

visions so repealed shall remain in force until the substituted provision or provisions shall come into operation by force of the last Act (§ 6). Numerous interpretations of particular words are contained in Acts of Parliament, either general, as "month," "county," "land," and other words in 13 and 14 Vict. c. 21, § 4, or for the purposes of the Act, as "settlement" for the purposes of the Settled Land Act, 1882.

The earlier Acts are generally simple in character and language, and comparatively few in number. At present the number passed every session is enormous; in the session of 1885 it was 80 general and 190 local and personal Acts. Without going as far as to concede with an eminent legal authority that of such legislation three-fourths is unnecessary and the other fourth mischievous, it may be admitted that the immense library of the statutes would be but a trackless desert without trustworthy guides. Revision of the statutes was evidently regarded by the legislature as desirable as early as 1563 (see the preamble to 5 Eliz. c. 4). It was demanded by a petition of the Commons in 1610. Both Coke and Bacon were employed for some time on a commission for revision. At times Consolidation Acts in the nature of digests of law (generally amending as well as consolidating) were passed, such as the Merchant Shipping Act, 1854, and the Criminal Law Consolidation Acts of 1861. The most important action, however, was the nomination of a revision committee by Lord Chancellor Cairns in 1868, the practical result of which has been the issue of an edition of the *Revised Statutes* in eighteen volumes, bringing the revision of statute law down to 1878. This edition is of course subject to the disadvantage that it becomes less accurate every year as new legislation appears. An index to the statutes which are still law is published about every three years by the Council of Law Reporting.

The principal statutes may be classified under various heads according to the matter with which they deal. It should be remembered at the same time that many of them—Magna Carta, for example—might fall with equal correctness under more than one head. A division, convenient, if not exhaustive, would be into historical, constitutional, legal, and social.

**Historical.**—Under this head would come those Acts which to a greater or less extent mark important epochs in the national history, such as the Statute of Rhuddlan, the Acts of Union defining the relations of Wales, Scotland, and Ireland to England, the Act of Settlement, the Stamp Act of 1765—the proximate cause of the revolt of the American colonies,—the Acts abolishing the slave trade and the corn laws, and those defining the position of dependencies, such as the Act for the Better Government of India, 1858, and the British North America Act, 1867.

**Constitutional.**—The principal Acts of this class would be Magna Carta, the statutes *De Tallagio non Concedendo* and *De Prærogativa Regis* and those dealing with mortmain and treason, the Petition of Right, the Bill of Rights, the Septennial Act, the Royal Marriage Act, the Mutiny, Militia, Naval Discipline, and Foreign Enlistment Acts, and the Acts affecting the parliamentary franchise from the time of Henry VI. to the Redistribution of Seats Act, 1885. Under this head too might be placed the numerous Acts dealing with the question of religion. Some of the more interesting of these are the *Articuli Cleri*, the Statutes of Provisors, the Acts of Henry VIII. abolishing monasteries, the Acts of Supremacy and Uniformity of Henry VIII., Elizabeth, and Charles II., the Toleration, Catholic Emancipation, Tithe Commutation, Church Discipline, Public Worship Regulation, Irish Church, and Scottish Patronage Abolition Acts.

**Legal.**—The most important of this class are perhaps

the Statutes of *Quia Emptores* and *De Donis*, the Statutes of Uses and of Wills, the Statutes of Limitation, the Statute of Frauds and its amendments, the Fines and Recoveries Act, the Conveyancing, Settled Land and Settled Estates, and Married Women's Property Acts, and the Acts for the amendment of procedure, e.g., the Chancery Amendment, Common Law Procedure, Judicature, and Appellate Jurisdiction Acts.

**Social.**—Social legislation (other than mere sumptuary laws) is of comparatively modern introduction. Among earlier instances are the Statute of Labourers of Edward III. and the Poor Law of Elizabeth. More modern examples are the Factory, Public Health, and Artisans' Dwellings Act, and, perhaps greatest of all, the Education Acts. Besides these there are the Acts dealing with patent, copyright, summary jurisdiction, friendly and building societies, trades unions, savings banks, theatres, commons preservation, and agricultural holdings. Acts which have trade for their special object are the Bank Charter, Merchant Shipping, Bills of Lading, Bills of Exchange, Crossed Cheques, Factors, Stamp, Licensing, Bankruptcy, and Trade Marks Acts.

The chief editions of the statutes are the *Statutes of the Realm* printed by the queen's printers, Ruffhead's, and the fine edition issued from 1810 to 1824 in pursuance of an address from the House of Commons to George III. The safest authority is of course the *Revised Statutes*. Chitty's collection of statutes of practical utility is a useful compilation. Among the earlier works on statute law may be mentioned the readings on statutes by great lawyers, such as the second volume of Coke's *Institutes*, Bacon's *Reading on the Statute of Uses*, Barrington's *Observations on the more Ancient Statutes from Magna Carta to the 21 Jac. I. c. 27* (5th ed. 1796), and the Introduction to Blackstone's *Commentaries*. Among the later works are the treatises of Dwaris (2d ed. 1848) and Sir P. B. Maxwell (2d ed. 1883) on the interpretation of statutes, and Sir H. Thring's *Practical Legislation, or the Composition and Language of Acts of Parliament*.

**Scotland.**—The statutes of the Scottish parliament before the Union differed from the English statutes in two important respects,—they were passed by the estates of the kingdom sitting together and not in separate Houses, and from 1367 to 1690 they were discussed only after preliminary consideration by the Lords of Articles. An Act of the Scottish parliament may in certain cases cease to be binding by desuetude. "To bring an Act of Parliament like those we are dealing with" (i.e., the Sabbath Profanation Acts) "into what is called in Scotch law the condition of desuetude, it must be shown that the offence prohibited is not only practised without being checked, but is no longer considered or dealt with in this country as an offence against law" (Lord Justice General Inglis in *Bute's Case*, 1 *Couper's Rep.* 495). Acts of the imperial parliament passed since the Union extend in general to Scotland, unless that country be excluded from their operation by express terms or necessary implication.

**Ireland.**—Originally the lord deputy appears to have held parliaments at his option, and their Acts were the only statutory law which applied to Ireland, except as far as judicial decisions had from motives of policy extended to that country the obligation of English statutes. In 1495 the Act of the Irish parliament known as Poyning's Law or the Statute of Drogheda enacted that all statutes lately made in England be deemed good and effectual in Ireland. This was construed to mean that all statutes made in England prior to the 18 Hen. VII. were valid in Ireland, but none of later date were to have any operation unless Ireland were specially named therein or unless adopted by the Irish parliament (as was done, for instance, by Yelverton's Act, 21 and 22 Geo. III. c. 48, i.). Another article of Poyning's Law secured an initiative of legislation to the English privy council, the Irish parliament having simply a power of acceptance or rejection of proposed legislation. The power of the parliament of Great Britain to make laws to bind the people of Ireland was declared by 6 Geo. I. c. 5. This Act and the article of Poyning's Law were repealed in 1782, and the short-lived independence of the parliament of Ireland was recognized by 23 Geo. III. c. 28. The application of Acts passed since the Union is the same as in the case of Scotland.

**Colonies and Dependencies.**—Acts of the imperial parliament do not extend to the Isle of Man, the Channel Islands, or the colonies, unless they are specially named therein. By 28 and 29 Vict. c. 63 any colonial law repugnant to the provisions of any Act of Parliament extending to the colony is void to the extent of such repugnancy, and no colonial law is to be void by repugnancy to the law of England unless it be repugnant to such an Act of Parliament. For colonies without representative legislatures the crown usually legislates, subject to the consent of parliament in particular cases. For instance, it was the opinion of the judicial committee of the privy council in 1876 that a cession of British territory in India to a native state would probably need the concurrence of the imperial parliament (*Damodhar Gordhan v. Deoram Kanji*, *Law Rep.*, 1 *Appeal Cases*, 332).

**United States.**—By the constitutions of many States English statute law, as it existed at the time of the separation from England, and as far as it is applicable, has been adopted as part of the law of the States. The United States and the State are not bound by an Act of Congress or a State law unless specially named. The States legislate for themselves within the limits of their own constitution and that of the United States. Here appears the striking difference between the binding force of a statute of the United Kingdom and an Act passed by congress or a State legislature. In the United Kingdom parliament is supreme; in the United States an Act is only of authority if it is in accordance with the constitution. The courts may declare an Act void if it contravene the constitution of the United States or of a State, so that practically the Supreme Court of the United States is the ultimate legislative authority. Examples of recent cases where the constitutionality of an Act has been contested will be found under PAYMENT and PRIVILEGE. The restrictions upon legislation contained in the constitution of the United States provide against the suspension of the writ of habeas corpus, except in case of rebellion or invasion, the passing of a bill of attainder or *ex post facto* law, the imposition of capitation or other direct tax, unless in accordance with a previous article of the constitution, or of a tax or duty on exports, the preference of the ports of one State over those of another, the drawing of money from the treasury except by appropriations made by law, and the grant of a title of nobility. The amended constitution contains further limitations, e.g., the taking of private property for public use without just compensation, and the abridging of the right of citizens on account of race, colour, or previous condition of servitude. State legislation is limited by § 10:—"No State shall . . . make anything but gold and silver coin a tender in payment of debts, pass any bill of attainder, *ex post facto* law, or law impairing the obligation of contracts, or grant any title of nobility." The section further forbids imposition of duties on imports or exports or any duty of tonnage without consent of congress. State constitutions often contain further restrictions; among the more usual are provisions against laws with a retrospective operation, or impairing the obligation of contracts, or dealing with more than one subject to be expressed in the title. The time when a statute is to take effect after its passing is often fixed by State constitutions. The statutes of the United States were revised under the powers of an Act of Congress passed in 1874 (sess. i. c. 333), and the volume of *Revised Statutes* (frequently amended since) was issued on February 22, 1875. Many of the States have also issued revised editions of their statutes. The rules of construction are in general agreement with those adopted in England. See Sedgwick, *Statutory Law*.

**International Law.**—The term statute is used by international jurists and civilians to denote the whole body of the municipal law of the state. In this sense statutes are either real, personal, or mixed. A real statute is that part of the law which deals directly with property, whether movable or immovable. A personal statute has for its object a person, and deals with questions of status, such as marriage, legitimacy, or infancy. A mixed statute affects both property and person, or, according to some authorities, it deals with acts and obligations. Personal statutes are of universal validity; real statutes have no extra-territorial authority. The determination of the class under which a particular law ought to fall is one of great difficulty, and one in which there is often a conflict of legal opinion. On the whole the division appears to have created more difficulties than it has solved, and it is rejected by Savigny as unsatisfactory. See Story, *Conflict of Laws*, §§ 12-16; Phillimore, *International Law*, vol. iv. ch. xvi. (J. Wt.)

**STATUTE MERCHANT AND STATUTE STAPLE** were two old forms of security, long obsolete in practice, though references to them still occur in some modern statutes. They were originally permitted only among traders, for the benefit of commerce, but afterwards extended by 23 Hen. VIII. c. 6 to all subjects, whether traders or not. The creditor under either form of security was allowed to seize the goods and hold the lands of a

defaulting debtor until satisfaction of his debt. While he held the lands he was termed tenant by statute merchant or by statute staple. In addition to the loss of his goods and lands the debtor was liable to be imprisoned.

**STAUNTON**, a city of the United States, the county-seat of Augusta county, Virginia, lies at the foot of the Blue Ridge Mountains, on the Lewis Creek (a tributary of the Shenandoah), 136 miles west-north-west of Richmond. It is the seat of the State lunatic asylum and of the State institution for the deaf and dumb and blind, and has besides an unusual number of important educational establishments. Iron-works, planing-mills, and flour-mills represent the manufacturing interest. The population was 5120 in 1870 and 6664 in 1880.

**STAUNTON, HOWARD** (1810-1874), Shakespearean scholar and writer on chess, was born about 1810. He was educated at Eton and Oxford, but left the university without taking a degree and settled in London, devoting much of his attention to the study of the English dramatists of the Elizabethan age. In conjunction with this he also took a great interest in the stage, and as an amateur once played Lorenzo to the Shylock of Edmund Kean. Between 1857 and 1860 he edited in monthly parts an edition of Shakespeare published by Routledge, which has been several times reissued, and must be ranked as superior, as regards both text and notes, to any previously published. His skill as a Shakespearean commentator, combining in a remarkable degree the acuteness and caution which qualified him to excel in chess, and disciplined to rare perfection by a thorough mastery of the literature of the period, is still more strikingly shown in his papers in the *Athenæum* on "Unsuspected Corruptions of Shakespeare's Text," commenced in October 1872. These formed part of the materials intended to be made use of in an improved edition of Shakespeare's works which he proposed to prepare, but which for a variety of reasons was never published. In 1864 he published a facsimile of the Shakespeare folio of 1623, and a finely illustrated work entitled *Memorials of Shakespeare*. He was also the author of the *Great Schools of England*,—an *Account of the Foundation, Endowments, and Discipline of the Chief Seminaries of Learning in England*, 1865. An account of his career as a chess-player, and a notice of his chief publications on the game, will be found under the heading CHESS (vol. v. pp. 601, 603). He died in London 22d June 1874.

**STAVANGER**, a seaport town of Norway, the administrative centre of an "amt" of the same name (population 114,164 in 1876), is situated on the west coast, on the south side of a beautiful fjord, about 127 miles north-west of Christiansand. A railway to connect Stavanger with Christiania has been planned, but as yet only the terminal portions have been constructed, the Stavanger portion, which runs south to Ekersund for 47 miles, being opened in 1878. The town is for the most part a collection of narrow and irregular streets, but signs of the wealth acquired by its shipping trade and herring fishery appear in the well-built stone houses erected since the great fire of 1860. In 1884 314 vessels (70,006 tons) entered the harbour and 267 (57,479 tons) cleared. Though the bishop's see was removed from Stavanger to Christiansand in 1685, the old cathedral of St Swithun's, founded by the English bishop Reinald in the end of the 11th century, and rebuilt after being burned down in 1272, still remains, and, next to the cathedral of Trondhjem, is the most interesting piece of Gothic architecture in Norway. The old episcopal palace of Kongsgaard is now a Latin school. The communal hospital is an important institution. The town dates from the 8th or 9th century and became the seat of a bishopric in the 13th. In 1801 the population of

Stavanger was only 2500; by 1855 it was 12,000, and by 1875 20,350.

STAVROPOL, a government of Northern Caucasia, Russia, having an area of 26,530 square miles, and a population (rapidly increasing by Russian immigration) last returned at 637,893. It is bounded by Astrakhan and the province of the Don Cossacks on the N., Kubañ on the W., Terek on the S., and the Caspian Sea on the E., occupying the eastern part of the broad plains and steppes which fringe the main chain of CAUCASUS (*q.v.*) on the north. In the western part of the government a broad undulating swelling, ranging from 1500 to 2000 feet above sea-level, extends northwards from the central mountain chain; in the southern part of this swelling, in the vicinity of Pyatigorsk, there is a group of sixteen mountains, 2800 to 4600 feet in height—the Beshtau,—which, as shown by Abich, ought to be considered as a porphyritic upheaval which took place at a point where the two predominant directions in Caucasia (south-west to north-east and south-east to north-west) meet. Northward and eastward of the above plateau are extensive steppes, from 400 to 200 feet above the sea, having gentle slopes both to the north (to the depression of the Manytch) and to the east (towards the low and dry steppes of the Caspian littoral). The geological structure of Stavropol is most interesting. The mountains in the southern parts of Pyatigorsk consist of trachytic porphyries and volcanic rocks. Numberless hot mineral springs (see PYATIGORSK) occur in this group, and earthquakes are most common in the region. A broad belt of Miocene deposits, represented by the "steppe limestone" with *Mastra podolica*, girdles the hilly tracts, attaining a breadth of 40 miles or rather more; while the remainder of the steppes, which gently slope towards the Manytch and the Caspian, are occupied by the Post-Tertiary Caspian formation (loess).

Stavropol is chiefly watered by the Kuma and its tributaries (Podkumok, Karamyk, Buivola, &c.), its basin being the most fertile part of the province, but the evaporation is so great that the Kuma never reaches the Caspian except in spring. The Manytch is less a river than a series of lakes occupying a depression which formerly was a connecting channel between the Black Sea and the Caspian. This channel has two slopes, the eastern sometimes discharging its scanty water-supply into the Kuma, while on the western slope the elongated lakes which fill up the depression drain into the Don, reaching it, however, only during spring. Two Yegorlyks (Great and Middle), the Kalas, and the Tehogra (temporary tributaries of the Manytch) water the west part of Stavropol; while the Yeya and the Barsukly—a tributary of the Kubañ—rise in the district of Pyatigorsk. On the whole, irrigation is scanty, and in the eastern steppes water is supplied only by cisterns. Besides the few lakes of the Manytch depression, there are many smaller salt lakes around the Caspian. Timber is scarce, even in the hilly tracts.

The climate is severe. Although Stavropol and Pyatigorsk both have an average yearly temperature of 48° Fahr., frosts of -22° Fahr. are not uncommon, and the average winter temperature is only 28°.7 at Stavropol (January, 25°; July, 71°). Yellow and other endemic fevers, sometimes very severe, are common on the low banks of the Kuma and Manytch.

The region is traversed by both the great highways along the western shore of the Caspian (the Vladikavkaz and the Derbent routes), and accordingly several nations in their migrations have left stragglers on the steppes of Stavropol. Thus we now find in these steppes Lamaite Kalmucks (about 10,000), Mohammedan Turcomans and Nogais (together about 60,000), as well as less considerable remains of several other tribes. On the other

hand, immigrants from Great and Little Russia, Poles, Germans, Esthonians, Greeks, and even a few Scots (in a colony close to Pyatigorsk) have settled in the most fertile and best watered parts of Stavropol in the course of the present century. The Russian population is growing very rapidly, and already numbers upwards of 500,000.

There are three administrative districts, the chief towns of which are Stavropol (35,470 inhabitants in 1884), Pyatigorsk (11,115), and Alexandrovskaya (8710), and a territory of nomad natives which occupies more than two-fifths of the entire area of the government.

The educational returns for 1883 show 7 gymnasiums and "real schools," with 1081 boys and 491 girls, and 139 elementary schools, with only 5310 boys and 1034 girls.

Agriculture is the chief occupation of the settled population, and so large is the harvest that no less than 16,000 labourers, attracted by high wages, come annually from European Russia to assist in gathering in the crops. Large amounts of corn are exported both to the mountainous districts of Caucasia and to Russia (Rostoff-on-the-Don). Cattle-breeding is engaged in very largely, not only by the Kalmucks, Turcomans, and Nogais, but also by the Russians. In 1884 Stavropol had 154,000 horses, 808,500 cattle, 2,540,000 sheep, 45,000 goats, 75,000 pigs, and 7500 camels. Cattle and horses, as also wool, hair, hides, and sheepskins, are exported in considerable quantities. A remarkable feature of Stavropol is the rapid growth among the Russian peasant population of a great variety of domestic trades both for local supply and for exportation. Silk wares are now woven in the villages to such an extent as to become an important article of export to Russia. Many other petty trades have also grown up of late, such as various kinds of cotton-weaving, the manufacture of leather wares, small metallic wares, and so on. Manufactures proper (chiefly distillation) employed some 1000 persons in 1870, and their produce was estimated at about £140,000 per annum. Since that time they have slowly expanded. A brisk trade is carried on in the above-mentioned articles of export, and twenty-nine village fairs show an aggregate annual return of nearly £300,000.

History.—The northern slopes of Caucasia began to be colonized by Russians at a very early period, and as early as the 11th century part of the territory now occupied by Stavropol was known to Russian annalists, as the Tmutarakañ principality, which had Russian princes. A new attempt to colonize North Caucasia was made in the 16th century, under Ivan the Terrible, who married a Kabardian princess. This was again unsuccessful, and it was not till 1711 that Russia began regularly to colonize the territory by Cossack settlements. The military colonization was continued during the whole of last century; Kizlar was founded in 1736, Stavropol in 1776 or 1777. Immense tracts were given by Catherine II. to her courtiers, who began to people them with serfs brought from Russia. The flow of immigrants rapidly increased as soon as peace was firmly established, and it is still on the increase, especially since the emancipation of the serfs, so that Stavropol is rapidly becoming a Russian province, with a comparatively limited number of natives in the steppes of its eastern part.

STAVROPOL, capital of the above province, is situated on a plateau 2000 feet above the sea, on the northern slope of the Caucasus, 360 miles to the north-west of Tiflis and 914 miles from Moscow. It is connected by rail with Rostoff-on-the-Don. Although founded only in 1776 for military purposes, it has rapidly grown, and has now a population of 35,500, while it is one of the best built provincial towns of the Russian empire. It has wide streets, and its houses are mostly of stone; large gardens surround the houses; and numerous farms and gardens occupy the territory (nearly 50,000 acres) belonging to the town. It is well provided with educational institutions, there being four gymnasias for boys and girls and several primary schools. Nearly all the manufactures of the province are concentrated in Stavropol. The trade is considerable, large numbers of cattle (more than 35,000 head annually) being sent to Moscow and St Petersburg, while tallow and more than 15,000 sheepskins are exported via Rostoff to Russia. Corn is also exported to the value of nearly £300,000, while manufactured wares are imported to the value of nearly £150,000. Armenian, Georgian, and Persian merchants carry on a lively trade in local wares.

## STEAM-ENGINES AND OTHER HEAT-ENGINES

Definition of heat-engines

A HEAT-ENGINE is a machine in which heat is employed to do mechanical work. In all practical heat-engines, work is done through the expansion by heat of a fluid which overcomes resistance as it expands—in steam-engines by the expansion of water and water-vapour, in air-engines by the expansion of hot air, in gas-engines by the expansion of a burnt mixture of air and gas. One of the most simple and historically one of the oldest types of heat-engines are guns, in which heat, generated by the combustion of an explosive, does work in giving energy of motion to a projectile. But guns differ so widely from all other types, both in their purpose and in their development, that it is convenient to leave them out of account in treating of engines which may serve as prime movers to other mechanism

### I. EARLY HISTORY OF THE STEAM-ENGINE.

2. The earliest notices of heat-engines are found in the *Pneumatica* of Hero of Alexandria (c. 130 B.C.). Two contrivances described there deserve mention. One is the æolipile, a steam reaction-turbine consisting of a spherical vessel pivoted on a central axis and supplied with steam through one of the pivots. The steam escapes by bent pipes facing tangentially in opposite directions, at opposite ends of a diameter perpendicular to the axis. The globe revolves by reaction from the escaping steam, just as a Barker's mill is driven by escaping water. Another apparatus described by Hero (fig. 1)<sup>1</sup> is interesting as the prototype of a class of engines which long afterwards became practically important. A hollow altar containing air is heated by a fire kindled on it; the air in expanding drives some of the water contained in a spherical vessel beneath the altar into a bucket, which descends and opens the temple doors above by pulling round a pair of vertical posts to which the doors are fixed. When the fire is extinguished the air cools, the water leaves the bucket, and the doors close. In another device a jet of water driven out by expanding air is turned to account as a fountain.

3. From the time of Hero to the 17th century there is no progress to record, though here and there we find evidence that appliances like those described by Hero were used for trivial purposes, such as organ-blowing and the turning of spits. The next distinct step was the publication in 1601 of a treatise on pneumatics by Giovanni Battista della Porta, in which he shows an apparatus similar to Hero's fountain, but with steam instead of air as the displacing fluid. Steam generated in a separate vessel passes into a closed chamber containing water, from which a pipe (open under the water) leads out. He also points out that the condensation of steam in the closed chamber may be used to produce a vacuum and suck up water from a lower level. In fact, his suggestions anticipate very fully the engine which a century later became in the hands of Savery the earliest commercially successful steam-engine.

<sup>1</sup> From Greenwood's translation of Hero's *Pneumatica*.

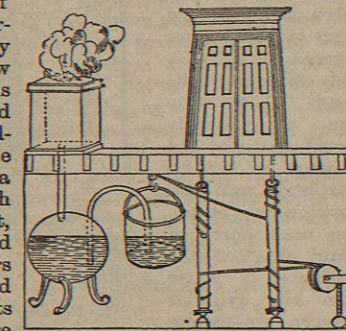


FIG. 1.—Hero's Apparatus, 130 B.C.

In 1615 Solomon de Caus gives a plan of forcing up water by a steam fountain which differs from Della Porta's only in having one vessel serve both as boiler and as displacement-chamber, the hot water being itself raised.

4. Another line of invention was taken by Giovanni Branca (1629), who designed an engine shaped like a water-wheel, to be driven by the impact of a jet of steam on its vanes, and, in its turn, to drive other mechanism for various useful purposes. But Branca's suggestion was unproductive, and we find the course of invention revert to the line followed by Della Porta and De Caus.

5. The next contributor is one whose place is not easily assigned. To Edward Somerset, second marquis of Worcester, appears to be due the credit of making the first useful steam-engine. Its object was to raise water, and it worked probably like Della Porta's model, but with a pair of displacement-chambers, from each of which alternately water was forced by steam from an independent boiler, or perhaps by applying heat to the chamber itself, while the other vessel was allowed to refill. Lord Worcester's description of the engine in his *Century of Inventions* (1663) is obscure, and no drawings are extant. It is therefore difficult to say whether there were any distinctly novel features except the double action; in particular it is not clear whether the suction of a vacuum was used to raise water as well as the direct pressure of steam. An engine of about two horse-power was in use at Vauxhall in 1656, and the walls of Raglan Castle contain traces of another, but neither Worcester's efforts nor those of his widow were successful in securing the commercial success of his engine.

6. This success was reserved for Thomas Savery, who in 1698 obtained a patent for a water-raising engine, 1698.

shown in fig. 2. Steam is admitted to one of the oval vessels A, displacing water, which it drives up through the check-valve B. \*When the vessel A is emptied of water, the supply of steam is stopped, and the steam already there is condensed by allowing a jet of cold water from a cistern above to stream over the outer surface of the vessel. This produces a vacuum and causes water to be sucked up through the pipe C and the valve D. Meanwhile, steam has been displacing water from the other vessel, and is ready to be condensed there. The valves B and D open only upwards. The supplementary boiler and furnace E are for feeding water to the main boiler; E is filled while cold and a fire is lighted under it; it then acts like the vessel of De Caus in forcing a supply of feed-water into the main boiler F. The gauge-cocks G, G are an interesting feature of detail. Another form of Savery's engine had only one displacement-chamber and worked intermittently. In the use of artificial means to condense the steam, and in the application

FIG. 2.—Savery's Pumping Engine, 1698.