PLUMBING & SANITATION
FROM EARLIEST TIMES

History Part-2

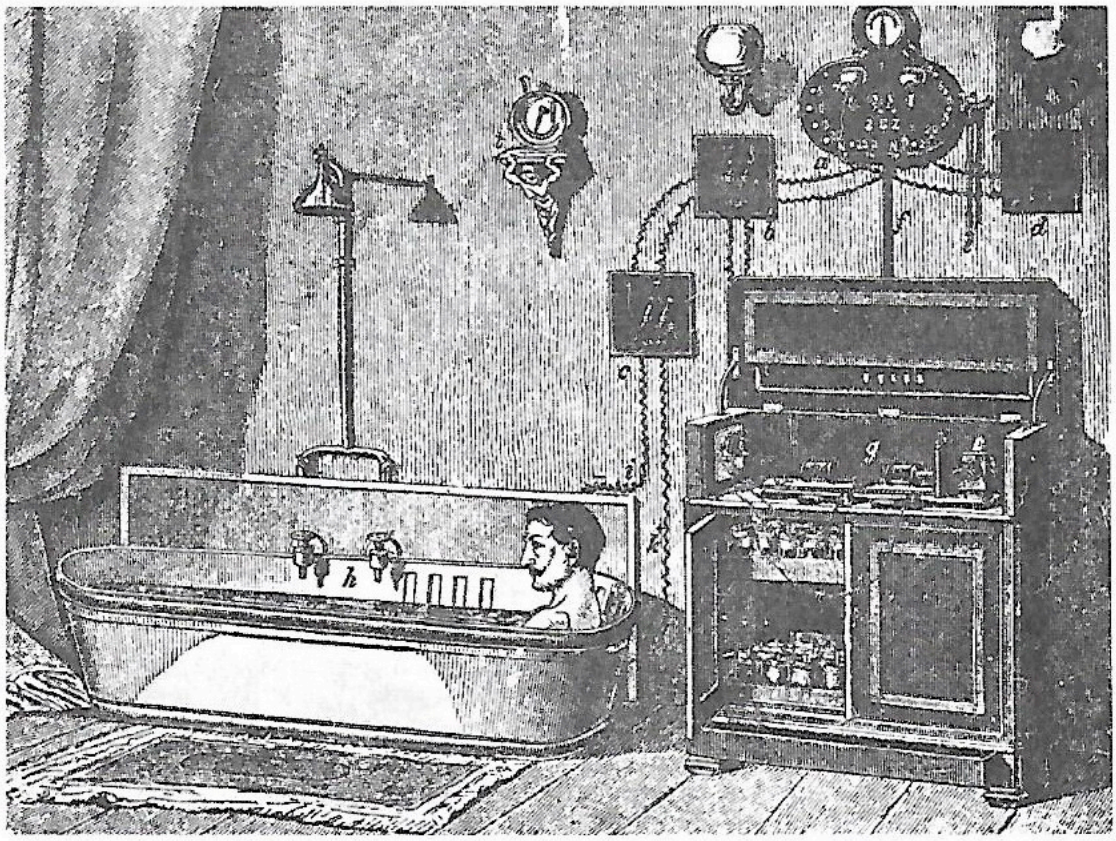

Fig. 7.13. Electric bath installation, with all necessary appliances for constant and Faradaire current application — from GEC catalogue of 1886.

From BUILDING SERVICES HERITAGE
A REVIEW OF ITS DEVELOPMENT
N S Billington & B M Roberts, 1982

Continued from PART-1

"Water distribution from the Oberspree, with sand filtration, had been installed by an English company in 1856, and it was taken over by the municipality in 1873. But this served only part of the city (Berlin). In 1878, besides many private wells, there were 1133 public fountains which gathered their supplies from the grossly polluted ground in the city. In 1877, a borehole was sunk in Tegel, which supplied water containing iron; it had to be closed in 1882... . The streams were polluted, and it was said that the Spree entered Berlin like a swan and left it like a pig."

Ninety-five new mains distribution systems were installed in Prussia in 1871-80 rising to 1633 new systems between 1901 and 1908. By 1903, in 303 towns in Germany with more than 15000 inhabitants, only 4% were still served by wells and cisterns; the remainder had mains supplies — 25% using surface water, 70% spring water or ground water, and ½% from artificial reservoirs. An ozonising process (used abroad more than in Germany) was introduced in 1895, and in 1910 chlorination was introduced.

The city of Melbourne (Australia) was founded in 1835, and according to Briggs, a supply of fresh water above the Yarra Falls was a great attraction to early settlers. But as Melbourne grew, the supply proved inadequate in quantity and unsatisfactory in quality. Attempts to set up a public water company in the early 1840's failed. One might have expected the lessons of the old world to have been learned, but it seems that this was not the case. Water distribution was in the hands of men who might be seen plying their vocation all day long through the streets of Melbourne. Exactly the same points were being made about Melbourne's water supply in the 1850's as in any European city. In 1853 the Commissioners of Water Supply and Sewage were appointed. When the Yan Yean water system was completed in 1857, and for the first time Melbourne had water laid on, the event was celebrated with a great procession of plumbers, firemen and members of the town's temperance societies.(17)

The first mains water system in Japan was put in the city of Yokohama in 1885-7, to a British design.(34)

7.1.12 Internal connections

The great majority of water undertakings in the UK have for many years prohibited direct-on-mains systems, that is, systems which permit water to be drawn off without the use of break- or storage-tanks (the only exception is one cold tap in the kitchen). The object has been to prevent any possibility of mains contamination, though the method has the advantage of providing some local reserve against failure of the mains supply. Most other countries permit domestic systems to be connected direct to the mains, and without any apparent hazard to health. In both, an adequate air-gap must be provided at each terminal fitting (tap or wc) between the supply pipe and the appliance, to avoid the possibility of back siphonage.

7.2 SANITATION

7.2.1 The pre-Christian era

With the establishment of the first cities, man began to realise the importance of drainage for protection against rainwater and flooding, and to recognise the need for water disposal and sanitation systems.

In 6000 B.C. the city of Catal Hüyûk in Turkey comprised flat roofed mud-brick built houses crowded together, the terraced roofs connected by ladders serving as the town's streets and providing entry at rooftop level into the living quarters below. Modern reconstruction suggests that groups of houses and shrines were clustered

round court-yards into which fed a system of drains from one roof to the next for carrying off rainwater.

The first major city with streets laid out to a modern grid system and with a properly planned and executed drainage and sanitation system, is the Moenjo-Daro of around 2500 B.C. It lay in the flood plain of the Indus, north of today's Karachi in Pakistan. Moenjo-Daro was planned with a boulevard some 9 m wide, running north and south, and crossed at right angles every 200m or so by somewhat smaller east-west streets. Running along the sides of the streets were brick-lined open sewers, and at intervals catch basins were dug below sewer level to trap debris that might otherwise clog the flow. The sewers were connected to each house by an open gutter, also constructed of brick, into which emptied the house drains, which generally consisted of an enclosed system of clay pipes. Two of the houses that have been excavated contained sit-down toilets. These were not simple commodes, but imposing brick structures connected to the drains- whether these toilets led to the sanitary sewer system has not been established, since the sewers seem to have been built mainly to drain away used bath-water. Many houses had bathrooms, their floors built of waterproof brick and fitted with drains leading directly into the sewer pipes.

In Ancient Egypt, large irrigation and drainge projects were undertaken during the Early Dynastic Period (3100-2698 B.C.). The ruins of Tel-el-Amarna (*ca.* 1400 B.C.) reveal what was once a large well-planned city. The villas of the wealthy had bathrooms with lavatories and basins fed by running water and "even the houses of the most humble had sanitary facilities".(6)

The ruins at Phaestos (*ca.* 2000 B.C.) in Crete, which include the Palace of Radamanthus, show there was a systematic approach to town-planning, which included streets laid out around an ordered system of sewers and freshwater canals.

In the Queen's Megaron (Principal Hall), which is part of the Palace of Minos at Knossos, a latrine similar to a modern "wash-out" closet was discovered, complete with a reservoir for flushing water. It is even believed to have had a wooden seat. After all, the word hygiene does come from the Greek Goddess Hygeia.

> "Each quarter of the palace had a drainage system of its own, passing into great main sewers, stone built, large enough for the passage of a sewer-man, and flushed by the sometimes torrential rainwater. The Minoans evidently delighted in hydraulic devices and used such refinements of the science as parabolic curves in the water channels and the precipitation of sediment in intermediate catch pits."(54)

All the public buildings, and many private houses, in Rome were connected to sewers which drained into a central channel — the Cloaca Maxima — some 3 m wide and 4 m deep, which discharged into the Tiber outside the city limits. It is thought to date from the time of Augustus (27 B.C.-A.D. 14). Pompeii, too, had an extensive drainage system.

Less advanced communities also had some sanitation. In the Stone Age village of Skara Brae (Orkney), there are the remains of an effective sewerage system.

7.2.2 The Middle Ages

The collapse of Roman influence led to neglect of their sewerage systems; peoples relapsed into a rural existence where the problems of sewage disposal were less significant. The Roman technology was largely lost in Europe, though it may have been retained in the Near East, and in the religious establishments. Streams filled with household garbage, and a virtual absence of sewage disposal typified the larger

towns of the 14th century.[27] At the time of the Black Death, London paid special attention to the cleaning of streets and ditches, and carting away filth. In 1388, Parliament forbade the throwing of garbage into rivers, or leaving it in the city: it had to be carried away out of the town.[31]

> "The first Act (of 1388) to appear on these matters prohibited the corruption of ditches, rivers, waters and the air of London (and elsewhere) and required that all dung, filth and garbage be carried away and not left where it would become a nuisance. However, despite this, kennels were generally provided either side of the streets to carry away rain and sewage. Householders were ordered not to throw water from the windows but to discharge it into the street — except fishmongers who had to carry their dirty water to the river. Each householder was responsible for clearing the dirt from his door, but refuse and dung appears to have been piled on the street. Each ward maintained its own 'rakyers' to clear this away. In Edward II's time (1327-77), twelve carts with two horses each were maintained to carry away the refuse and sewage."[20]

The primary function of the primitive drainage systems of this time was removal of surface water run-off (connection of cesspools was not permitted until 1815). An Act during the reign of Henry VI (1422-61) appointed a Commission of Sewers and in the time of Henry VIII the Bill of Sewers appeared (1531), which consolidated previous legislation and which was to remain the chief statute on the subject for the next three hundred years.

An ordinance in Siena forbade throwing refuse into the street or emptying vessels from windows between dusk and dawn. Most mediaeval streets had a central gutter, closed with slabs. The Emperor Sigismund ordered that fines imposed on "felons, bawds and whores" were to be used to improve the paving of the streets. Sewers were built, but not systematically, and the lack of sufficient water for flushing them became serious in the 15th and 16th centuries.

In 1663, a report on the Paris sewers revealed a shocking state of filth, and more systematic repairs were begun. During the 17th century, authorities began to give more attention to public health. Street cleaning was the difficult problem. In the Middle Ages, fecal matter was collected in trenches in the streets, removed at intervals and dumped outside the towns. In 1551, Defroissis recommended washing the streets with water, but the lack of supply prevented this.

Even in the 17th century, household rubbish was dumped in the streets of London, though after the Great Fire in 1666, dumping places were officially provided in the streets of the City, from which the refuse was removed by a paid staff of "takers".[27] The contents of privies were removed by night-soil men when the streets were deserted. A permanent Court of Commissioners of Sewers was set up to undertake the construction of sewers and the paving and lighting of the streets of the City.*

7.2.3 *Chadwick's Report*[21]

The overcrowding and poor conditions of many of the dwellings in London led to grossly insanitary conditions up to and including the 18th century. Mortality, particularly amongst the poor, was exceedingly high. In 1765, there were 23230

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*By the 19th century, this body was exercising all the functions of a sanitary authority, until dissolved in 1897. As late as 1755, Marylebone had to obtain a local Act which, *inter alia*, forbade the throwing of night soil in or near the streets.[29] The Westminster Paving Act of 1762 provided for scavenging of streets and removal of household rubbish. Rain water down pipes were introduced.

deaths in London, of which 35% were of children under 2 years of age, and half were of people under 20. In that year, the commissioners of the Sewers and Pavements within the City and Liberties presented their report to the City Corporation. They stated, *inter alia*:[25]

> "2. That the prevailing method of placing the channels in the middle of the streets, which are generally made very deep, and in many cases attended with cross channels, renders the coach way very disagreeable to passengers, as well as highly detrimental to horses and carriages.
>
> 3. That the too common practice of the lower sort of inhabitants and servants throwing ashes, rubbish, broken glass and earthenware, offal and other offensive things into the streets stops the current of the channels, makes the highway very inconvenient and sometimes dangerous, to coach horse, and foot passengers, and even to the health of the neighbouring inhabitants.
>
> 9. That foot passengers are likewise greatly annoyed in rainy weather by the water conveyed from the tops of old houses, through spouts projecting into the streets."

In the year 1800, the death rate in London was one in 24. Sewage treatment in any modern sense did not exist. The privy and the cesspool were still the principal means of disposal, and any drainage system which did exist was merely a pipe into the nearest river or watercourse.[25] Yet some improvement had been made, for Dr Marshall wrote, in 1819:[29]

> "If any causes could have contributed to the immunity we enjoy from the plague, they are to be found in the greater cleanliness of the inhabitants, the widening of the streets and the better and more general construction of sewers and drains, to which may be added the profusion of water now distributed throughout the metropolis."

A letter printed in *The Times* of 5 July, 1849 gives a picture of conditions in London at that time, which was probably by no means uncommon:

> "To the Editor of the Times Paper;
> Sir,- May we beg and beseech your proteckshion and power. We are Sir, as it may be, living in a wilderniss, so far as the rest of London knowns anything of us, or as the rich and great people care about. We live in muck and filthe. We ain't got no priviz, no dust bins, no drains, no water splies, and no drain or suer in the hole place. The Suer Company, in Greek St., Soho Square, all great, rich and powerful men, take no notice whatsomedever of our complaints. The Stench of a Gullyhole is disgustin. We all of us suffer, and numbers are ill, and if the Colera comes Lord help us... ."

The Metropolitan Board of Works, created in 1855, assumed responsibility for London sewers and established sewage outfalls at Barking and Crossness.* Sir Joseph Bazalgette (engineer to the Metropolitan Water Board) built five main sewers running parallel with the Thames, and discharging twelve miles downstream. The water carriage system was introduced. Edward, Prince of Wales, opened the main drainage system in London in 1865.[56]

The construction of house drains to connect to public sewers had been permitted in London in 1815, but many years elapsed before it became general. The Public Health

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*The area of the (London) Metropolitan Board of Works (1855) was defined, not by facts of civic history, or by human geography, but by the network of drains and sewers.[17]

Act of 1848 set up a General Board of Health; and modern sanitary law came into being with the passage of this Act. The Local Government Act of 1858 gave urban authorities the power to make by-laws, and so extend the London legislation to the other cities. After the passage of the Public Health Act of 1875, new houses in most British towns had to be provided with a piped water supply and water-borne sanitation (though in tenement blocks, both often had to be shared).

Social problems were exacerbated by the industrial revolution and the growth of towns; the factory owners were little concerned about living conditions for their workers; and they were often, too, the councillors (certainly the ratepayers) who said yea or nay to improvement schemes. One symptom of increasing housing density which conduced to ill-health was the spread of back-to-back housing as a regular feature; there was a similar extension of cellar dwellings.* A dwelling house with water supply, sewers and sanitation, in a paved and drained street, could not be afforded on any income under 30s a week — about 2 or 3 times the labourer's wage. Chadwick's "Report on the Sanitary Conditions of the Labouring Population of Great Britain (1842)" gives a very clear picture, not only relating to Britain, but also of the position in Paris and other cities.

Chadwick's report[21] abounds with evidence contained within staid official documents from all over the country: it is the more impressive for the unemotional character of the reports. There is a wealth of statistics of mortality rates. All this demonstrated the privations and squalor of the working (poor) classes. There was little piped water supply; there was little drainage; sanitary provisions were of the most primitive. There were few sewers, save in the better class districts, the working-class areas being served by open drains into which all refuse was thrown, or by none at all.

> "It is useless to have a good sewer carried through the centre of a street (in Truro) if the houses at the sides, and still more, those situated in courts and lanes adjoining, have no communicating sewer."
>
> "Some parts of Stafford are without drainage. There is not any provision made for refuse dirt which, as the least trouble, is thrown down in front of the houses, and there left to putrefy. There are not any sewers even in the principal streets, the water being carried off by open channels."
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> "In spite of a local Act of 1830, the majority of the streets of Liverpool inhabited by the working classes are without sewers."

The sanitary arrangements for the populace were still primitive — water-closets were rare — and the provisions for clearing privies were totally inadequate. In Glasgow:

> "There were no privies or drains there, and the dungheaps received all filth which the swarm of wretched inhabitants could give; and we learned that a considerable part of the rent of the houses was paid by the produce of the dungheaps."
>
> "The present mode of retaining refuse in the house in cesspools and privies is injurious to health. The process of emptying them by hand labour, and removing the contents by cartage, is very offensive. But the expense of this mode operates as a complete barrier to all cleanliness in this respect in the dwellings or streets occupied by the labouring classes. The usual cost of

*Flinn (Introduction to 1965 edition of Chadwick's report) says: in 1797, 9000 of Liverpool's population of 63000 lived in back-to-back houses; in 1841, some 20% of the 175000 inhabitants of the city lived in cellars.

cleansing the cesspools of a tenement in London is about £1 each time."

In Edinburgh:

> "The practice of introducing water-closets has become pretty general wherever it is practicable; but in the greater part of the old town nothing of the kind can be accomplished from the want of drains."
>
> "According to the municipal, building and sanitary regulations of Manchester, the authorities insist that any dwelling-house to be built within the borough shall be provided with privy or ash-pit, and shall be constructed in a yard attached to the premises, but not in front of the house; and over such privy or ash-pit no bedroom or sleeping room shall be built. (It may be said that Manchester does not stand high in the estimation of the public for its sanitary condition.)"

It was sometimes asserted — though Chadwick's Report casts doubt on the assertion — that French practice was in advance of British at the time. Braudel, too, paints a poor picture of Paris in Louis XVI's time — few apartments had wc's; chamber pots were emptied from windows; streets were sewers; Parisians relieved themselves under a row of yews in the Tuileries.(16) There was a body of writing on public health in France during the 20 years before Chadwick's Report — due principally to A. J. P. Parent-Duchâtelet and to L. R. Villerné, who edited the first public health journal *Annales d'Hygiene*.

> "The general practice in Paris is to cast all the rubbish of the house into the street on the overnight, or before seven o'clock in the morning, when men attend with carts to sweep it up and remove it. In the night-time, however, the chiffonier comes with a lantern and rakes amongst the refuse, and picks from it bones, rags or whatever may have been thrown away by accident ... . In the beginning of 1834, the municipality decided that the cleansing of the streets should be done by contract ... which would have led tc a practice similar to that of London, where the dust-carts take the refuse direct from the house without any deposit in the streets ... . The chiffoniers attacked and drove away the contractors and broke to pieces the new carts."(21)

The scouring of the sewers by a current of water was again proposed in Paris in 1667; again it came to nought because there was no water — and indeed water was not generally available in 1842, when Chadwick wrote. There was a sewage collecting basin at Montfaucon, in Paris, where the collected night-soil was stored until dry — a very unhealthy method. In 1832, Louis XVIII gave to the city of Paris a tract of land by the Ourcq canal for a new sewage works. At La Petite Villette, a small port was built for loading sewage for canal transport to the new works. But because of the insistence of the police on the tightness of the pits, the volume of materials to be handled increased rapidly to 210000 m^3 in 1848. Transport by barge or rail had to be reconsidered. M. Mary (chief engineer of roads and bridges) proposed to erect at La Villette a sealed building where the night-soil carts could discharge their load into large tanks, whence the supernatent liquid refuse would be piped through underground pipes to Bondy ten kilometres away. This was built between 1845 and 1848 (the Depotoir). The bitumen-coated pipes 27 cm in diameter connected La Villette and Bondy. The pumps were driven by a 25-hp steam engine which was capable of pumping 100 m^3/h. The liquid was used to make manure and ammonium sulphate.(45)

Chadwick quotes Emile Beres on the methods of clearing night-soil:(21)

> "The use of the moveable inodourous tanks has long been understood in Paris. It consists in substituting for the tanks of masonry, vessels of oak, painted and strongly hooped with iron, so as to allow neither matter nor smell to

escape. They are placed beneath the pipe which conveys the contents of the water-closet, and when full, are carried away, and replaced by others at every hour of the day without difficulty, without danger to the workmen, without inconvenience to the inhabitants. (This method was, however, rarely used -- NSB/BMR). There is another method, more recent, and in all probability more advantageous, for preventing the inconveniences of the ancient receptacles; it is the system of disinfection of fecal matter discovered by a learned chemist, M. Payen. Independently of its hygienic advantages, this method comprises a question of human dignity of great value. It is necessary, as far as possible, to take from our fellow-men the mischievous necessity to perform labours which invest them with ideas of disgust."

Every medical writer from 1780 onwards insisted that typhus was the product of overcrowded slums and insanitary conditions, and it was growing steadily by the 1830's. The 1838 Reports to the Poor Law Commissioners, by Kay, Arnott and Southwood Smith, emphatically placed the blame on urban squalor.

Chadwick recommended:

"The primary and most important measures, and at the same time the most practicable, and within the recognised province of public administration, are drainage, the removal of all refuse of habitation, streets and roads, and the improvement of the supplies of water. The chief obstacles to the immediate removal of decomposing refuse of towns and habitations have been the expense and annoyance of hand labour and cartage requisite for the purpose. This expense may be reduced to one-twentieth or one-thirtieth, or rendered inconsiderable, by the use of water and self-acting means of removal by improved and cheaper sewers and drains."

He goes on:

"The comparatively recent mode of cleaning adopted in the wealthy and new-built districts by use of wc's and the discharge of all refuse at once from the house through the drain into sewers saves the delay and the previous accumulation, and it also saves the expense of the old means of removal."

This proposal presupposes an adequate water supply.

"The chief objection to the extension of this system is the pollution of the water of the river into which the sewers are discharged. A practical example of the money value which lies in the refuse of a town, when removed in the cheapest manner (by a system of cleansing by water) is afforded in connexion with the city of Edinburgh. (This was a system by which land near the city was irrigated with the watery refuse.) From some of the land so irrigated, four of five crops a year have been obtained. Land once worth 40 or 50s per acre is now let for £20 or £30 per acre."

7.2.5 The 19th century

The widespread introduction of water supply and drainage systems was dependent less on technology than on politics and economics. The efforts of reformers like Chadwick led to the Public Health Act. An enabling Act of 1838 reorganised local government, to provide elected representatives. And although in theory one might have expected this to give a spur to the provision of sanitation, it seems to have had an opposite effect. Briggs recounts how civic pride was expressed in new buildings like Leeds Town Hall, while pressure from the ratepayers to economise forced councils to delay drainage works or to cut back on street lighting and cleansing. Gas undertakings were "municipalised" to make a profit; water companies were bought out only as the result of pressure from ardent citizens.

The fact was that there was little profit to be had from developing water supplies and drainage systems. Lewis Mumford regards this as one of the major characteristics of what he termed the "paleotechnic age". But there were some far-sighted individuals. Thomas Cubitt (1788-1855), the founder of a large building firm, was particularly interested in drainage and sewage. His housing estates in Euston and North London had first-class amenities, including land drainage and lighting.[19]

The Board of Surveyors appointed in Bradford in 1843 following a procedure laid down in the Highways Act of 1835 described the Bradford Canal in these terms:[17]

> "The drains of the town are emptied into this watercourse, and principally above the flood gates. Besides on both sides of the stream there are a great many factories of various kinds, the soil, refuse and filth of which fall into the beck. In summer time the water is low, and all this filth accumulates for weeks or months, above the flood gates, and emits a most offensive smell. This noxious compound is conveyed through the sluice into the canal, when it undergoes a process which renders it still more offensive. For the mill-owners below the flood gates, having a deficiency of water, contract with the proprietors of the canal, for a supply of water for their boilers. The water is conveyed for this purpose in pipes to the boilers, and after being used for the generation of steam, is conveyed back again to the canal, so that the waters of the canal are scarcely ever cool in summer, and constantly emit the most offensive gases."

Leeds, faced with pollution of the River Aire, failed to deal adequately with its problem of sewage disposal until well into the present century. A combined sewage system for Sheffield was not decided upon till 1884.

Sewage disposal was frequently on the agenda of Birmingham Town Council in the late 1860's. Sewage was piped raw into the River Tame at Saltby; and in 1858 an injunction was obtained restraining the Council from depositing solid sewage on land at the sewer outlet. A new plan of sewage disposal was adopted in 1871 — though Briggs does not specify the means.

Sanitation in the Houses of Parliament was in little better state. Sewage from the Palace was simply discharged into the Thames via open drains, or even carried by hand, in the 18th century; in the 19th century, sewage was discharged through drains at low tide only. John Darwin[24] (Resident Engineer at the Palace) gives the following account:

> "In the new Palace (i.e. after rebuilding in 1840) a very large oval section drain was built under the main central courtyard for the whole length of the building, with a fall to the south and arranged to discharge by gravity into the river. When the 1857 Act created the main sewers and the Palace was coupled to the Metropolitan system, that was inadequate to take the overall load, and backfilled into the Palace sewers. It was the practice to discharge the rather oily steam and condensate from the steam engines into the Palace sewer which greatly increased the odours."

(Pallot notes that there are records of the House of Commons being adjourned on account of the smells within the Chamber. A Committee of 1884 noted the insanitary condition of the House, and as a result, the arrangements were reorganised. Traps were provided in all waste pipes).

Darwin goes on:

> "Isaac Shone advocated a pneumatic ejector scheme. This scheme, which was largely complete by 1890, was to lay a pipe sewer within Barry's sewer with a fall towards the north end of the Palace. There a deep ejector chamber was built, coupled to the larger Metropolitan sewer only by the discharge from the

ejectors, preventing backing up into the Palace. The work proved highly successful ... . The original ejectors are still in use."

In spite of being a new town, Melbourne had its sewage problems: in 1861, the President of the Medical Society of Victoria said:

"The magnificent water supply which this city enjoys will prove a curse instead of a blessing if a thorough system of underground drainage is long delayed."

Sewage was carried away in huge open gutters; and the pollution of the river Yarra and other waterways was as bad in 1889 as anything Chadwick noticed in Britain in the 1840's.(17) It was not until 1898 that central Melbourne was connected to the metropolitan sewerage system.

At about that time, water-borne street cleaning was in use in Holborn and Finsbury. But "the prominent provisions of the modern Sewers and Streets Acts are those which contain penalties against the most effectual means of street cleaning – that by discharging the street refuse through the sewers." It was Mr Roe, the engineer for Holborn and Finsbury, who designed sewers with semi-circular bottoms, which were more effective in removing solids than the previous pattern which were constructed with flat bottoms.

A paper to the American Society of Civil Engineers gives the credit for the first complete water-borne sewerage system which was flushed weekly with river water to the city of Hamburg in Germany in 1843 – a system designed by the British engineer Lindley, who recommended the use of the refuse for agriculture instead of discharging it into the river. In Berlin, sewerage was begun in 1875, and by 1878 the first section of the radial system was in use. Most of the city had only soakaways, for liquid waste to leak into the subsoil, so that solid waste could be carried off in wagons. A ministerial edict in Prussia in 1877 prohibited the discharge of effluent from wc's into the rivers, and a later edict required any sewage works effluent to be discharged into a river should not contain more than 300 bacteria/cm^3.(12)

The first public system in the USA was at Boston, where the city took over the maintenance of the existing drains, and the building of all new ones, in 1823. But it was not until 1857 that the earliest complete system was set up, in Brooklyn. Water-borne carriage was introduced in 1850, but it was for liquid waste only. Household plumbing systems began to evolve following the introduction of water carriage.

The Paris sewers were begun by Baron Haussmann (who also created wide boulevards) during the 1850's, in response to criticisms of Government failure to stop the spread of cholera in 1848.(55)

A sewage system for Tokyo was proposed in 1887, but it was only partially completed at that time.(34)

Yet, almost 30 years after Chadwick's report, and 20 years after the Public Health Act of 1848 to which it led, there had been some improvement in the cities of Britain. The major towns had sewers, and most had an abundant water supply. While many people of those classes who were able to choose had adopted water-closets, the poorer people were unable to do so. In fact, only in Leeds and Liverpool were wc's available in the poorer districts. In 1869, there were 86176 houses in Liverpool; there were 31150 wc's and 20000 privies attached to ashpits. In the previous three years, over 14000 privies had been converted to wc's, at a cost of some £40000.

Systematic improvement in Lancaster was begun in 1855, and it included a public water supply in place of wells, a system of sewerage in place of open square drains, and a system of wc's instead of cesspools and middens. An earth closet system for the poorer houses was initiated in 1866, and in three years it comprised 90 earth latrines to serve some 2250 persons. In Edinburgh, some parts of the city had water-closets, and the soil from these was used to irrigate land to the north-east of the city. In the poorer parts, wc's were found to be unsuitable, and almost all the huge tenements had neither wc's nor privies nor ashpits attached to them.* The excrement from these, together with all town ashes and other refuse (a total of 50000 tons a year) was taken to depots to be sold as manure. The whole cost of cleaning the city, including the profitless removal of mud and snow, was £13000 a year; the sale of manure realised £7000. Of the 90000 families in Gasgow, 40000 had no wc's. Here the manure contributed £18000 to the £27000 annual cost of cleansing.

It is clear that the introduction of wc's was attended by some difficulties. Appendix 4 of the 12th Report of the Medical Officer of the Privy Council (1869) discussed at some length the relative merits of earth closets, water-closets and middens.

The difficulties are illustrated by the experience at Lancaster:(18)

> "At the grammar school at Lancaster, (the water-closets) were always getting out of order, by reason of marbles, Latin grammar covers and other properties being thrown into them, and by their machinery breaking under rough usage."

The wc's at Lancaster school were replaced by earth closets — a method to which the Medical Officer of the Privy Council devoted a good deal of attention in his 1869 report. Fresh earth was supplied to the closet pit once a day, and the manure was removed at intervals of a month or so. The report adds that the headmaster obtained remarkable results by the application of the earth manure to various garden crops. The earth closets used in the town itself seem to have been satisfactory from a health point of view. The Medical Officer's report concluded that the earth closet, properly managed, was a satisfactory method, and indeed has some advantages over the wc. The report considered the midden, the pail, the box or trough system, the earth system and the wc, but could not "affirm of any one of the methods that it will develop into the only perfect system of the future" (Fig. 7.7).

In other towns, misuse was reported, since the closets were common to several families, and they were uncared-for.

A design for a trough closet used at Liverpool seems to have been fairly satisfactory (Fig. 7.8). This was to a large extent due to placing on the several users of each closet a responsibility to ensure their cleanliness. There is an opening giving the scavenger access to the trough and the water supply. "The scavengers are employed by the corporation, and every day they visit each of the trough closets, discharge the contents of the trough, flush it out with water, sweep it clean and leave it charged with fresh water for the next 24 hours' use."(18)

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*"For the most part, the poorer people deposit their excrement, ashes and house refuse of all sorts in pails, and keep these actually within their living-rooms, or some adjoining recess or passage, until the time comes for the daily removal of the pails into the street in expectation of the scavenger's visit."(18)

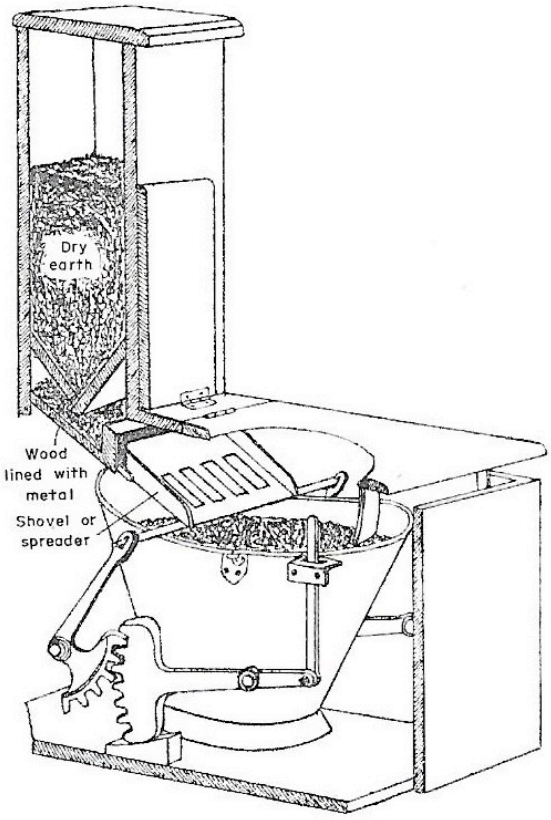

Fig. 7.7. Earth closet (*ca.* 1923).
(Courtesy, O.U.P.)

7.2.6 20th century sanitation

Progress was slow. As late as 1923, Adams wrote:[13]

> "The water-carriage system is rapidly replacing conservancy (i.e. earth closets, privies and middens) on account of the difficulties in the effective and sanitary operation of the latter, and many large towns have decided to abandon the latter system altogether... . Up to as recently as 1910, the pail system was fully retained in Hull, Rochdale, Warrington, etc. In Manchester, privies and middens were replaced in 1871 by pail closets, which in their turn were superseded in 1908 by water-closets."

The Appendices to the British Green Paper "Housing Policy" (1977)* show that modern amenities were lacking in many dwellings even comparatively recently. In 1914, a bathroom or an indoor wc was a rarity in working-class homes. Even in 1976, 1.64 million households in England and Wales (9%) were without an indoor wc, while almost 1 million did not have a fixed bath. It was not until 1944 that the Dudley Report recommended the provision of a bathroom in public housing. Statistics for other countries are illuminating:

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*Cmd 6851 (HMSO, 1977).

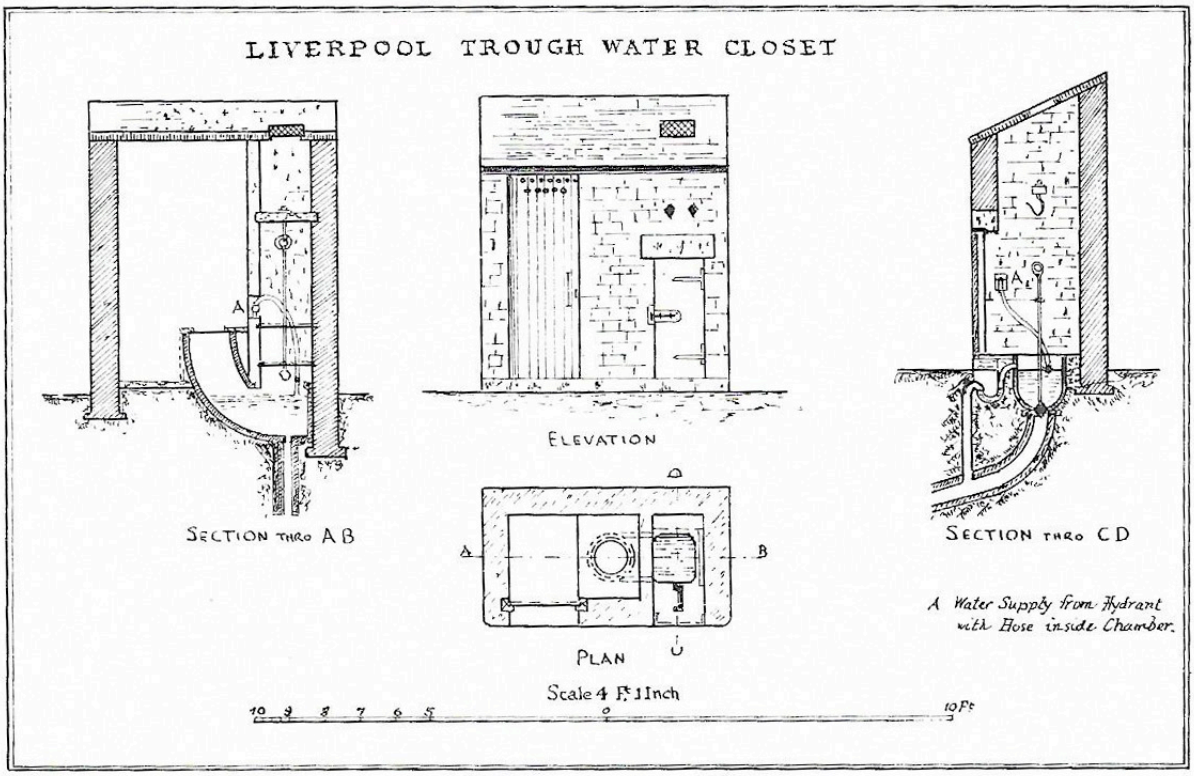

Fig. 7.8. Liverpool trough water closet.

	Proportion of dwellings without	
	bath or shower	flush toilet
Australia	-	10.5 % (1971)
Austria	45.5 (1970)	-
Canada	10.2 (1967)	5.7 (1971)
Denmark	36.6 (1965)	3.8 (1970)
France	51.1 (1968)	48.2 (1968)
W. Germany	17.6 (1972)	5.8 (1972)
Japan	34.4 (1968)	-
Italy	71.1 (1961)	20.9 (1971)
Norway	54.8 (1960)	28.2 (1970)
New Zealand	1.9 (1971)	2.9 (1971)
USA	5.0 (1970)	4.0 (1970)
UK	9.1 (1970)	1.1 (1970)

7.3 BATHING

7.3.1 The Greek, Roman and Islamic world

Bath tubs of stone or clay have been found in archaeological sites in Assyria (from 14th century B.C.) and in Babylon (from 25th century B.C.). At Knossos, decorated tubs of terracotta, dating from 18th to 15th centuries B.C., have been found. These baths had the tapered elongated form of the modern bath (Fig. 7.9).

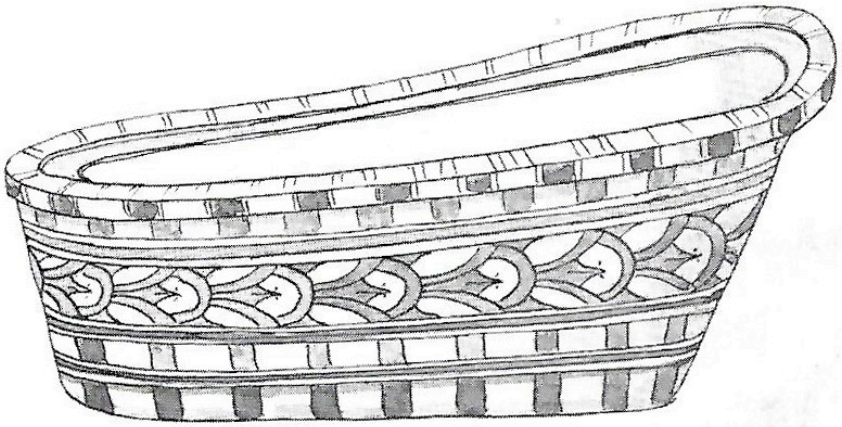

Fig. 7.9. Terracotta bath from Minoan Palace, Crete.

In Egyptian civilisation of the same period, bath tubs were unknown. Instead, the bathers were sprinkled with water. In the bathrooms of the larger houses, the water drained away through a hole in the floor.

In the 6th century B.C., in Greece, baths began to take the place of sea and river-bathing.(2) As in Egypt, sprinkling and showers were important features of Greek baths. A large pedestal basin was employed, and slaves sprinkled the bathers. The "sweat" bath, with shower, appeared in Sparta a little later. Public baths were provided for the poorer people.

Bathing became a well-developed social habit in ancient Rome. The Romans set up, throughout their Empire, the "thermae" or bathing establishments, which served as communal leisure centres. The most famous of these are the Baths of Titus (built in A.D. 80 on the foundations of Nero's "Golden House") and the Baths of Caracalla (A.D. 211-217), both in Rome.(53)(54) The Baths of Caracalla could accommodate 1600 bathers; the Baths of Diocletian at Split in Yugoslavia (*ca.* A.D. 300) are said to have been able to take twice this number.

As the Roman Empire developed and expanded, their baths became larger and more elaborate, and also more formalised in their design. This can be seen in Hadrian's Baths at Lepcis Magna (A.D. 126-7) on the coast of North Africa, where the building included an open-air swimming bath, a cold room (*frigidarium*), cold plunge-baths, a hot room (*calidarium*), and a number of superheated rooms or sweating baths (*laconica*). Also, wherever the Romans found hot springs they used them, as at Bath.

Roman villas, too, had their baths; and an important step was taken when the hypocaust was introduced. Various means of heating the water for small baths were used. One consisted of an urn within which was a pipe to contain a fire. Another, described by Seneca, was a "once-through" heater, made from a spiral copper pipe through which the water flowed, the pipe being heated by the flames of a fire.

The Greek and Roman "sweat" bath developed into the Turkish bath, and appeared in eastern Europe and Moorish Spain.

The Muslim bath (*hammām*) is believed to be directly inherited from the Classical World, but with emphasis on Islamic concern for both ritual and cleanliness, rather than social and sporting aspects. Early examples include the Bath (172-15 B.C.) at Qusayr'amra (now in modern Jordan) belonging to the Umayyad Period, during which the large and magnificent baths of the unfinished Palace (740-50 B.C.) at Khirbat-al-Mafjar (in present-day Israel) were also constructed where "sixteen piers carried a roof of barrel vaults and domes over a great frigidarium".(41)

The earliest known public hammãns date from about the middle of the 12th century. A typical public bath is the Hammãn-al-Bzouria of Damascus, containing a disrobing room and fountain, and with cold, warm, hot and steam rooms, and lavatories.

One of the best preserved Islamic buildings in Spain is the Bath at Ronda (12-15th centuries?), which is a rectangular building with three barrel-vaulted chambers (the calidarium, the frigidarium, and the apodyterium), and a courtyard with a pool. It is known that the water supply for the bath was drawn by a water-wheel from the river and poured into a system of gulleys.

In Istanbul, the Haseki Hürnen Hammãn (1556) is an outstanding example of baths built during the Ottoman period, with separate facilities for men and women (Fig. 7.10).[41] Turkish baths were freely available to everyone in Buda after Ottoman domination; they were still in existence after the recapture of the city by the Christians in 1699.

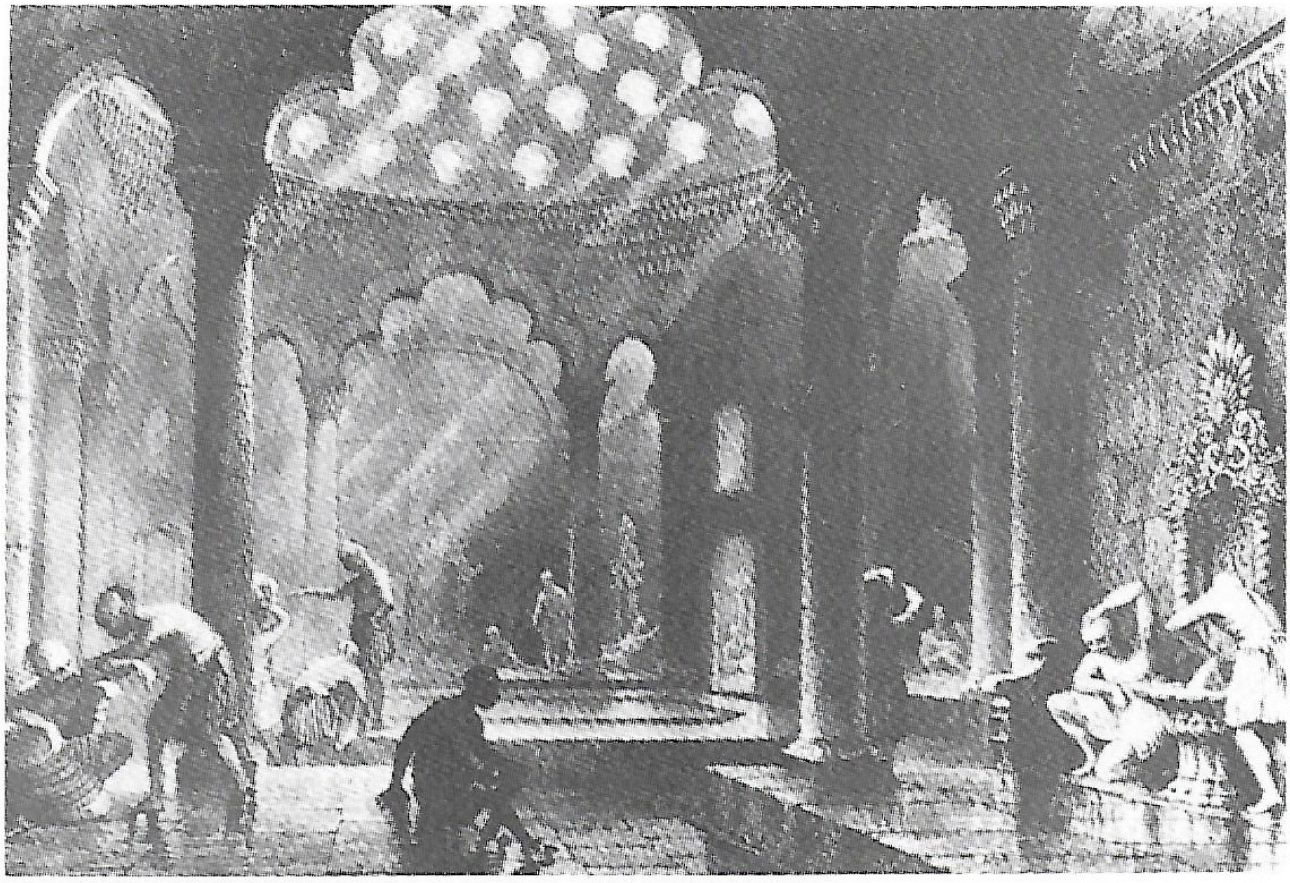

Fig. 7.10. The Çağaloğlu Hammãn (Bath), Istanbul, Turkey (18th century).(41)

In India, from the 8th century, there developed a form of "water architecture" which included stepped wells, bathing fountains and "ghats", reservoirs and stepped tanks.[43] Over the next 1000 years, these became extremely elaborate, many examples providing facilities for ritual bathing and festivals, with water storage and "retreat rooms" (Fig. 7.11).

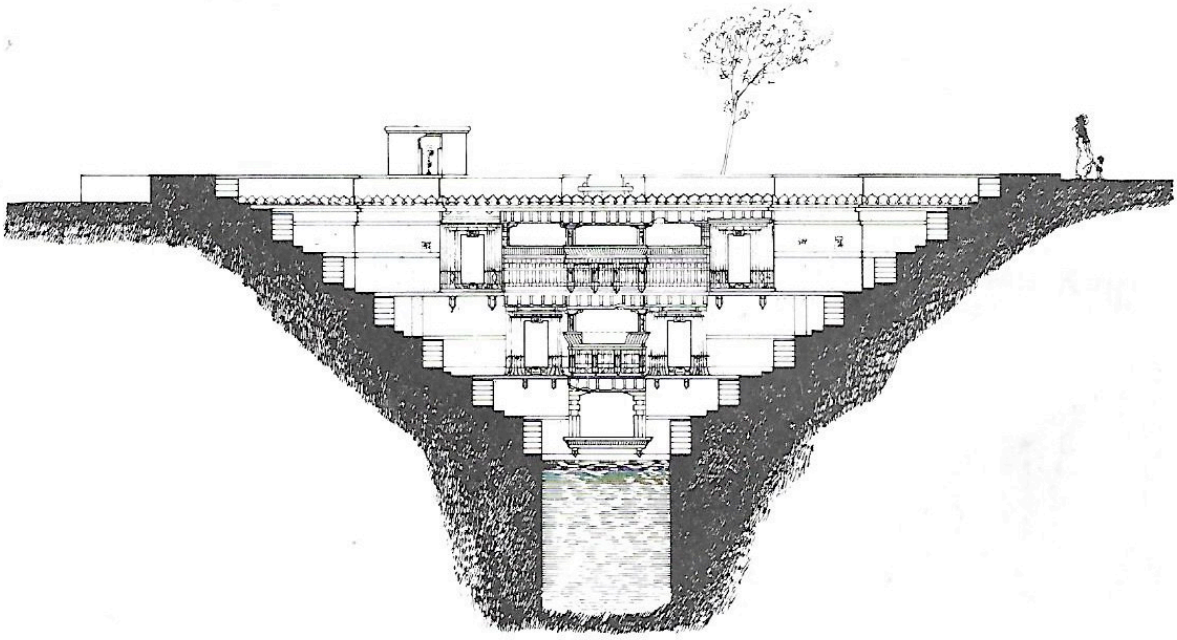

Fig. 7.11. A stepped tank or bath: the Sabali Kund-way Gujarat, India (*ca.* 1500).

Bath tubs seem to have been used in the Far East. In China, the bath was heated directly by iron boilers beneath it.(2) A Japanese tub was oval in shape, and at the narrow end, an iron or copper pipe, in which a charcoal fire could be placed, was built in.

7.3.2 The Middle Ages

The practice of bathing seems to have been largely forgotten (at least in Europe) with the decline of the Roman influence, only to be revived for a time in the Middle Ages. The monasteries had their lavers, and there was probably some friendly competition with the owners of castles and manors over the standard of facilities provided. Some travellers took no chances, for King John (1199-1216) was accompanied on his journeys by his travelling bath and bathman.(35) At the castles of Warwick (*ca.* 1070), Aydon (*ca.* 1280) and Compton (1320), there are washing sinks with drains in the service quarters, while there is a hall laver in Battle Hall, Kent, (*ca.* 1330). Public bath houses (with mixed nude bathing) were again established.

Gimpel states that standards of hygiene in the 12th and 13th centuries were relatively high, but progressively the authorities worried about the permissiveness in the public baths; and the incidence of the Black Death hardened this attitude. There were 32 privately-owned public baths in Paris in the 13th century and for their use, 2d. was charged for the steam bath, and 4d. for a tub bath (1268). In London, too, the communal delights of the Turkish bath were introduced by returning Crusaders. By the reign of Richard II (1377-1399) there were eighteen bath houses or "stews" in Southwark alone, and the waterfront came to be known as Stewsbank.(54) These stews were owned by the Lord Mayor of London, William Walworth, and probably made a handsome profit from the immoral business done on the side, and to which the Church objected. The stews were finally closed down by Henry VIII.

The prudish attitude caused bathhouses to close; and hygiene disappeared from Western society, not to re-appear for 500 years. Public baths were, however, retained in Finland and Russia.

The Renaissance in Italy gave rise to sumptuous bathrooms in the palaces (e.g. the Pitti Palace in Florence, and the Palazzo del Té in Mantua); and this spread to Germany in the wake of trade. There were also washhand stands, with a waste pipe, but they had to be filled by hand from cans, in the absence of a water supply. For the mass of the population, however, with the disappearance of the bathhouse, the habit of bathing as an aid to health was forgotten. At the end of the 18th century, there were only two bathhouses in Paris, for a population of 54000. Bathing was regarded as a luxury, and those who wished to bathe used a tub at home (Fig. 7.12).

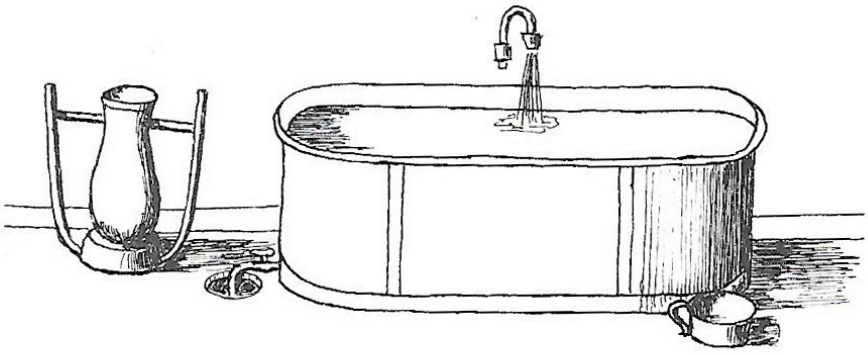

Fig. 7.12. Domestic bathtub, Germany (late 18th century). At left 'cylinder" heater for bath.

7.3.3 The 19th century

The influence of Rousseau's philosophy led to a revival of the habit of bathing, both in France and in Germany in the mid-18th century. Contemporary reports suggest that bathrooms were becoming commoner. The metal tub itself was small, of the size of a sitz-bath, with an emptying tap. A copper vessel in the bathroom was used for mixing hot and cold water, and there was sometimes a secondary heater in the form of a cylinder containing burning charcoal which could be immersed in the water.

In spite of the obvious risks of poisoning, the apparatus was used for many years.

As the demand for bathing facilities grew, in advance of adequate water supplies, portable tubs were developed. One such was in the form of a sofa ("baignoire"); another like a sabot. Water had to be carried in horse-drawn carts, from which the water-carriers took water to the houses. In the early 19th century in Paris, a bathroom was still a luxury enjoyed by few; but portable tubs could be hired. These came on a cart, together with a supply of hot and cold water. The whole family would bathe, one after the other, in the same water (for refilling was too costly), and sometimes the water would be used for laundry as well. These bath-wagons were also used in Berlin, and it was related that when Kaiser Wilhelm I desired a bath, he hired a tub from the Hotel de Rome. The Frankfurt bath-ship was

famous. The superstructure resembled a Greek temple. In the for'ard part of the vessel there were 8 small bathrooms; in the stern section there was a family bath and a toilet. River water was pumped aboard and heated by a boiler amidships.(2)

There was some revival, too, of public bath- and wash-houses, though in these more modern establishments, each customer had his own cubicle. The Rheims baths were used by 30000 persons a year, and 300 tonne of laundry was washed. The Leopoldstadt baths in Austria (1855) had a swimming bath as well. The Hamburg baths, built in the same years, had a Perkins heating system which heated the drying room; small stoves provided for heating irons. But the conservative German house-wife made little use of such establishments. The Russians had public steam baths, for a traveller in 1873 records: "In Moscow, our road was lined with public hot rooms"; they were used by both sexes and were cheap.

The private bath-tub or bathroom spread quickly in the latter half of the 19th century. This was due in part to the knowledge of hygiene based on the work of Pasteur (1822-1895), Eberth and Koch (1843-1910), and Lister (1827-1912), but became possible only with the construction of water supply networks. As usual, the spread occurred first among the upper classes.

> "As early as 1813 the Earl of Moira's Donnington Park in Leicestershire had two bathrooms and at least six water-closets, on two floors. His wife had a water-closet and bathroom off her dressing room; the bathroom was furnished with a gilded wash-hand stand, a dressing stand with gilded basin and ewers, a rosewood book stand, a thermometer and a copper tea kettle. Immediately below, her husband had a water-closet and bathroom off his study and powdering room. By the late 1830's and early 1840's the Dukes of Buckingham were equipping Stowe with plumbing almost as lavishly as their predecessors had equipped it with temples. By 1844 it had at least nine water closets, a shower bath and four bathrooms. The shower bath, which was in the Duke's apartment and had piped hot and cold water, was not altogether a new phenomenon; the Duc de Levis had described it as a 'machine... now very much in use' by the English in 1815."(32)

Burton notes that up to about 1850 in Britain, piped water was hardly ever available beyond the kitchen sink, and the portable tub in the kitchen was the common method of bathing.(19) Some of the larger houses did have a bathroom, even though there was no hot water supply to it, nor any drain from it. He says that when Queen Victoria married, there was only one bathroom in Windsor Castle. Hellyer did not approve of the English viewpoint, for in 1877 he wrote(33)

> "In every house, a wc may be considered a necessity. But by English people, lavatories and baths, fitted up with hot and cold services, would, I suppose, be considered a luxury."

The tub was shaped to correspond roughly with the human form. Cheap baths of zinc or copper, often cased in wood, were produced. One American product of the time was made of compressed wood fibre, enamelled inside. Around 1900, when the sanitary industry expanded rapidly, a nickel-plated steel bath was made. But cast iron soon dominated the market, because the casting could be decorated, and because it could be given a long-lasting enamel surface. English and American manufacturers also produced ceramic baths.

Continued in PART-3