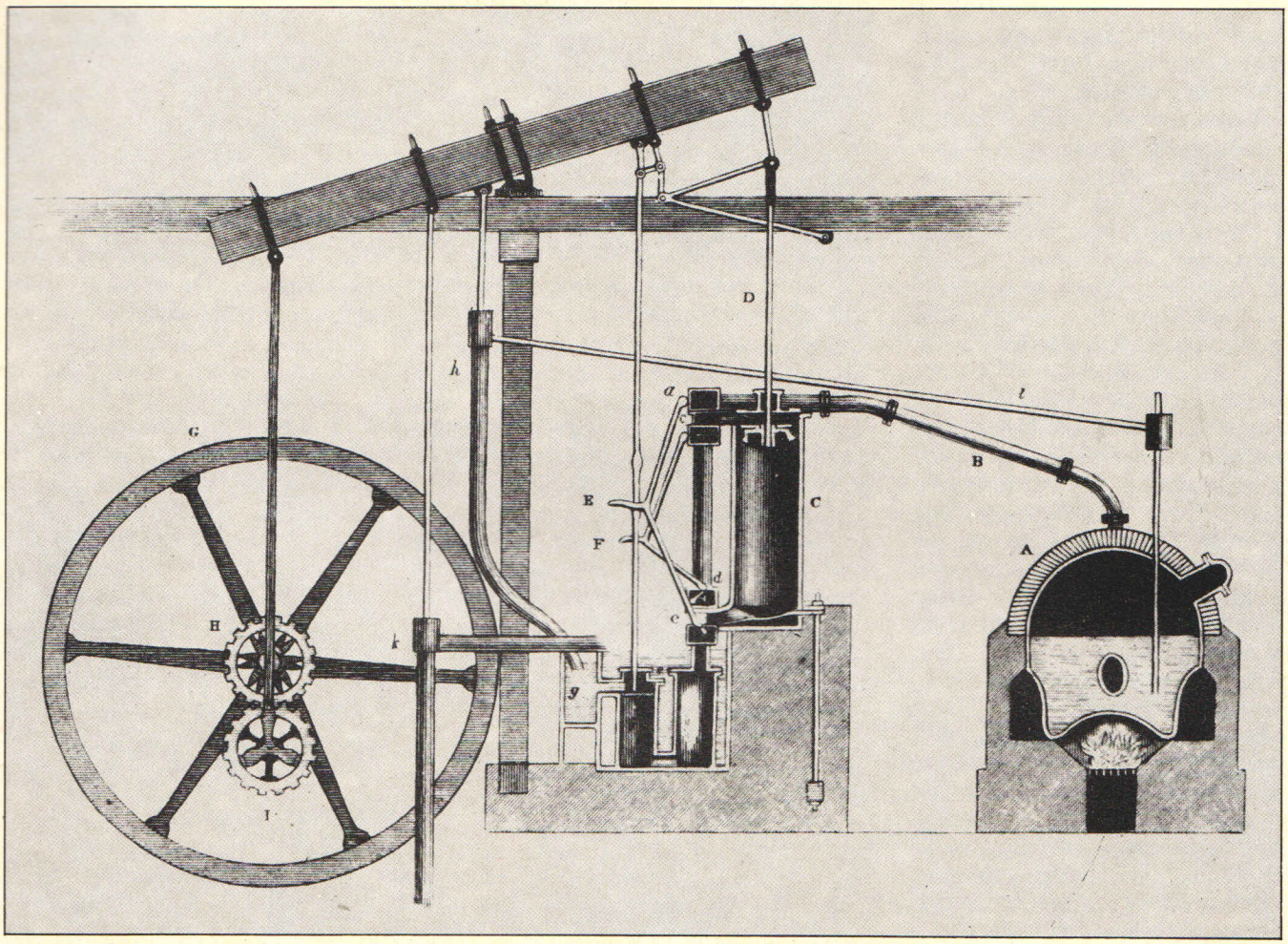
Cover: Workmen shovel coal into the retorts of the Beckton gasworks in 1878, symbolically fuelling the fires of the industrial explosion by which Britain transformed the world.

INDUSTRIAL EXPLOSION



James Watt's dependable steam-engine, a prime cause of the Industrial Revolution, replaced innumerable water-wheels.

Great Britain began the Industrial Revolution and was the first nation to be transformed by it. Between the mid-18th and mid-19th Centuries, steam, iron and mass-production machinery combined to create an explosion of industrial growth that for a time made Britain the wealthiest, most powerful nation on earth. The climax was the Great Exhibition of 1851, a spectacular display of confidence and inventive genius. But decline came soon, and its impact on the British Empire was enormous. As other nations began to catch up, late Victorians developed an unprecedented enthusiasm for Empire, anxiously hoping that imperial markets and resources would bolster Britain's sagging industrial supremacy. They were hopelessly misguided.

by Jim Hicks

Queen Victoria later described May 1, 1851, with her girlishly emphatic underlinings, as "the greatest day in our history, the most beautiful and imposing and touching spectacle ever seen. . . . It was the happiest proudest day in my life." It was the day she opened the Great Exhibition in Hyde Park.

A musical greeting from massed trumpets, organs and a 600-voice choir overwhelmed her with "a sensation I can never forget" as she entered the magnificent glass house – as big as three St. Pauls and dubbed by *Punch* "the Crystal Palace" – to view the wonders of the modern world assembled there.

After Victoria's regal inspection, the 25,000 guests and season-ticket holders flowed through the hodge-podge of displays from almost every nation: the *objets d'art* and soaps, farm tools and fabrics, cookers and jewellery, false teeth, china – even a stuffed elephant borrowed by India's exhibitors from an English museum in order to show a howdah. But it was to the machinery exhibition that most spectators gravitated, as would most of the six million other visitors who saw the Exhibition over the next 140 days.

People marvelled at the size of the steam locomotives, with special awe reserved for the pride of the Great Western Railway, the massive *Lord of the Isles*. On the north side of the hall they stood in crowds, craning to see the amazing ingenuity of Britain's mechanical engineers represented there. The machines in that section were actually working – off a boiler located outside the building. James Nasmyth's famous steam-hammer was there (the machine used by Robert Stephenson to drive home the piles of his bridge at Newcastle), Garforth's riveting machine, marine engines from Maudslay's works, McNicholl's travelling crane and De La Rue's Patent Envelope Machine. Operated by only two boys, this could cut, fold, gum and stack thousands of envelopes an hour in "a series of the most beautiful mechanical movements it is possible to conceive." There was even an alarm bed that ejected its occupant at a pre-set time.

Perhaps the most impressive exhibit of all was the Crystal Palace itself. Designed by Joseph Paxton, a former landscape gardener, it was a monument to the excellence of Victorian engineering. Graceful, airy, and yet vast enough to cover 19 acres and enclose fully grown trees, it was built within seven months using 4,500 tons of ironwork and 300,000 panes of glass. These amounted to about one million square feet in area. The structure itself was a daring innovation. Some thought it too daring. The Astronomer Royal, Sir George Airey, announced that the first strong wind would blow the building down, but after the Exhibition it was disassembled and moved to Sydenham where it stood securely until fire destroyed it in 1936.

The day of the opening was a public holiday. The Great Exhibition might include products from many parts of the world, but it was primarily a British occasion, a celebration to mark the coming of age of the first industrialized nation in the world.

Britain was to the 19th Century what California is said to be to the 20th: the place where the future happened first. For Britain was the originator of the Industrial Revolution and the first state to be transformed by it. By 1851 she had already experienced the explosive force of the machine age. Through her Empire and her adventurous, outward-looking stance in the 19th Century, she transmitted that force to the rest of the world.

That year, 1851, the census revealed that more than half Britain's people had come to live in cities and towns, a situation probably unprecedented in any large country. After half a century of industrial growth, her urban centres clanged, hissed and hummed to the rhythm of foundry and factory, and the thunder of steam locomotives was driving deeper every year into the peace of rural England.

In 1851, Britain made half the world's pig-iron and more than half the world's cotton cloth. She produced more coal, had more miles of railway (5,000 miles, half of it built in the preceding eight years), and with her merchant fleet (at three million tons, by far the world's largest), exported more manufactured products and made more money than did any other nation and, for that matter, more than any other nation had ever done.

By hindsight, it is apparent that by the mid-19th Century, industrialization had revolutionized British society, which is why 20th-Century historians use the convenient term "Industrial Revolution" to describe the developments of the period. But the crowds that milled around the Crystal Palace had no such concept of – and thus no name for – the amalgam of influences that had come together in the late 18th and early 19th Centuries to change their nation so profoundly.

So intertwined were the developments which made the Industrial Revolution that even now economic historians differ about the date of its origin. Did it begin with the new machines that in the late 18th Century initiated a textile boom? Or later, when steam-engines were sufficiently improved to power those machines? Or earlier, when a new iron-making technique assured the great quantities of that metal which eventually would be needed? Or did it begin with an even more fundamental element: men to run the machines? Without the existence of a potential work force, the revolution could not have begun.

Most of the workers needed by 19th-Century industry came from the British countryside, which had gone through a revolution of its own. This revolution was of far longer standing. Over the years, the small, unfenced farming plots that once had characterized most of the English countryside had been steadily "enclosed" into larger holdings. And in the 18th and 19th Centuries enclosures, coupled with crop rotation, proper drainage systems and improved breeds of livestock, had revolutionized agriculture.

Enclosures were sanctioned by Parliament, and some cash or land compensation was provided for leaseholders, but this did little to alter the fact that the old rural economy had been dealt a mortal blow. Often small tenants were evicted without any compensation and, most disastrous, the peasant lost his traditional rights to graze animals, snare game and collect wood for their fires from common lands and woods.

In Scotland a similar system of "clearances" was taking place at the same time as the enclosure movement in England. Here the motive was to expand sheep-farming and profit by the fast-rising

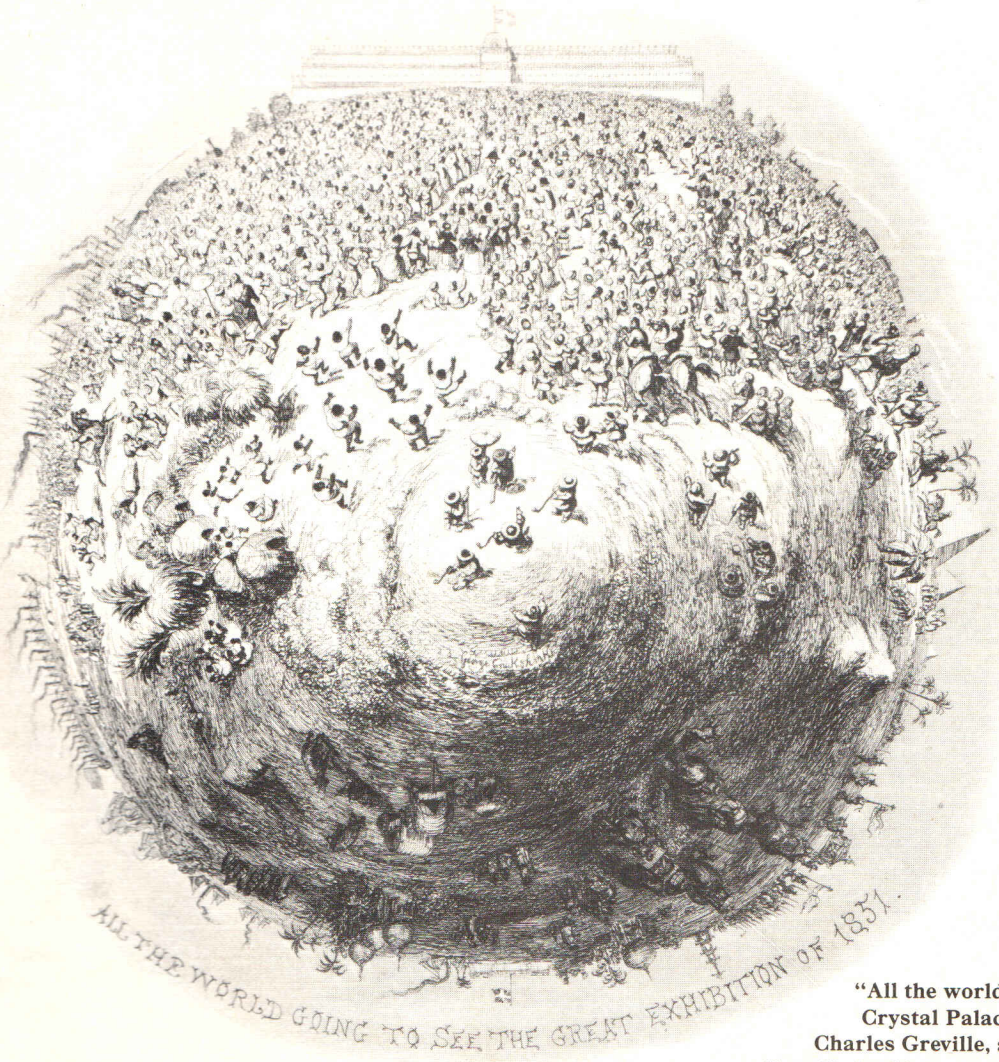
Prince Albert (studying plans), in his post as the hardworking president of the Royal Commission for the 1851 Exhibition, won the public admiration Queen Victoria wanted for him.

price of wool (it doubled between 1785 and 1795). Clearances, however, were simpler to accomplish. Highland dukes who owned whole counties outright could clear their estates just by driving out the people and burning their cottages. Between 1800 and 1806, some 19,000 people were evicted from the West Highlands and the Isles. Between 1811 and 1820, about 15,000 people were turned out of Sutherland alone.

Luckily there was work for many dispossessed peasants – on the new "farms" whose improving landowners needed labour – and so the rural population of Britain did not actually fall as a result of enclosures. But a large number of surplus hands were now being generated by a rising birth-rate and a falling death-rate. By choice or under duress, many of the dispossessed on both sides of the border went to the colonies or to the United States. "A rage for emigration," wrote one Scotsman laconically, "has got to a great height, of late, in the highlands." A special inquiry into emigration in 1826 was told how Laird Maclean of Coll had "just emptied the island of Rum into that of Cape Breton," the latter being off the coast of Canada.

Some of the unemployed and landless stayed in their cottages and starved – or poached the landlord's game for food, even though a cottager could be transported for seven years simply for being caught with nets on his person. ("We have," an emigrant wrote from Canada, "no gamekeepers and more privileges.") Even those who found employment as farm labourers suffered great hardship. Their wages, which in England were fixed by magistrates, usually big landowners, were often so low their families could not live on them. To make matters worse, food prices were going up rapidly at the time. The Berkshire magistrates, meeting at the Pelican Inn in Speenhamland, a suburb of Newbury, in May, 1795, reached a novel solution. Rather than raise the wages to subsistence level, they decided that the pay of the "poor and industrious" should be supplemented from the rates, in varying amounts determined by size of family and the price of bread.

The Speenhamland scheme was copied by many other counties, but it had grave disadvantages. Besides putting honest



"All the world has been flocking to the Crystal Palace," remarked the diarist Charles Greville, an impression portrayed literally in this cartoon by George Cruikshank.

workmen on the dole, it compelled small freeholders who had survived the enclosures to pay exorbitantly high poor rates to support workers on neighbouring large estates. As a consequence, many of these freeholders had to sell out. In 1800, although about 80 per cent of Britain's population still lived on the land, it seemed increasingly clear that, unless a man was already a landholder, there was no way for him to live at more than subsistence level except by moving to a town and working at higher wages in one of the new factories.

Factories of a kind had in fact been in existence for almost a century. The first truly mechanized factory in Britain was built in 1716 from stolen plans – an early example of industrial espionage. A Derbyshire man, John Lombe, went to Italy in about 1713 and got a job in one of Piedmont's jealously guarded silk mills whose organzine yarn made their silks superior to any others in Europe. Italian law provided that anyone who disclosed the secret spinning method would be executed, would forfeit his property and would be portrayed on the outer wall of the prison hanging by one foot "for a perpetual mark of infamy."

Lombe must have been an accomplished draughtsman with a flair for surreptitious sketching at work. When he returned to England in 1716, he brought with him two Italian silk workers and a parcel of plans, for which he secured a British patent. The silk "throwing" mill he built on the River Derwent was, by any standard, a real machine in a real factory. Housed in a five-storey building with 468 windows, the water-powered monster had 97,746 moving parts and was attended day and night by 300 workers.

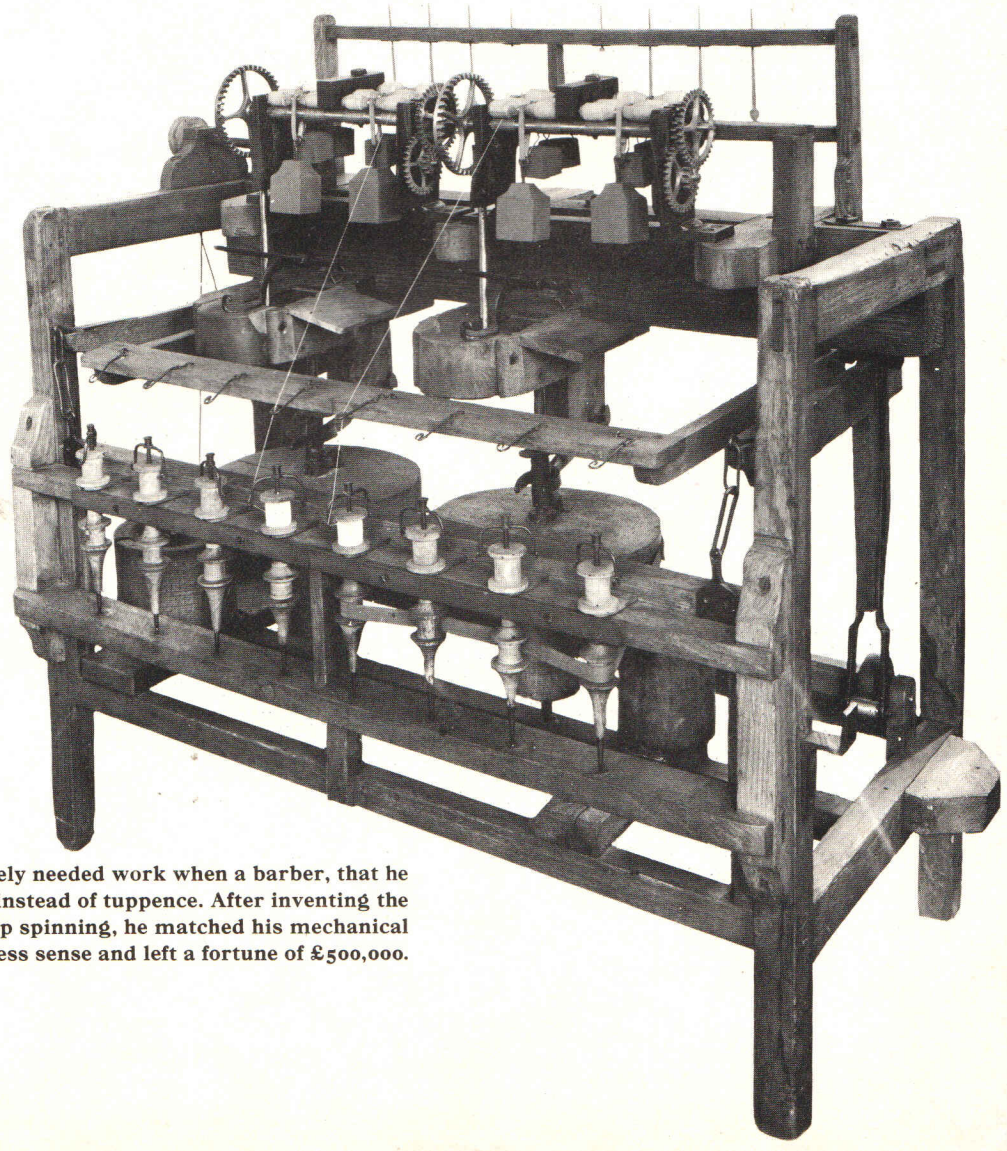
Lombe's machine broke the Italian monopoly, drove down the European price of fine silk, enriched his heirs and may have cost him his life. He died mysteriously, there being some intimation that an Italian woman who had been seen in his company was an agent sent to poison him.

Silk, however, was a relatively minor business. The manufacture of cotton cloth was to prove more responsive to mechanical innovation. Here the inventions were genuine British originals, although just who first thought of what was loudly and expensively debated in a number of lawsuits over patents.

A simple loom improvement called the flying shuttle had by 1760 doubled the productive power of the home weaver, but his wife in the other corner of the cottage still spun yarn off her wheel at the traditionally slow speed. Then James Hargreaves, a weaver, invented the spinning-jenny – or, at least, patented it; some insisted he stole the idea from one Thomas Highs. Hargreaves's first jenny spun eight threads at once, instead of the spinning-wheel's single filament, and within a few years there were to be jennies that worked as many as 120 spindles.

Two ominous portents for the future accompanied the introduction of the jenny. Soon after Hargreaves began to sell his machines in 1768, a mob of hand spinners smashed his machines and gutted his house. And then it was observed that the jenny, because of its configuration and the lack of skill it required, could be more easily operated by children than adults.

Lancashire textile manufacturers eagerly adopted the jenny, perhaps the



Richard Arkwright (left), so desperately needed work when a barber, that he offered cut-price shaves: a penny instead of tuppence. After inventing the water-frame (right), which speeded up spinning, he matched his mechanical genius with business sense and left a fortune of £500,000.

more so because they managed to invalidate Hargreaves's patent on the grounds that he sold some machines before applying for legal protection of his invention. By 1784, some 20,000 jennies with 80 spindles each were in use.

The jenny could spin only the weft – the cross threads; the yarn it produced was too weak to be used as the warp of the cloth. In 1767 a wigmaker named Richard Arkwright asked a clockmaker to "bend him some wires and turn him some pieces of brass." He then closeted himself in a house at Preston, in Lancashire, from which emanated noises that neighbours positively identified as the devil's bagpipes, proof that witchcraft was being practised.

In 1769 Arkwright emerged and patented a machine that produced a multiplicity of fine, hard threads, suitable for warp. It was a complex mechanism based on a completely new principle, spinning by rollers. Unlike the jenny it could not be worked by a woman at home. It required a power source. Arkwright's first machine was driven by horses harnessed to a shaft, but in 1771 he built a water-powered mill at Cromford, Derbyshire and his invention became known as a water-frame. This mill marked the genesis of Britain's factory system.

Arkwright was the prototype of the new British industrialist – self-made, hard-working, daring, confident. The youngest of 13 children in a poor family, he began his working life as a barber's apprentice. When he was 50 years old and rich from his invention, he worked from 5 a.m. to 9 p.m. and gave up two hours' sleep each night to study grammar, so that his business correspondence should not suffer from his want of education.

Although he lost a long series of patent battles against infringers, he made sure he received the benefits of his invention by erecting more and more mills of his own (one, at Chorley, was wrecked by anti-machine rioters in 1779).

He would earn so much money, he frequently boasted, that he would single-handedly "pay the national debt." Perhaps George III heard of his boast, because Arkwright completed the pattern that other successful industrialists would later follow by receiving a knighthood and crashing through rigidly established barriers of class and caste – no small achievement at that time. The ex-barber's apprentice became High Sheriff of Derbyshire, and when he died in 1792, he was building himself a church and a castle.

As with Hargreaves before him, Arkwright was accused of stealing the idea for his invention from Thomas Highs, who must have been either a singularly brilliant and unfortunate man or a useful stooge used by patent-breaking manufacturers. Arkwright was also accused of having stolen the design of a carding machine from Hargreaves, but it was fairly well proved that Hargreaves had purloined it from him.

Another man who suffered particularly harshly in these fierce fights over ownership of inventions was Samuel Crompton, who invented the spinning-mule. Crompton, who spun yarn on a jenny under his mother's critical eye, grew weary of being upbraided whenever his yarns broke. Between the ages of 22 and 27, he worked in secrecy to create something better than Hargreaves's machine. The result, in 1779, was the mule, so-called because it married the jenny and the water-frame. The mule could mass produce a thread so fine and so strong it could be used for the manufacture of muslins, which until then had to be imported all the way from India at great expense.

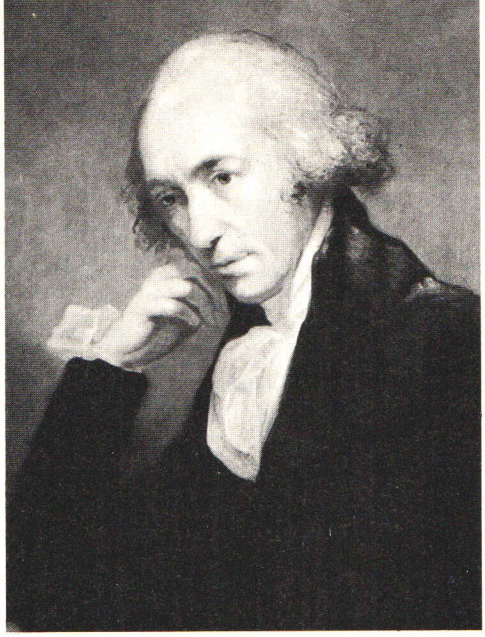
Crompton's yarn was soon much in demand and manufacturers clamoured to see his miracle-working machine. Arkwright, it was said, once got into Crompton's house for a surreptitious survey while Crompton was absent. The pressure on the young man was terrific, after a few months reducing him "to the cruel necessity, either of destroying my machine altogether, or giving it to the public. . . . I had no patent, nor the means of purchasing one. . . . I gave it to the public."

Jubilant textile manufacturers announced a subscription for Crompton in gratitude for his generosity. But the subscription ended as soon as Crompton surrendered the mule, leaving the inventor with the princely sum of £67 6*s*. 6*d*. He was soured for life. Later he actually did destroy an improved carding machine he had designed, muttering, "They shall not have this too."

Hargreaves's jenny, Arkwright's water-frame, Crompton's mule: these were the three basic mechanisms that launched the textile phase of the Industrial Revolution. All that was lacking was a better source of power than the water-wheel, and steam ended this deficiency.

Steam power was no new discovery. Thomas Newcomen, whose obituary in the *Monthly Chronicle* identified him as the "sole inventor of that surprising machine for raising water by fire," demonstrated his first steam-engine in 1712, near Wolverhampton. It is thought

The jenny enabled one person to spin 16 or more threads simultaneously. Its inventor, James Hargreaves, may or may not have been inspired by an overturned spinning-wheel; it is certain he made no money from the jenny.



Watt, in despair over his ideas being stolen, said: "Of all things in the world, there is nothing so foolish as inventing."

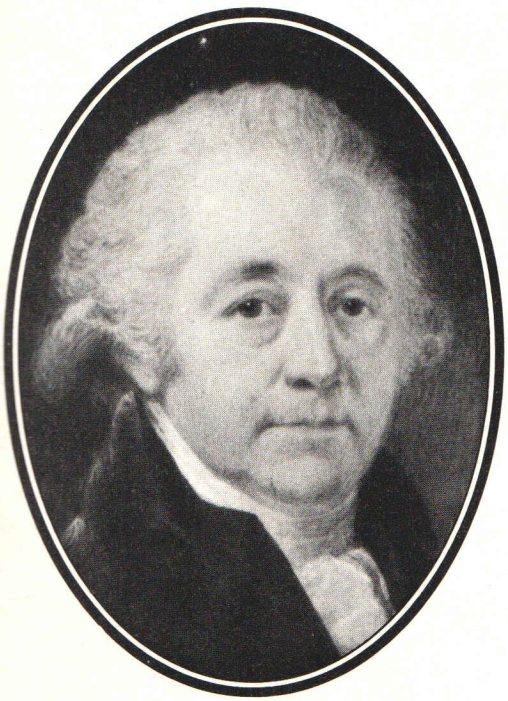
to have operated at about 5½ horsepower and functioned at the then amazing rate of 12 strokes per minute.

Inefficient it may have been, but it was power, and an advertisement in the *London Gazette* in 1716 claimed it was already in use in Stafford, Warwick, Flint and Cornwall. Miners welcomed its steady, plodding ability to power the pumps that kept the shafts clear of water. That was about all it could do. Steam-power was then too immature to mate with manufacturing industry or transport.

Half a century passed before James Watt, an instrument-maker at Glasgow University, tired of struggling with a Newcomen engine that stubbornly refused to work properly, built a better one. The drawback with Newcomen's engine, Watt discovered, was that the steam was condensed in the cylinder, so cooling it. As a result, the next input of steam was partially wasted on re-heating the cylinder. By extracting the steam at once into a separate condenser, Watt managed to keep the cylinder much hotter and so created a machine with three times the earlier engine's efficiency.

For financial support, Watt set up a partnership with Matthew Boulton, founder of the Soho Engineering Works near Birmingham. The two men were a formidable combination: Watt with his inventive genius, Boulton with his capital and business sense.

Matthew Boulton, Watt's business partner, was jubilant when England went "steam mill mad."



When the Boulton & Watt model reached the market in 1777, there were 75 Newcomen engines in the Cornish copper- and tin-mines. Within six years the new engine replaced all but one of them, and in 1790, Sir Thomas Arkwright, always in the forefront of progress, brought steam-power to industry by equipping his Nottingham factory with a Boulton & Watt engine.

During the 1780s, Watt adapted his engine to give rotative power, which was what manufacturers needed. A simple crank action was the obvious answer, and he designed one, but one of his employees, named Pickard, reached the patent office ahead of him and claimed the device for himself. Rather than deal with Pickard, Watt worked out a complicated sun-and-planet wheel arrangement and thereafter would admit only in private that a simple crank worked as well.

Watt resisted any attempts to increase his engine's pressure above five pounds per square inch, saying the whole notion of using high-pressure steam was both unsound and unsafe. But in 1812, after Watt's original patent expired, a Cornish engineer named Richard Trevithick built a stronger boiler and adapted a Watt engine to work at 40 pounds per square inch. This "Cornish Engine" became the workhorse of the 19th Century. Its tirelessly nodding beam, so huge that it had to be mounted on a wall or a massive pillar, was a common sight at mines, factories and waterworks. In our day of planned obsolescence its durability seems remarkable; one Cornish Engine installed at Kew in 1846 gave faithful service until 1943, a lifespan of almost a century.

With each new improvement of the steam-engine came new applications. Britain began to breathe steam. By 1840, threequarters of all cotton was spun on steam-driven machines. In 1850, British industry was using 500,000 horse-power of steam, and the railways ran on another 750,000 horse-power. By 1870, the country's steam muscle had expanded to four million horse-power. Obviously, Matthew Boulton had been right when he told King George III, "I sell, Sire, what all the world desires – power."

The Industrial Revolution, with its textile machines and steam-engines could never have happened without enormous quantities of iron. And those would not have been available without the discovery of Abraham Darby, a maker of iron cooking-pots. In 1709 he became the first man successfully to fire a blast-furnace fuelled by coke instead of charcoal.

By the 18th Century, the ancient craft of ironmaking had not changed significantly since the Middle Ages. Furnaces were larger than before and the bellows that blasted air through them were now powered by water-wheels instead of by hand. But charcoal was still the only fuel and a tremendous amount of wood was required to produce it.

English ironmakers had literally burned up the forests of the Sussex weald and at the beginning of the 18th Century were working their way through the woods of the West Midlands. The industry could not keep up with demand, then comparatively small, much less expand. Some ironmakers had experimented with coal, but burning coal released sulphur and other impurities that ruined the ore.

Darby knew that coke – coal precooked in a process much like charcoal-making – was used successfully in malting kilns, and so he tried it in his small foundry at Coalbrookdale, Shropshire. It worked. At first Darby's coke-smelted iron was cast into such prosaic items as cooking-pots, fire grates, and hatter's irons; smiths were convinced it would never do for forge work.

But in 1718 Darby's company was asked to make iron piping for a Newcomen engine, and in 1722 it cast the first steam-engine cylinder to be made of iron rather than brass, which was much more

Gargantuan in size and power, James Nasmyth's steam-hammer was so finely controlled it could gently crack a nut. Artist as well as engineer, Nasmyth himself painted this scene.

expensive. Despite these inklings of the future, Darby's process was slow to be taken up. In 1760 there were still only 17 coke-smelting furnaces in the whole country. Their output was a tiny fraction of the prodigious quantities of iron that would be needed once industrialization was truly under way.

Iron was basic to the developing pattern of interdependent industries. Eventually these would become so enmeshed as to give industrial Britain the appearance of one enormous machine, no part of which could work without the others. Just as iron was essential to a steam-powered economy, so steam was essential to the production of iron. In 1776, for instance, a steam-engine was first used to force air through the furnace at John Wilkinson's works in Willey, Shropshire, thus solving the problem that had retarded the coke-smelting process – the creation of the more powerful blast needed when coke rather than charcoal was used as fuel. Steam, too, powered the heavy rollers that Henry Cort invented in 1783, cutting down the hammering previously needed to process iron.

With the help of steam, iron production increased four times in the two decades before 1805. This was fortunate, because more iron was needed to make more steam-engines that were needed to power new textile factories and to drive the machinery of the coal-mines which were expanding because more coal was needed to make more steam and more iron.

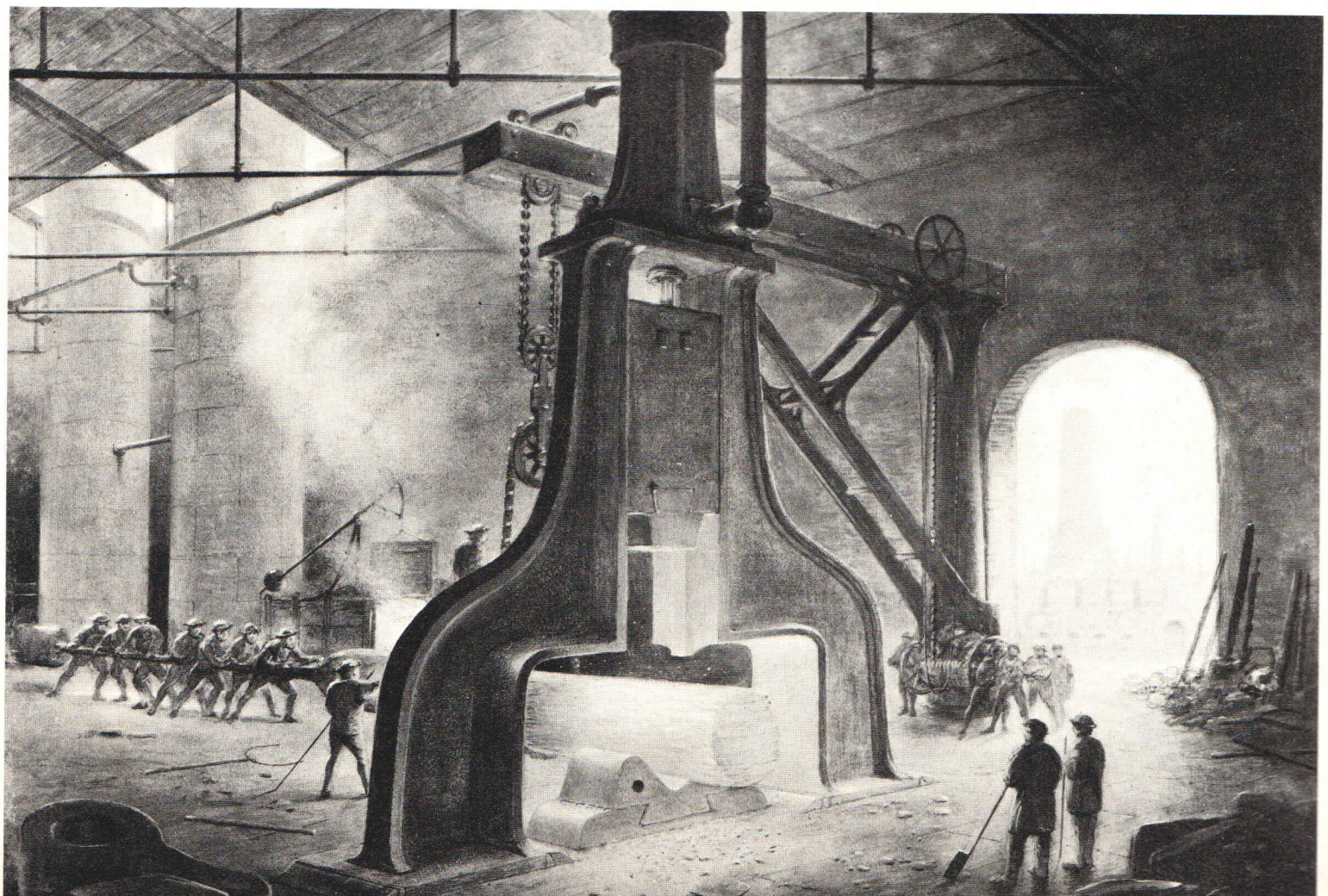
Each new industrial development gave further impetus to growth. Wooden textile machines gave way to iron ones as more powerful steam-engines – built with more iron, fired by more coal – were developed to drive them. Improved steam technology led to railways with coal-burning iron locomotives running on iron rails and over iron bridges. Between 1800 and 1846, coal production climbed from 10 million tons to 44 million tons a year; iron output soared from 250,000 tons to two million tons. It is not difficult to see why this period has been called an "industrial explosion."

And for all the humming, clacking, steam-puffing cotton mills of Lancashire or Glasgow, the hub of the new industrial economy remained firmly fixed in the Black Country where nature had been packing away mineral wealth for aeons. Iron-ore and coal abounded, and frequently could be taken from the same shaft. The Staffordshire "Ten Yard Seam" produced up to 20,000 tons of coal an acre.

Here Abraham Darby and other iron-makers stoked their blast-furnaces and foundries. Before they developed less wasteful methods, the ironfounders coked their coal in vast, smouldering exposed piles and smelted their iron-ore in open furnaces, creating a scene that can have resembled nothing so much as the Hell invoked by the Nonconformist preachers to whom so many of the workers in the industry listened on Sundays.

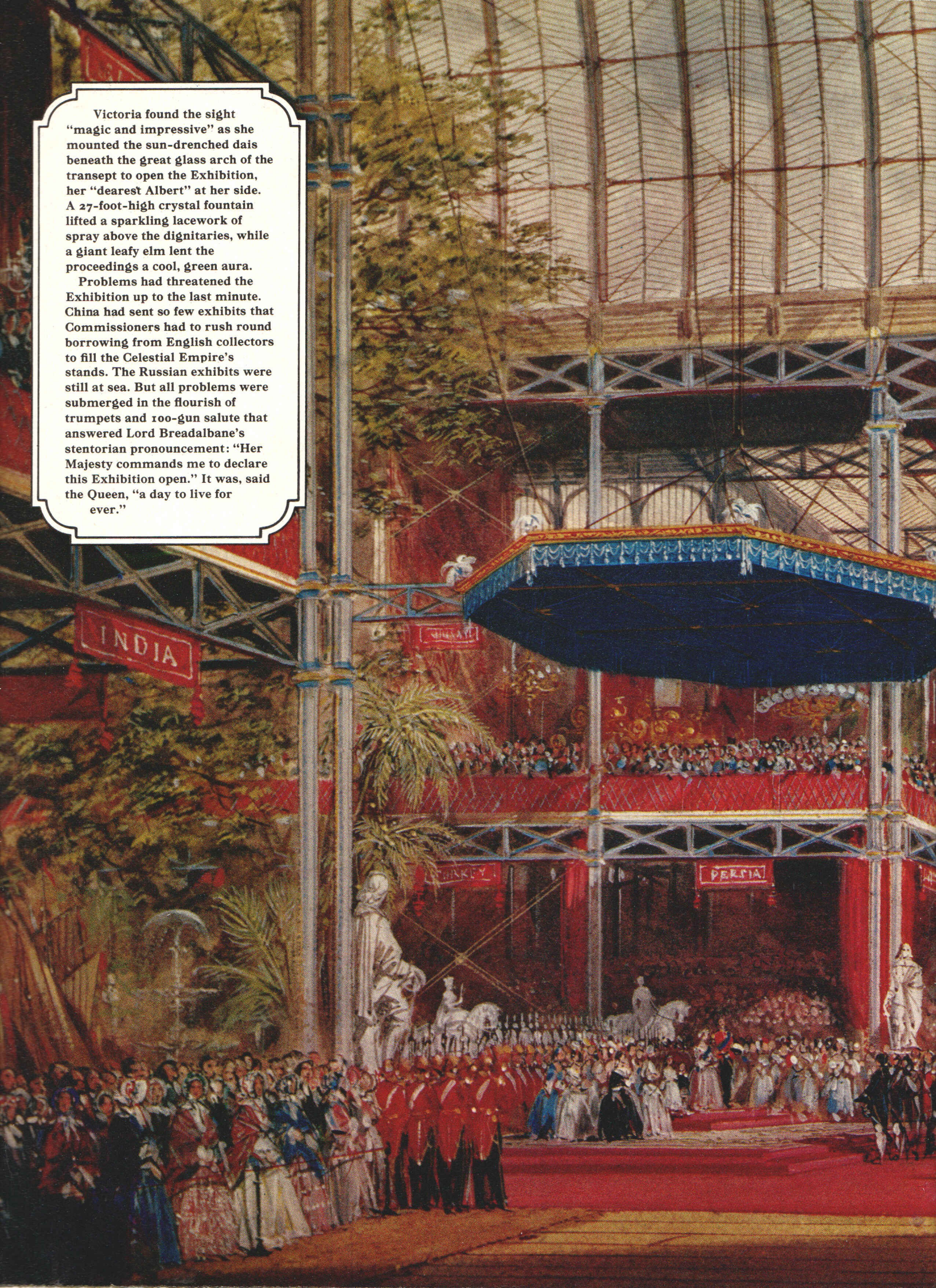
"I have walked over this country in a dark night," wrote an astonished foreign visitor in the early 19th Century; "the horizon about me was bounded by a circle of fire. From all parts, columns of smoke and flame rose in the air, and the whole country around seemed as if lighted by an immense conflagration." And around the foundries, rolling-mills and engineering works sprang up, forming a great, sprawling industrial complex.

This creation of a new economy and way of life was happening so quickly that Englishmen were often as awed and puzzled by it as were foreigners. The 1831 census-takers could identify and count potters easily enough, but after some head-scratching about new categories of labour, they could only report that in Staffordshire many were engaged "in producing the more various and complex aid of human industry which is comprehended under the name of machinery"



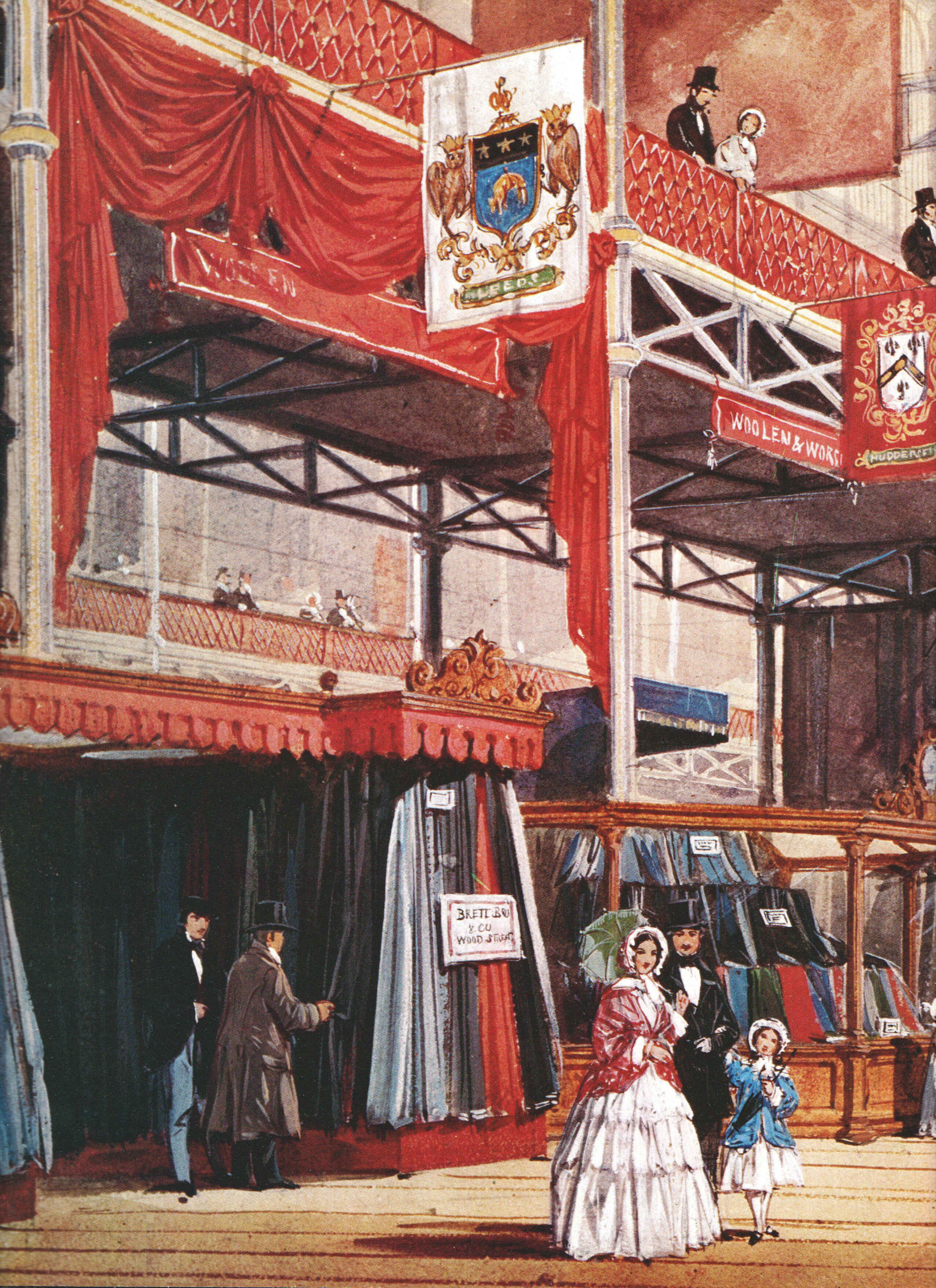
THE GREAT EXHIBITION

"We shall probably have to give up the whole Exhibition," Prince Albert gloomily wrote in July, 1850, for the public was outraged by his Royal Commission's plan to build a squat exposition hall in Hyde Park. Then Joseph Paxton came forward with a brilliant design for a vast, imaginative glass structure, and Britain's "Exhibition fever" rose as rapidly as the building. For the opening on May 1, 1851, fully half a million people thronged the park, many taking to boats on the Serpentine for a better view of the Crystal Palace (below). And the "Great Exhibition of the Works of Industry of all Nations" – shown in the contemporary watercolours on these pages – was an unprecedented success from the start.



Victoria found the sight "magic and impressive" as she mounted the sun-drenched dais beneath the great glass arch of the transept to open the Exhibition, her "dearest Albert" at her side. A 27-foot-high crystal fountain lifted a sparkling lacework of spray above the dignitaries, while a giant leafy elm lent the proceedings a cool, green aura.

Problems had threatened the Exhibition up to the last minute. China had sent so few exhibits that Commissioners had to rush round borrowing from English collectors to fill the Celestial Empire's stands. The Russian exhibits were still at sea. But all problems were submerged in the flourish of trumpets and 100-gun salute that answered Lord Breadalbane's stentorian pronouncement: "Her Majesty commands me to declare this Exhibition open." It was, said the Queen, "a day to live for ever."


WOOLEN
LEEDS
WOOLEN & WORS
HUDDERSF
BRETT BRO
& CO
WOOD STREET

The Great Exhibition was much more than a trade fair; it was a national experience. Merchants took a keen interest in seemingly prosaic displays like the woollen fabrics seen here, surmounted by banners bearing the arms of the great textile-manufacturing cities. Workers could find products from their own factories, a symbol of their involvement in the Industrial Revolution.

This sense of participation drew people of all classes from every part of Britain, many making their first-ever railway journeys on cheap excursions for the Exhibition's "shilling days." But many returned again and again, and attendance soared. Among the most faithful visitors was the Queen herself, who toured the Crystal Palace more than 40 times and professed that "it has taught me so much that I never knew before."

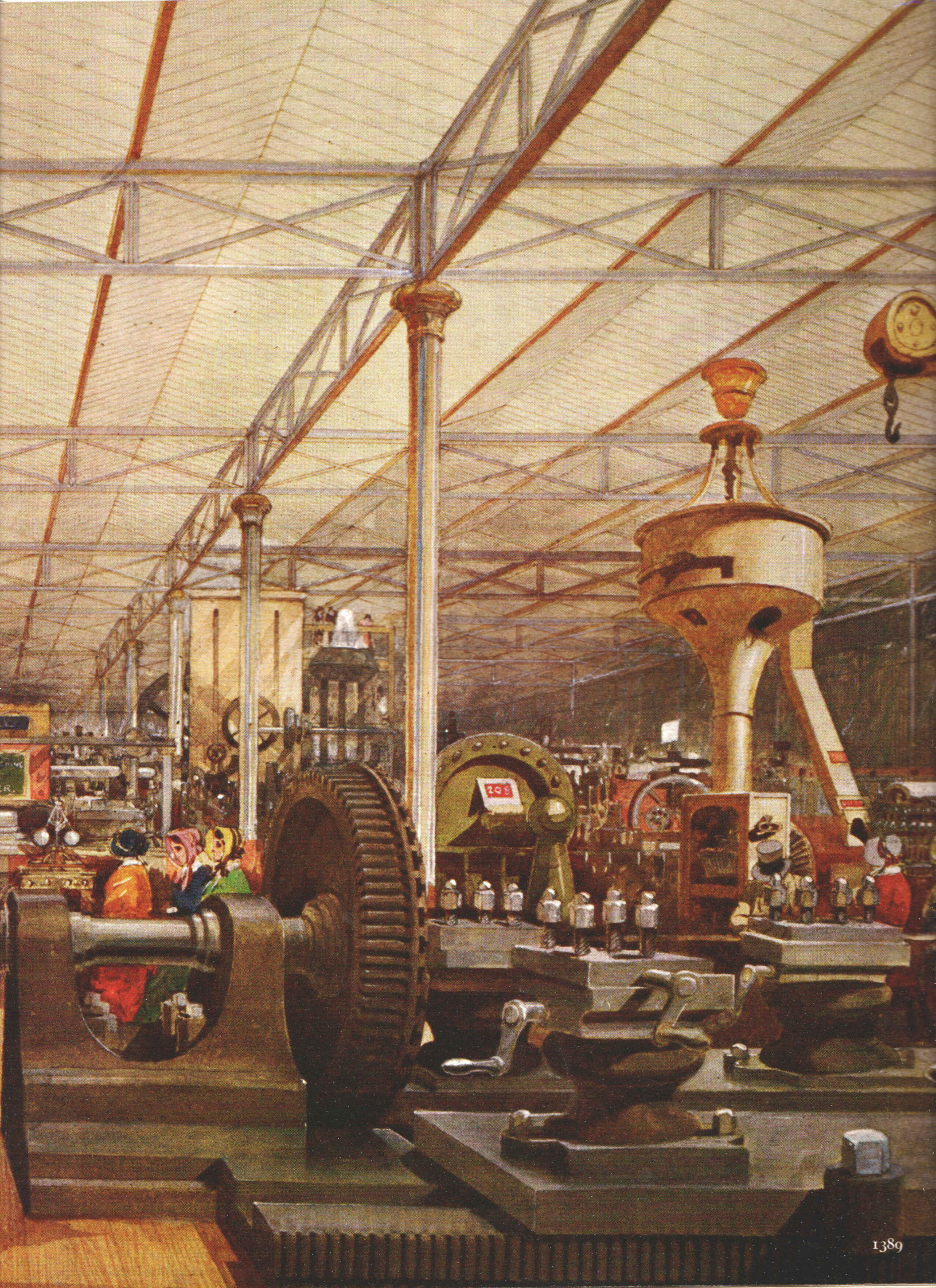
The popularity of the stained glass gallery (below) confirmed the Victorians' deep attachment to religion, but said little, some critics contended, for the quality of contemporary stained glass. Of greater lasting interest were the objects assembled by Augustus Welby Pugin for his Medieval Court (left), a curious backwater that looked to the past amidst the worship of progress.

Pugin, a brilliant architect, was a Roman Catholic who sought to return England to Rome by reviving interest in the Gothic style that had flourished in the centuries before the Reformation. His section included Gothic domestic furniture as well as church ornamentation. Pugin's aggressive Catholicism made Protestants resent his exhibits, and he was compelled to remove a large crucifix. He died in 1852, but his work greatly influenced the Gothic revival of the next half-century.


CLAUDE F. HOUGHTON
J A Gibbs

The purpose of the Great Exhibition, said Prince Albert, was to show "the point of development at which mankind has arrived . . . and a new starting point from which all nations will be able to direct their future exertions." In the case of machines, it did just that.

In the mechanical section (below), there were machines for washing ore, grinding wheat, sawing wood, cutting screws, making wire and for "the manufacture of French and Italian chocolate." There was a portable steam sugar-cane mill, a steam riveting machine, improved high-pressure steam engines and, perhaps for the Victorian handyman, a "one horse power portable steam-engine for amateurs." Farming had long lagged behind industry in the use of steam power, but in the Exhibition's agricultural section (left), products of engineers like Ransomes & May showed that this was rapidly changing.



"The world talks of nothing but the Exhibition," recorded one diarist that magic summer. The Crystal Palace became a centre of London social life, where bonneted ladies like the ones in this view chatted beneath the great elm. And, recorded the Queen with satisfaction, "Mr. Wellesley preached a very nice sermon, alluding in a very pretty and proper manner to the Exhibition."

No formal ceremony marked the public closing on October 11, 1851, but the crowd sang "God Save the Queen" and cheered for a solid half-hour. The Exhibition made a profit of £186,000 much of which was used to buy the nearby Kensington site now occupied by museums and colleges. The Royal Commission for the 1851 Exhibition is still active under its president – Albert's great-great grandson, Prince Philip – and uses its capital of £1,266,800 for the promotion of arts and sciences.


INDIA
INDIA

II. Industry and Empire

The early 19th Century was truly an age of wonders. In October, 1829 the *Scotsman* somewhat breathlessly reported an event that would be "a greater impulse to civilisation than it has ever received from any single cause since the press first opened the gates of knowledge to the human species at large."

The event was the opening of the famous Rainhill Trials, where George and Robert Stephenson's *Rocket* conclusively proved the practicability of steam railway locomotion. This was a question that had remained in doubt even though four years earlier George Stephenson had persuaded the owners of the Stockton and Darlington Railway, which he had built, to use steam-engines instead of horses to pull the carriages.

The directors of the Liverpool–Manchester line, which Stephenson was now building, wanted steam, but they preferred to use stationary engines, spaced along the tracks, to pull the carriages by a system of ropes. In order to settle their doubts, they organized the Rainhill Trials to see whether Stephenson, or any other engine-maker, could make good his claims for locomotives. A £500 prize was offered to the engine that performed best while fulfilling certain conditions: the engine had to average at least ten miles per hour as it travelled 70 miles by running back and forth over a short stretch of level line in one day, carrying a set load.

Thousands of spectators – many of them the new engineers and mechanics that the census-takers had trouble in classifying – came to Rainhill near Liverpool for the contest. A grandstand was erected for the ladies, and the horses and carriages of fashionable onlookers lined the two-mile stretch of track, "as if," wrote Samuel Smiles, the great contemporary biographer of Victorian engineers, "the St. Leger were about to be run."

There were four entries; a fifth, the *Cycloped* was disqualified since it was powered by a horse running within a frame. The judges were rumoured to favour John Braithwaite's *Novelty*, since it looked smarter than the *Rocket*. *Novelty* made one run at an astounding 24 miles an hour before collapsed bellows and burst pipes put it out of the competition.

Hackworth's *Sanspareil* had boiler trouble. Burstall's *Perseverance* never topped six miles an hour. Only *Rocket* completed the course, averaging 15 miles per hour. After collecting the prize, Stephenson removed the extra weight from the *Rocket* and dumbfounded the crowd by careering along the line at 35 miles an hour – more than three times the speed that one judge had declared was the absolute limit of physical possibility.

Eleven months later a parade of eight steam trains carrying the Duke of Wellington and almost every other national leader opened the Liverpool and Manchester line. It was a grand occasion marred somewhat when William Huskisson, M.P., a man with a "peculiar aptitude for accident," fell in front of one of the locomotives. His death had little effect on the railway age; by 1843 there were 2,000 miles of track in Great Britain; by 1850, more than 5,000 miles.

The lines were built by the great engineers whose names – George Stephenson, Isambard Kingdom Brunel, Joseph Locke – became bywords to schoolboys caught up in the excitement of the new era.

George Stephenson was the son of a colliery fireman and grandson of a gentleman's servant (he himself was wed to a housemaid). He learned to read at the age of 18 and taught himself engineering by repeatedly dismantling and reassembling a Newcomen engine at the coal-mine where he worked. From this beginning he became the prime mover of the railway age and one of the most famous and respected men in England.

His son, Robert, if not so prescient – he condemned the projected Suez Canal as impracticable, saying "the thing would only be a ditch" – was a brilliant mechanical and civil engineer. He managed the family's locomotive works, where he was largely responsible for the design of *Rocket*. His high-level bridge over the Tyne at Newcastle was completed in 1849 and still carries traffic. His Britannia Bridge over the Menai Straits, a dramatic innovation built in 1850, was in use until May, 1970 when it was damaged by fire.

Isambard Kingdom Brunel was a visionary who sometimes found his ideas opposed by the cautious Stephensons – and often lost to them. Most railways had tracks four feet 8½ inches wide simply because that was the normal distance between the wheels of standard road wagons when the first lines were built. Brunel chose a gauge of seven feet for his Great Western Railway because it promised a smoother ride and could accommodate larger engines, capable of greater speed. The wider gauge was a logical development, but Brunel ultimately lost "the battle of the gauges" for the equally logical reason that people did not like interrupting their journeys where broad gauge met narrow.

Brunel embraced, and invested money in, the notion of "atmospheric railways," which required the creation of a vacuum within a tube. A plug, fitting tightly inside the tube, would be pushed through the tube by air pressure, and so would drive the train along. " It won't do," said George Stephenson, denouncing the idea as "gimcrack." Nevertheless, in 1845 an atmospheric railway between London and Croydon was opened, and Brunel began working on another in South Devon. But that year Parliament rejected Brunel's atmospheric scheme for the Newcastle–Berwick line in favour of Stephenson's conventional plan. Three years later all the atmospheric railway tubes in use were pulled up and sold for scrap.

Perhaps Brunel's greatest achievements were in steam-powered sea transport. His *Great Western* caused a frenzy of celebration in New York in 1838 when she crossed the Atlantic on her maiden voyage in only 15 days, five hours. He proved the superiority of screw propulsion over the paddle by staging a tug-of-war between two Royal Navy sloops, one equipped with paddles, the other with a propeller. He used his experience in building the iron-hulled *Great Britain*, which when floated in 1846 was the largest ship ever constructed.

The *Great Eastern* was Brunel's last and most ambitious project. With her 692-foot length, watertight compartments and double iron hull displacing 32,000 tons, she was the forerunner of all modern ocean liners. But the ship was built decades too soon: there was not enough passenger business to support her Atlantic

runs. However, the vast capacity that made her a commercial disaster also enabled her to play a special role in the Industrial Revolution. She laid the first successful trans-Atlantic telegraph wire in 1866, running out the cable from immense reels in her spacious holds.

Industrialization happened so fast that Britain's political and social institutions were left far behind. They were geared to an earlier age. Eventually the shock waves from the industrial explosion would force these institutions into forms that enabled Britain to live with its new machines and benefit from them. But reforms were slow in coming during the transitional period and the lives of large numbers of working people were subjected to the merciless operation of economic forces.

The first tremors were felt by craftsmen displaced by machines. There resentment turned to violence in the Luddite movement, which started in the north and in the Midlands and raged from 1811 to 1816. The name taken by the angry workers commemorated Ned Ludd, a stocking-maker who had smashed a stocking-frame some 30 years earlier. Now his successors signed their threats and ultimatums "King Lud." In April 1812, Luddite hand-loom weavers destroyed a steam-loom factory in West Houghton. When caught, four were hanged and 17 transported.

In the same month about 150 Luddites in Yorkshire, shearmen whose skilled task of cutting the nap off woollen cloth had been taken over by shearing frames, marched on William Cartwright's mill to smash the frames with a hammer they called "Great Enoch." Cartwright was waiting with an armed party. Two of the shearmen were killed, the others driven away. Later that month another frame-using manufacturer was assassinated. After the risings in Yorkshire, 14 men were hanged.

A similar anger moved agricultural labourers in 1830. Already tormented by low wages and stiff penalties for poaching, they now found their winter employment – flailing the grain – being taken away by a mechanical thresher invented by Andrew Meikle. In August, Kentish farmworkers marched through the countryside, smashing threshers, burning ricks and demanding higher wages. The violence spread through Surrey and Sussex, west to Dorset and Gloucestershire, and north to Norfolk and Northamptonshire before it was stopped by firm government action: three men were hanged, 420 transported.

Apologists for the new machines pointed out that they created many more jobs than they eliminated. But the factories that offered the jobs were dirty and often dangerous, and pay, though high when compared to farm work, was much lower than that earned by skilled craftsmen. Worst of all, the early machines were simple enough to be operated by children.

Poor Law officials quickly recognized the opportunity offered by mechanical progress. Required by law to apprentice pauper children, they contracted them to cotton-makers in batches of up to 100, shipping them in droves from London and the south to the mills in the north. The cotton-master had labour for the cost of keeping the children alive, and if the outbreaks of fever common to the apprentice house cut down his labour force, he could always order more from officials who were eager to oblige.

The children worked up to 15 hours at a stretch – in shifts, so that only half as many beds were needed as there were children employed. The young workers were prodded and flogged to keep them awake at their machines. One boy was reported to have been strung up by his wrists over a machine, so placed that unless he kept his legs drawn up his feet would be mutilated. Although that was an exception, punishments for transgression of rules were generally severe.

The booming coal-mining industry also found handy uses for children. In fact, the agent for the Countess of Durham's collieries told a commission investigating children's employment in 1842 that there was no way "of carrying on collieries so as to dispense with the labours of very young children; any restricting law that should produce a scarcity of children would prevent many pits from being carried on beneficially."

It was simply a matter of size. Children could move through low, narrow tunnels where adults had difficulty. So children of only four or five spent up to 18 hours a day in the dark, on their hands and knees, pulling trucks loaded with coal to which they were harnessed with chains.

Adult workers suffered as well, especially those driven from the countryside to the alien world of factories by the constantly increasing number of enclosures. The hours were no longer than those they were accustomed to, and the wages usually higher, but an ill-lit, noisy mill was a poor change for a field of corn. Most importantly, instead of setting his own rhythm for his work, as he had done with a scythe, the new industrial labourer had to match the rhythm set by his machine. The tool had become the master.

Nor was the damage only psychological. According to a contemporary observer, there was between 1800 and 1830 a "vast deterioration in personal form . . . brought about in the manufacturing population. . . . Their complexion is sallow and pallid – with a peculiar flatness of feature, caused by want of a proper quantity of adipose substance to cushion out the cheeks . . . a very general bowing of the legs. Great numbers of girls and women walking lamely or awkwardly. . . . Nearly all have flat feet . . . a spiritless and dejected air."

Reforms to ease these miseries were on their way, brought about in large measure by an unforeseen result of the Industrial Revolution. The growth of industry had divided the rich and powerful into two opposing camps, one urban and one rural. Both groups were conservative, but each had special and conflicting interests.

The newly successful businessmen and manufacturers of the cities wanted to break the grip that the largely country-based, landowning Tories had on Parliament. The landowners, jealous of the increasing power and wealth of the urban middle class, countered attacks on their own power by supporting the factory-reform acts, acts that were bitterly opposed by the laissez-faire industrialists. Quite incidentally, workers benefited from this conflict of the wealthy groups.

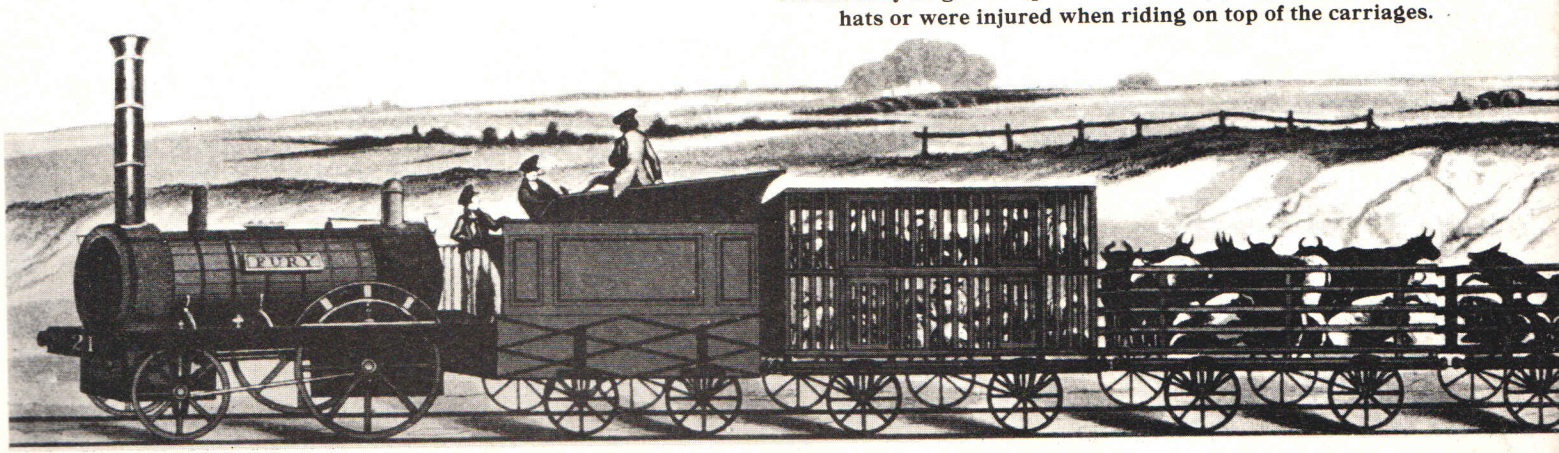
Reform by no means derived entirely from such selfish motives. There was a new humanitarianism at work in Britain, embodied in men like Robert Owen. Owen,

continued on p. 1396

George Stephenson (above) proved with his *Rocket* (below, as seen now in the Kensington Science Museum) that steam locomotives were a practicable form of transport.

The cartoonist George Cruikshank lampoons early fears of "the railway monster." It was thought that locomotives would frighten the cattle to death and set fire to fields and houses.

The public were enthralled by the possibilities of the new railways and the great variety of goods they could carry. But passengers occasionally forgot the speed and casually jumped off to retrieve lost hats or were injured when riding on top of the carriages.

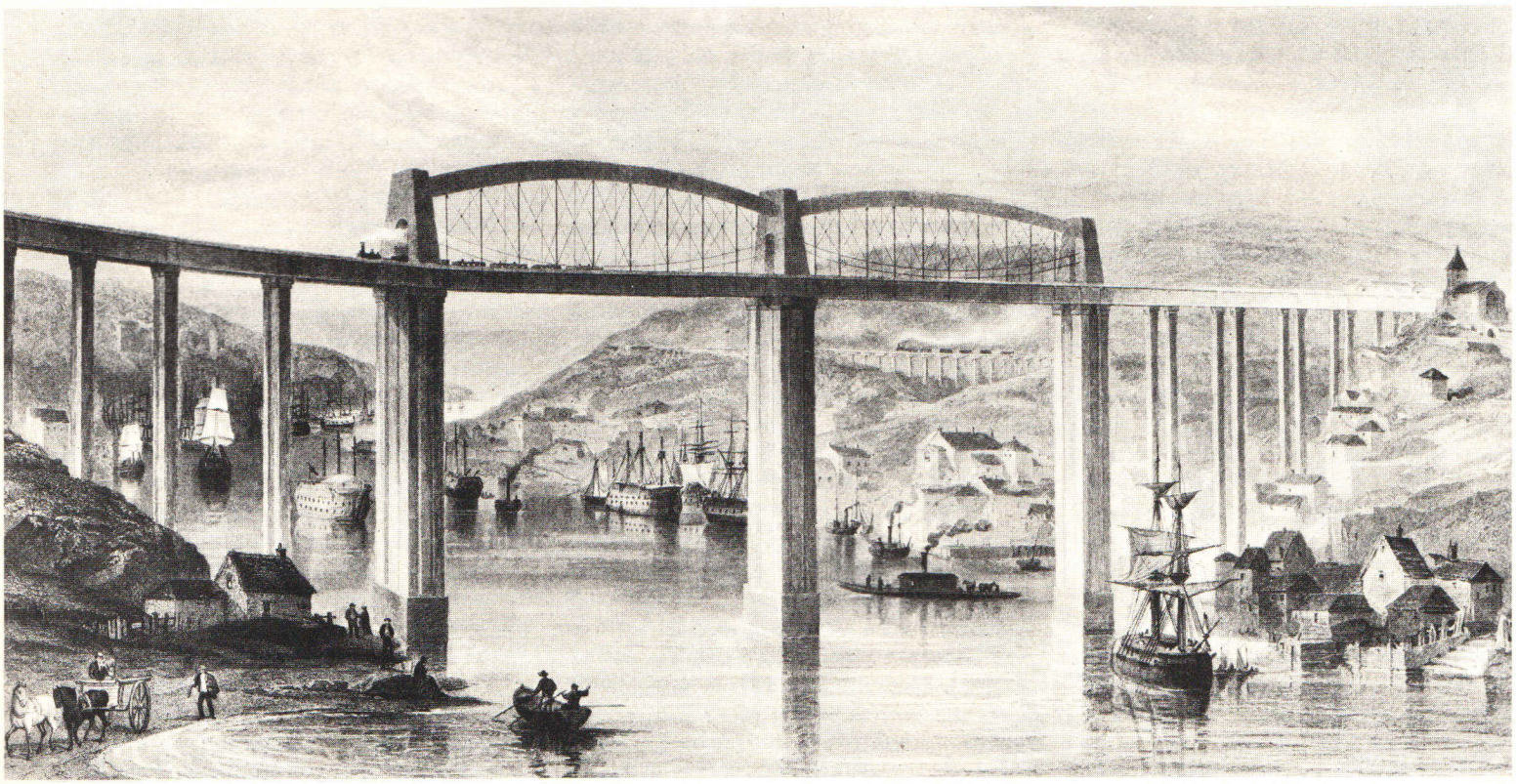


RAILWAY MADNESS

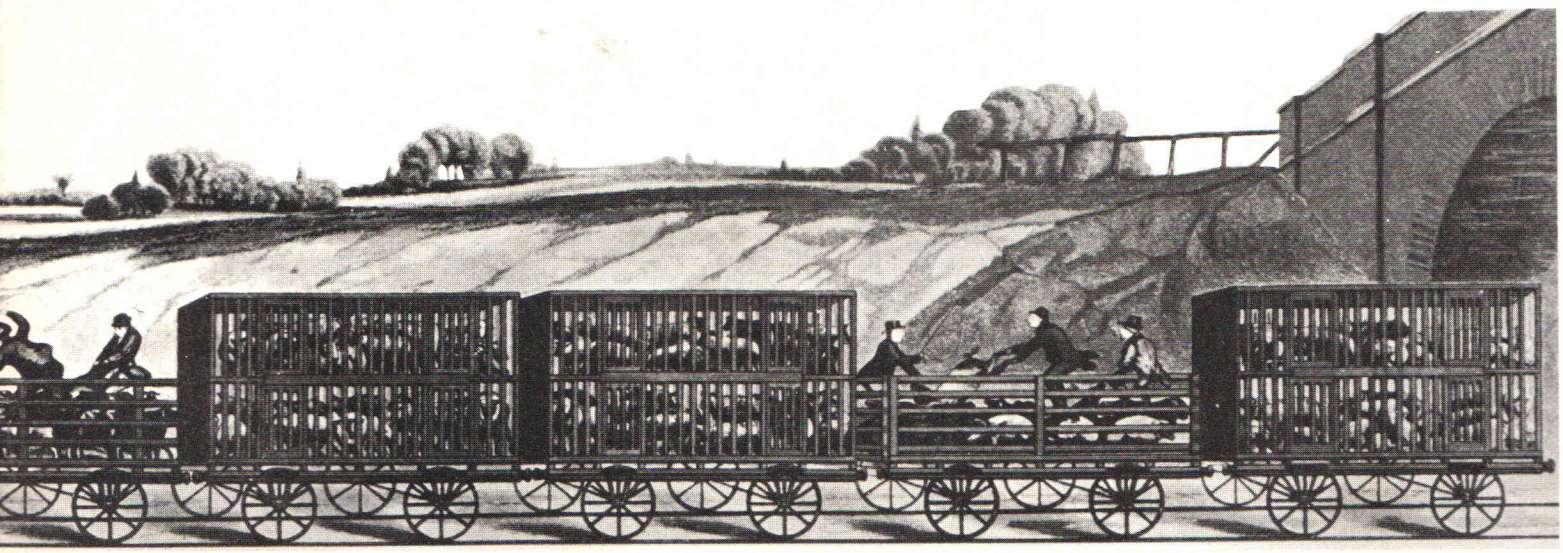
Even after the success of George Stephenson's Liverpool and Manchester line in 1830, railways met strong opposition. Canal companies spread rumours that birds flying over the "fire horses" dropped out of the sky, stone dead. Learned doctors insisted that passengers could not survive long tunnels because of "destruction of the atmospheric air." Railways it was said, would drive up the price of coal and beat down the value of nearby property.

Events soon disproved the myths. Prices of property near railways shot up, and the cost of coal and many other goods went down because of the new, fast transport. The towns of Northampton and Maidstone, which had compelled railways to bypass them, were soon asking the companies for lines. A marquis who had forced a railway to construct two expensive tunnels in order to pass at least five miles away from his house asked belatedly to be connected, but had to build his own branch at a cost of £160,000.

As the advantages and profitability of the lines were proved, railway mania gripped the nation. In 1845 alone 623 new lines were proposed. Stephenson and other reputable engineers stayed clear of the shakier schemes, but the public invested with a passion. When the bubble burst in 1848, the year Stephenson died, many shareholders were ruined. The boom was over, but what a boom! By then Britain had 5,000 miles of line and Stephenson's oft-expressed dream – of railway travel so cheap that a poor man could not afford to walk – had virtually come true.



The Royal Albert Bridge was designed by I.K. Brunel to carry the Great Western Railway line over the River Tamar in Cornwall.



who had started his business on a borrowed £100, made himself rich and used his cotton mills at New Lanark to show what enlightened industry could and should achieve. He opened company stores that sold food and clothing at low prices. He put all children under 12 in the company-owned town into school instead of on the shop floor. In 1807, when an American embargo on the export of cotton to Britain shut down his mill for four months, Owen paid his 1,300 workers full wages while they were idle.

There were men like Richard Oastler, who was so shocked to learn the truth about child labour in 1830 – "I had all the while fancied these factories were blessings to the poor" – that he spent the next 20 years campaigning for labour reforms. His zeal cost him his job and, because of a large debt, landed him in Fleet Prison for three years.

Another was Lord Shaftesbury, who was instrumental in reforming lunatic asylums, limiting the hours children could work, getting women and children out of coal-mines and setting standards for workers' lodging-houses.

The movement towards parliamentary reform was not without violence, and there was a threat of civil war from mobs in the streets – one held Bristol for two days. But the first major change was peacefully accomplished when the House of Lords passed the 1832 Reform Bill, which, at least in theory, shifted electoral power away from the country landlords and towards the new urban middle class. Parliament passed a weak factory inspection act in 1833, and a municipal reform act in 1835, giving control of towns and cities to the people who actually had to live in these smoke-filled slums.

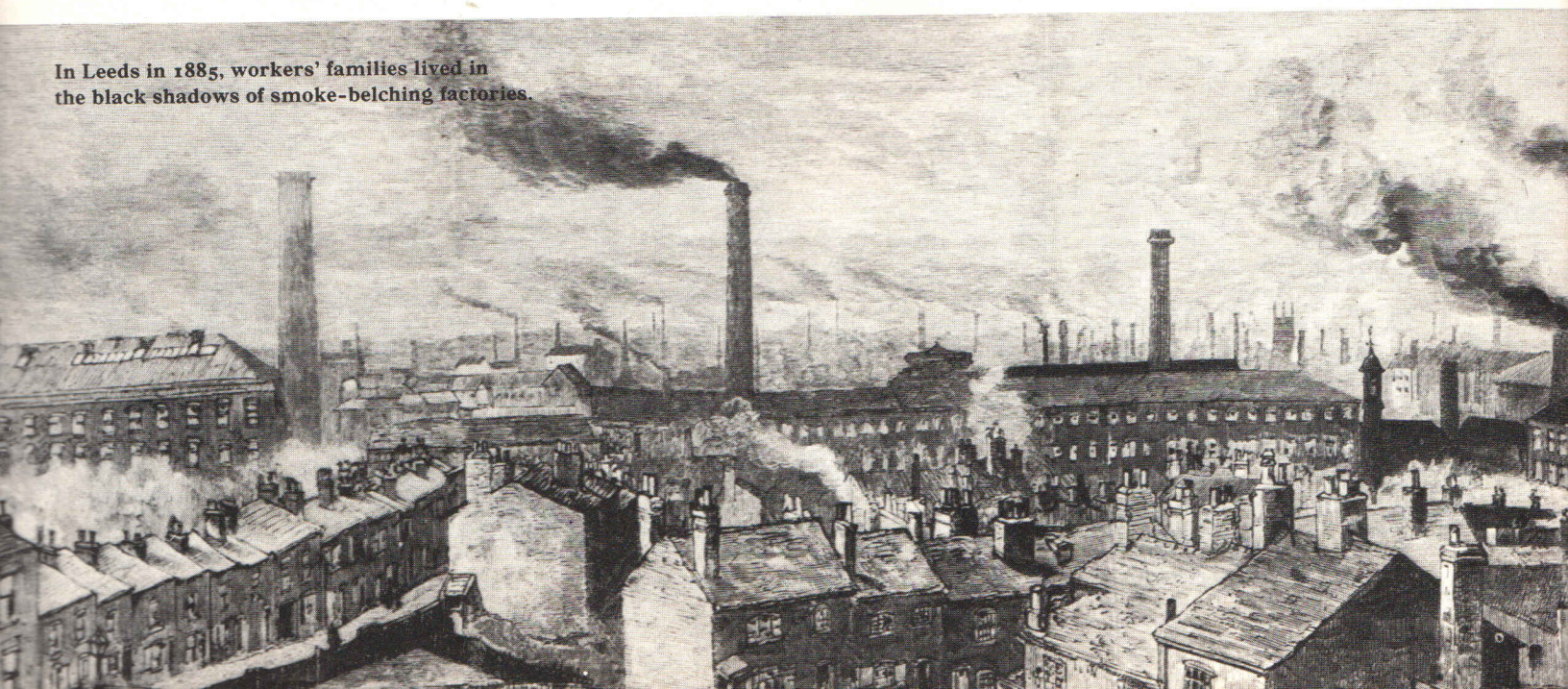
It was not enough. An economic depression in 1837 and 1838 gave birth to Chartism, the first national and largely working-class movement. The Charter presented to Parliament demanded political reforms, notably universal adult male suffrage, but the Chartists were primarily interested in improving the miserable economic conditions of workers' lives. "Chartism," said Thomas Carlyle, the contemporary historian, "was a knife and fork question."

Rebuffed by Parliament, Chartists rioted in Birmingham in July, 1839, and again in November at Newport, where 20 demonstrators were killed by police. In 1842 the Chartists managed to stage a fairly widespread strike in support of the Charter and brought out workers in Lancashire, Cheshire, Staffordshire and other industrial districts. This threat of rebellion from the lower classes, combined with the altruism of some members of the ruling classes – and the self-interest of others – pushed Parliament into another decade of reform. The Mines Act of 1842 banned women and boys under ten years old from working underground. In 1847, Oastler's and Lord Shaftesbury's long-sought reform, the Ten-Hours Act, limited the working days of women and children in the textile factories, and brought in its train a similar limitation on the hours of men as well. In 1850 the Mines Inspectorate was established.

Although industrialists disliked government interference on behalf of workers' welfare, they made common cause with the labourers on the most important reform of the 1840s, repeal of the Corn Laws. Passed in 1815, these placed duties on imported grain, and so worked to the benefit of the landowners whose home-grown produce fetched higher prices than it otherwise would have done. In the late 1830s, a succession of bad harvests drove up the price of corn and consequently the price of bread, which was the staple food of the poor. Higher food prices would tend to generate demands for higher wages. The industrialists who would have to pay them argued that the cost of grain imports could easily be met from increased exports of textiles and manufactured goods, the new wealth of Britain. In 1838 seven rich Manchester manufacturers founded a pressure group for the express purpose of repealing the Corn Laws. It was called the Anti-Corn Law League and, with the aid of publicity gimmicks such as Free Trade hats and cheap-bread breadboards, attracted working-class support.

But it had a wider purpose. Free Trade was not just a question of cheap bread. As the only industrial power, Britain could undersell everyone else in manufactured goods, and the fewer obstacles to trade there were, the more she could undersell. Without the Corn Laws, symbolic of obstacles to trade, industrialists hoped at last to enter the promised land of Free Trade towards which they had been marching since Adam Smith, the great laissez-faire economist, proclaimed the doctrine in the 1770s.

Tories called the Anti-Corn Law League "the most cunning, unscrupulous, knavish, pestilent body of men that ever plagued this or any other country," but Richard Cobden, its brilliant leader, finally prevailed. In 1846 the Corn Laws were all but repealed: the duties were reduced to such a nominal amount that



In Leeds in 1885, workers' families lived in the black shadows of smoke-belching factories.

they became ineffective. It was a victory for the new industrial classes. The working people got cheaper food. And the triumphant middle class at last threw off the remnants of the old mercantilism by which Britain had previously sought to protect her trading interests. Confidently, they led the new, industrialized Great Britain into the era of Free Trade.

Once Free Trade became accepted as the new way of British life, attitudes toward Empire began to shift. Colonies were about as useful to a Lancashire textile magnate, or any other mid-Victorian Free-Trader, as a hand-operated spinning-wheel would have been. Colonies cost money to defend, were not profitable, and could not easily be controlled.

After 1846 they were no longer bound to give tariff preference to British exports and in turn lost their advantages on the British market. From 1849, Empire trade no longer had to be carried on British ships. Some colonies – Canada, Australia, New Zealand, Cape Colony – were being given substantial measures of self-government, and Disraeli was complaining that before long they would want to be independent as well.

While few seriously thought of getting rid of the colonies, equally few had any desire to acquire new possessions. The world, not the Empire, riveted the attention of British businessmen. Colonies became relatively unimportant when there was so much money to be made in world trade, which ballooned rapidly after the discovery of gold in California and Australia in the middle of the century.

In possession of the most advanced means of production – no other nation's Industrial Revolution had progressed nearly so far – and having the biggest merchant fleet afloat (60 per cent of the world's tonnage), Great Britain had the most to gain from Free Trade.

In the years between 1850 and 1870, Britain almost tripled her production of pig-iron to six million tons. Exports of coal increased fivefold between 1850 and 1880, from four to 20 million tons. Although other nations now had textile mills, in 1870 Britain still made half the cotton cloth used by the world. "English industry," one historian wrote, "was as mighty as Gulliver in Lilliput."

In 1870, the external trade of Great Britain was greater than that of France, Germany and Italy combined, and was three times that of the United States. Britain's cotton fabrics, coal, iron, manufactured clothing, locomotives, chemicals, cutlery and machines of every description flooded the world markets.

Her own tables were now heavy with cheaper food and "luxuries" such as oranges and lemons. Arnold Toynbee, the Victorian economist and sociologist who grew up during this period, expressed amazement at how Free Trade improved the lot of the working man. It had, he said, "enormously increased the aggregate wealth of the country, and therefore increased the demand for labour. . . . It has created greater steadiness in trade. . . . Since 1846 workmen have been more steadily employed than in the preceding half-century."

Despite this, Britain continued to export men. After the Irish potato famine of the late 1840s, people left the British Isles at the rate of 300,000 a year. About two-thirds of them were Irish, most of whom went to the United States. The English emigrants went mainly to Australasia – 89,000 in the peak year of 1852 and a total of 365,000 over the following eight years.

The causes of the English exodus are not so easy to discover as the reasons that impelled the starving Irish. There were, to be sure, special instances like the mid-century gold strikes or the American railway boom in the 1880s when high wages were a special inducement to British navvies, the world's most experienced railway and construction workers. But, by and large, English workers were not starving to death. Why then were they leaving in such great numbers?

Since Malthus, the English economist who predicted that population growth would lower the standard of living to subsistence level, overpopulation had been blamed for most of the evils in British society. It was a ready-made excuse for rulers who could have improved conditions. If wages were low, the cause was too many workers, never that industrialists took unconscionably high profits. When cholera swept the slums, it was because the country was overcrowded rather than because housing and sanitation were inadequate. And since it was accepted that overpopulation was always to blame, there grew up the feeling that emigration was morally right as a solution to the grave problems of the times. Even labour unions promoted it as a means of raising wages for those who stayed behind. A farmworkers' union in 1871 adopted the surprising motto, "Emigration, migration, but not strikes."

The government encouraged emigration. The Colonial Land and Emigration Commissioners sent 340,000 people over-

The toughened dignity of these women at a Welsh ironworks in 1865 may have derived from the demands of their jobs: breaking limestone,

seas in its 25 years of existence, most of them to Australia and New Zealand. Philanthropists and private organizations like the London Female Emigration Society and the Female Middle Class Emigration Society lent a hand. And shipping lines did their bit. One had 3,400 agents working on both sides of the Atlantic to arrange passages on money advanced by friends and relatives in North America.

The basic impulse seems to have been a desire for a better life. This was a thoroughly understandable aspiration in mid-Victorian Britain, when workers' families were crowded into squalid back-to-back houses, jerry-built with walls one brick thick and designed to last no longer than the short lease of the land on which they stood; when Lord Shaftesbury could find a family living in each of the four corners of a single London room; when a cholera outbreak in Soho could be traced to the presence of human excreta in the Broad Street pump, from which families drew their drinking water. In search of a life more humane than this, between 1840 and 1897 an estimated ten million people decided they would rather live elsewhere than the British Isles.

On June 24, 1872, Benjamin Disraeli announced that "the maintenance of the Empire" was one of the great objects of the Tory party – startling words from the man who 20 years earlier in his career, had called colonies "millstones." He defeated Gladstone in the 1874 elections. It was a symptom of a new climate in international affairs.

Within a few years there would be British troops fighting in North Africa and West Africa. And before the end of the century the nation would be staging the 1897 Jubilee – the biggest, most garish, most self-inflating spectacle in homage to her own colonial Empire that the world had ever seen.

The shift from the anti-imperialism of the 1850s and 1860s arose, not from Disraeli's enthusiasm, but from changing world conditions. It was an outgrowth of the same Industrial Revolution that had made Britain shun colonial responsibilities in the first place. Now, however, a new factor had come into existence: competition from other nations, new industrial powers, for the markets of the world.

By the 1870s Britain was no longer the only steam-driven giant among underpowered pygmies. Both the United States and Germany were having their own industrial explosions, and were competing for Britain's customers. Moreover, while Britain held on to the ideal of Free Trade, others were protecting their home markets, with tariffs. In the 30 years after 1870, the decline in England's position became all too evident.

By 1897 Great Britain was still the biggest exporter in the world, selling goods worth £216,000,000 a year. But the rate of increase of exports had slowed disturbingly. Between 1870 and 1900, German exports had doubled and American exports increased four times, while Britain's expanded by only 45 per cent. The sales figures of Britain's two most important products, cotton and iron, must have been especially shocking to the officials at the Board of Trade. Cotton exports were roughly the same in the 1890s as they were in the late 1870s, and foreign sales of iron and steel in the 1880s were actually slightly less than they had

carting ore, feeding furnaces. But life was worse for London needleworkers, who often had to supplement their wages by prostitution.

been throughout the previous decade.

"In order to save the 40 million inhabitants of the United Kingdom from a bloody civil war," said a somewhat alarmist Cecil Rhodes, the diamond magnate, "our colonial statesmen must acquire new lands for settling the surplus population of this country, to provide new markets for the goods produced in the factories and mines."

This new imperialism, effectively concluded by the Boer War of 1899, has often been attributed exclusively to economic factors. It has been said that Britain expanded her Empire for the sole purpose of stimulating her faltering industrial growth.

It is true that some imperialists saw new colonies as replacement markets for the customers being lost to competitors, and as assured suppliers of raw materials. If, they argued, the Empire became self-sufficient in all the raw materials and food it needed, the Mother Country need have no fears for the future.

New colonies also, it was said, were good places to invest Britain's "surplus capital." Because of the decline in growth of the export trade, industry at home was not expanding as fast as it had been and therefore could not make such good use of the spare cash available for investment as could underdeveloped areas. And if overseas investments looked profitable, would colonies not be more attractive and safer to a British investor if his government were the chief influence in the land where he planted his money – or, better yet, owned it outright?

In fact, these arguments deny reality and are far too simple to explain the resurgence of imperialism in late 19th-Century Britain. It resulted from a complex mixture of attitudes, and each was as different as the type of colony to which it applied.

Interest focused first on the white settlement colonies – Canada, Australia, New Zealand and Cape Colony. Distrusted during the 1850s as an unrewarding cause of expense, they were now seen by imperialists as offering three potential advantages to the Mother Country in her struggle to remain the world's greatest power. Their manpower might bolster the British Army. Their wealth might subsidize the British Navy. And – if they could be persuaded to remove their barriers to British trade – their markets might absorb a significant amount of the exports which were being excluded from Europe by high tariffs.

Next in importance was India, a special case, a category by herself. As a customer she was already secure, for British India was not permitted a protective tariff. Her large army, paid for by Indian taxes, was controlled by Britain and was available to support British power and prestige from the Red Sea to China.

But India's special appeal to the new imperialists was a romantic one. When, on the Queen's suggestion, Disraeli in 1876 induced Parliament to give her the title Empress of India, he was paying tribute to the unique value most Englishmen placed on this keystone of the imperial system. The rewards for ruling this great and ancient civilization were as much in glory as in economics.

But what value was seen in the multitude of smaller and often poverty-stricken territories which Britain was busily acquiring in Africa and elsewhere? Hard-

headed merchants never truly believed that these incredibly poor places could provide substitute markets for Europe. Capitalists invested large amounts in such areas only if there were special and rare attractions – gold, tin, diamonds – or if the government was prepared to guarantee minimum profits on railways or other public works.

They offered none of the potential advantages of the white colonies nor the glamour of rule in India: little trade, few soldiers, no money. The reasons Britain scrambled for these new possessions varied with each case. Some were annexed for non-economic reasons, because they lay across vital naval routes or had other strategic importance; others because continual friction with indigenous states or tribes interfered with the small amount of trade that did exist – which, even if it was insignificant to Britain as a whole, was often of great importance to the traders involved.

When economics provided the motive power for the new imperialism, it was frequently as a defensive reaction. As other countries began to compete for trade and investment in Afro-Asia, Britain feared losing the freedom of access she had long taken for granted. As an ideal solution, she preferred an "open door" policy, international agreement to keep "hands off" the area in question. Where this failed, and it appeared some other European state was moving towards annexation to assert its special interest, Britain increasingly felt it necessary to "peg out" her own claims. Thus the Empire grew. And grew.

As a prop for Britain's industrial primacy, the new imperialism was in the end a disappointment. The dream of making the Empire a self-sufficient economic entity was only that. Most of Britain's food came from non-Empire countries. In 1896, almost half the 64 million cwt of wheat imported into Britain came from the United States, only a twentieth of it from the Empire's big wheat-producer, Canada. Nor did possession always ensure that the Mother Country would get the raw materials. The British possession of Malaya produced more than half the world's crude rubber – but more than half of what it produced was shipped direct to the United States of America.

As markets, the colonies were insufficient to support a great expansion of British industry. The settlement colonies refused to open their tariff walls and continued to buy where they pleased. Canada in the early 20th Century bought only 17 per cent of her imports from Great Britain, as opposed to 67 per cent from the United States. India began to develop her own industrial base.

Because Britain remained true to the ethic of free trade even in her new imperialism, the recently acquired colonies were wide open to foreign competitors and were usually poor markets anyway. In 1897, all tropical Africa accounted for only 1·2 per cent of Britain's total exports. Until well after 1900, all the colonies together continued taking about the same proportion of total British exports as they had in the 1860s – roughly a third.

The most extensive empire earth had ever seen could not preserve Britain's place as the industrial leader of the world against competitors who were increasingly outproducing and underselling her. In 1897 – the year of the Jubilee – the United States surpassed Britain in production of iron and steel. In 1903, Germany pushed her into third place. None of Britain's important industries was growing as quickly as those of her rivals.

There are many possible explanations why Britain's Industrial Revolution seemed to settle into quiescent old age while other nations surged ahead. One was education. Germany had long been educating all her children, with special emphasis on scientific and technological training. Victorian Britain, by contrast, was rather off-handed about schools. For most of the 19th Century it fell to churches and private charities to teach the country's children, although in 1833 the government began providing a subsidy for these private schools – a total of £20,000 a year. State schools were not established until 1870.

Whether or not neglect of education was the cause, it was apparent as early as 1860 that Britain's engineering creativity was declining as that of America and Germany advanced. Some attribute this to the British engineers' "nothing like steam" attitude, for they were prone to scorn the possibilities of the internal combustion engine (a Frenchman built the first one in 1860); this prejudice would have far-reaching consequences as the motor-car age dawned in the early years of the 20th Century.

Social developments probably had some effect on Britain's declining fortunes. The Industrial Revolution had been largely the creation of Nonconformists, who, in the 18th and early 19th Centuries were not admitted to the professions and could not set up trade in the older towns. Consequently, they went to the north and Midlands and began practising new trades – iron-making, textile manufacturing and engineering.

Once they had established their own power as a class, the industrialists found that the old establishment was not averse to opening its doors to the most brilliant and successful of the newly rich. Nonconformism ceased to be a social stigma. A rich industrialist without pedigree could marry into a landed family. His sons began to attend the same public schools as did those of the old aristocracy, and the product of an Eton education rarely turned his talents to the engineering that had made his father wealthy.

Whatever the reason for her loss of leadership, Great Britain could take pride in the fact that the Industrial Revolution had become a global phenomenon. She had made good use of her industrial primacy while it lasted: it is no exaggeration to say that she changed the course of human history. She it was who first discovered that the standard of living of a whole people could be raised by the proper application of capital. The almost universal belief in "growth" and "development" that dominates the 20th Century is the result. In her own interests, but to the advantage of the world, Britain exported everything that enabled other countries to follow her lead: her capital, her men, her skills. The world of the 19th and 20th Centuries was different because men such as Watt and Brunel, Hargreaves and Arkwright, Darby and Bessemer first changed the face of Britain. The Great Exhibition of 1851, Victoria's "happiest proudest day," was a crystal ball in which humanity could have seen the outlines of its future.

Lieutenant, Royal Navy, 1777