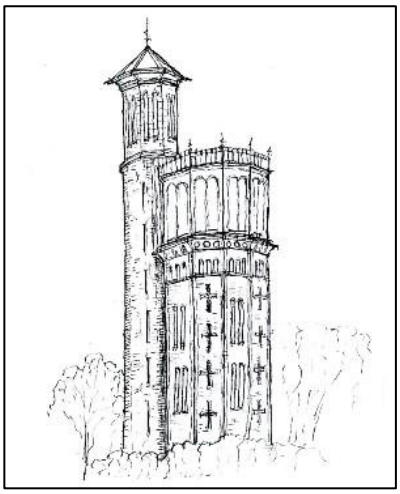
The Landmark Trust

Appleton Water Tower

History Album



Researched and written by Charlotte Lennox Boyd

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BASIC DETAILS

Built:	**1877**
Designed by:	**Robert Rawlinson**
Structural Engineer:	**James Mansergh**
Lease acquired by the Landmark Trust:	**1976**
Repaired:	**1976-77**
Architects:	**Michael and Sheila Gooch, Norwich**
Builders:	**Fisher & Sons, Fakenham**

Contents

SUMMARY

In 1871, the then Prince of Wales (the future King Edward VII) fell ill with typhoid while at Sandringham. Three years later, so too did his eldest son. Both royal illnesses must have vividly brought to mind the death of the Prince's father, Prince Albert, from the same disease while at Windsor Castle. Following that tragedy the engineer Robert Rawlinson was asked to report on the drainage of the Castle (it proved to be underlain by numerous foul cesspools, almost certainly the source of the Prince Consort's infection). The Sandringham water supply must have at once come under suspicion, and indeed tests showed it to be "unsatisfactory". As a matter of urgency, the house and indeed the whole estate had to be provided with a reliable and clean water supply.

The engineer responsible for the design of the new waterworks was James Mansergh (he is said to have been assisted by an amateur architect named Martin ffolkes, but there is little evidence for this.) Rawlinson was appointed to supervise the construction of the new waterworks; he and Mansergh had previously worked together successfully on the Birmingham water supply.

It was decided to take the new supply from a chalk spring a mile or so from Sandringham House. The level of the spring was more than 20 feet below that of the house, so a pumping station was needed. Moreover, the highest point of the Sandringham estate was still only about 5 feet above the roof of the house, and in order to ensure that there would be sufficient pressure for fire-extinguishing purposes a service reservoir would be needed: this is the 32,000-gallon cast-iron tank that tops the Appleton Water Tower, and it is this tank that is the 60-foot Tower's *raison d'être*. Incidentally, the height and the elevated position of the Tower ensure that it is a conspicuous feature visible from many miles around.

Mansergh's polychromic design, described as "neo-Byzantine" and carried out in differently coloured red bricks and local stone, exploited this position in more ways than one. Realising that the upper levels of the tower would command a dazzling view of much of Norfolk, he reserved the second-floor room for the use of the royal family and their guests when shooting parties or picnickers required a base during the day. A floor above the viewing room accommodated the valve gear, and the two lower floors made a dwelling for either the engineer in charge of the pumping station or perhaps a caretaker. A separate entrance and stair were made within the smaller tower to give independent access to the viewing room.

Work began in the summer of 1877 – the Princess of Wales, her brother and two of the young princes all laid foundation stones – and finished about a year later. Water flowed from the spring under gravity through stoneware pipes for some 750 yards to the pumping station, where it was softened and pumped via a further 400 yards of pipes and a four-inch rising main into the tank. (In winter the water in the tank was kept from freezing by the heat from the fireplaces below, the flues of which passed through the middle of the tank.) From here it ran under pressure for more than a mile to the house and the surrounding cottages, via branch mains that carried a dozen hydrants encircling the house. When all was complete the hydrants were tested by the famously energetic and strikingly handsome Captain Shaw of the Metropolitan Fire Brigade (immortalised by

Gilbert in one of the songs in *Iolanthe*), "to his entire satisfaction", three or four jets being played simultaneously over the roof of the house. Not only, therefore, had the Prince of Wales now supplied his household with a "pure and wholesome" water supply, but he had placed it in "a condition of security from fire possessed by few of the great country houses of England".

RESTORATION BY THE LANDMARK TRUST

The Appleton waterworks served the Sandringham estate well for many years as a private concern, but eventually came to be operated by the local water authority. By 1973, however, it had become surplus to their requirements, and stood empty for three years. It was then leased to the Landmark Trust, a charity that specialises in rescuing buildings of architectural and historic importance.

The Trust was delighted to be given the rare opportunity of saving a fully functional building of such high quality. The architects Michael and Sheila Gooch, a husband and wife partnership from Norwich, were commissioned to carry out the restoration, the builders being the local firm of Fisher and Sons, of Fakenham.

The old outbuildings were demolished, to leave the Tower free-standing in its clearing in the woods. The roofs of the tank and for the turret of the staircase tower were decayed, and had to be replaced. The intricate details of the elaborate brickwork were all carefully repaired and repointed, and cracks in the tank's ironwork were repaired; in addition, replicas were specially made to replace missing details of the ornamental ironwork. New windows and doors were fitted, and a new kitchen and shower room formed on the ground floor. One of the most significant changes was the construction of an extended internal staircase linking the viewing room on the second floor to the floors below, which meant that the Tower became for the first time a fully integrated dwelling. It received its first visitors exactly a century after the Princess of Wales laid the first foundation stone. Happily if fortuitously, in the same year the Norfolk Industrial Archaeology Society restored the old steam engines in the pumping station.

As you see it today, however, the Water Tower has recently undergone a further rejuvenation, carried out in the light of twenty years of Landmarkers' experiences of living in this much-loved if eccentric "holiday cottage". Under the guidance of the architect Will Hawkes of Hawkes Cave and Edwards, Stratford-upon-Avon, and with Linfords of Lichfield as the main contractor, the building has been fully rewired, replumbed and redecorated, and a new heating system has been installed. The ground-floor shower room and kitchen have also been refurbished. Perhaps the most practical change has been that a way has been found to bring part of the top floor, the old valve room beneath the tank, into service as additional living accommodation in the shape of a much-needed extra bathroom.

The old sitting room next to the kitchen on the ground floor has now become the dining room, while perhaps the best room in the Tower – the viewing room on the second floor – has been redesigned as a bed-sitting room. As a result, while you are staying in the Tower you can, if you choose, spend as much as possible of your day here, gazing at the

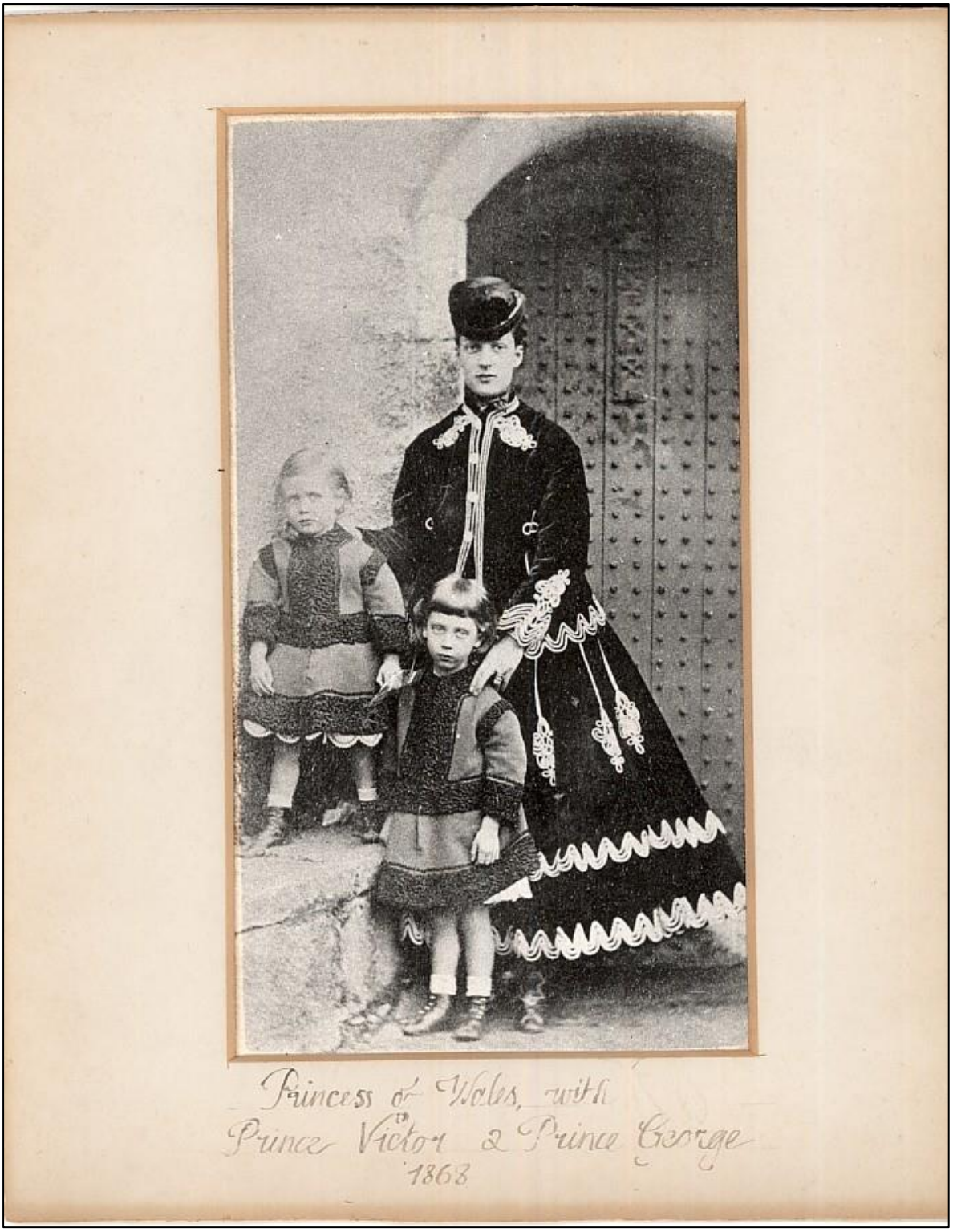
Norfolk landscape spread out below you, and in the evening watch the seabirds quietly flying home to the distant sandbanks of the Wash.

The Restoration

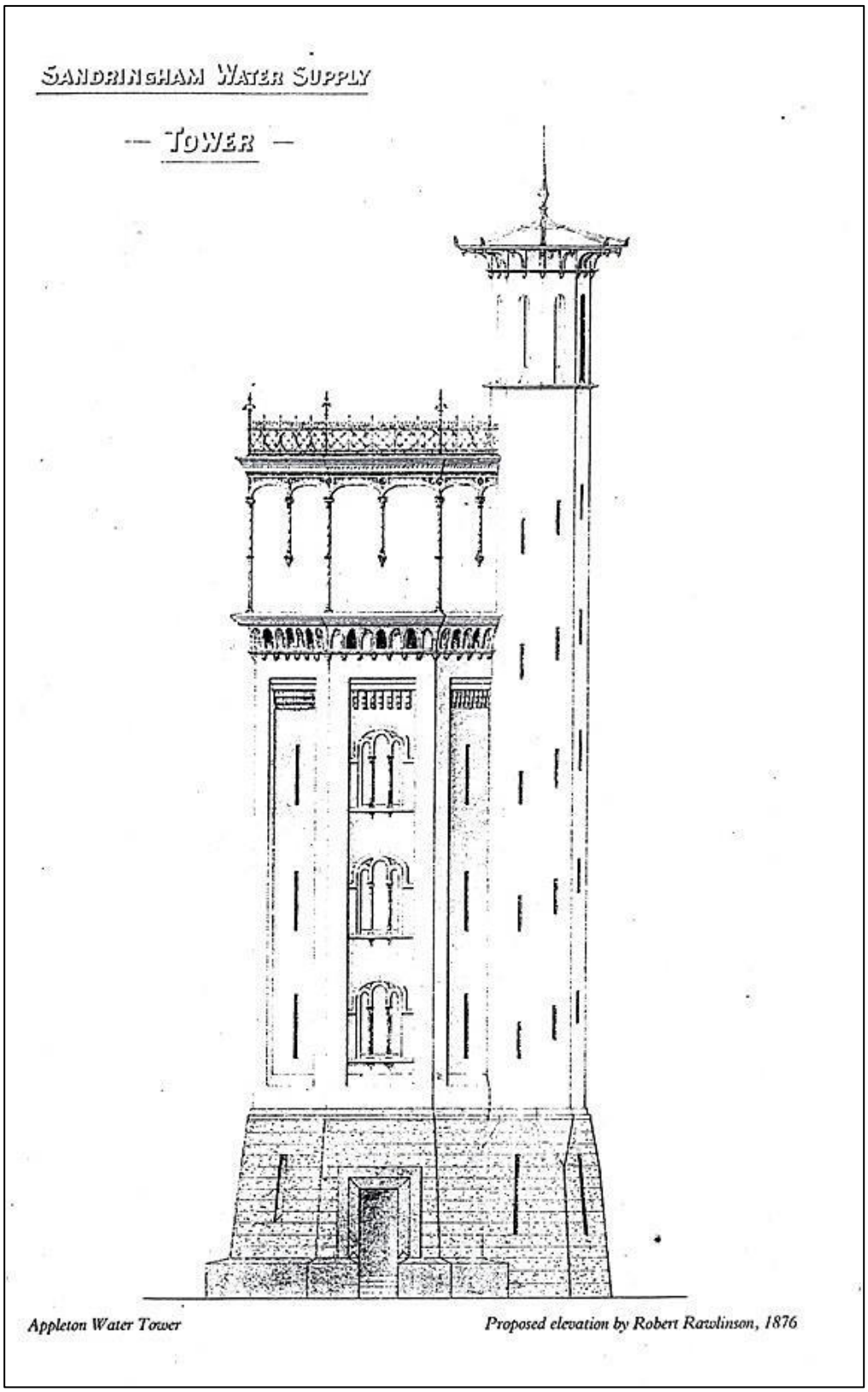
The water tower at Appleton forms part of a private water-works system for the Sandringham estate, and was originally supplied with water from the pumping-station. The tower was later taken over by the Water Authority, who ceased to use it in 1973, and it stood empty until 1976, when it was leased to the Landmark Trust from, to quote the *Handbook*, "a public-spirited local landowner".

The restoration involved the repair of the fabric, with new roofs being put on both turret and tank. The brickwork was repaired and repointed, the tank's ironwork and its ornaments were mended and replaced, and new windows and doors were put in. The second-floor room, originally intended for use by royal shooting parties and formerly accessible only through the spiral stair in the smaller octagonal tower, was connected to the ground- and first-floor rooms, which had been the modest home of the tower's caretaker. Some outbuildings were demolished. The architects were Michael and Sheila Gooch, a husband and wife partnership working from Norwich and Halesworth.

The restoration was completed in 1977, one hundred years after the Princess of Wales, later Queen Alexandra, laid the first stone. In the same year the Norfolk Industrial Archaeology Society restored the engine in the pumping-station.



Princess of Wales, with
Prince Victor & Prince George
1868



Appleton Water Tower *Proposed elevation by Robert Rawlinson, 1876*

History of the water tower

The Appleton water tower was built to ensure a clean water-supply to the Sandringham estate. The future Edward VII had contracted typhoid at Sandringham in 1871, as did his eldest son in 1874. The most vivid description of the atmosphere in which the tower was put up is to be found in the rancorous and snide memoirs of Mrs Louisa Cresswell, the tenant-farmer of the Appleton estate. She had fallen out with the Prince of Wales over the damage done to her crops as a result of his obsession with preserving and shooting game. The tenant had to tolerate huge numbers of greedy birds on the land, and also to do without the labour of the beaters on shooting days. It was her farm which was disrupted by the operations to build the tower and the pumping-station:

> It was rather inconvenient having contract-work and workmen all over the premises. A new road I had made was cut to pieces by carting bricks for the engine-house, and the Prince being annoyed at the ruts and holes, for once in a way complained to me himself under the impression that it was *his* road and that *I* with my usual malignity has destroyed it. ... I answered rather sharply, "It is *my* road, Sir, and your Royal Highness's carts have cut it all to pieces."

To her amazement she was then accused of sabotage:

> Down came the land-agent in a grand bustle one morning, "Prince Albert Victor has typhoid and it is all your doing." I almost worshipped those children and now to be accused of killing one of them!

When Mrs Cresswell's memoirs came out the Prince was so incensed he ordered that all available copies should be bought up and destroyed, and so the book is now exceedingly scarce.

Mrs Cresswell in about 1864

THE PRINCE AND PRINCESS OF WALES.

The Prince and Princess of Wales dined with his Excellency the Brazilian Minister at his house in Grosvenor-gardens yesterday week. Princess Christian visited their Royal Highnesses the previous day at Marlborough House. The Prince and Princess, with their children, left town on Saturday last for Sandringham. On Sunday their Royal Highnesses and Princes Albert Victor and George attended Divine service at St. Mary Magdalene's Church, Sandringham Park. The Rev. J. N. Dalton officiated. The Prince has left for Rutland Lodge, Newmarket. The Princess is entertaining at Sandringham her youngest brother, Prince Waldemar, and on Wednesday the Royal party laid the foundation-stone of a new water tower to be erected on the Sandringham estate. Stones were laid by the Princess, Princes Albert Victor and George, and Prince Waldemar. The Prince, accompanied by the Princess, will visit Wantage on Saturday, the 14th inst., for the purpose of unveiling the statue of King Alfred in the market-place of that town, which is celebrated as his birthplace. The statue is presented to Wantage by Colonel Loyd-Lindsay, V.C., M.P., and has been executed by Count Gleichen, the Queen's cousin. Their Royal Highnesses will be the guests of Colonel Loyd-Lindsay and the Hon. Mrs. Lindsay at Lockinge House until the following Monday.

The Princess of Wales lays the foundation stone of the water tower. ***The Illustrated London News*****, 4 July 1877**

296 THE BRITISH ARCHITECT AN

PURSTON, PONTEFRACT.

ST. THOMAS'S CHURCH. MR. T. POLLARD, ARCHITECT.

THE consecration of this new church took place on the 18th inst. The church is in the thirteenth century Gothic style, and is built of pitch faced stones from the Bracken Hill quarries. The plan shows nave, aisles, chancel, organ chapel, and vestry. The nave is 71 feet by 26 feet, making, with the aisles, a total width of 51 feet. The chancel is 32 feet by 23 feet 6 inches, and on the north side are situated the organ chapel and vestry. The east end is lighted by a three-light lancet window of stained glass. The various works were executed by the following:—Masons' work, Mr. Henry Smith, Leeds; joiners', Mr. George Yates, Bradford; plumbers', Mr. Thomas Parker, Pontefract; plasterers', Messrs. Charles Howroyd and Sons, Bradford; slaters', Messrs. Hill & Nelson, Bradford; painters', Messrs. Morrell & Hartley, Bradford; gasfittings, Mr. F. A. Skidmore, Coventry; organ, Messrs. Conacher & Co., Huddersfield; east window, Messrs. Frampton & Hean, London. The church will accommodate 550 persons. The total cost has been over £6,000.

SANDRINGHAM.

THE NEW WATER SUPPLY FOR THE RESIDENCE OF H.R.H. THE PRINCE OF WALES. MR. RAWLINSON, C.E.; C.B., ENGINEER.

THE works in connection with this water supply have been completed from the designs and under the immediate superintendence of Mr. Mansergh, of the firm of Messrs. Lawson & Mansergh, of Westminster. The new supply is obtained from a chalk spring a mile or so from the house. The water is conveyed through 9-inch stoneware pipes from the spring to the pumping station, a distance of about 750 yards. The water is then pumped into the tank on the tower through a 600-yard main. The tank is 24 feet wide with a depth of 12 feet, and will hold 32,000 gallons. The supply main to the house is 6 inches in diameter, and 1,870 yards in length. Two 4-inch branches, to which are fixed twelve hydrants, surround the house, and are supplied from this main. The stables, gardens, equerries' lodge, and Sandringham cottage are suppled by 3-inch mains. West Newton is also to be supplied from these works. Messrs. Pratchett Brothers, of Carlisle, supplied and erected the pumping machinery and tank.

***The British Architect and Northern Engineer,* Vol 9, 21 June 1878, p 296**

THE BUILDING NEWS. JUNE 7, 1878.

THE WATER SUPPLY AT SANDRINGHAM.—The water supply to the residence of the Prince of Wales at Sandringham having been found unsatisfactory, Mr. Rawlinson, C.E., C.B., was some time ago instructed to investigate the matter and advise as to an improvement. After making careful surveys of the whole neighbourhood and trial borings at several places, the source of supply ultimately determined upon was a chalk spring in Den Beck Wood, at a distance of nearly a mile and a half from the house. This spring issues from the base of the chalk at 92ft. above Ordnance *datum*, or 22ft. below the level of the ground floor of the house, and between the spring and the house there is a ridge of high ground rising to 175ft. above Ordnance *datum*, or 5ft. above the highest point of the roof. Upon this ridge a water tower 60ft. high has been erected, and on this tower a tank has been placed, to be used as a service reservoir. By this means ample pressure has been provided for the discharge of water over the house in case of fire. The yield of the spring varies from 15,000 to 150,000 gallons per day of 24 hours. From the spring the water is conveyed through 750 yards of 9in. stoneware pipes (having Stanford's patent joints), laid with a fall of 1 in 800 to the pumping station. The tower is built principally of brick, the angle quoins in the battered base being of red Mansfield stone filled in between with the "carrock" of the district. The pumping machinery and tank have been erected by Messrs. Pratchitt Brothers, of Carlisle. Messrs. Lawson and Mansergh were the engineers of the works.

Extract from *Illustrated Carpenter and Builder*

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OUR ILLUSTRATION.

A VINERY and hot-house for raising cuttings, the design for which has been sent to us by a correspondent (W. Hathaway) is the subject of our front page illustration. The wall should be a 9 in. one, and 2 ft. 8 in. high, and a 4½ in. brick wall is built in stove, as shown in sectional views. A 4½ brick wall is built on each side of trench, and to be covered over with flags or perforated cast-iron work in centre of footpath. In both the stove and vinery there should be a cistern for watering the plants. The wood work to be made to fit the brickwork, with top and front lights to open, with a hand crank to open all at once, to regulate air according to the plan shown on section of front detail. Vinery and stove can be heated by kitchen boiler. If large the best way would be to get a tubular boiler, of which a sectional view is given. Hot-water apparatus should be fitted with indiarubber joints, the pipes to rise from boiler to part of vinery, and then fall back to the boiler. The return pipe should be placed directly under flow pipe. Place the pipes round as shown. The pipes in the stove rise to the bottom of lights to the end of glass, and then fall a little till one pipe nearly touches the other, and then fall down to the bottom, going up to the top, and then back again and out, into the return back to boiler. In vinery the pipes rise round to the door, and then come back in bottom pipe, returning to boiler. This is to be a small ½ in. pipe, let into the high part of pipes to allow the air to escape, so that water will circulate. A valve to be placed on each lot of pipes, both for flow and return, so that at one part heat can be turned on and the other off, if wanted. The pipe of both at top and bottom heat and the side heats to have a trough in the centre of the pipes to be filled with water, and as the pipes heat the water evaporates, keeping the plants moist. A self-acting cast-iron cistern is fitted to supply boiler and pipes with water, by a ball-tap; this goes in at the under side of

return pipe. The fire is built 6 in. clear all round the boiler, and at each turn over the top a space of 9 in. is left open at top next front for the flue, and it passes over the top of the arch into chimney. The damper is just where the flue enters chimney: and should have a 2 in. hole through centre, so that there is always a draught.

SANDRINGHAM WATER SUPPLY.

THE water supply to the residence of his Royal Highness the Prince of Wales at Sandringham having been found unsatisfactory both as regards quantity and quality, Mr. Rawlinson, C.E., C.B., was recently instructed to investigate the matter and advise as to an improvement. In these preliminary inquiries with regard to the water, and in an examination of the house drainage arrangements and the better disposal of the sewage, Mr. Rawlinson availed himself of the assistance of Messrs. Lawson and Mansergh, of Westminster, and under Mr. Rawlinson's supervision Mr. Mansergh has designed and superintended the whole of the works as acting engineer. After making careful surveys of the whole neighbourhood and trial borings at several places, the source of supply ultimately determined upon was a chalk spring in Den Beck Wood, at a distance of nearly a mile and a half from the house. The spring issues from the base of the chalk at 92 ft. above Ordnance *datum*, or 22 ft. below the level of the ground floor of the house, and between the spring and the house there is a ridge of high ground, rising to 175 ft. above Ordnance *datum*, or 5 ft. above the highest point of the roof. Upon this ridge a water tower 60 ft. high has been erected, and on this tower a tank has been placed, to be used as a service reservoir. By this means ample pressure has been provided for the discharge of water over the house in case of fire.

The yield of the spring varies from 15,000 to 150,000 gallons per day of 24 hours. The water is clear, cool, and sparkling, and has a hardness of about 17°, which is reduced to about 6° by Clarke's softening process. From the spring water is conveyed through 750 yards of 9 in stoneware pipes (having Stanford joints), laid

with a fall of 1 in 800 to the pumping station. This establishment consists of three buildings. The first serves as a lime-store, and contains a small oval tank in which the lime-water is prepared for the softening process. The solution of the lime is assisted by a pair of agitators driven by a three-cylinder Ramsbottom hydraulic engine, worked by a small branch from the rising main. From this tank the lime-water is delivered in the proper proportion into two chambers in the second building, each of which contains 3000 gallons of the spring water to be acted upon by the lime-water. After standing for several hours the softened water is drawn off from the chambers by means of self-acting syphons (which obviate the necessity for the stuffing boxes frequently used for this purpose) into the reservoir or pump-well, containing 18,000 gallons, and it is then ready to be pumped into the tank on the tower. The boiler and engine are placed in the third building, and betwixt the engine-house and the softening-houses there is a cooling pond for the condensing water.

The water is pumped through an air-vessel having a capacity of 25 cubic feet, and fitted with proper gauge-glass and air-pump. The rising main is 600 yards in length from the pumping station to the tank on the tower, and the net lift from the bottom of the pump-well is 175 ft. This is made to deliver the water through the bottom of the tank, so that the pressure is always available for working the "Ramsbottom" at the agitator. The tank is of cast iron, octagonal in plan, 24 ft. across and 12 ft. deep, and contains 32,000 gallons.

The tower is built principally of brick, the angle quoins in the battered base being of red Mansfield stone filled in between with the "carrock" of the district. The two lower floors are to be used as a dwelling-house for the man in charge of the pumping station, and above these are two other rooms and the lead flat on the top of the tank, which have separate access by means of a circular staircase fixed in an octagonal turret attached to the main tower, and rising to the height of 100 ft. above the ground.

The supply main from the tank to the house is 6 in. in diameter, and 1870 yards in length. This main feeds two 4 in. branches which encircle the house and upon which are placed 12 hydrants. The stables, gardens, equerries' lodge, and Sandringham Cottage are supplied by means of 3 in. branches, and it is also intended to supply the village of West Newton.

A few weeks ago the working of the hydrants was tested by Captain Shaw, chief of the Metropolitan Fire Brigade, to his entire satisfaction—three or four jets being played simultaneously over the roof of the building. By these works his Royal Highness has placed his Sandringham residence in a condition of security from fire possessed by few of the great country houses of England, and, what is even more important, he has provided a supply of pure and wholesome water free from contamination and in every respect well adapted for all domestic requirements. The pumping machinery and tank have been erected by Messrs. Pratchitt Brothers, of Carlisle.

NOTES CURRENT.

ALTHOUGH the electric light seems to make but slow progress here its display in the streets and thoroughfares is becoming one of the attractions of Paris. Eight electric lamps have been placed in the Place de l'Opéra, twenty-four others in the Opera Avenue, and eight more on the Place du Théâtre Français. Six lamps were lighted for the first time on June 1 on the part of the Palais Bourbon facing the Place de la Concorde. The private illumination of the Grands Magasins du Louvre comprises about seventy lamps; Belle Jardinière, eight; Concert de l'Orangerie des Tuileries, twenty; and the Hippodrome, thirty-two. All these illuminations are made by the Jablochkow candles. An electric lamp of great power has been placed also on the top of the Trocadero Palace.

THE Swiss Kunstverein, at its annual assembly in Zofingen, on June 2nd, finally decided to entrust the execution of the four wall-paintings in the interior of the Tellskapelle, on the Axenstrasse, to Herr Stückelberg, of Basel, who is to receive the honorarium of 45,000 francs.

According to the terms arranged between the Kunstverein and the Government of Canton Uri, the artistic jurisdiction over the chapel has been entirely transferred to the former.

THE summer Conversazione of the Working Men's College took place on Thursday in last week. The science classes, under the teaching of Mr. Dunman, have during the past winter been highly successful, and the Council have accordingly arranged for a considerable extension of the work of the college in this direction. Classes in several branches of science will be held during the next winter session, the lectures being in all cases accompanied by an abundance of practical work. At the same time the classes in history, literature, and language will be reorganised. We wish all success to this institution, and would like to hear of its obtaining a full measure of the support it justly deserves.

THE NEW LAW COURTS.—On Thursday week Mr. G. Noel stated, in reply to Mr. Adam, that considerable progress had been made with these buildings during the last three months, and that he hoped the eastern portion of them would be open by the end of September or October next.

THE WALTER PRESS. — The *Daily News* of Saturday says:—"The great increase in our circulation having rendered the machinery—seven Walter presses—no longer adequate to produce the numbers required, an eighth Walter press, ordered a few weeks ago, has this week been erected in the machinery room of the offices in Bouverie-street, and was yesterday morning brought for the first time into use. The result, which is an extraordinary one, deserves mention in the history of machinery. Yesterday morning the eight presses, working simultaneously at the astonishing rate of 104,000 perfect copies per hour, accomplished the printing of no less than 120,000 copies of the *Daily News* in time for the departure of the early newspaper trains."—*The Times.*

Extract from *Engineering*, 31 January 1879, pp.91-3

of sedimentary formations imbedded in their mass, and occupying most irregular and complicated positions. Numbers of faults and slides can be observed at every step, not only in the mountainous part, but in the flat country also as far as the eruptive rocks extend.

The distribution of the mineral deposits of this district is of course nearly connected with the geological arrangement. On the west side we naturally find the deposits of a sedimentary origin, such as brown hematite, cupriferous sandstone, coal, &c., whereas *lodes* have to be looked for on the eastern slope, where magnetite, chrome iron, auriferous quartz, and copper ore are abundantly worked.

If we continue the nomenclature of the eruptive rocks of Russia, we come next upon the Caucasian and Crimean hills, that appear to be of a far more recent date than the Oural Mountains. Not only are the Jurassic beds the oldest to be found in this district, but an abundant volcanic formation, marked on the map, seems to have played an important part in the outline of the country. Iron, copper, silver lead, cobalt, and manganese are found here, as well as Jurassic coal, and lastly, native sulphur in connexion with the volcanic rocks.

Towards the Turkish frontier, in the neighbourhood of the Bougue river, granite appears again, surrounded by tertiary formations, but seemingly having but slightly influenced the country's level. We remark that for many miles the Bougue follows its course through the centre of a narrow strip of granite, that is limited on either side by tertiary rocks. The granite is probably soft, and partially decomposed, as well as of ancient date.

We must, lastly, take note of some fragments of granite, apparently belonging to the same epoch as the one just mentioned, that have evidently played an important part in the upheaval of the carboniferous beds of the Donetz district.

From what has been said of the eruptive rocks of Russia we can infer that by far the most extensive portion of the empire has escaped their influence, and that for many square miles between the Oural Mountains, St. Petersburg, and the extreme south, the sedimentary beds have been allowed to retain their primitive regular stratification. The carboniferous formations are therefore, in general, extremely regular, and the beds succeed each other in perfect order. The largest, although not the most important, rests on the Devonian rocks of the Baltic that we have already mentioned. It extends south-east beyond Moscow, and far north, in a narrow strip to the White Sea. Although covering an immense tract of country, workable coal has, as yet, been only found in two places—to the north-west of Moscow, and to the south of the same city. As we shall see hereafter, the quality of the coal discovered so far in these districts, is not altogether satisfactory, having the appearance of lignite, and containing high percentages of ash.

The Donetz basin in the south of Russia contains numerous seams of very excellent coal, with every variety of quality from gas coal to anthracite. They are extensively worked, and in 1875 yielded upwards of 800,000 tons of coal of different kinds. Although much smaller than the first formation mentioned, this basin is far richer in coal deposits and is better situated, commanding water carriage by the Donetz and the Don, as well as a railway line to a seaport at no great distance. The working of these coal seams is likely to be greatly and rapidly developed. Iron was also discovered in the same district by Messrs. Le Play and Lalaune in 1842, and now is worked and smelted by the New Russian Company and by Mr. Pastoukhoff at his Soulinovsk works. The iron ore in both cases is taken from the carboniferous beds. The coal measures rest on a mountain limestone of a dark shade, and are characterised by numerous fossils of the *productus giganteus*. First come a series of sandstone and argillaceous schists, that contain iron ore and sometimes layers of carbonate of lime; the sandstone is traversed in different places by quartz lodes with silver lead. Above these are the coal beds or seams that M. Ludwig divided into five groups, characterised by paleontologic remains. Last of all the formation is completed by a series of coloured clay, sandstone, and calcareous beds, the last containing fossils of the *fusulina cylindrica*.

In Polish Russia, coal is found near the German frontier, where a portion of the Silesian basin is worked to advantage. The Dombrowa deposit is most remarkable for its regularity and the dimensions of its beds. It is said to be capable alone of supplying the wants of Poland and of West Russia.

The Polish coal formation further contains iron and lead ore, as well as bituminous limestone. Lignite has been found in the tertiary beds of Poland.

Fragments and ribbons of carboniferous beds that were brought to surface by the eruptive influence of the Oural Mountains are found both to the west and to the east of the range. On the west side, the basis of the formation is again the mountain limestone, resting in its turn on the Devonian rocks. The coal measures that follow contain many good seams of coal, although the percentage of ash appears to be rather high. Five groups of beds have been met with containing gas coal of excellent quality.

On the east side of the Oural a few seams of no great importance have been worked and explored, but in most cases they have been abandoned.

Coal has been also met with in the Caucasian range, but the formation is supposed to be Jurassic. A considerable number of seams crop out on the banks of the Tchirdiliss-Oukali river, varying in thickness from 2 ft. to 10 ft., but so far the amount of ash has been found too high to encourage working. As only surface workings have been undertaken, it is possible that the quality of the coal may improve in depth.

As we have mentioned before, the more modern sedimentary rocks are largely represented in Russia. The Permian beds are distributed in fragments over different parts of the country, in the north, to the east of the Volga, near the Courland frontier, in the neighbourhood of the Donetz coal district, and finally in Poland. Salt, sulphur, petroleum, and copper ores are found in the Permian formation.

The trias rocks cover a triangular space, of which the angles approach the towns of Mezen, Oustiongena, and Orenbourg. They are also found near the plains of Astrakhan and in Poland. In this last country they contain calamine, galena, coal, and iron ore.

The Jurassic beds form detached fragments, of which the most important are in the neighbourhood of Moscow, in the Petchara basin, and on the borders of the Volga. Amongst other workable substances, they contain bituminous slate, iron pyrites, iron ore, and phosphate of lime.

The cretaceous layers are found in Central and South Russia. They contain phosphate of lime and white chalk.

The tertiary rocks cover larger spaces in the south, and sometimes contain lignite deposits.

The plains of Astrakhan to the north of the Caspian Sea, are entirely formed of post tertiary deposits, that running westward to the Black Sea, plainly show the water communication that once existed between the two basins.

Having thus given a hurried glance at the general outline of geological Russia, we shall be better prepared to enter into more detailed descriptions of the most advanced and richest districts of the empire.

(To be continued).

SANDRINGHAM WATER SUPPLY.

Some time ago the water supply to the residence of His Royal Highness the Prince of Wales, at Sandringham, was found to be in a very unsatisfactory condition both as regards quantity and quality. In consequence of this, Mr. Rawlinson, C.E., C.B., received instructions to investigate the matter, and to advise as to remedial measures. It was found necessary to extend these preliminary inquiries beyond the question of water to those of the house drainage arrangements and the disposal of the sewage. In these investigations Mr. Rawlinson availed himself of the services of Messrs. Lawson and Mansergh, of Westminster, and under Mr. Rawlinson's supervision, and with his approval Mr. Mansergh has designed and superintended the whole of the works as acting engineer. Careful surveys of the whole district were first made, and trial borings for water were put down in several places. In the end it was determined to obtain the water supply from a chalk spring situated at a distance of about 1½ mile from Sandringham Hall. This spring is the principal feeder of a small stream running through Den Beck Wood, and which at that point forms the boundary line betwixt the estate of His Royal Highness and the Earl of Leicester. The spring is thrown out by the clay underlying the chalk at about 92 ft. above ordnance datum, or about 22 ft. below the ground floor of the hall. Between the spring and the hall a ridge of high ground intervenes, rising to 175 ft. above ordnance, or to about 5 ft. above the highest part of the roof.

Although this is the most elevated point in the neighbourhood, still it is not sufficiently high to give adequate pressure for fire extinguishing purposes. A tower 60 ft. high has, therefore, been erected, upon which is placed a tank to be used as a service reservoir, and from this tank supply mains have been laid down to and around the hall. The yield of the spring varies from about 15,000 to 150,000 gallons per 24 hours. The water is clear and sparkling, and has a total hardness of about 17 deg. on Clarke's scale, but is softened to about 6 deg. prior to being pumped into the tank. The relative positions of the spring, the pumping station, and the hall, are shown on the general plan (Fig. 4) in our two-page engraving. In order to preserve the water from contamina-

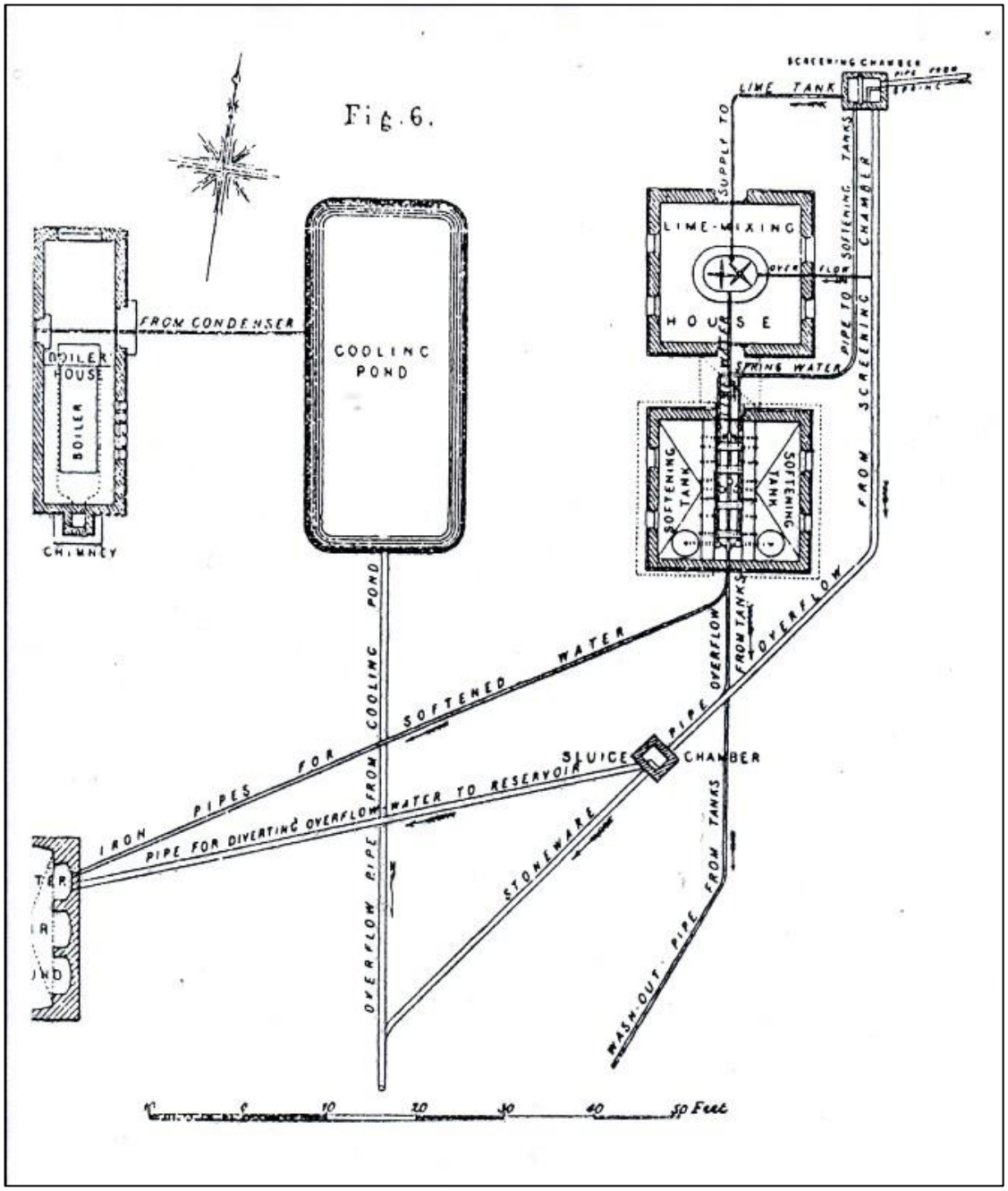
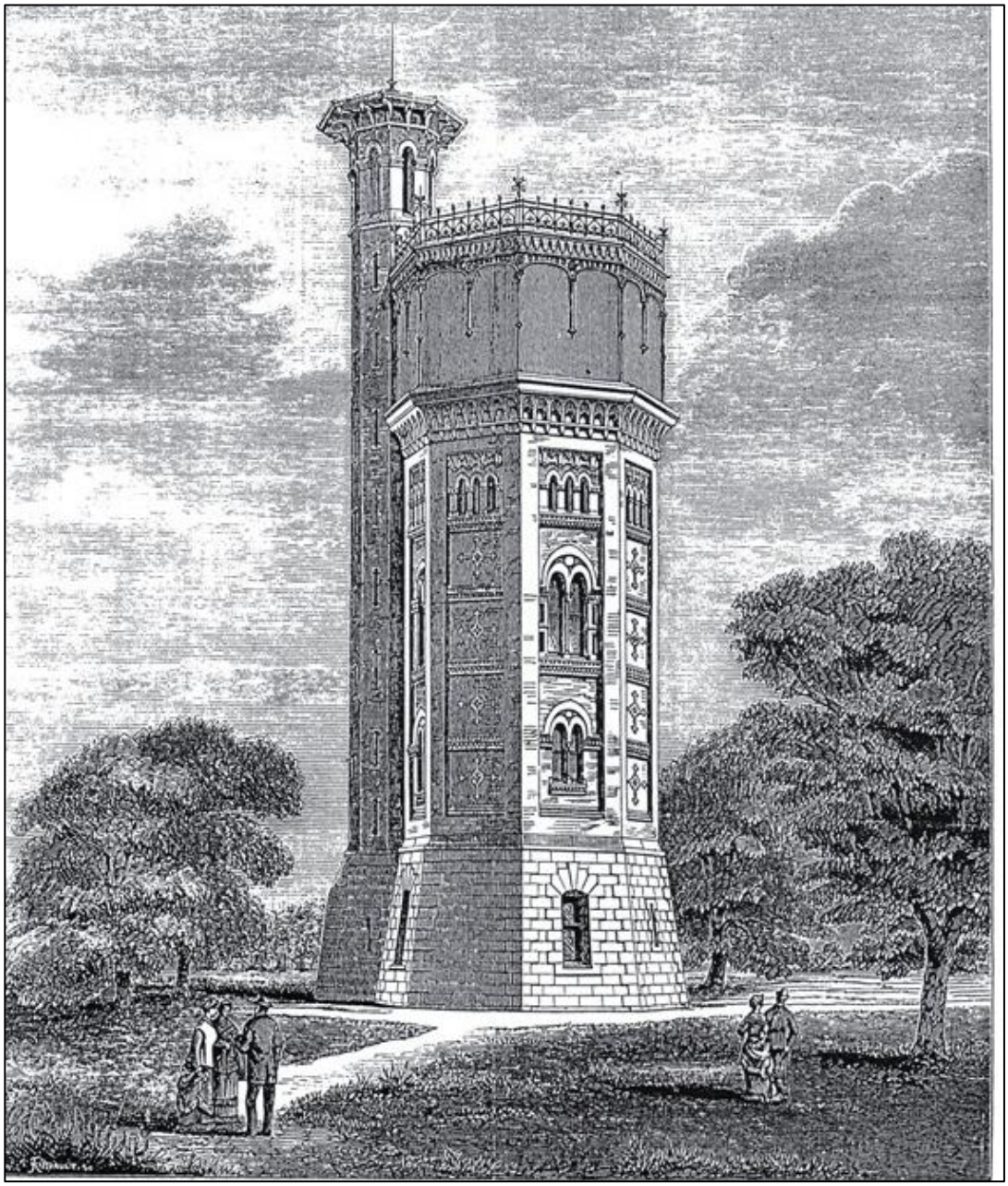


Fig. 6.
SCREENING CHAMBER
LIME TANK
SUPPLY TO
LIME-MIXING
HOUSE
FROM CONDENSER
BOILER HOUSE
BOILER
CHIMNEY
COOLING POND
SOFTENING TANK
SOFTENING TANK
FROM SCREENING CHAMBER
SOFTENED WATER
IRON PIPES FOR COOLING POND
PIPE FOR DIVERTING OVERFLOW WATER TO RESERVOIR
SLUICE CHAMBER
PIPE OVERFLOW FROM TANKS
OVERFLOW
STONEWARE
OVERFLOW PIPE FROM COOLING POND
WASH-OUT PIPE FROM TANKS
0 5 10 20 30 40 50 Feet

tion of any description and to prevent waste, the spring has been closed in a bricked chamber covered with a landing, and provided with an overflow and notch plate for measuring the quantity, and in the landing there is a locked manhole. From this chamber a line of 9-in. glazed stoneware pipes conveys the water to a small screening chamber at the pumping station. This line of pipes is 750 yards long, and has a fall of 1 in 800, and its water-tightness is insured by the use of Stanford's patent joints. In the screening chamber there is a fixed overflow by means of which any surplus water may be turned into the stream, or the whole diverted past the softening tanks into the underground reservoir.

In ordinary working a certain quantity is delivered in the oval chamber in the first building seen to the right in the general plan of the pumping station, see Fig. 6. It is there converted into lime-water, the mixture with the lime being assisted by a pair of revolving agitators driven by a three-cylinder Ramsbottom hydraulic engine, worked by a small branch from the rising main. The cylinders are about 8 in. long and 1¼ in. in diameter. The lime-water is then delivered into two softening tanks in the second building, each holding 3000 gallons, and this quantity is turned into them to be mixed with the lime-water. After allowing a proper time for the reaction and the settlement of the precipitate, the water is drawn off by means of self-acting syphons into the underground reservoir, which contains 18,000 gallons, and is then ready to be pumped into the tank on the tower.

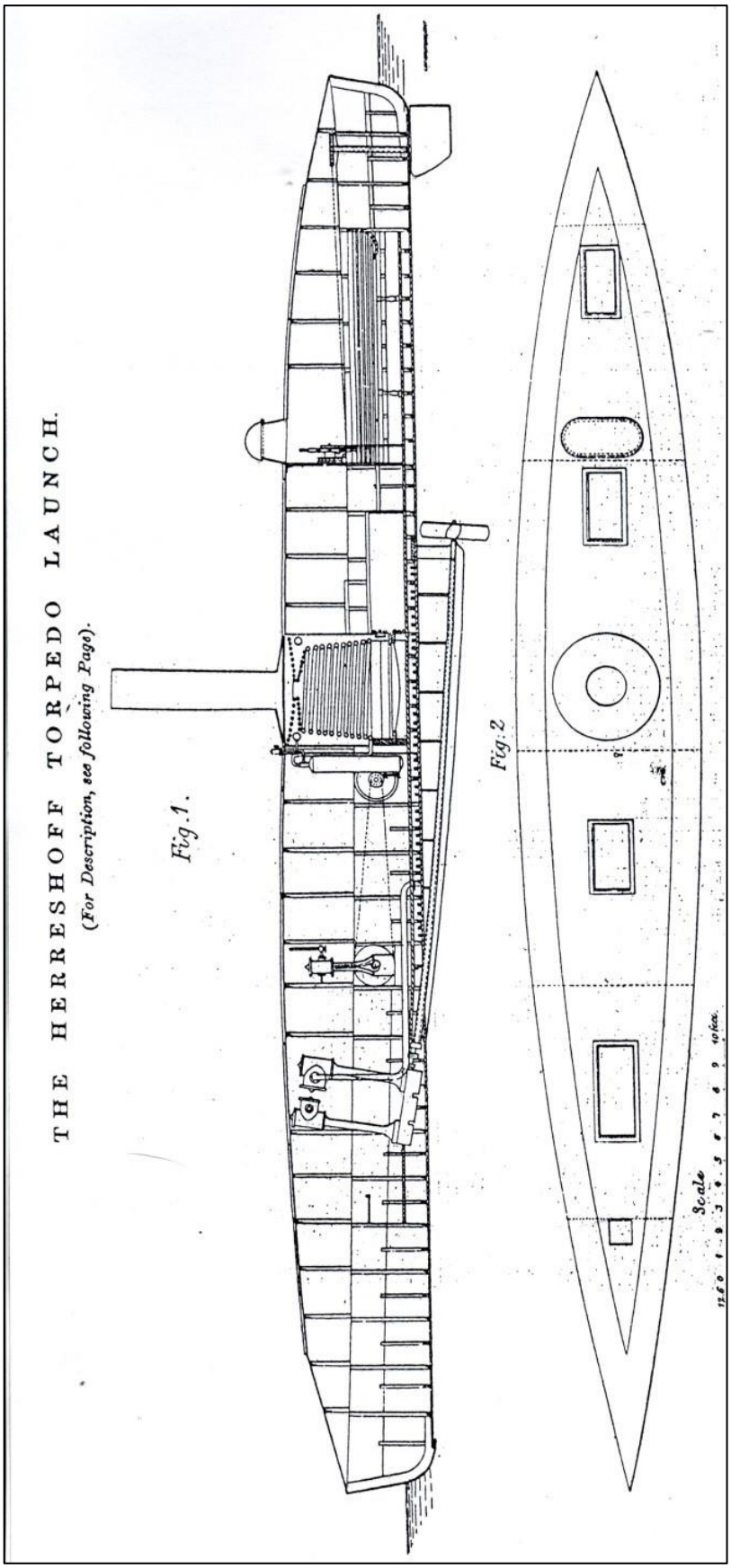
The pumping apparatus is shown in elevation, plan, and section at Figs. 1, 2, and 3 of our two-page engraving. It consists of a set of three-throw single-acting ram pumps driven by a horizontal condensing engine supplied with steam from a Cornish boiler. The boiler is 4 ft. in diameter and 12 ft. long, and has a 26 in. flue fitted with three Galloway tubes. The plates of the shell are of best best Staffordshire iron ⅜ in. thick, with the edges planed. The end plates are ½ in. thick in one piece, the back end flanged, and the front turned true on edge and



secured to the shell with external angle iron. Both end plates were bored for the flue. The longitudinal seams are double-rivetted, and the flue is formed at the front end with two flanged rings of Lowmoor iron and the back of best best Staffordshire $\frac{3}{8}$ in. thick. All the rivets are of Lowmoor, and the manhole frame and dome are of wrought iron. The boiler has the usual fittings and a No. 4 Giffard's injector, with a valve to admit a supply of water from the rising main. The cylinder of the engine is 9 in. in diameter, steam jacketted, and fitted with double covers, lubricators, &c., and is covered with felt under mahogany lagging; the stroke of the piston is 18 in. Variable expansion apparatus on Meyer's principle has been adopted and is adjusted to cut off the steam at from one-tenth to three-tenths of the stroke. The crosshead connecting-rod, piston-rod, crank-pin, crankshaft, eccentric-rods, and valve spindles are all of steel. The flywheel is 7 ft. in diameter, weighs two tons, and is turned and polished. A governor of ordinary construction acts upon an equilibrium throttle-valve, and is set to a maximum speed of sixty revolutions per minute. A polished balanced disc crank is keyed on the crankshaft, and the eccentrics are of cast-iron with gun-metal rings. The condensing apparatus is fixed behind the cylinder on the same bedplate, and the air-pump has a gun-metal ram worked by the piston-rod.

The pumps are placed in a room in the engine-house, and consist of a set of three brass rams 7 in. diameter and 19 in. stroke with brass valves and seatings. Upon the rising main is an air vessel fitted with glass gauge to indicate the quantity of air contained in it, the supply of which is kept up by a small air pump worked from the main pump shaft. The pump driving gear consists of a polished Lowmoor three-throw crankshaft carried in five pedestals with gun-metal steps supported upon a strong framing, part cast with the engine bedplate and part bolted to it. A spur mortise wheel 6 ft. in diameter is keyed on the pump shaft and driven by an iron pinion on the crankshaft. The pump connecting rods are of forged iron and the guide bars of steel firmly secured to the pumps and also to the framing which carries the shaft over them. At the ordinary working speed of ten strokes a minute the pumps will lift 75 gallons in that time. Betwixt the engine-house and the other building is a cooling pond for the condensing water.

The rising main is 4 in. in diameter and 600 yards in length from the pumping station to the tank on the tower, and the net lift from the bottom of the underground reservoir, or pump well, is 175 ft. The rising main is made good to the bottom of the tank so that the pressure is always available for working the hydraulic engine at the agitators. The tank is of cast iron octagonal in plan, 24 ft. across and 12 ft. deep, and will hold 32,000 gallons. It stands upon jack arches supported by two main and six cross girders of cast iron fixed on the top of the tower. The bottom consists of 49 plates, the central plate being octagonal and carrying a 12 in. hollow pipe or column which serves partly to support the roof and acts as a smoke flue for the cottage below. The remaining 48 plates of the bottom are cast from four patterns. The plates of the outside ring are turned up 12 in. to form the lowest course of the sides. Above this there are five


THE HERRESHOFF TORPEDO LAUNCH.
(For Description, see following Page).
Fig. 1.
Fig. 2
Scale

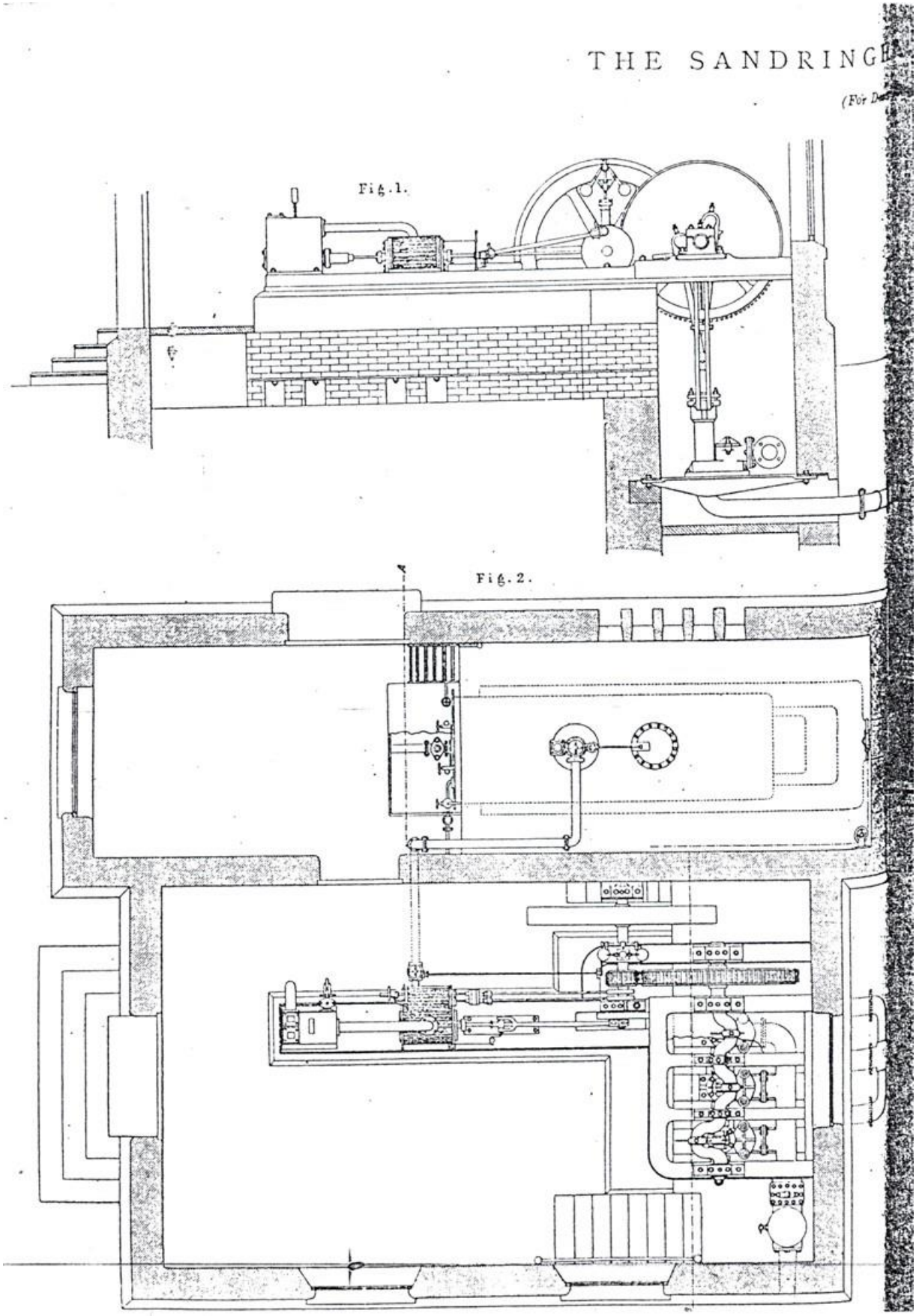
courses or tiers of plates, breaking joint, and consisting of 120 plates cast from six patterns. The top tier has an internal flange 9 in. broad, supporting the outer ends of the roof bearers. All the plates, with the exception of the one in the centre of the bottom, are $\frac{3}{4}$ in. thick; the edges are planed and the joints are formed by internal flanges caulked with rust cement.

On each of the eight sides of the tank there are two internal vertical cast T stiffeners fitting accurately betwixt the bottom and the underside of the top flange, having lugs cast upon them for attachment to all the plate flanges. Upon these stiffeners are also formed bosses through which the four sets of tie-rods pass from side to side of the tank. These tie-rods are secured in the following manner: On the inside the tank plate a boss is formed the depth of the joint flanges and supported by four radial brackets. This boss has a conical hole truly bored in it 2 in. in diameter outside and $1\frac{1}{4}$ in. inside. The end of the tie-rod is turned accurately to fit this hole. Just on the inside of the stiffener boss the tie bolt is threaded and a nut and washer are screwed home against the boss. The tie-rods are in two lengths, each half being passed through from the outside of the tank and then the two are secured and tightened up by means of right and left-hand couplings.

The roof is of timber covered with lead, and is provided with lights, ventilators, and manholes. It is protected by a neat cast-iron railing, and may be used as a look-out, affording as it does a magnificent view of the surrounding country. The roof and the two floors below the tank are accessible from the outside by means of a circular cast-iron staircase fixed in an octagonal turret. The two floors at the foot of the tower are intended to be used as a dwelling house, and have an independent entrance and staircase. The tower, of which we give a perspective view on the previous page, is built principally of brick, the angle quoins in the battered base being of red Mansfield stone filled in with the Carr rock of the district.

The supply main from the tank to the hall is 6 in. in diameter, and 1870 yards in length. This main feeds two 4 in. branches, which encircle the house, and upon which are placed twelve hydrants. The stables, gardens, equerries' lodge, and Sandringham Cottage, are supplied by means of 3 in. branches. The working of the hydrants has been tested in the presence of Captain Shaw to his entire satisfaction, and the residence of His Royal Highness may now be considered as well protected in case of fire, so far as an ample provision of water under pressure can protect it. The new supply is all that can be desired for general, sanitary, and domestic requirements.

During construction the works were superintended for the engineers by Mr. Edmund Beck, Jun., and Mr. Samuel Groves acted as clerk of works on the tower. The pumping machinery and tank have been made and erected by Messrs. Pratchitt, of Carlisle. Messrs. Cochrane, Grove, and Co., of Middlesbrough, have supplied the iron pipes; and Messrs. Doulton the stoneware pipes. Altogether the works form a very interesting and satisfactory example of modern private water supply on a large scale, and they are highly creditable to all concerned in their design and execution.


THE SANDRINGH
Fig.1.
Fig.2.

VATER WORKS.

ge 91.)

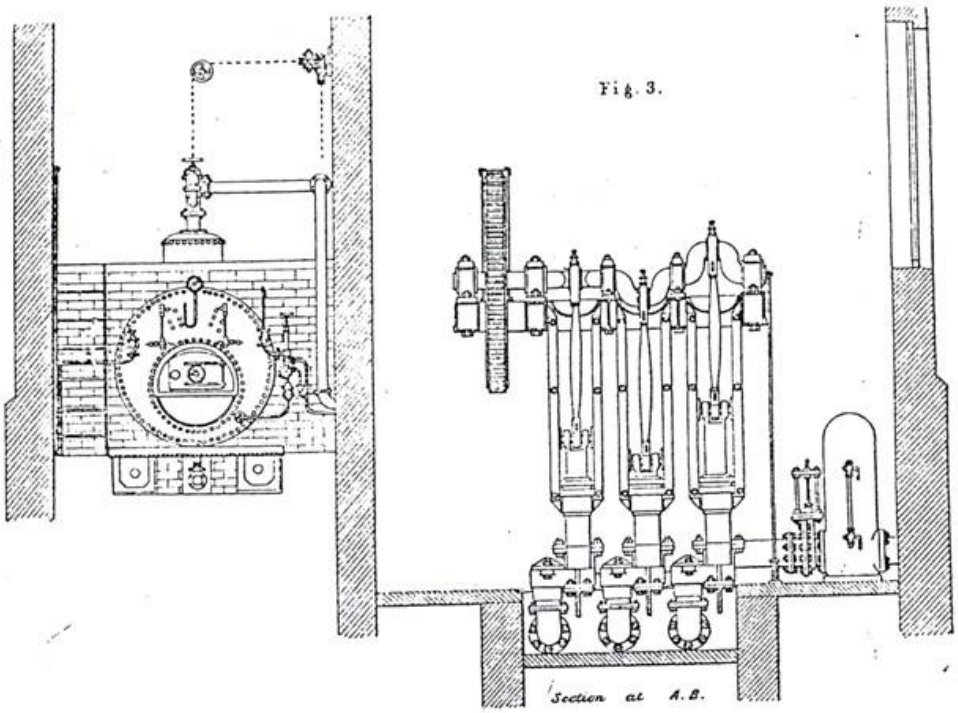


Fig. 3.

Section at A.B.

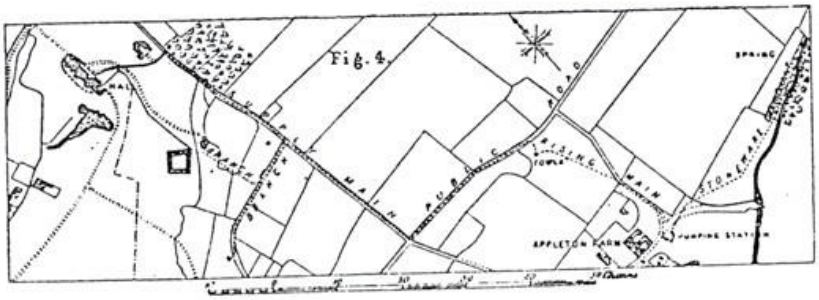


Fig. 4.

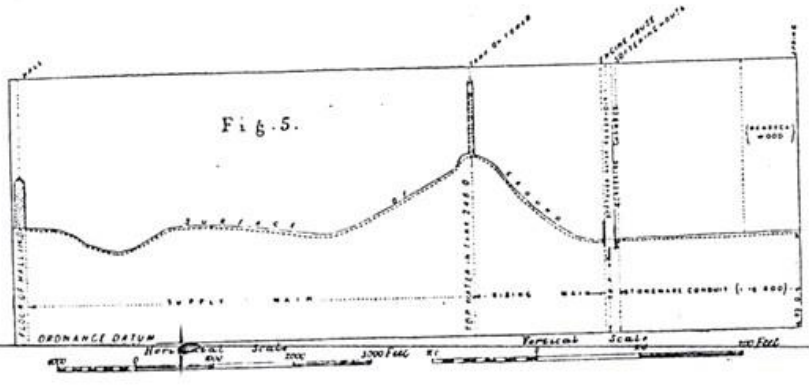
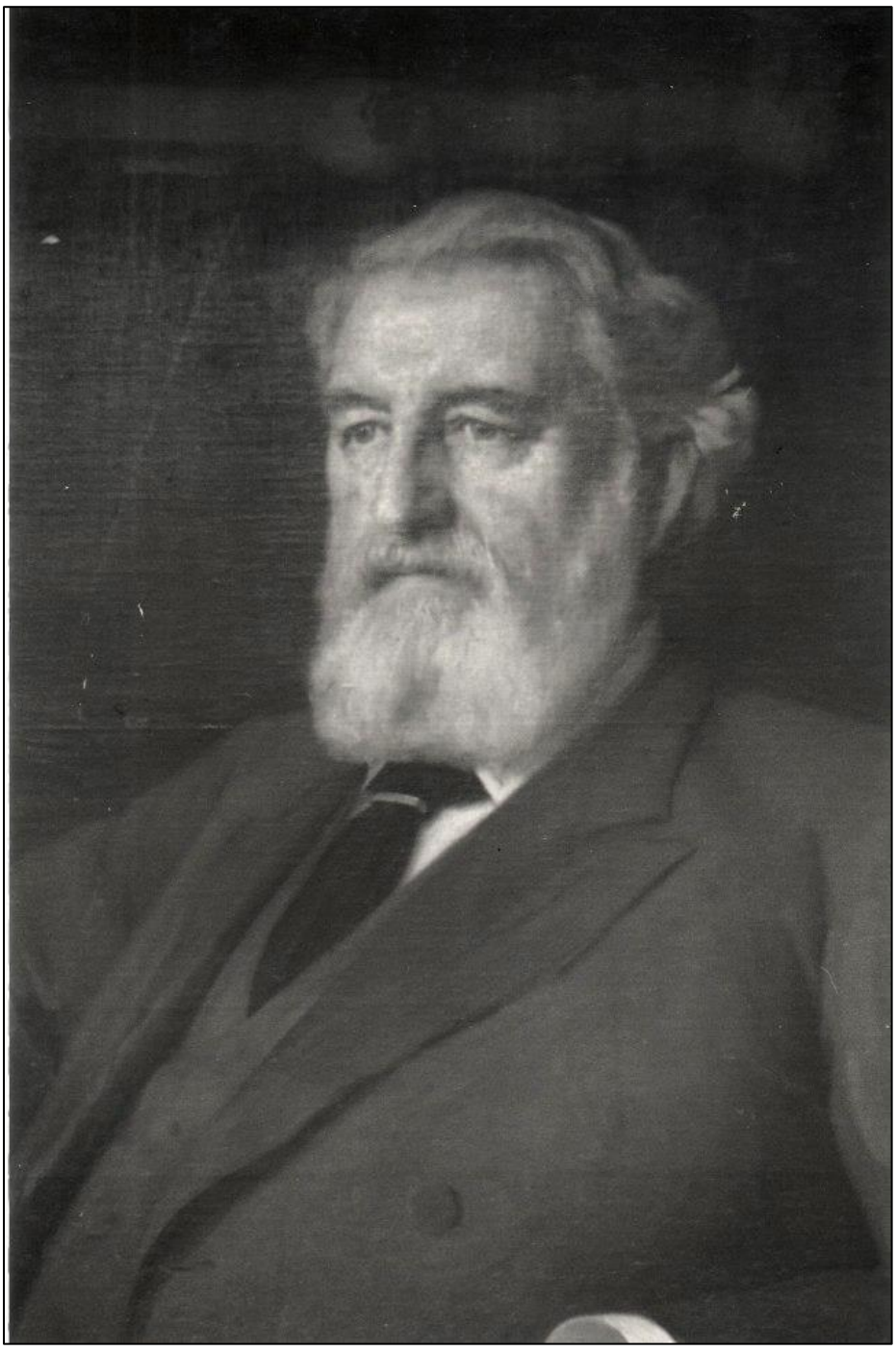


Fig. 5.



James Mansergh, C.E., F.R.S., from the painting by his son-in-law W Palin, in the possession of the Institution of Civil Engineers

James Mansergh

The engineer responsible for the design of the water tower and pumping-station was born at Lancaster on 29 April 1834 and died at Hampstead on 15 June 1905.

James Mansergh was educated at "Harmony Hall" (Queenwood College), a rather interesting progressive school in Hampshire which pioneered the teaching of science. There he was a contemporary and friend of the feminist Henry Fawcett and was taught by John Tyndall, who aroused his interest in engineering. It is said that Tyndall and the chemist Sir Edward Frankland, who was also a teacher there, used to wake at 4 a.m. in order to exchange lessons with each other before school-work began. The headmaster, George Edmondstone, is supposed to have examined the boys in the use of *Bradshaw's Railway Guide*.

In 1849 Mansergh was apprenticed to Messrs H. McKie and Lawson, engineers and surveyors, of Lancaster. Subsequently he went to Brazil and worked on the Dom Pedro II railway from Rio de Janeiro to the interior between 1855 and 1859. On his return he was employed on other railway and water-supply projects, of which the one that would prove most important to him was the report, with Robert Rawlinson, on Birmingham's water-supply in 1870–71. This was to lead ultimately to his great Elan Valley scheme, which was inaugurated by Edward VII and Queen Alexandra on 21 July 1904.

In 1901 Mansergh was elected a Fellow of the Royal Society, and in 1900 he was President of the Institution of Civil Engineers. He was High Sheriff of Radnorshire in 1901–2, and a Justice of the Peace in Radnor from December 1902. When he was made an honorary freeman of his native town, Lancaster, in March 1903, he observed in his acknowledgement of that honour:

> My success has been mainly due to the opportunities I have had. I was brought up in a God-fearing household – one that would nowadays be considered ultra-Puritanical – and its influence on my life has never been lost ... I have worked hard and steadily, and have tried to do every thing honestly and straightforwardly.

James Mansergh was twice married, and had two sons and two daughters. The sons joined his profession, and carried on business in Victoria Street until their deaths in 1933 and 1941 respectively.

Sir Robert Rawlinson

The distinguished engineer who was put in charge of the water-works at Appleton had been born in Bristol in 1810, and had worked for Jesse Hartley (1780–1860), the engineer of the Liverpool docks, from 1831 to 1836. Subsequently he worked with the great Robert Stephenson (1803–59), of the "Rocket", on the London and Birmingham Railway. In 1855 he was head of the sanitary commission sent to the Crimea by the government; and during the Lancashire cotton famine in 1863, caused by the American Civil War blockade, he was in charge of the relief of the unemployed. These, and his other work in connection with public health and sanitation, resulted in his being knighted in 1885, and made K.C.B. in 1889. He was made a member of the Institution of Civil Engineers in March 1848, and served as its president in 1894. He was married in 1831, and died in London in 1898.

It is possible that the appointment of Rawlinson to supervise the new water-works at Sandringham may have been influenced by his having been responsible for the report on the drainage of Windsor Castle, which was published in 1863.

As well as being the author of numerous works on engineering and sanitary matters (for example, *Maps and Plans for Drainage*, London 1878–80; *Hygiene of Armies in the Field*, London 1883). Rawlinson also published verse; as this is not widely known, some examples are included here, for interest.

A portrait of Rawlinson is in the possession of the Institution of Civil Engineers, and at the time of writing is on indefinite loan to the Department of Health.

VERSES:

Composed and Written

BY

SIR ROBERT RAWLINSON,

Civil Engineer & Sanitary Commissioner;

C.B., 1864; Knight Bachelor, 1885; K.C.B., 1889.

LONDON:

S. HOGG, 32, CHARING CROSS.

1893.

THOUGHTS AFTER ATTENDING VESPERS IN YORK CATHEDRAL, 1848.

LO! where that Gothic pile its bulk uprears,
And casts its serried shadows all around,
To careless eyes a mass of stone appears,
And merely noise peals in the organ's sound!
But to the Student this is holy ground,
Fill'd with a shadowy moving mighty throng,
And sounds of bygone chantings float around,
And shapes and forms ethereal crowd among
Chants of dead ages blent with Even-Song.

Ye glorious fabrics of the mighty dead!
I love to pass your lofty aisles along
When dusky night begins around to spread
A mantle o'er the present living throng
Of careless Worshippers, and pass among
The time-worn monuments of Priest and Sage,
Catching the echo of the Even-Song
Amidst the din of this tumultuous age,
Whilst rolls the railway car, and screaming whistles rage.

TIME.

TIME puts down the lofty,
Time makes strong the weak ;
Time outwits the crafty,
Time exalts the meek.

Time rolls along ; impartial
Time dimns the tinsel's glare ;
Time present seems but partial ;
Time will all truth declare.

Time onward ever ranges—
Men dream that Time will stay :
Time's web is whole ; though changes
Time weaves in every day.

Time is ever ringing
A never-ceasing change ;
Time is ever bringing
All things within its range.

Time is old, and Time is young,
New life resteth in decay ;
Empires have an infant spring,
And empires have their day.

Oppression, pride, and slander
Scheme with all their might ;
Men cringe, men fawn, men pander :
Time sinks them in dark night.

SONG.

BEAUTIFUL IS SUMMER-TIME.

OH ! beautiful is Summer-time,
When flowers are in their prime,
When birds in love make melody
From morn till eventime.

Oh ! beautiful is Summer-time,
When mountain, lake, and lea
Are flooded o'er with bright sunshine,
And sleeps the tranquil sea.

More beautiful to me by far,
Art thou, my lovely Maid !
Than morning or than evening star,
Than sunshine or than shade.

I love the glorious Summer-time,
The mountain, lake, and sea,
The songs of birds, and bells' sweet chime :
But more do I love thee.

THOUGHTS ON ART.

STUDENTS of Art, be to your purpose true,
Sell not your hire alone for dross of earth,
Let not the vanities of time subdue
The brighter glories of your higher birth.
Mere wealth and titles are but little worth,
They gild the Knave, but do not make the Man.
Let ignorance display its barren dearth,
And fools applaud the charlatan :
Such know not Art as known to you, nor ever can.

AVARICE.

(FROM "THOUGHTS MEDITATIVE AND CONTEMPLATIVE.")

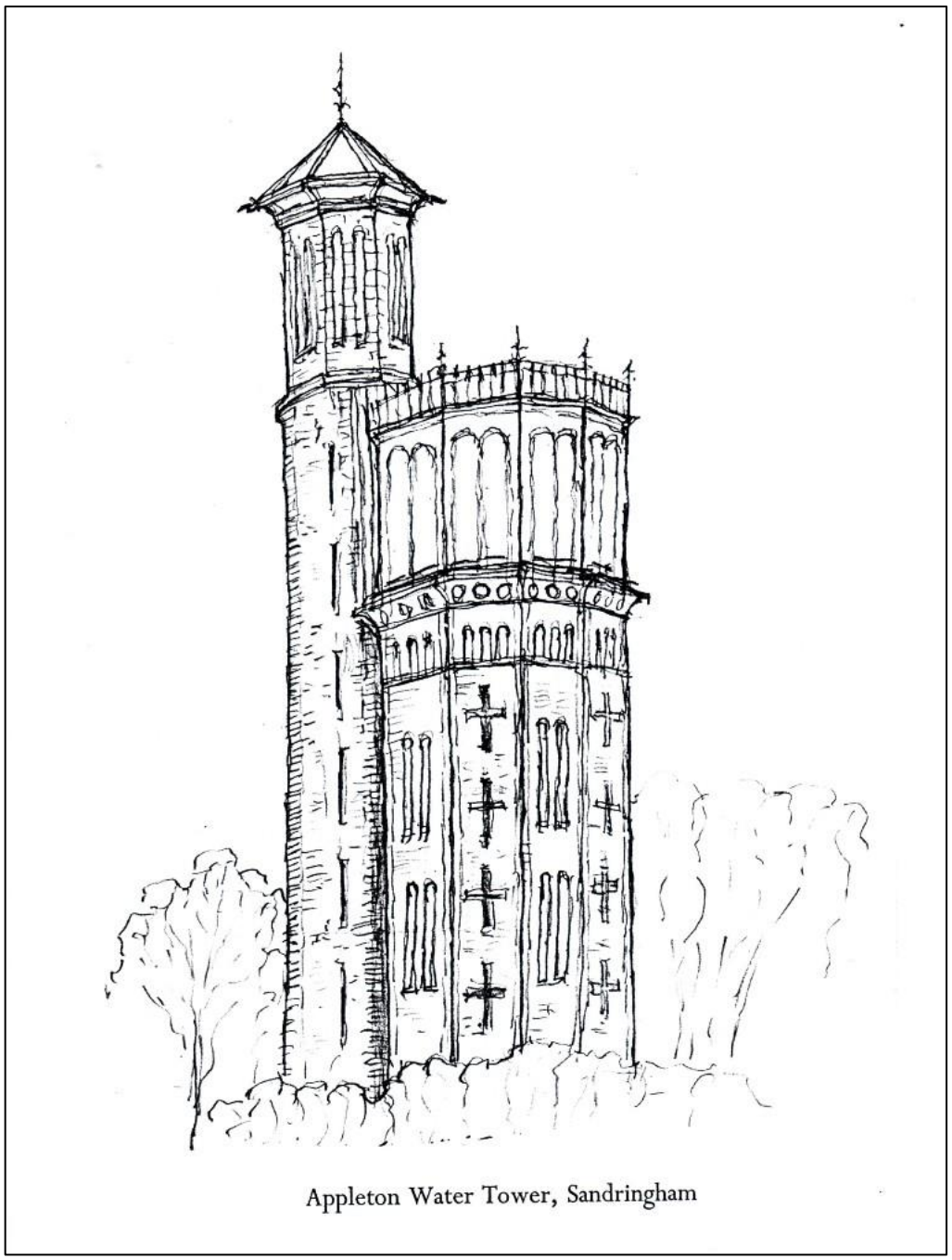
"A love of power is a root of evil."
"Lay not up for yourselves treasures on earth."

THE Sun shines down on palace and on stall ;
The Sun shines down on park and cover wide ;
The Sun shines down on hovel and on hall ;
The Sun shines down on London's streaming tide
Of pompous heartless carriage-driving pride,
Rolling in careless thoughtless ease along ;
The Sun shines down on many scenes beside,
In this huge Babel's strangely mixed throng,
Where pamper'd wealth o'er blighted lives moves on.

Wealth gives not knowledge, else the Rich were wise ;
Exalted Power gives not the love of truth ;
The grovelling Misers waste their sensual eyes,
And lustful Men in lust burn out their youth ;
Their life throughout is but one great untruth,
A contradiction to the soul of man.
Angels look down in their deep pitying ruth,
To see immortal beings waste their span
Of brief existence, so unlike the Christian.

THE POET'S DREAMS.

THE Poet lives in Dreamland far away,
His darkest night has visions bright as day ;
The world of Spirit is to him more clear
Than blazing sunshine to the sensual seer.



Appleton Water Tower illustrated in Claude J. W. Messent, *The Architecture on the Royal Estate of Sandringham*, 1974

Other water towers

I have not been able to find any study of the history of water-tower architecture. The subject is characterised by immense diversity; it is as if the engineers, having no obvious examples to follow, simply let their fancy rip. But certainly Sandringham was by no means the only nineteenth-century country house to include a water tower among its amenities. One of the earliest stood at Somerleyton, built by John Thomas between 1844 and 1851; the tower stood in the back yard of the hall, and served to embellish the skyline of the house itself. Towers were similarly exploited elsewhere, and one example – Bearwood, 1865–74, built by Robert Kerr for John Walter, the owner of *The Times* – was illustrated in *The Architect* for 14 January 1871. Some water towers, being functional, have survived the demolition of the great houses they were designed to serve (draughty, servantless and grotesquely large as they now seem) and still stand today. This is true of Aston Webb's Hildon Hall, Hampshire (1898) and of R. Norman Shaw's Haggerston Castle (1892–7).

Some other examples of great houses with water towers include:

Broomhill (Sir D. L. Salomans, 1854)
Osborne (the Prince Consort and Cubitt, 1865)
Normanhurst (Habershon Brook and Webb, 1867)
Humewood (Willlliam White, 1867–70)
Clouds (Philip Webb, 1879–91)
Standen (Philip Webb, 1891)
Tylney Hall (R. S. Wornum, 1898–1902)
Stowell Hill (E. Guy Dawber, 1927).

Other water towers of architectural interest are still standing at the following places:

Saxon Street, Cambridgeshire
Soham, Cambridgeshire
Colchester, Essex
Epping, Essex
Hunstanton, Norfolk
Southwold, Suffolk
Littlestone, Kent
Southborough, Kent
Busbridge, Surrey
Godalming, Surrey
Catsfield, East Sussex
Swanage, Dorset
Broomy Hill, Hereford
Croydon, London
Greenwich, London
Southall, London
Wellington. Somerset
Swindon, Wiltshire
Arbroath, Angus

The illustrations that follow have been chosen to exemplify some contrasting approaches to the design of water towers. An article describing some relatively recent structures (Alan Griffiths, *Water*, January 1981, pp. 21–4) is also reproduced here.

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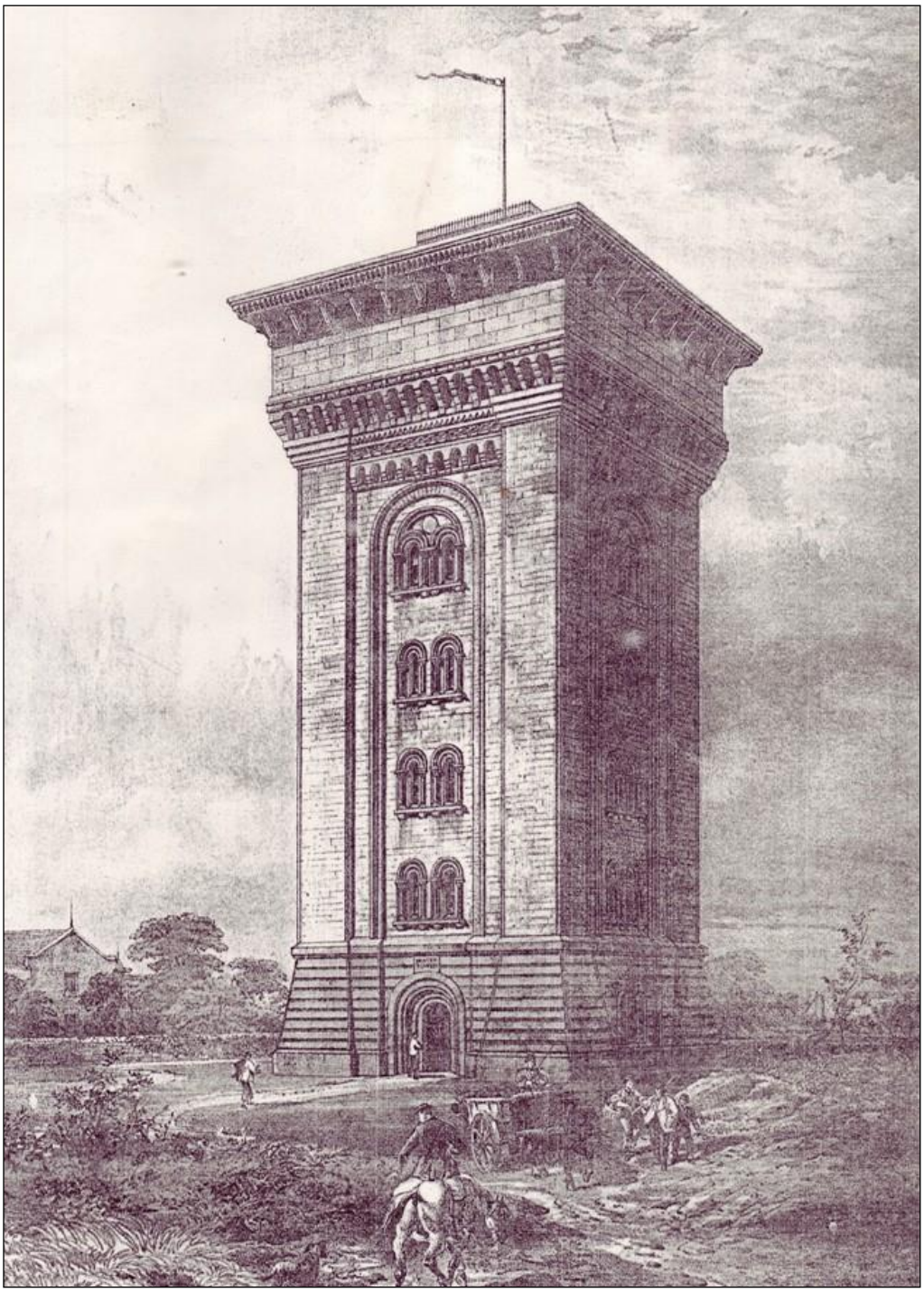
Dictionary of National Biography: articles on James Mansergh (1834–1905; Edward Frankland (1825–99); John Tyndall (1820–93); George Edmondstone (1798–1863); Henry Fawcett (1833–84)
L. T. C. Rolt, *Victorian Engineering*, London 1970, p. 246
W. H. G. Armytage, *A Social History of Engineering*, London 1970, p.151
Information from the Association of Consulting Engineers

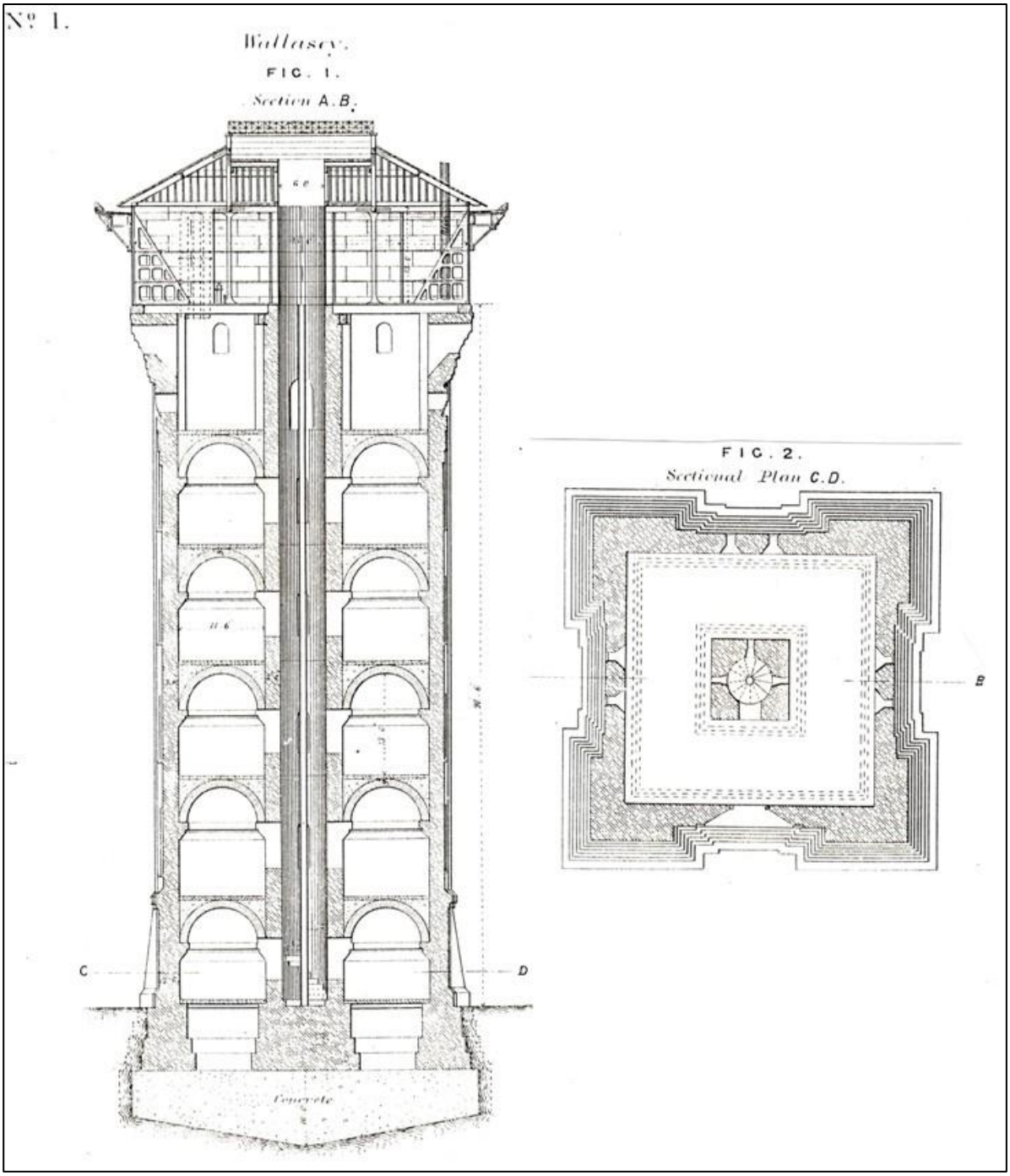
Sir Robert Rawlinson:
Dictionary of National Biography: articles on Robert Rawlinson (1810–98); Jesse Hartley (1780–1860); Robert Stephenson 1803–59)
Information from the Institution of Civil Engineers

Other water towers:
Mark Girouard, *The Victorian Country-house*
Clive Aslet, *The Last Country Houses*
Rainer Slatta, *Technische Denkmäter in der Bundesrepublik Deutschenland*, Bergbau Museum-Bochim, 1975, pp. 568–95, "Abtswasserkunst und Ratswasserturm".

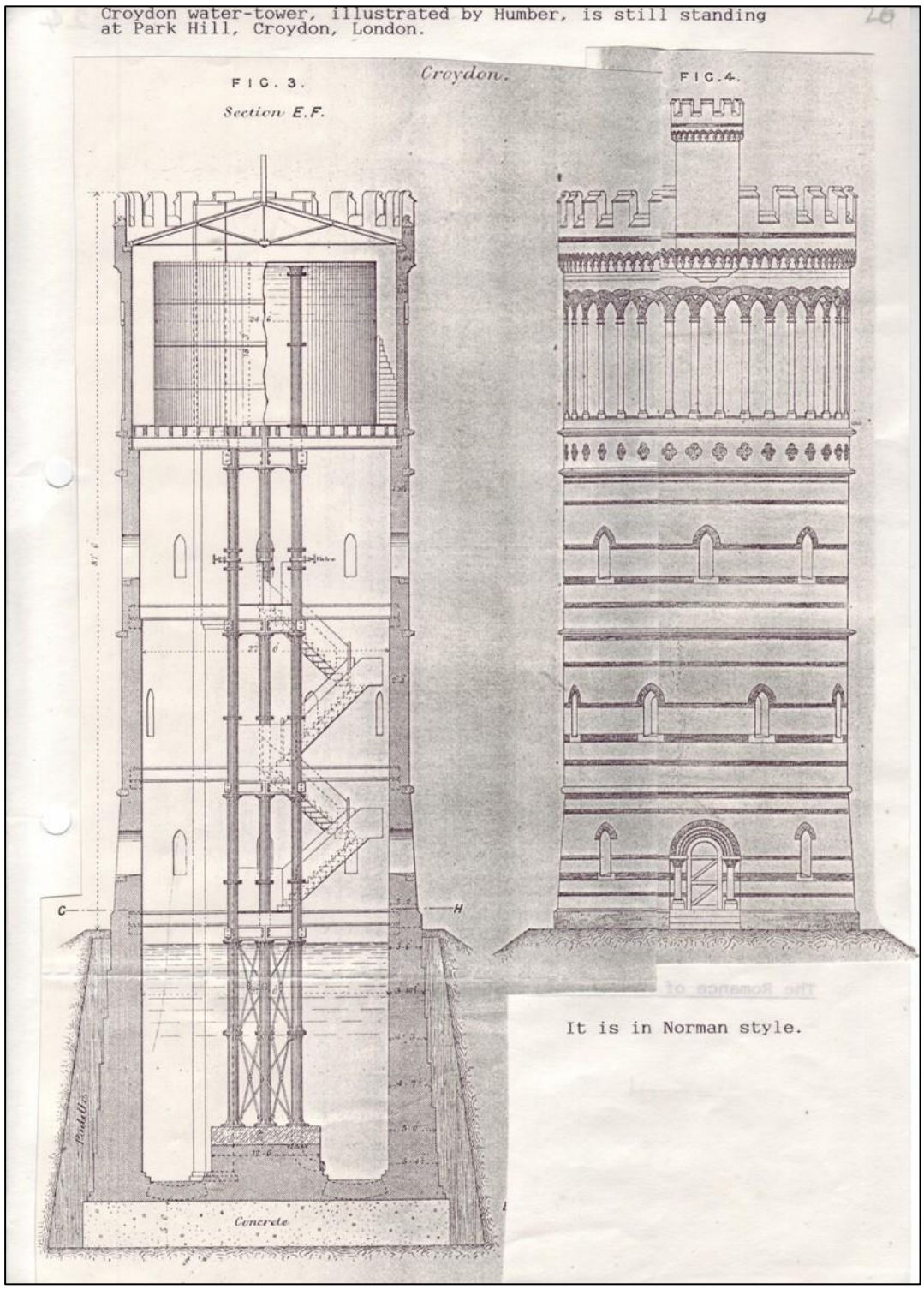
Lady Harrod, Mr Michael Gooch, Mr K. A. Falconer of the Industrial Monuments Survey and the librarians of the Institution of Civil Engineers and the Association of Consulting Engineers all very kindly supplied information of great help towards the compilation of this short history of the Appleton Water Tower. The Landmark Trust's restoration of the tower is described in *Building Refurbishment and Maintenance*, Vol. II, no 10, April 1980, pp. 32–3.



Wallasy water tower, by Robert Rawlinson, with whom Mansergh worked, and who was in overall charge at Appleton: illustrated in W. Humber, *Comprehensive Treatise on the Water Supply of Cities and Towns*, 1876



The interior of Rawlinson's Wallasey tower, from W. Humber, *Comprehensive Treatise on the Water Supply of Cities and Towns*, 1876



The water tower at Park Hill, Croydon incorporating interlaced Norman-style arcading around the tank

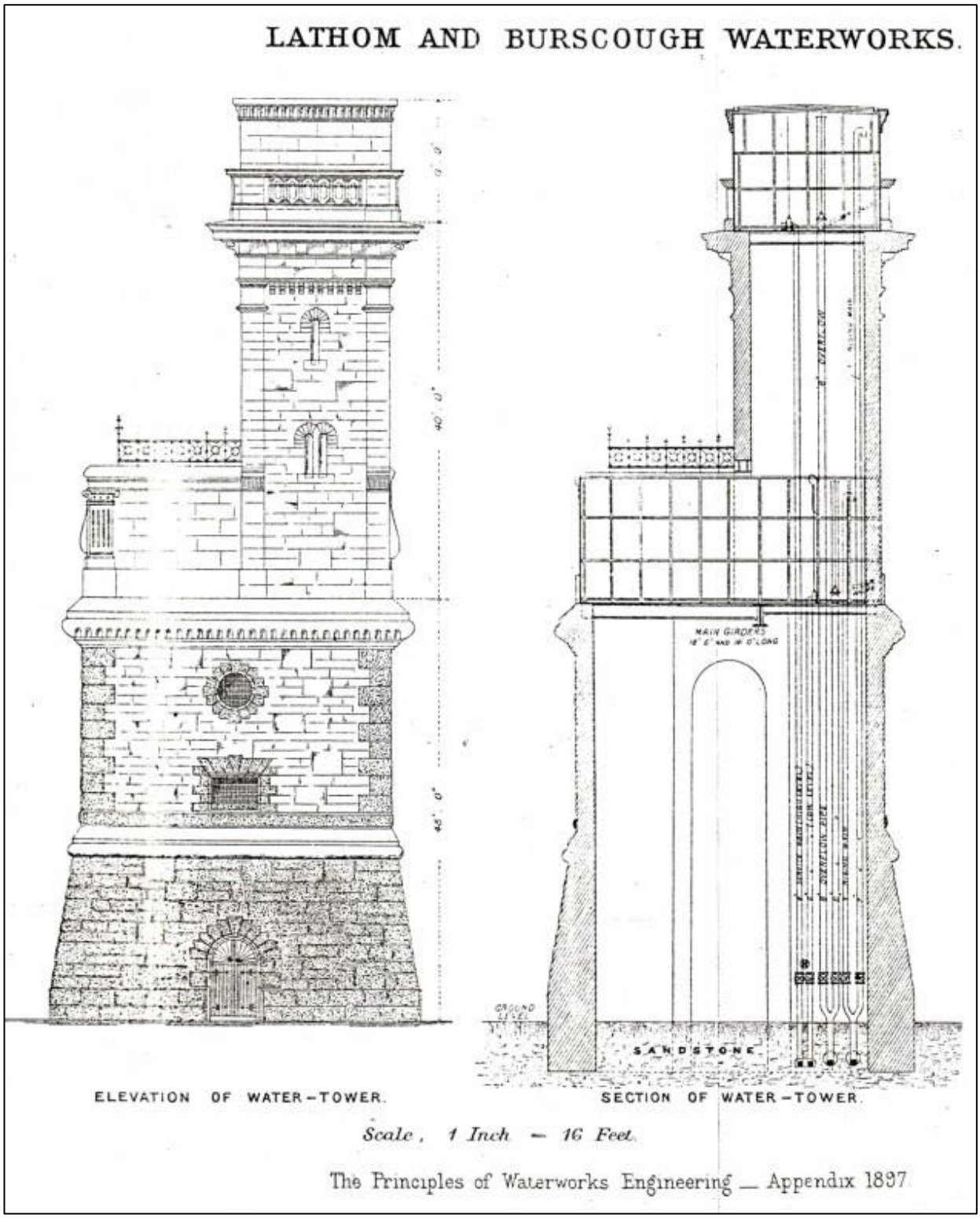


Illustration from Tudsbery and Brightmore, *The Principles of Waterworks Engineering,* 1905

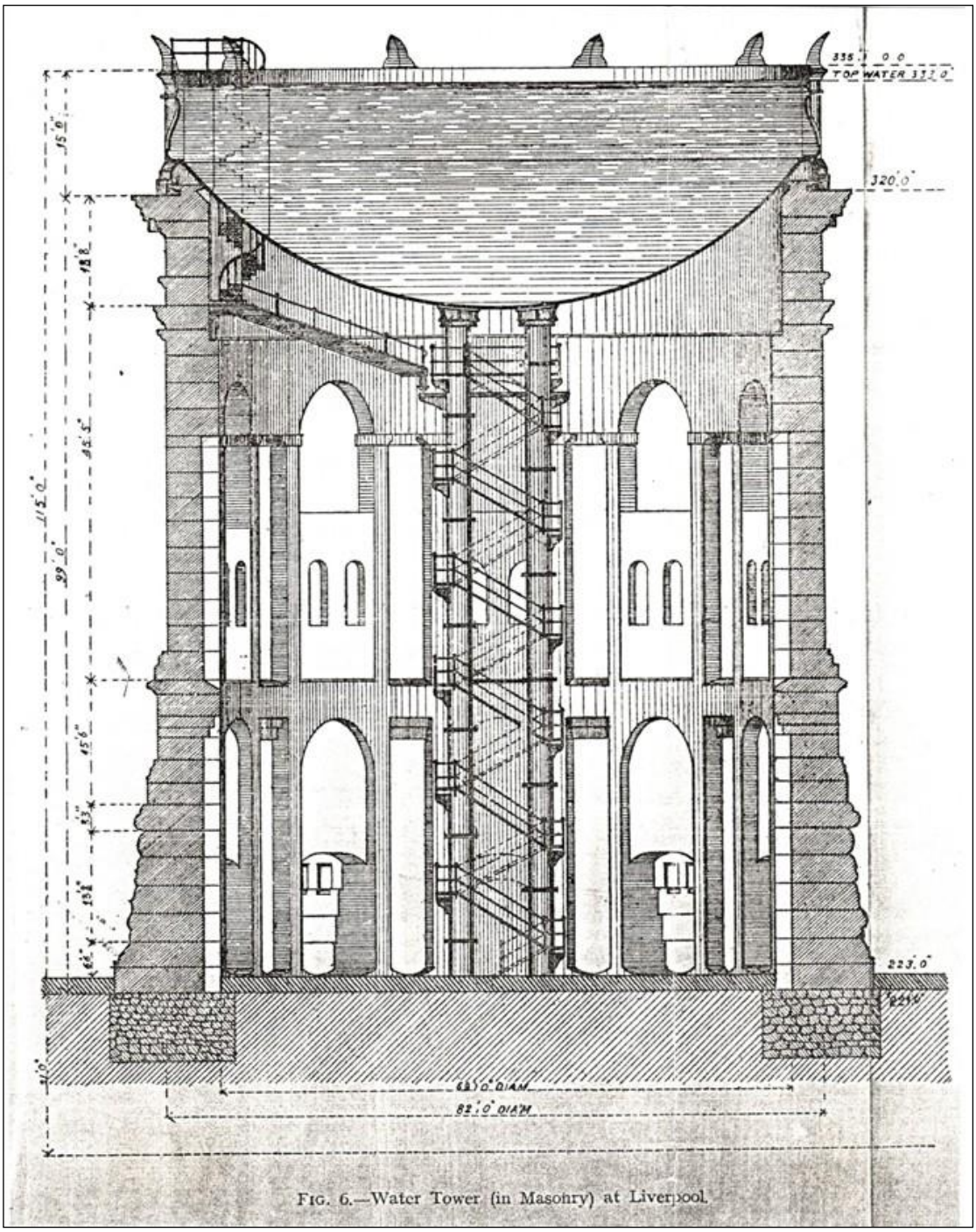
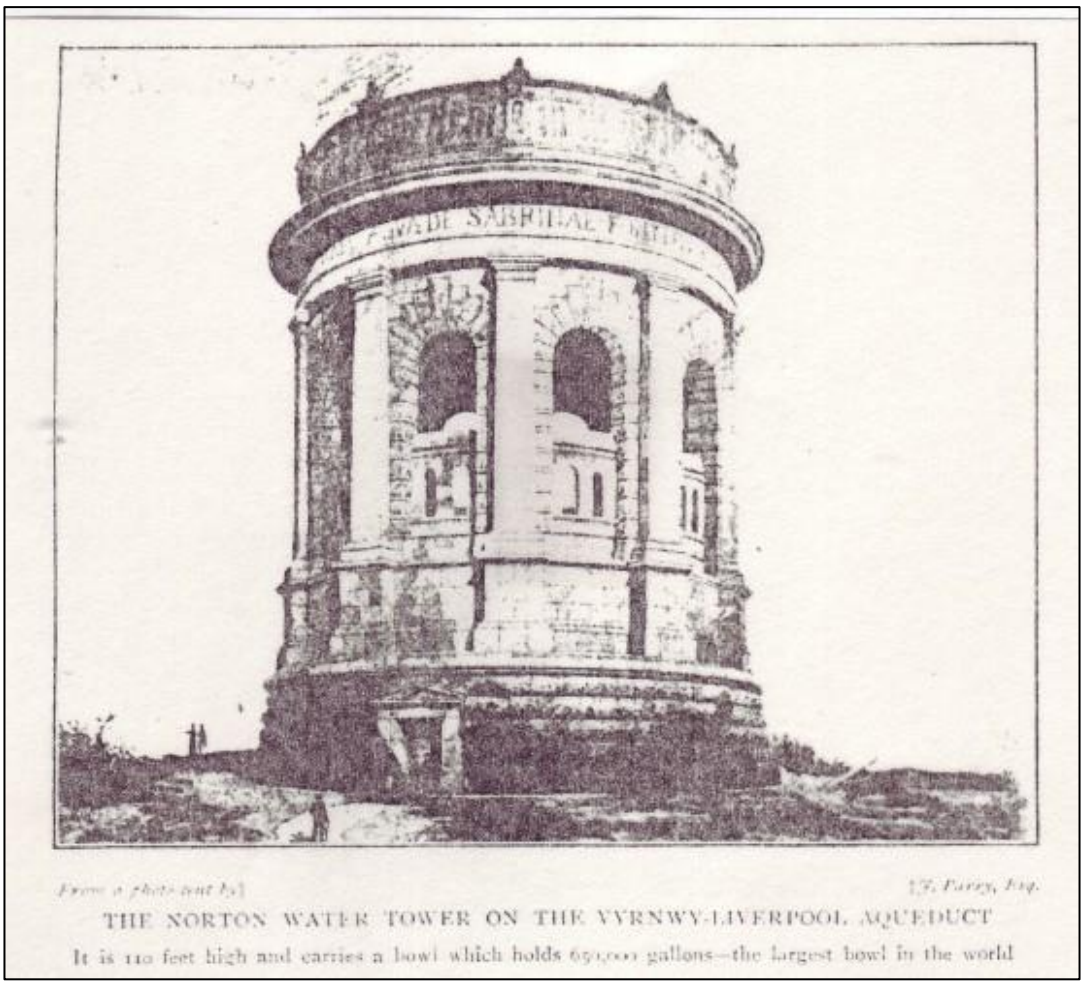


FIG. 6.—Water Tower (in Masonry) at Liverpool.

W K Burton & J E Dumbleton, *The Water Supply of Towns* 1928
"The design of the tank itself – a dish of wrought iron without support except at the edge – is a bold and admirable one"



A water tower in the classical style; illustrated in Archibald Williams,
***The Romance of Modern Engineering*, 1913**

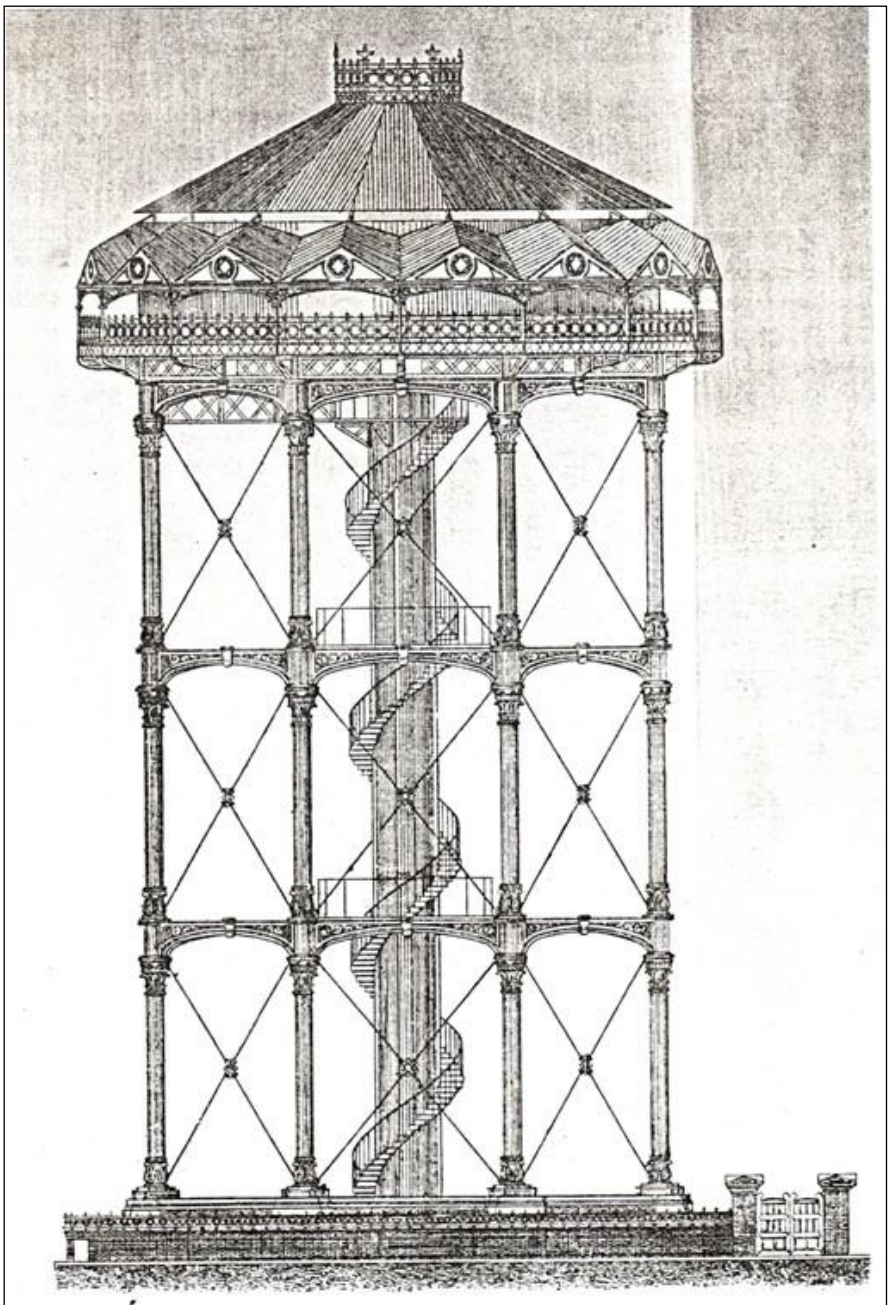


FIG. 7.—Water Tower (in Cast- and Wrought-iron) at Shanghai.

WATER TOWERS AT LIVERPOOL AND SHANGHAI.

A tower forming part of the Shanghai waterworks (Engineer J. W. Hart); it is a composite structure of cast and wrought iron; illustration from W. K. Burton and J. E. Dumbleton, *The Water Supply of Towns*, 1928

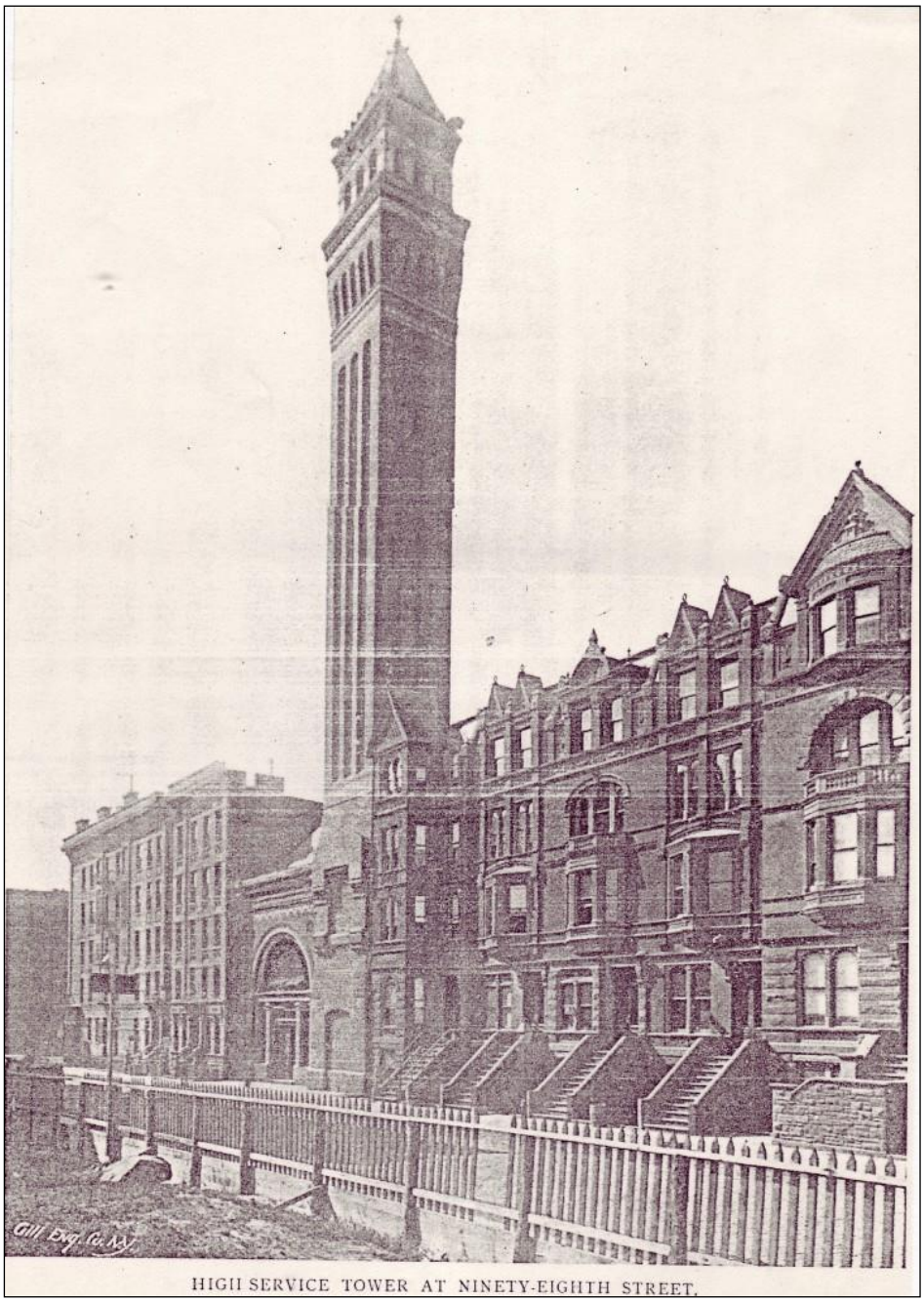
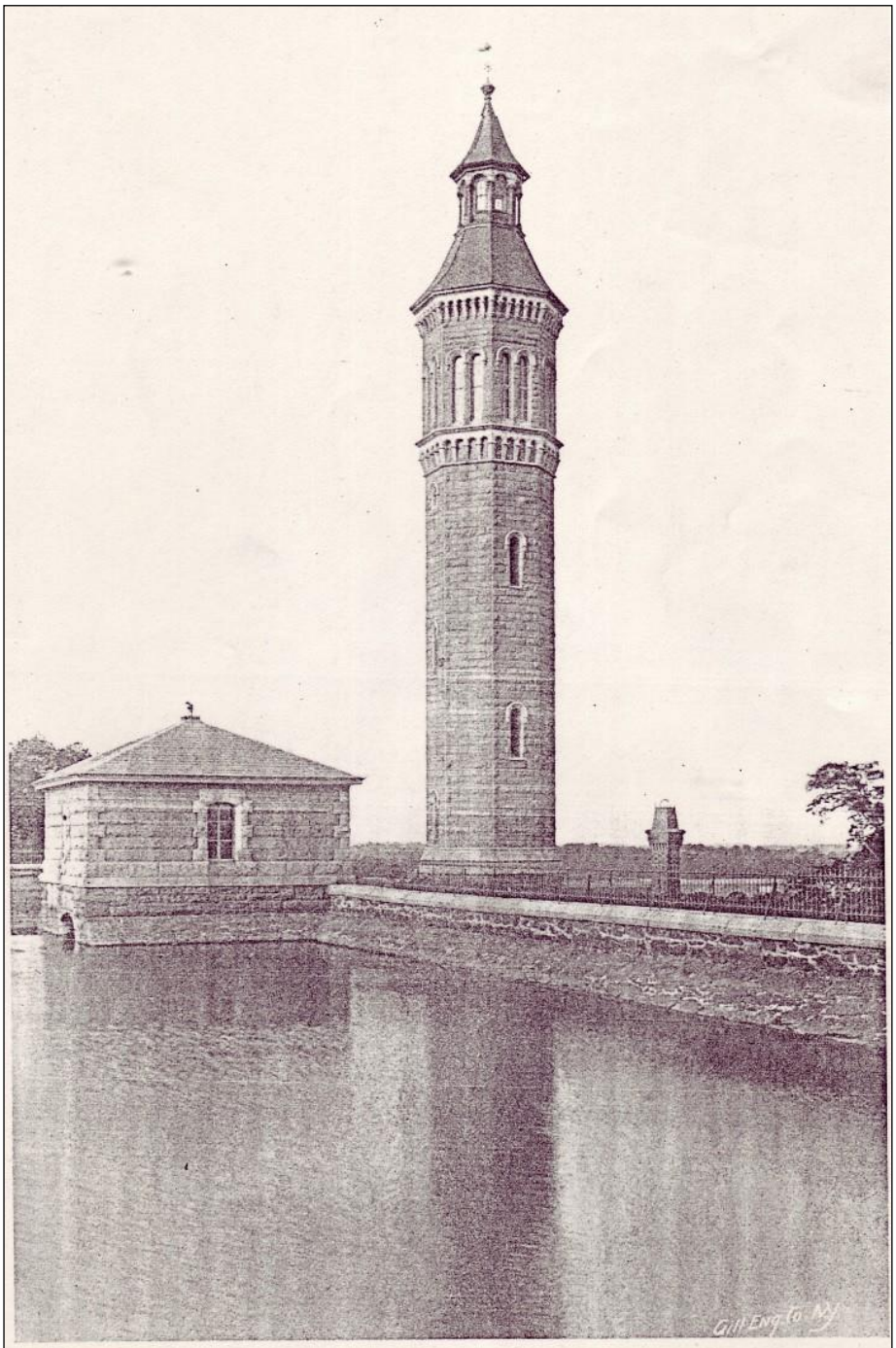


Illustration from E. Wegmann, *The Water Supply of the City of New York*, 1896



HIGH-SERVICE TOWER AND RESERVOIR AT HIGH BRIDGE.

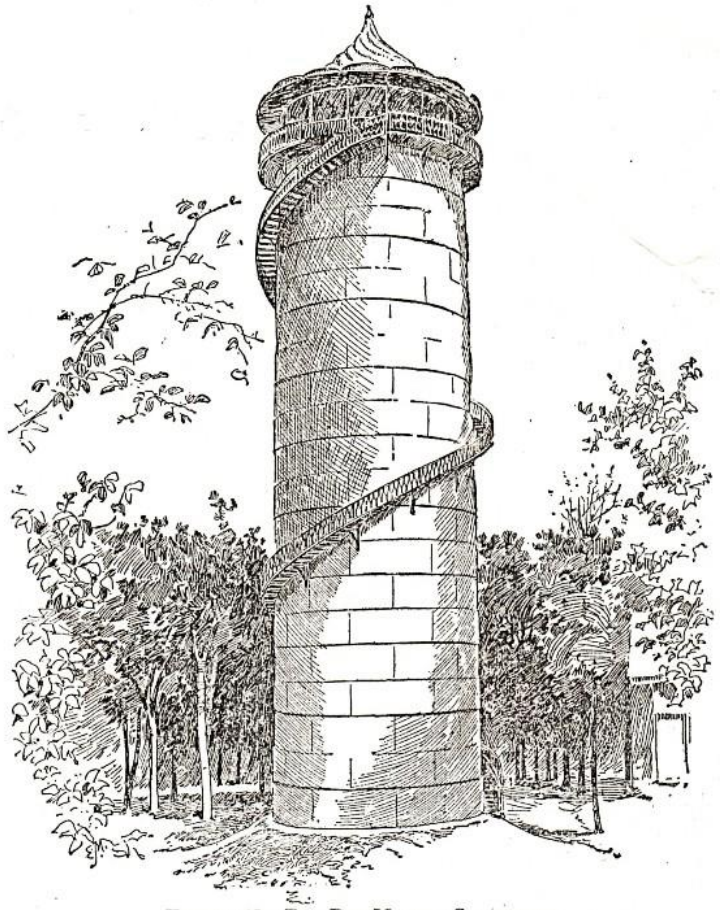


FIGURE 48.—THE DES MOINES STANDPIPE.

The tank shown in Figure 48 was built a number of years ago for the Des Moines Water Company from the plans of Mr. Chester B. Davis. It is 30 feet in diameter, 100 feet high and furnished with a balcony and roof which relieves the hard lines of the tower. The roof is covered with unpainted No. 22 sheet copper. The floor is supported by iron beams and consists of a 2-inch bottom course of pine finished with a course of selected 1-inch hard pine. The ceiling of the roof is No. 20 corrugated iron. Another attractive tank, shown in Figure 49, was built at Norwood, Ohio, from the plans of Mr. G. Bouscaren.

It is sometimes desirable, occasionally even necessary, to enclose the standpipe in masonry to protect it from wind pressure and the cold. When this is done very attractive architectural effects can be produced, as is shown by completed structures and the results of a prize competition instituted by "The Engineering Record" in 1890. The best of the plans received in that competition are published by the journal mentioned. The masonry tower at Lawrence, Mass., is shown in Figure 50. The first 27 feet of the masonry above ground is broken granite ashlar, and the remainder is brick with granite trimmings. The main tower is octagonal in plan and there is also a projecting circular tower of 6 feet inside diameter in which an iron stairway winds upward to the balcony. The tank is 30 feet in diameter and 102½ feet high. The floor of the balcony is about 107 feet above ground, and the point of the roof about 157 feet.

Illustration from *Waterworks for small cities and towns* by J Goodell 1899

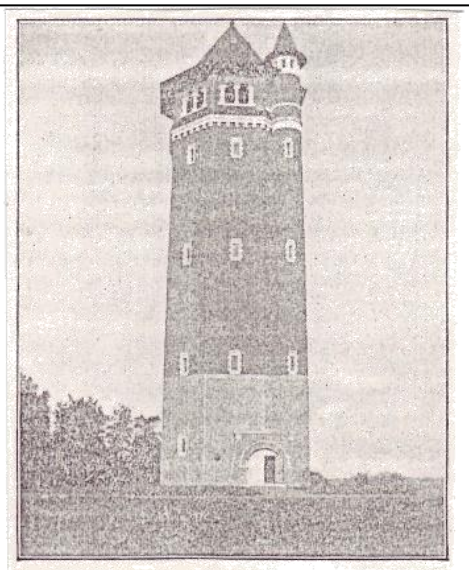


FIGURE 50.—LAWRENCE WATER TOWER.

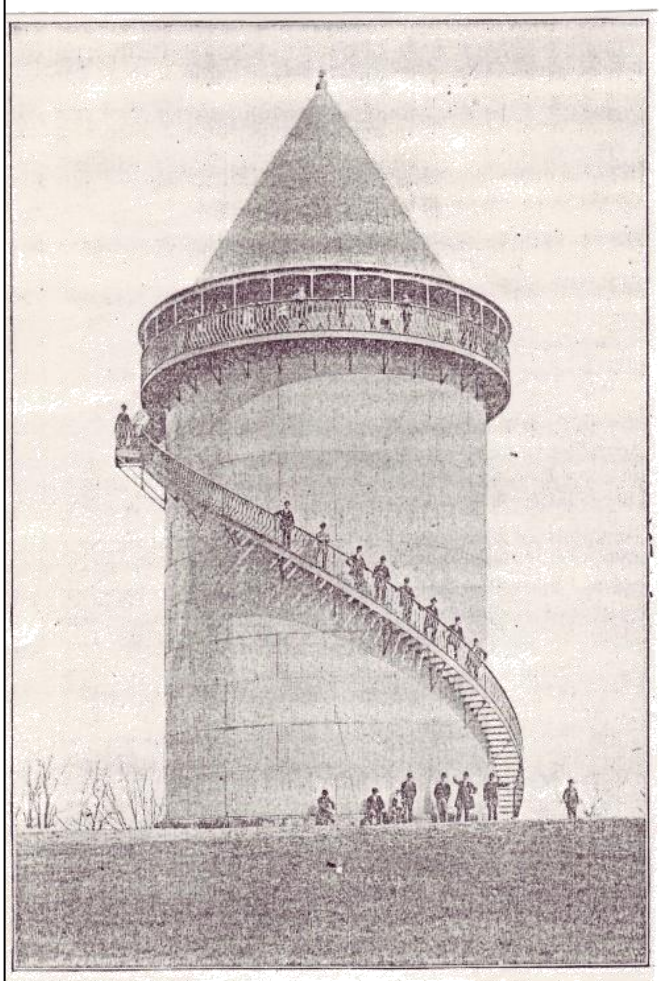


FIGURE 49.—WATER TANK AT NORWOOD, OHIO.

Article from *Water*, no. 6, January 1981

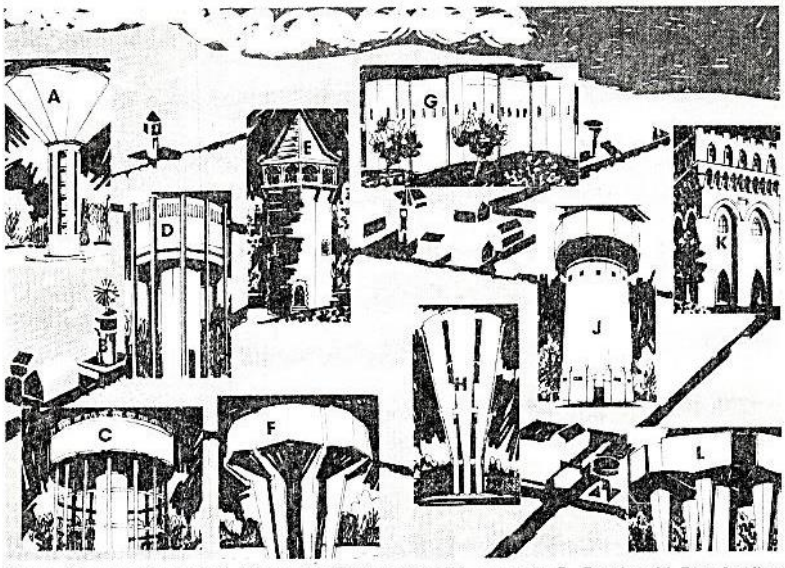
ALAN GRIFFITHS, an architect and a partner in the Harry Bloomer Partnership, takes a look at water towers. This heavily illustrated article examines various design approaches to these supposedly mundane public utilities which nevertheless exhibit a surprising range of styles and shapes.

Towers of water

A VISITOR to this country, in querying the function of a local water tower, described it as a strangely beautiful saucer-like object which seemed to float above the trees. When told of its purpose, the curious response suggested that it seemed wrong to build ugly things like water towers in prominent positions! These rather contradictory remarks naturally provoked some discussion. Why is it that some towers look good and some do not; that some are unduly prominent; and that some areas have more water towers than others?

Water towers are simply miniature reservoirs, carefully sized and sited to serve a local need. Reservoirs, situated on high ground, provide sufficient water at suitable pressure for the majority of properties. They are designed to cater for seasonal variations, drought and burst mains without excessive costs in pumps and pumping. Since it would be uneconomic to build large storage capacity above the level of all water taps, local towers are used to provide for the needs of a few difficult high spots. Water towers can range in size from several cubic metres to monsters of four megalitres. Sometimes many towers are used to keep up the water pressure in extensive, low-lying and sparsely populated areas like East Anglia.

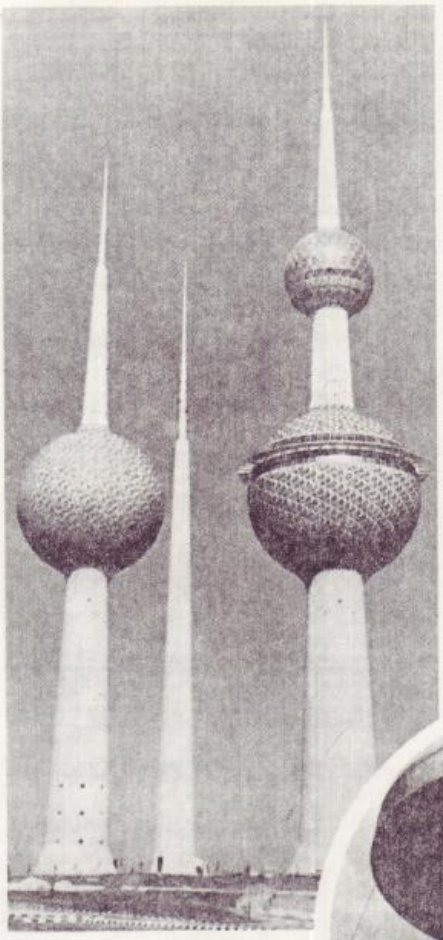
In Kuwait, groups of towers have been used to pressurise a widespread desert network (1). These towers serve a double purpose, acting also as parasols, and giving shade to small parks which are being planted beneath them. The design has recently been included in the Aga Khan's Awards for Islamic architecture. Before looking at water towers in this country, mention must be made of another Aga Khan Award Winner in Kuwait (2). It seems that this group had to be built in the back garden of the Emir's Palace and the designer pulled out all the stops! Any designer, who is asked to tackle a water tower, regards it as an opportunity to design an unusual feature if not as a challenge to his ability, but those commissioning designs can also be very specific and if they are not sure what a water tower should look like — then they may insist that it looks like something else.

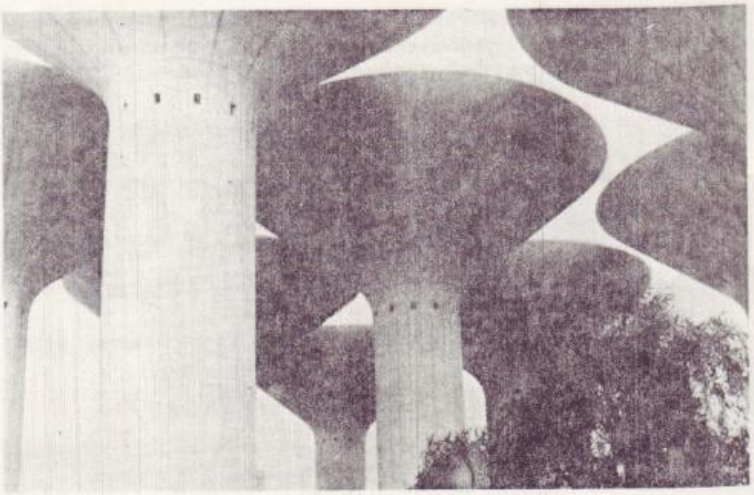


Cover: 'Towers of water': A - Thorne No. 2, Yorkshire WA, concrete; B - Southwold, East Anglian WC, 1900, brick and windpump; C - Warley, Essex WC, 1938, concrete; D - Durdham Down, Bristol WC, 1956, concrete; E - St. George's Hill, North Surrey WC, brick and tile; F - Brookmans Park, Lee Valley WC, 1968, PC and in-situ concrete; G - Siwards How, York WC, concrete; H - Towell, Lee Valley WC, 1965, concrete; J - Caister, East Anglian WC, 1932; K - Knowle, Bristol WC, brick; L - Tadley, Thames WA, PC and in-situ concrete.
Cover design: John Dufton.

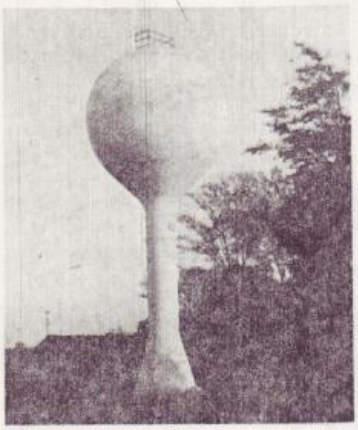
The Emir clearly wanted minarets, but Victorian water engineers or their clients, chose vaguely ecclesiastical or medieval style towers (Cover K). This tradition is still strong in Britain. The largest tower in the country, at 4.5 megalitres, was clearly too much to stand on a column, but it crowns a hill in Yorkshire in a manner very reminiscent of a 'castle' (Cover G). At the turn of the century this was a popular approach, so it is interesting to note an early 20th century energy conscious and functional design, in Suffolk with its own wind pump to fill the tank (Cover B). In general, at this time, engineers were building masonry towers, with either exposed or hidden cast iron tanks, and utilising recognisable architectural features in entirely new ways, such as machicolations, to sensibly enlarge the top part of a tower to accommodate a large tank (Cover K). (I can't believe they intended the water to pour down through these, although dam designers have used the same device for this purpose!)

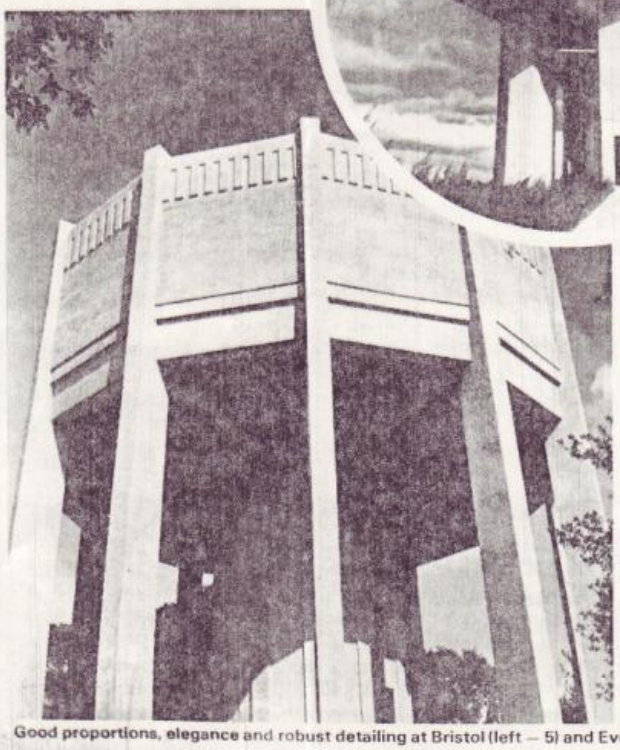
Another early 20th century approach is illustrated by the very picturesque tower on St. George's Hill, near Weybridge. Set amongst the trees this very beautiful structure (Cover E) gives little indication of its true function and yet neither does it set out to mislead. The idea of locating water towers amongst trees is a good one, but whether this comes about because the trees were there in the first place — as they often are on high ground — or because of a degree of cowardice by the designer or his client, is difficult to decide. It is strange that in our environmentally conscious society two distinctly different approaches are being pursued. On the one hand designers are endeavouring to tackle bold objects, such as water towers, in an honest and sculptural manner yet on the other hand the same designers (and perhaps more so planners) are asking for such objects to be hidden

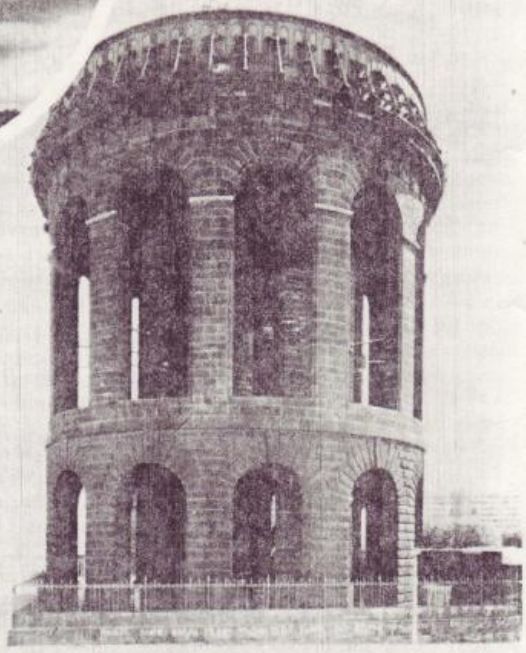




Above (Picture 1) and left (2) award winning water towers in Kuwait. Right (3) spherical steel tower near Cardiff and below (4) a mushroom tower at Ormskirk.







Good proportions, elegance and robust detailing at Bristol (left — 5) and Everton (right — 6)

22

WATER January 1981

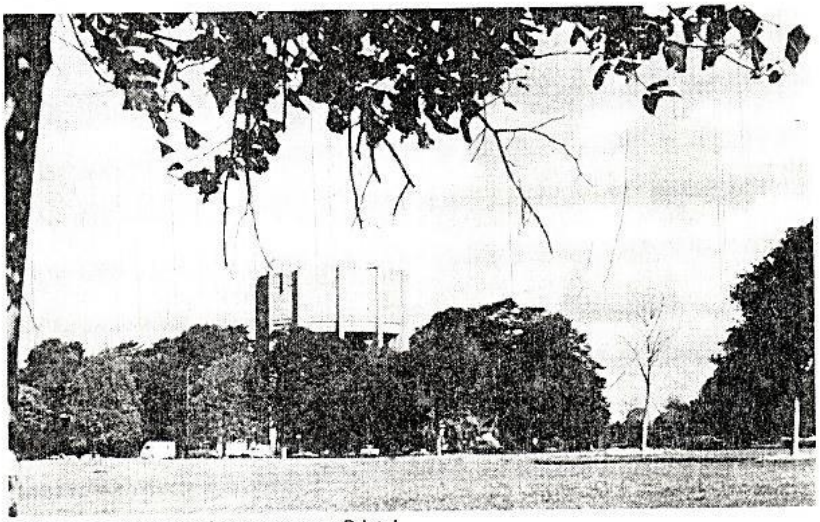
by trees. There is no doubt that most modern structures, or buildings, look better with the foil of foliage, but there is a difference between a structure associated with foliage (7) and being hidden by it. Nevertheless, we are all familiar with some towers and other structures which deserve to be hidden!

In the inter-war and early post war years, water tower design was fairly functional, but there was a difference between the two most clearly defined attitudes of designers. One approach is to go for an emphasis on the supporting structure, sometimes with architectural pretensions — usually in the details (10). The other approach is at pains to emphasise the massive quality of the tower and often tries to create a monumental edifice.

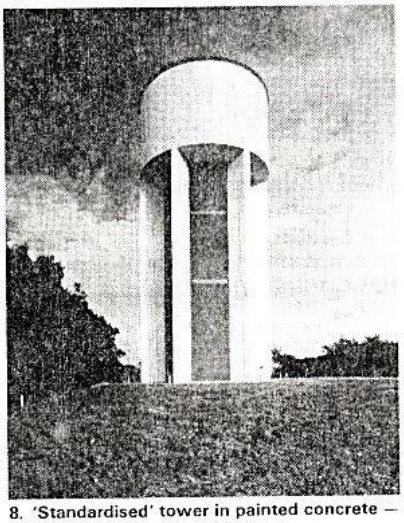
It is interesting to follow the development of structural systems: from the small tank on a tower of similar dimensions, like a lighthouse (11), to the tank on an open structure (12) which gradually became a forest of columns (13) as the tank diameter increased; then the attempt to reduce the clutter of columns by using simple but larger fins (14). The next major development is towards the central support (15), originally formed by clustering the fins together, and later by removing the fins to leave a smooth central column (16). The peak of perfection in this arrangement is reached with single columns, sometimes tapered, curving into heads like wine glasses, tulips, mushrooms or other shapely forms (17). When cost restrictions hit hard, leaving a rationalisation of this elegant shape, but with no tapers and no curves; this usually took the form of an inverted cone on a straight column (18).

Water towers are clearly not cheap objects, anything built so high off the ground rarely is, but cost is a factor which is more important today than it was in the past. Most of our heritage of water towers was built by private water companies who were comparatively wealthy and who, in conjunction with municipal corporations, were anxious to project a good corporate image. Cost was not then the most important factor. In more recent years cost and the visual environment have become the two most important factors, and they are frequently in conflict.

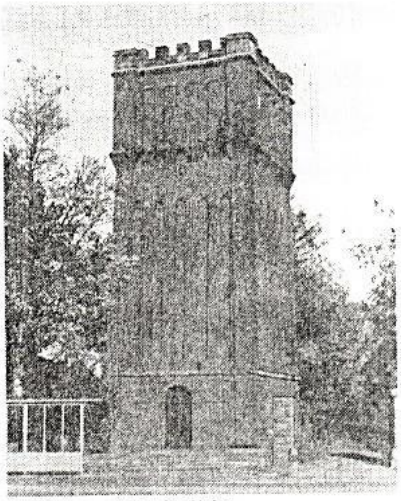
Towers today are rarely if ever built in brick or stone. The more usual materials are steel and concrete. Steel towers are usually of the proprietary pattern with light steel framework criss-crossed with diagonal bracing. Concrete is the most ubiquitous and versatile constructional material. The big problem in building with concrete is the casting mould and its supporting structure which has to be built first and removed afterwards. Any



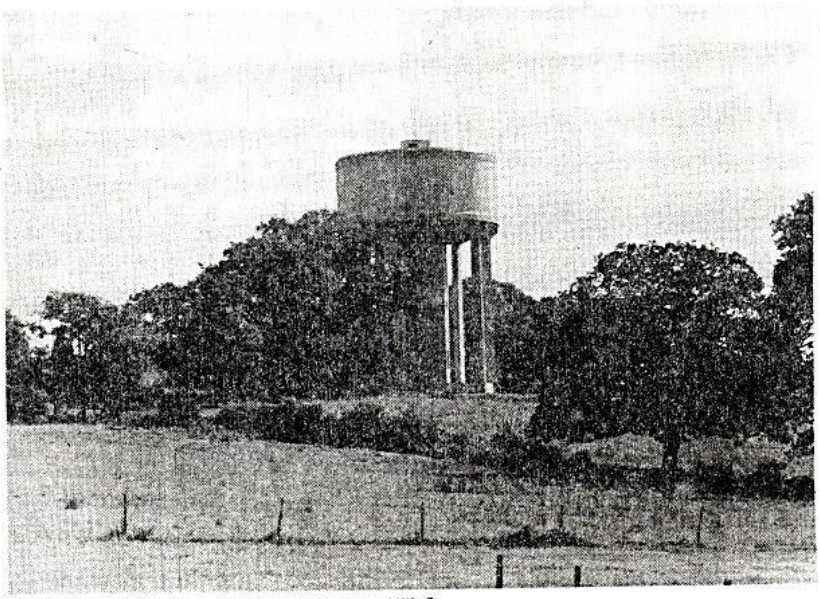
7. Trees as a foil to an elegant tower at Bristol.



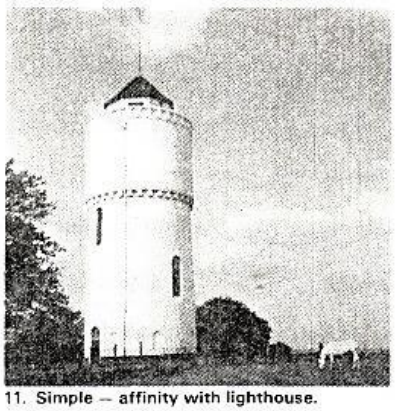
8. 'Standardised' tower in painted concrete — near Cambridge.



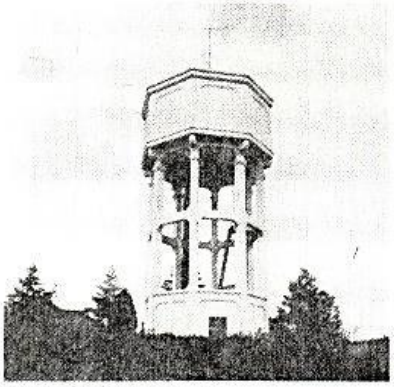
9. Monumentality in Wales.



10. Refined and elegant structure — Burgess Hill, Sussex.



11. Simple — affinity with lighthouse.



12. Emphasis on structure.

13. Larger tank — structure gets out of hand.

14. Structure simplified into highly stressed fins.

design which allows the formwork to be used more than once is significantly cheaper than the one-off form. Hence tapered and curved shapes are now difficult to justify on economic grounds — although the elegance of such forms cannot be denied (17). Some water authorities are now developing standardised towers purely to economise on formwork and shuttering (8). The visual form is clean and simple — sterile even, and the excitement has gone.

Using concrete, it is difficult to achieve the warmth of colour or the sympathetic texture which is characteristic of masonry. There are various ways in which designers try to overcome this disadvantage. One way is to emphasise the essential nature of concrete by making the formwork reveal the timbers of the mould. Another is to hide this characteristic by covering the structural concrete with more sophisticated concrete panels, using perhaps coloured aggregates or other devices (15). Sometimes the concrete is just painted (Cover J). Painting is rarely done imaginatively — the usual way is to use cream or fawn masonry paint. Why not adapt and develop some of the wartime camouflage techniques? Surely naval type 'dazzle' painting would be an interesting starting point and modern 'Op' art techniques, used with sophistication, could also be a good influence.

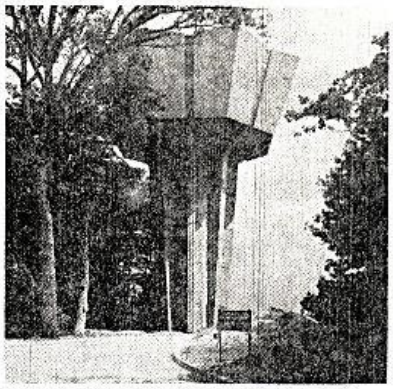
Perhaps it is time to seek alternatives. It is surprising that steel construction has not been used to greater effect in recent water towers — not in the form of a standard tank but maybe using high stressed steel sheets to produce interesting sculptural shapes (3). Maybe, the use of sophisticated pumping arrangements, and micro-chips will give such a quick response to demand that towers will no longer be necessary. If so it would be a great pity. It is to be hoped that the tradition will continue and even more exciting shapes will be developed in the future.

There is, however, a steady loss, through demolition, of the older water towers. Some redundant towers are being used for other purposes, such as museums and even houses, like the 'House in the sky' at Thorpness. It would be wise to ensure that these undervalued structures are photographed and properly recorded before too many disappear.

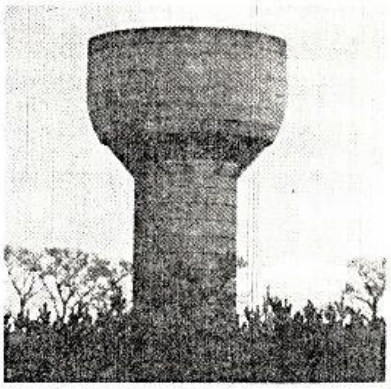
Details of water towers illustrated in text:

1. Agu Khun Award. 2. Winning towers — Kuwait. 3. Pentrebane, Welsh WA, 1960s, steel. 4. Ormskirk, North West WA, concrete. 5. Durdham Down, Bristol WC, 1956, concrete. 6. Everton, North West WA, concrete iron and stone. 7. Durdham Down, Bristol WC, 1950, concrete. 8. Balsham, Cambridge WC, painted concrete. 9. Penylan, Welsh WA, 1930s, brick. 10. Burgess Hill, Mid-Sussex WC, concrete. 11. Havering atte Bower, Essex WC, 1935, rendered. 12. Hockley, Essex WC, 1930, concrete. 13. Warley, Essex WC, 1938, concrete. 14. Tilkhurst, Mid-Sussex WC, concrete. 15. Silver Leys, Lee Valley WC, 1976, PCC and concrete. 16. Pukefield, East Anglian WC, 1959, painted concrete. 17. Morwick, Newcastle and Gateshead WC, 1963, concrete. 18. Headless Cross, East Worcs WC, 1970s, concrete.

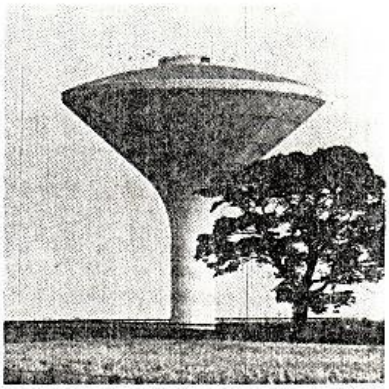
Note: photographs 16 and 18 are by the author.



15. Fins clustered to form central support.



16. Head and shaft simplified.



17. Elegant and smooth 'wine glass', but expensive.

18. Rationalised wine glass.

SANDRINGHAM

THE NORFOLK HOME OF HM THE QUEEN

JOHN MARTIN ROBINSON takes a tour of the country house beloved and developed by generations of the royal family, including rooms not seen by the public

OVER the front door in the hall at Sandringham is an inscription (**Fig 4**): 'This house was built by Albert Edward, Prince of Wales and Alexandra his wife in the year of Our Lord 1870.' The property had been bought for the future Edward VII on his coming of age in 1862, at the initiative of his late father, the Prince Consort. This acquisition of a private estate reinforced the country-gentleman image of the monarchy. It was an image that had been first established by George III in the 1770s, and has remained strong in British royal life ever since.

Much of the charm and special interest of Sandringham derives from this combination of a quintessential English country estate with its special royal status and ownership. It is both ordinary and highly unusual, not least in its ensured survival as a large Victorian country house through the decades when many architecturally similar buildings were demolished or converted to other uses, as being unmanageable and unfashionable. It is now a rare example of its type, lived in and beautifully maintained, complete with its original contents, gardens and dependent estate buildings, including the largest Victorian game larder in Europe.

Although it has undergone some later changes and alterations, the original character of the building and the personalities of its first chatelaines, Queen Alexandra and Queen

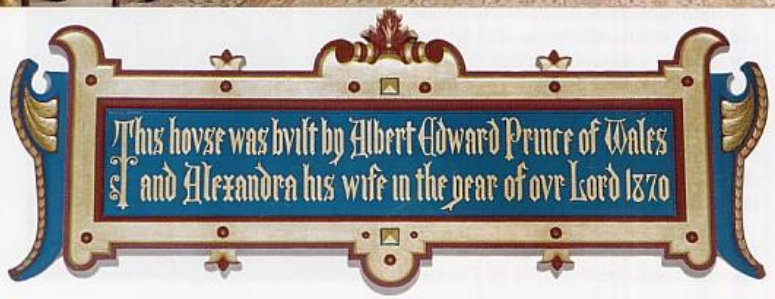
(*Above*) 1—The North Front designed by A. J. Humbert in 1870, with prominent *porte cochère*. The lower wing on the left is the Ballroom that was added to the design of Colonel R. W. Edis in 1883–85. (*Right*) 2—The guest entrance to the Ballroom, built of reused stonework from the porch to the old house, with superb decorative ironwork. To the right is a giant thermometer

Mary, still resonate. The light and comfortable rooms—Queen Victoria described them as 'luxurious'—recall the interiors of late-19th-century and Edwardian Mayfair as recorded in the photographs of Bedford Lemere, as well as the country houses of that era which are difficult to contemplate now without nostalgia for a lost gilded age.

Edward, Prince of Wales, was the leader of the 'Smart Set' of his day, and Sandringham was a 'Smart House', with its well-organised shoots, large house parties, theatricals and balls, but it is redolent of the period as a whole, when shared values shaped society and the buildings of the time. As Lady Desborough reminisced to *The Times* in 1929: 'Society was very interchangeable: members of all the various sets, including the racing world, were often to be met at... country houses.'

Sandringham was considered to be one of the most comfortable houses of its day, but it was never a pretentious place. Most of the rooms were not large, and it developed out of an old gentry house. The atmosphere was, and is, homely. Queen Alexandra said to a guest: 'To tell the truth, it is a very small place, but by means of all this gardening and laying out, we make it look very big.'

When it was acquired in 1862, old Sandringham Hall was a plain, white-stuccoed house, built in 1771 by Cornish ➢



(*Above*) 3—The Great Hall or Saloon, a two-storeyed Jacobean space complete with a minstrels' gallery, was fitted out and furnished by Holland & Son of London, the fashionable Victorian decorators. It is now an informal living room. In Edward VII's time, tea was served here at a round table. (*Left*) 4—The plaque over the front door, commemorating the building of the new Sandringham house by the Prince of Wales in 1870, was also made by Holland & Son

5—The space under the Hall gallery includes a weighing machine for arriving and departing visitors, who were expected to record their weight before and after staying in the house

Henley, whose wife's family, the Hostes, had owned the property since 1686. A Victorian 'Jacobean' front porch and knobbly carr-stone conservatory had been added by the architect S. S. Teulon. These characterful additions provided a stylistic pointer when it was decided to build a completely new house in 1870, to accommodate a growing family after the Prince of Wales's marriage to Princess Alexandra of Denmark.

The new house **(Fig 1)** was designed by A. J. Humbert, an architect employed by Prince Albert for farms and houses at Osborne and Whippingham church on the Isle of Wight, as well as the two royal mausolea in the grounds at Frogmore. For Sandringham, Humbert, who was competent in most styles if not especially inspired, devised an 'Old English' or Jacobean manner, influenced by places such as Blickling, as well as Teulon's additions to the previous house. It was executed on the old site in red brick with stone dressings, the shell being built by Goggs Brothers of Swaffham. The two long main ➢

6—The grand Ballroom, designed by Col R. W. Edis in 1883. It was intended for entertaining Norfolk neighbours, tenants and staff (for whom there was a separate entrance), as well as guests of country-house parties. The wallpaper was added by Queen Mary, who also brought the chandeliers, made by Osler of Birmingham, from Buckingham Palace. The weapons were given to Edward VII when he was the Prince of Wales on his Eastern tour in 1875–76. The room is the largest in the entire house, and sports an elaborate and broad plaster barrel ceiling

7—The Library was originally built as an American-style bowling alley in the 1870s, after one the Prince of Wales admired at Trentham, the seat of the Duke of Sutherland. It was converted to its present use and the shelves installed in 1901. The books were supplied by Hatchards of Piccadilly

façades faced east and west, as had the previous house, the plan of which was partly reproduced, together with some internal features **(Fig 8)**. The overall external effect was gently asymmetrical, enlivened by gables, bay windows, turrets with onion-shaped roofs and tall, ornamental, East Anglian brick chimneys. On the entrance front, there was a large *porte cochère* to shelter arriving guests, who proceeded into the Great Hall **(Figs 3 and 5)**.

On the garden front, Teulon's projecting conservatory of darker gingerbread carrstone was retained and made into a billiard room. Next to it, in the same style, was built a single-storeyed 'American' bowling alley on the model of one the Prince of Wales had seen and admired at Trentham in Staffordshire, seat of the Duke of Sutherland.

Sandringham continued to grow over subsequent years, and these later works greatly enhanced the composition, lending an organic quality to the 'Jacobean' architecture of the house. In 1883–5, a large single-storeyed Ballroom **(Fig 6)** was added on the south-east side of the entrance forecourt. This has its own separate outdoor entrance **(Fig 2)**, an unusual feature made necessary because, as well as house parties, it was intended for the three annual balls given by the Victorian royal family: for the neighbouring gentry, for the tenant farmers on the estate, and for the staff and employees.

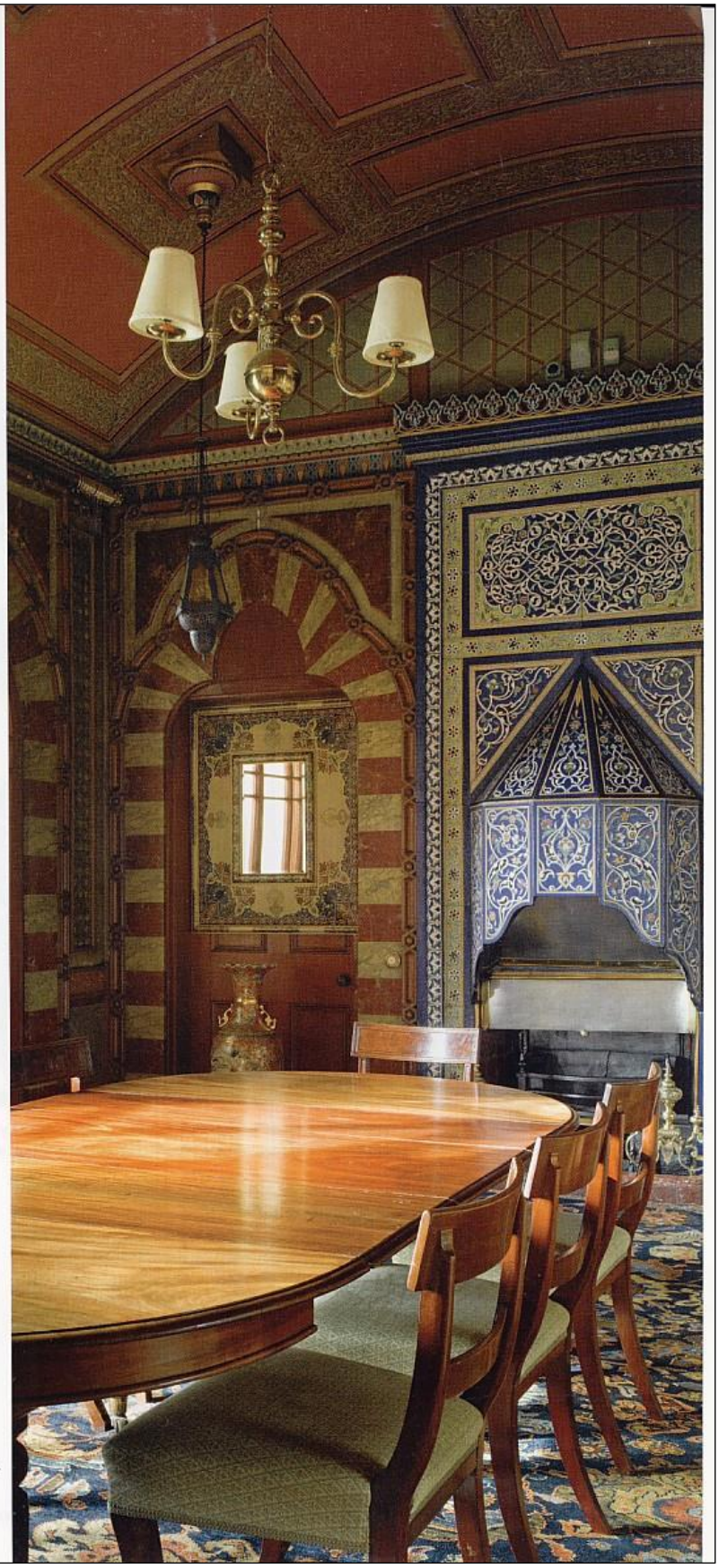
It was designed by Col R. W. Edis, who was a colonel in the Artists Rifles (TA). He

'The charm of Sandringham derives from its combination of quintessential English country estate with special royal status'

was the architect of Marylebone and Liverpool Street station hotels, as well as private houses in London and elsewhere. It deploys the same Jacobean style as Humbert's main block, but is handled in a livelier manner. The visitors' entrance incorporated stonework from Teulon's demolished porch of the old house, which had been in store awaiting reuse. The additions of the 1880s by Edis also included a new kitchen, drying room and other service accommodation, but these subsidiary buildings at the back were demolished in 1969 as part of a domestic re-ordering and modernisation carried out under the direction of Hugh Casson.

When the Ballroom and new kitchen were completed in 1885, the Prince of Wales remarked: 'I have, I think, finished all my improvements here.' In 1891, however, a fire damaged the roof of the main house and destroyed 13 bedrooms, so Edis was called back to restore the damaged part, and also to add a range of bachelors' bedrooms over the bowling alley, converting it into a substantial additional wing. This was also executed in ginger-coloured stone with brick trim. Internal fire-proofing with iron doors was installed at the same time under the aegis of Capt Shaw of the London Fire Brigade.

Further works were carried out following Edward VII's accession to the throne in 1901. At that time, the bowling alley was converted to a library **(Fig 7)**, a change which Queen Alexandra regretted. The old segmental plaster ceiling was retained, but fitted oak shelves were installed and a comprehensive collection of contemporary books



8 and 9—Interiors not open to the public include the North Staircase (*above*). Built in the Georgian style, it was copied from that in the old house. The large equestrian portrait at the turn of the stairs is of Frederick, King of Denmark. Also rarely seen, the Turkish Room (*right*) was designed by Orientalist artist Carl Haag, and fitted out by Holland & Son

supplied by Hatchards of Piccadilly. Electric light was introduced in 1902 in place of gas, which had been made at the estate's own gasworks at the Home Farm. The last architectural embellishments were two Classical stone porches added to the North Front and an angle of the West Front in 1904 and 1908.

Queen Alexandra continued to occupy Sandringham, which had been left to her for life, after the king's death in 1910. She lived there in rooms silted up with the possessions of a lifetime, surrounded by devoted old courtiers, and continuing to develop and embellish the garden. A characteristic feature is the little summer house in the Pulhamite rockery overlooking the lake, The Queen's Nest, erected for her by her comptroller, Gen Sir Dighton Probyn VC in 1904.

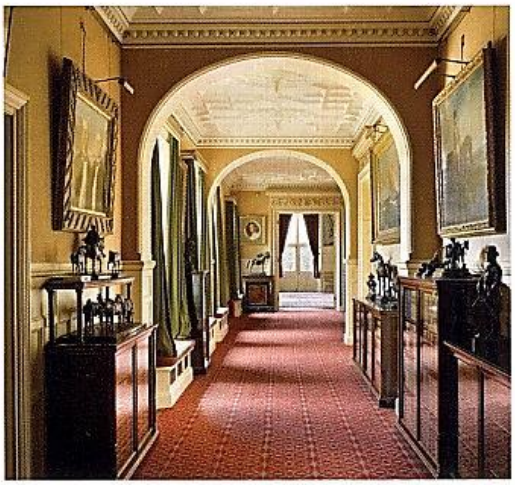
It was not until 1925 that George V and Queen Mary moved into the 'Big House' from York Cottage in the grounds, which had been their home when they first married and which is now the Estate Office. Queen Mary immediately tackled the interior with her usual zest and taste, thinning the bric-à-brac and taxidermy, but keeping the vitrines of jade and Fabergé objects, many of them gifts from the Tsarina of Russia, Queen ➢

10—The bay window in the Drawing Room, surrounded by Classical white marble statues by such sculptors as Mary Thorneycroft, Count Gleichen and others. The room is a good example of fashionable late-Victorian decoration in the French manner, with *boiserie* and mirrors

Alexandra's sister. Queen Mary's own additions of miniature silver, Worcester china, needlework, and good Georgian furniture enhanced the 'Edwardian' flavour of the house. George V himself took a keen interest in the shoot and farms, and in retrospect, the Norfolk estate seems perhaps even more closely associated with him than his father.

George VI and Queen Elizabeth carried out more work in 1938, simplifying the Great Hall and painting the dining-room woodwork a light green colour that Queen Elizabeth had admired at Braemar Castle near Balmoral in Aberdeenshire. At the same time, the North garden was laid out by the distinguished landscape designer Sir Geoffrey Jellicoe as a splendidly scaled formal set-piece bounded by monumental hedges.

Despite these changes, and further alterations, judicious prunings and redecoration of mainly subsidiary areas in the present reign, Sandringham preserves its late-Victorian character to a remarkable degree. The whole interior was fitted up in the 1870s by Holland & Son, the fashionable London firm that had furnished Osborne for Queen Victoria, and also did Marlborough House for the Prince of Wales. Holland's work at Sandringham, which is documented in its ledgers at the V&A, was remarkably comprehensive and included the provision of the luncheon tent for royal shoots and unpacking and displaying Queen Alexandra's birthday presents. The firm was responsible for not only the furniture, from nurseries and bedrooms to the kitchen, offices and main rooms, but also chimneypieces, architectural joinery, ornamental plasterwork, 'wainscot', floors and painting and papering, chintz and other textiles. It also executed the Turkish Room **(Fig 9)**, now the ante-room to the library, under the direction of the Bavarian-born



(*Above*) 11—The Drawing Room is divided into two, an arrangement repeated from the old house. (*Left*) 12—The Ballroom Corridor is lined with royal portraits, sporting pictures and notable late-19th-century bronzes by leading sculptors such as Dalou and Gilbert

Orientalist artist Carl Haag, who had been court painter to the Duke of Saxe-Coburg and Gotha and was much patronised by the British royal family from the 1840s. It remains unaltered as one of the most interesting historical set-pieces at Sandringham.

The Drawing Room **(Fig 11)** is a *tour de force* of fashionable late-Victorian decoration, with white stucco ornaments, convincing French *boiserie*, large wall mirrors, pretty painted ceiling panels and overdoors. Its form as two interconnected rooms was repeated from the old house. The furnishing is largely unchanged and is complemented by white marble statues by Mary Thorneycroft, Edward Lanteri, G. G. Villar and Count Gleichen **(Fig 10)**. Edward Hughes' full-length portrait of Queen Alexandra (1896) still hangs over the chimneypiece.

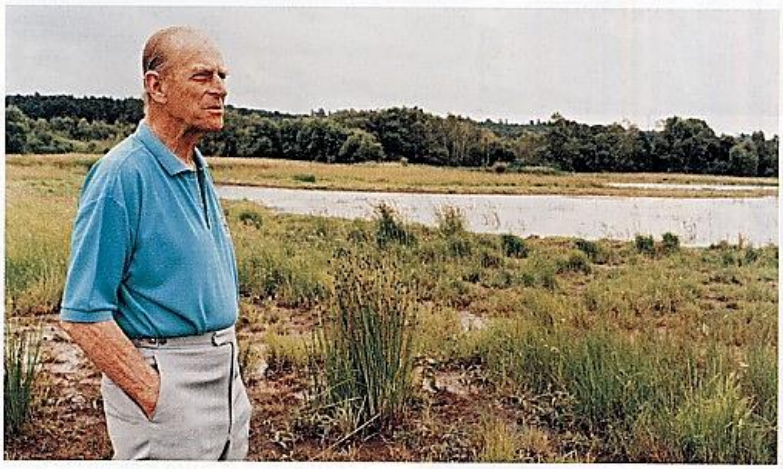
'Much of Sandringham's special atmosphere comes from the fact that it has always been loved'

A special feature of Sandringham is that many of the contents were presents from European royal relations to Edward VII and Queen Alexandra. In the dining room, the walls are hung with brightly coloured Madrid tapestries after the designs of Goya, given by Alfonso XII of Spain in 1876. In the Small Drawing Room, the Dresden china chandelier and elaborate frame to the pier glass were presents from Wilhelm II of Germany. Two little bronze cannons in the Ballroom were given by Napoleon III. More exotic gifts include the dinner gong—a present from the Maharajah of Hill Tipperah to the Prince of Wales during his Eastern tour of 1875–6. The collection of Asian arms on the walls of the Ballroom was brought back from the same tour. The latter room is the largest in the house, 63ft long and 30ft wide, with an elaborate white-painted plaster barrel ceiling. In 1934, Queen Mary redecorated the room, replacing the original stamped leather with wallpaper, and bringing the handsome glass chandeliers by Osler of Birmingham from Buckingham Palace. Even the Ballroom Corridor holds works of art **(Fig 12)**.

Much of Sandringham's special atmosphere comes from the sense of family continuity and strong personal association: the Holland & Sons fittings and furnishings, the royal portraits, the gifts from foreign heads of state and relations, but, above all, from the fact that it has always been loved. It was noted of Queen Alexandra that she was 'really happy here'. George V called it 'dear old Sandringham', and George VI told his mother, Queen Mary, 'I love the place'. The same remains true today.

Photographs: Will Pryce.

(*Above and below*) **The Duke of Edinburgh is passionate about wildlife and conservation, and has created 10 new wetlands on the estate**



WILL PRYCE

The Sandringham Estate

Vital statistics

8,300 hectares of which:
- 4,070 hectares are let
- 2,560 hectares are farmed in hand
- 1,420 hectares are woodland

JOHN GOODALL meets The Duke of Edinburgh at Sandringham to discover how the estate has changed over the past half-century

AFTER her accession to the throne in 1952, The Queen passed responsibility for her private estate at Sandringham to The Duke of Edinburgh. He has maintained it ever since, and it is hard to think of many individuals who have managed one area of land for so long. It remains a place firmly associated in the popular imagination with shooting and as the home of both The Queen's stud and the labrador kennels.

My own tour of Sandringham before meeting The Duke of Edinburgh made apparent the care with which the estate is managed. Everything, from the cottages to the hedges and gates, is meticulously kept. Yet appearances only tell half the story. In conversation with the Duke and The Queen's Agent, Marcus O'Lone, the thinking behind the development of the estate is revealed. So, too, is the magnitude of the labour involved in maintaining it.

When the Duke's long stewardship began, life at Sandringham was still conditioned by the effects of the war. The estate, he recalls, was served by a large workforce and was relatively neglected. Even at the time, it was apparent that there were massive changes in store.

As mechanisation drove down the number of farm hands and the profits of farming dropped, there was initially an effort to encourage tourism and develop real estate. Increased mobility stimulated demands for access to the countryside. This led to the designation of 250 hectares as a country park and the creation of a visitor centre. They now attract some 500,000 visitors a year. In 1977, the gardens and part of Sandringham House were opened to the public. The visitor enterprise eventually overtook farming as the main income for the estate.

There are now two caravan parks, providing a total of 450 pitches, one managed by the Caravan Club and the other by the Caravan and Camping Club.

The driving force behind many of the overarching agricultural changes that have taken place in the meantime has been—as it still remains—Government policy. Nevertheless, the Duke is insistent that everyone comes with their own offering to help shape the estate. From the start, his own interests were conditioned by the conservation movement. The founding president of the World Wildlife Fund, he was particularly concerned to minimise the use of toxic chemical sprays during their vogue in the 1960s and 1970s. At present, and with the encouragement of The Prince of Wales, nearly a third of the land is being farmed organically.

Such care has also been extended to the wildlife. Under the direction of the Duke, 10 new wetlands have been created. The

The boardwalks at Dersingham Bog, an area now managed by Natural England. They allow visitors to view the bog without disturbing the wildlife

estate also maintains more than 200 hectares of uncultivated and wild land along the coast, including Dersingham Bog, an SSSI currently managed by Natural England. A particular beneficiary of these habitats has been the pink-footed goose. Some 150,000 of this migratory bird return to north Norfolk every year in the autumn, with nearly 50,000 counted on Sandringham's stretch of the coast last winter.

Sandringham, meanwhile, has always been prized for its shooting. Much to the credit of its gamekeepers—whose achievement the Duke emphasises particularly—it is one of a handful of estates that has relied on wild game since the beginning of the Second World War. To encourage the native English partridge, 160 hectares of wild-bird cover have been established and more than 124 miles of wide field margins created. The Duke sees shooting as an undertaking that enriches the social life of the estate, involving the community as a whole.

Perhaps the most significant cumulative change to the estate since 1952 has been the creation of 45 new woodlands and the planting of more than two million trees. In the past decade, almost 30 miles of new hedges have also been planted.

The redundant farm buildings at Sandringam have been the object of considerable investment in recent years. As the Duke explains, these have not always been easy to deal with, being isolated and difficult to adapt. Several of those next to villages and roads have been developed for residential use, and other buildings have been adapted as workshops, offices and a small factory for producing apple juice.

Sandringham is also in the process of establishing a pub in the estate village of Shernbourne. It is to occupy the building

Sandringham's extensive orchards supply fruit for eight different flavours of apple juice

of one of the former clubs established by Edward VII to serve the local community. The king did not like pubs on the estate, so each of the small villages—West Newton, Appleton, Flitcham, Anmer, Wolferton and

> 'For the Duke, the successful management of Sandringham is a matter of dynamic compromise between its ruling triumvirate'

Shernbourne—had self-managed clubs. With the decline in the number of farm labourers and the increased numbers of 'incomers' and general mobility, the clubs were no longer serving their original purpose.

Like many large estates, Sandringham successfully markets its own produce. The Duke evidently takes considerable pride and pleasure in this undertaking, which he explained in some detail. When George VI planted the original orchards, the intention was to harvest them and sell them into the market in the usual way. This turned out to be uneconomic, and a system of 'pick your own' was initiated. This works well, but there is considerable wastage. After the public have had their pick, the remaining apples are collected and squeezed for their juice. Each variety of apple is bottled separately so that it is now possible to buy eight different flavours, including Cox's and Bramley's. There are also 40 hectares of blackcurrants.

Perhaps the most unusual departure in recent years has been the plantation of a *truffière*. The Duke came across a stand at at the Chelsea Flower Show one year that claimed to have a system for growing truffles, and thought it might be fun to have a go at Sandringham. He has created a small, half-hectare plantation, but it will be another three years before the success of this venture can be assessed.

For the Duke, the successful management of Sandringham is a matter of dynamic compromise between its ruling triumvirate: the agent, the farm manager and the head gamekeeper. All of these figures, he explains, represent interests that are in natural conflict with each other. For the estate to operate, however, they need to come to a working accommodation.

He is very reluctant to take any personal credit for the achievements of his stewardship, which he attributes entirely to those who have worked on the estate. Yet it is hard to imagine that Sandringham would be the place it is without his long and dedicated contribution.

For more information on the Sandringham estate, visit www.sandringham-estate.co.uk


SANDRINGHAM.