**The Development of Steam Power**

**蒸汽机的发展**

By the eighteenth century, Britain was experiencing a severe shortage of energy. Because of the growth of population, most of the great forests of medieval Britain had long ago been replaced by fields of grain and hay. Wood was in ever-shorter supply, yet it remained tremendously important. It served as the primary source of heat for all homes and industries and as a basic raw material. Processed wood (charcoal) was the fuel that was mixed with iron ore in the blast furnace to produce pig iron (raw iron). The iron industry’s appetite for wood was enormous, and by 1740 the British iron industry was stagnating. Vast forests enabled Russia to become the world’s leading producer of iron, much of which was exported to Britain. But Russia’s potential for growth was limited too, and in a few decades Russia would reach the barrier of inadequate energy that was already holding England back.

在18世纪之前，英国正在经历一次严重的能源短缺。因为人口增长，英国在中世纪时大部分森林已经被农田和牧草代替，因此木材更加缺乏，但是它却一直都很重要。木材不仅是家庭和工业取暖的主要来源并且还是基本的原材料。加工过的木材（木炭）作为燃料和铁矿混合，经过高炉加温形成生铁。炼铁业对木材的需求是巨大的，到1740年之前，英国的炼铁业处于停滞状态。相比之下，得益于广阔的森林，俄国成为世界上主要的铁制造商，其大部分铁出口到英国。但是俄国的增长潜力也受到了限制，在接下来的几十年里俄国和英国一样，也遇到了能源短缺的障碍。

As this early energy crisis grew worse, Britain looked toward its **abundant** and widely scattered reserves of coal as an alternative to its vanishing wood. Coal was first used in Britain in the late Middle Ages as a source of heat. By 1640 most homes in London were heated with it, and it also provided heat for making **beer, glass, soap, and other products.** Coal was not used, however, to produce mechanical energy or to power machinery. It was there that coal’s potential was enormous.

随着这种早期能源危机愈演愈烈，英国转而使用数量丰富且分布广泛的煤炭作为即将消失的木材的替代品。英国在中世纪晚期首次使用煤炭来供热。到了1640年之前，伦敦的大部分家庭开始使用煤炭取暖，并且还把它作为制造啤酒，玻璃，肥皂和其他产品的热量来源。然而，这个时候，煤还未被用来生产机械能或驱动机器。而这正是煤的无穷潜力。

As more coal was produced, mines were dug deeper and deeper and were constantly filling with water. Mechanical pumps, usually powered by hundreds of horses waling in circles at the surface, had to be installed. Such power was expensive and bothersome. In an attempt to overcome these disadvantages, Thomas Savery in 1698 and Thomas Newcomen in 1705 invented the first primitive steam engines. Both engines were extremely inefficient. Both burned coal to produce steam, which was then used to operate a pump. However, by the early 1770s, many of the Savery engines and hundreds of the Newcomen engines were operating successfully, though inefficiently, in English and Scottish mines.

随着产煤量的增加，煤矿被挖的越来越深。然而煤矿深处，不断有水灌注进来。人们通常在地表安装由成千上百只马转圈拉动的机械水泵。但是这种动力不仅造价昂贵，而且费时费力。为了克服这些弊端，托马斯萨瓦瑞在 1698 汤姆斯纽克门 在1705分别发明了第一批最早的蒸汽机。早期的蒸汽机效率极其低下，它们燃煤来产生蒸汽，被用于驱动水泵。然而，到了18世纪70年代早期，萨瓦瑞和纽克门发明的成千上百的蒸汽机已经成功运行在英国和苏格兰的煤矿中，尽管效率还有待于提高。

In the early 1760s, a **gifted** young Scot named James Watt was drawn to a critical study of the steam engine. Watt was employed at the time by the University of Glasgow as a skilled crafts worker making scientific instruments. In 1763, Watt was called on to repair a Newcomen engine being used in a physics course. After a series of observations, Watt saw that the Newcomen’s waste of energy could be reduced by adding a separate condenser. This **splendid** invention, patented in 1769, greatly increased the efficiency of the steam engine. The steam engine of Watt and his followers was the technological advance that gave people, at least for a while, unlimited power and allowed the invention and use of all kinds of power equipment.

在18世纪60年代早期，一个满腹才华的年轻苏格兰人詹姆斯瓦特开始认真研究蒸汽机。瓦特当时受雇于格拉斯哥大学，是学校制作科学工具的熟练技工。1763年，学校要求瓦特去修理物理课上使用的一台纽科门蒸汽机。在观察之后，瓦特发现增加一个分离的冷凝器可以提高纽科门蒸汽机的效率。这项杰出的发明，在1769年取得专利权，大大提高了蒸汽机的效率。瓦特和其同事的蒸汽机是巨大的技术进步，给于人们，至少在一段时间内，无限的动力，并且催生了各种发明和动力设备。

The steam engine was quickly put to use in several industries in Britain. It drained mines and made possible the production of ever more coal to feed steam engines elsewhere. The steam power plant began to replace waterpower in the cotton-spinning mills as well as other industries during the 1780s, contributing to a phenomenal rise in industrialization. The British iron industry was radically transformed. The use of powerful, steam-driven bellows in blast furnaces helped iron makers switch over rapidly from limited charcoal to unlimited coke (which is made from coal) in the smelting of pig iron (the process of refining impure iron) after 1770 in the 1780s, Henry Cort developed the puddling furnace, which allowed pig iron to be refined in turn with coke. Cort also developed heavy-duty, steam-powered rolling mills, which were capable of producing finished iron in every shape and form.

蒸汽机很快被用于英国的各行各业。它帮助人们抽干煤矿的水，从而挖掘更多的煤炭来带动其他地方的蒸汽机。在18世80年代，蒸汽动力取代水力用于棉花纺织工业和其他工业，这促进了工业化现象的崛起。英国的炼铁业从根本上发生了变革。1770年之后，因为高炉中使用动力十足、蒸汽驱动的风箱，铁制造商们在铸造生铁（提炼铁的过程）时，很快不再使用数量有限的木炭，转而使用无限的焦炭（由煤制作而成）。在18世纪80年代，亨利科特发明了搅铁炉，这一发明可轮流提炼生铁和焦炭。科特也发明了蒸汽驱动的重型轧钢厂，能把炼过的铁轧成各种形状。

The economic consequence of these technical innovations in steam power was a great boom in the British iron industry. In 1740 annual British iron production was only 17,000 tons, but by 1844, with the spread of coke smelting and the impact of Cort’s inventions, it had increased to 3,000,000 tons. This was a truly amazing expansion. Once scarce and expensive, iron became cheap, basic, and **indispensable** to the economy.

这些技术革新的经济影响是促进了英国炼铁产业的巨大繁荣。在1740年，英国年产铁量只有17,000吨，但是到1844年之前，随着焦炭熔铸法和科特搅铁炉的广泛应用，英国年产铁量增加到3,000,000吨。这的确是令人惊异的增长。曾经稀少昂贵的铁，变得廉价、基础，成为了经济发展的不可缺少的一部分。