DESIGNS
FOR
TALL CHIMNEY SHAFTS

R. RAWLINSON. C.E.

Adj. Lepper
Ballindallock
Monks

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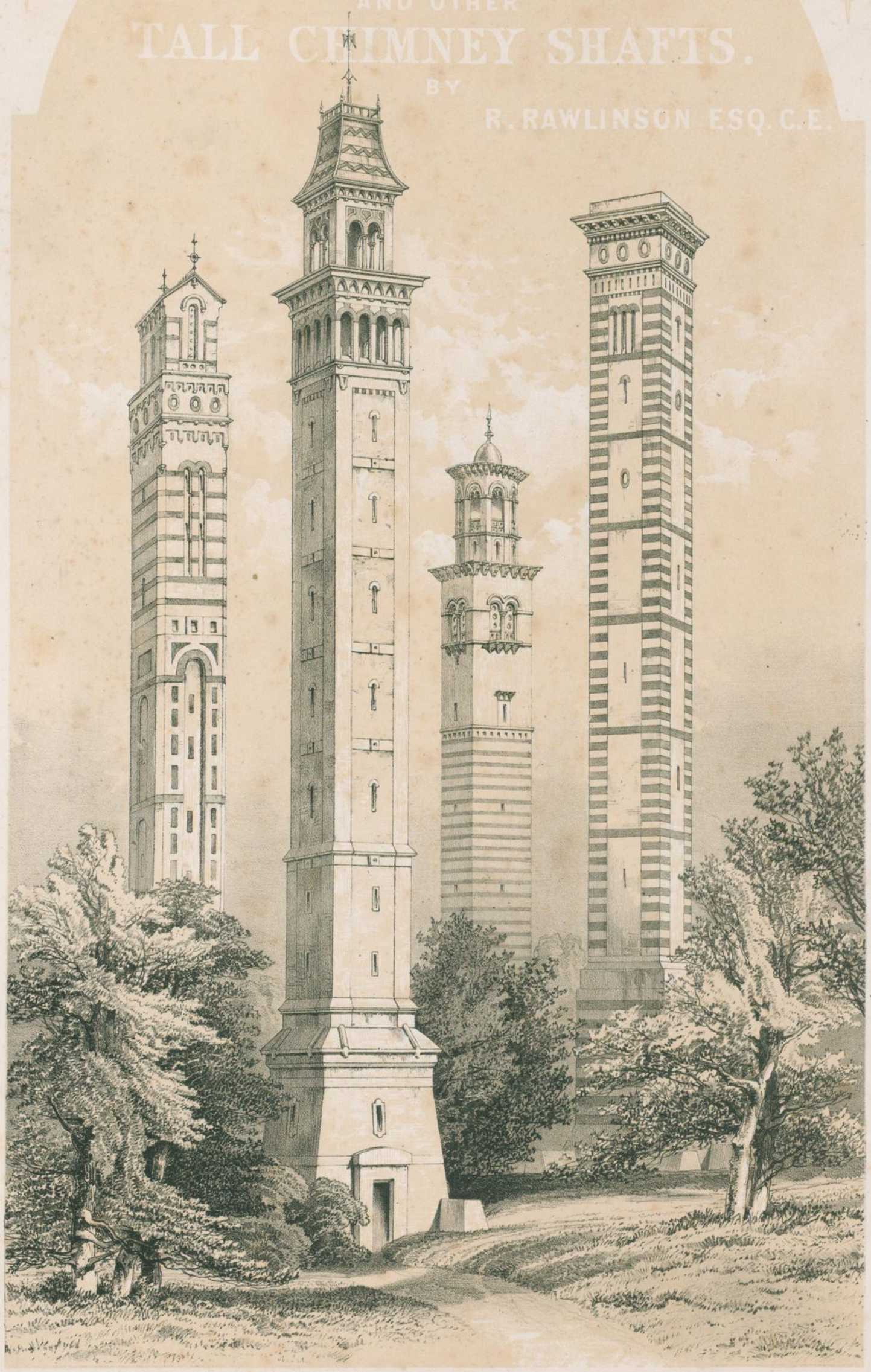
(1858)

±25°

Designs for
FACTORY FURNACE
AND OTHER
TALL CHIMNEY SHAFTS.
BY
R. RAWLINSON ESQ. C.E.



DRAWN ON STONE & PRINTED BY KELL BROTHERS, 2, CASTLE ST HOLBORN.

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To the
President, Council and Members
of the
Liverpool Architectural and Archeological
Society.

This Series of Designs
for
Tall Chimney Shafts,
Ventilating Towers, Elevated Water Tanks,
Water Works,
Engine and Boiler Houses &c.

Is most respectfully dedicated
By their obedient Servant,
Robert Rawlinson,
Civil Engineer.

KELL BROS LITH^rs CASTLE S^t HOLBORN.

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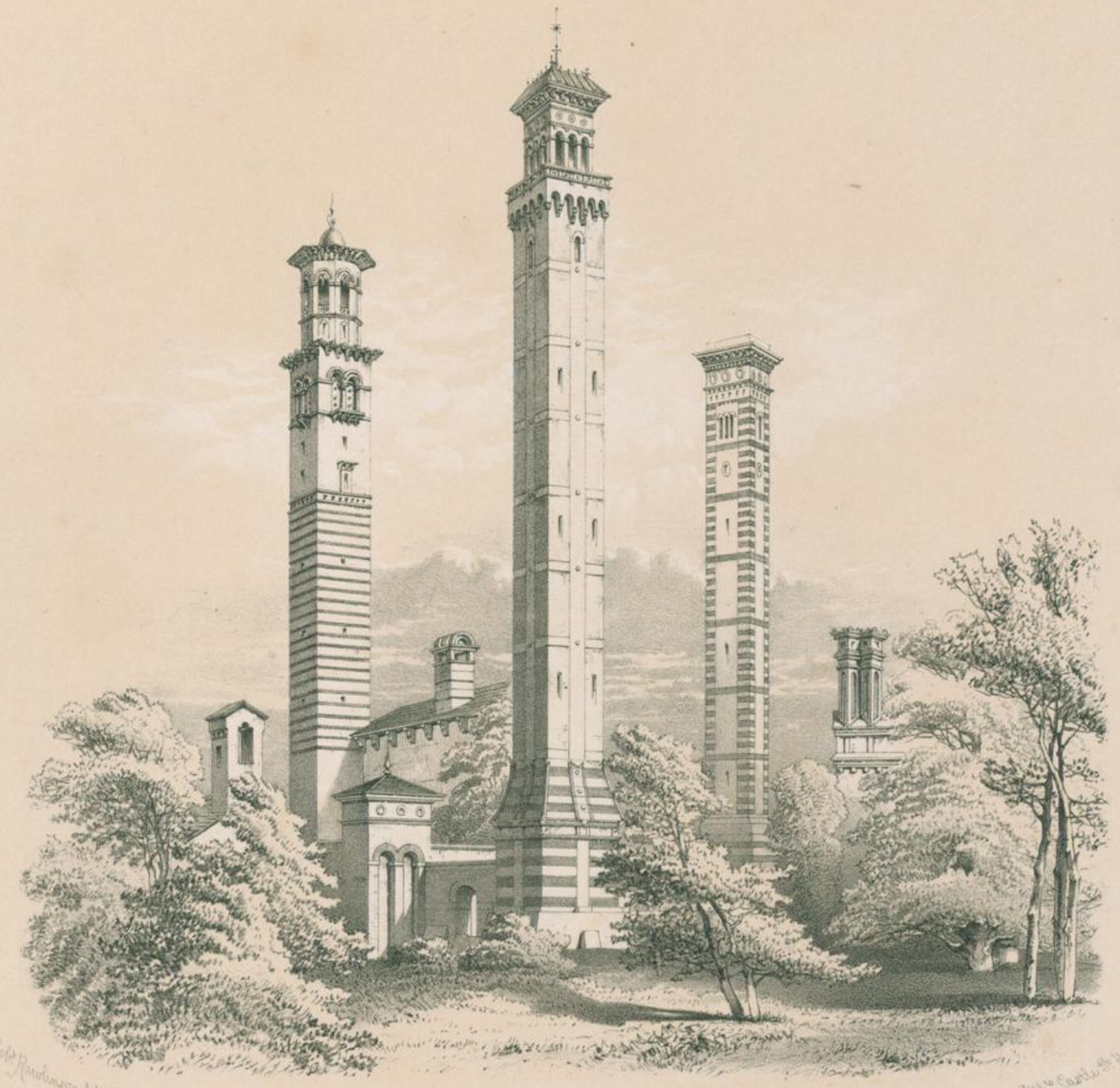


TALL CHIMNEY CONSTRUCTION.

"CHIMNEY construction" may appear to many a very simple theme; but if we examine most of the structures erected to pass smoke and foul vapours into the atmosphere, we shall find that Tall Chimneys are as bald as the theme is simple. To be "as hideous as a factory chimney" has passed into a byword, or proverb, of comparison; and most certainly huge piles of brickwork, without break in line or contour—bare and grimy—cannot be said to present to the eye much to admire. For the most part, factory, and other tall chimneys, have one form,—a vertical base, then a uniform batter, finished at the top by a plain stone coping. Some few tall chimneys have heavy overhanging cornice-finishings, cramped and bound in place. Many of these are, however, lumpy, painful to sight, and dangerous to the structures.

Factory and other tall chimneys, as now erected, cannot be considered eminent for beauty. There are, however, exceptions; and it is to be hoped, that which is exceptional may become the rule.

It will be no new thing to add beauty to a tall chimney, as some of our best architects have designed and erected ornamental tall chimneys in England. In Italy, and throughout the East, towers and minarets have had the best architects of the day for their designers; and they have stood for ages monuments of beauty.

Campaniles, watch-towers, and minarets exist as tall, and as slight in sectional area, as many of our factory chimneys.

These remarks will give the key-note to the designs now placed before the public. The Moresque, the Eastern, and the Italian features and types in the several designs, will no doubt be recognised.

In Italy, and throughout the East, a bare, or positively ugly chimney-shaft, or group of chimneys, is rarely to be seen; but there are hundreds which in design and form please the eye. Our house chimneys are, for the most part, brick abortions, made more frightful by pipes and cowls of pot, zinc, and iron. To be ugly is an evil: but such chimneys are not only ugly,—they are also dangerous.

It has been said, "there is a time for everything." In Italy, during the middle ages, there was a time for building tall towers. In 1159, there were many tall towers in Pisa,* and a proportionate number had been erected in most of the principal cities of Italy. The towers of Asinelli and Garisenda, at Bologna, show how tall-chimney-like they were in appearance. The Asinelli tower remains almost entire, and is 376 feet high. Mr. Gally Knight designates it "a standing monument of pride and absurdity,"—an Asinelli folly. The nobles of Italy built these towers, first, as a means of defence, but subsequently, in rivalry, as a symbol of illustrious birth. They were fashionable; and

* My authority is Gally Knight, but I think there must be some mistake—"ten thousand towers" in one town is a large number.

what will man not do to head a prevailing fashion? The trade requirements of modern times necessitate the building of tall chimneys; and Manchester (in chimneys) can match (for numbers) the numerous tall towers of Pisa, as the manufacturing towns of England can match the other cities of Italy. May we hope that it will become fashionable to strive after grace and ornament;—a tall chimney need not be ugly.

The chimney constructions of mediæval times are only named for the purpose of directing the attention of students to their beauties. Examples are to be found in castles, baronial residences, and in mansions dating from 1400 downwards. Engraved representations exist in well-known architectural works. Old English mansions may also be inspected. There are many modern imitations in pot, in terra-cotta, and in cement. Few of the modern ornamental brick chimneys are, however, worked out as in the honest old times.

There are numerous architectural works in existence which owe their beauty, in a great measure, to terra-cotta ornament and coloured glazed bricks. There are many beautiful examples of enriched arches, strings, panels, and cornices in the buildings of Italy. Much of this ornament is in low relief, and has been designed with elegance and finished with care. In India and in Persia, coloured glazed bricks, and gilded bricks, have been used in remote periods of history. The Byzantines and Moors also used colour externally and internally, with rich, varied, and most beautiful effects. There are many fine old brick buildings in England, in which strings, cornices, and chimneys are admirably wrought in bricks of the period, and endure in almost pristine perfection when stone has crumbled to decay. Most of our best brick buildings are old. Let our Architects once more condescend to design for brick and terra-cotta. Let them pay attention to the make of the materials, so as to insure their coming together in use, and also design and describe minutely the colour and character of the mortar, and we may equal, at least, some of the specimens of antiquity. Cement—terrible cement—has been a great drawback to modern architecture.

The foundation of any building must be the first constructive care of an architect. The foundation of a tall chimney may require extraordinary precautions. Rock will be excavated and dressed off to a level and even bed. Clay, marl, gravel, sand, or varying mixtures of these, may tax all the resources of the engineer or architect. An unequal or uneven foundation—part soft and part hard—is most to be dreaded. A compressible foundation is also unsafe: that is, clay, marl, or shale, compressible by weight. Many of the oolitic and tertiary marls are compressible to considerable depths, and ought not to be trusted, however solid they may seem to be. The probability is, that most of the leaning towers of Italy are founded on such strata. Some of them may stand as designed—architectural tricks; but most of the leaning towers are, no doubt, foundation-failures.

The modern architect has at his command means and appliances of the greatest utility, which were unknown to men in former times. Steam can be brought to aid in driving timber or iron piles, and simple applications of water or air will sink hollow iron piles with comparative ease. The old eastern plan of forming wells, and then filling them up with concrete, has been too much neglected. Modern well-sinkers will go down in any strata, almost to any depth,—certainly to any depth required in practice,—and a secure foundation may thus be made for the loftiest structure in the most difficult ground. Masses of concrete, or of brick or stonework, placed on a compressible substratum, however cramped and bound, may prove unsafe. Solidity from a considerable depth can alone be relied upon.

Enlarging the area of a base or foundation by footings can be resorted to; but mere enlargement of area may not in itself be sufficient. A lofty structure which is to stand secure, must have solidity sufficient to maintain each part in the position in which it is first placed.

Foundations are too frequently slighted, or labour and material are wrongly applied. The

compressibility of oolitic and tertiary clays can only be overcome by piling, deep sinking, heavy ramming, or heavy weighting. The point of bearing must be carried below any possibility of upward reaction. A heavy embankment, or heavy pile of building, frequently disturbs the surface-ground at a distance of many yards, the subsidence causing a corresponding rise around, or on either side, as the case may be. A tall chimney, or tower of like proportions, built on such a foundation, if not made safe to a sufficient depth, would become a "leaning tower," if not actually a falling tower. Probably the depth of a foundation in compressible ground ought not to be less than one-fourth the intended height above-ground. That is, for a shaft of 200 feet, the foundation should be made secure to a depth of 50 feet. This can easily be done by piling, or by well-sinking and concrete.

The lofty towers of Italy, and the minarets of the East, are, for the most part, constructed with bricks and mortar, and neither the one nor the other is better, if so good as the modern architect may have at his command. The proportion of brick to mortar in the foreign structures differs, however, most materially from modern practice.

The bricks of Italy and of the East are generally very thin in proportion to area of bed—nine inches square by inch, or at the most inch-and-a-quarter in thickness. These bricks, or tiles, are frequently set or bedded in mortar as thickly spread as the brick ; so that there is almost as much mortar as brick. The permanence of the work is in a great measure dependent on this liberal use of hard-setting, tough mortar. The tornado's sweep, and the earthquake's shock, have alike failed to overthrow these slender and lofty piles ; though many times they must have shaken, vibrated, and bent under the furious effects of the contending elements, and tremblings of the earth. The elasticity and tenacity of the mortar has, probably, alone preserved the structures from sudden overthrow. It is a modern practice to stint the use of mortar. Specifications generally set forth that a bed of mortar shall not exceed one-eighth of an inch. It will be a new clause—but not any less useful one—if at times it is specified that a bed of mortar shall not be less in thickness than half or quarter of an inch. In tall chimneys or towers the mortar should be of the best quality ; it should be ground by horse or steam power, and should be used liberally.

Those who wish to ascertain the quality and power of mortar have only to visit the Liverpool Docks, and inspect the works of Jesse Hartley. They will there find river and dock walls having in their composition almost as much mortar as stone, and the one as enduring as the other, although that stone is the hardest and best granite.

With thin bricks and thick beds of mortar the Italians used iron bolts for bond, and some of the eastern minarets have poles of timber enclosed vertically in them. Timber cannot, of course, be used in tall chimneys, but hoop-iron for bond is well known to the profession, and its aid is highly desirable for many purposes. Rods or bolts of wrought-iron to give vertical tie may be used ; but all tall structures should depend on the cohesion and gravity of the materials for stability and permanence, rather than on iron or other aids.

Tall chimneys have elements of destruction to contend with which are absent in Italian tower and eastern minaret ; namely, great heat, and gases which may affect and destroy both bricks and mortar. The only remedy against these elements will be, so to design and construct the chimney as to have an inner lining of the flue, which may be cut out, taken away, and be replaced without endangering the structure. A space ; or, air-chamber, betwixt the true shaft and lining will be of great service in preserving the whole.

Towers and minarets have, for the most part, internal stairs or means of access up them. Our largest and tallest chimneys may easily have means of access provided, as, also, means for erecting temporary scaffolding for examination and repairs, should repairs be required. This hint will, I doubt not, be sufficient. An architect or an engineer should provide for all contingencies, and not build a

tower or chimney three hundred feet in height and remove his scaffolding, without having considered the means of future examination and repairs. A recess with step and hand-irons, and putlock holes at regular stages, properly formed for easy use, may furnish means within the shaft. Openings through the shaft may form part of the design ; such openings having the character of sunk spaces, the formed space being filled in, but affording means for the removal of the filling without fracturing the main work of the shaft. All tall chimneys or towers should have proper electric conductors secured in the best manner.

Colour and ornament may be used in tall chimneys : contrast of colour may be made to produce ornament. The common bricks of almost any district may be sorted so as to produce contrast in tint or "tone"—red, and yellow or "cream colour." This tint of the bricks may be preserved and heightened by using mortar of the same tone or tint. Furnace-ashes and lime will produce a dark mortar ; pounded red brick or red tile mixed with lime will give a red tone to mortar ; and cheap mineral colours may be added to mortar for pointing. The colour of mortar is sadly neglected, as, generally, the same white lime and sand are used for all tones of colour in bricks, and not unfrequently white putty-mortar is used for jointing the reddest, as well as the lightest coloured bricks ;—the light-coloured work having harmony of breadth and keeping,—the red brick portion being frittered and broken up by the contrast, betwixt bricks and beds and joints.

If precedent may be our guide in outline, it may also be a guide in the use of coloured contrast ; and although the use of marbles of various colours with stone and with bricks, is designated "strange and preposterous," there is at present a leaning in favour of colour. There are plenty of brick and stone fronts dreary and wearying to the imagination. The oppressive feeling produced by a red brick-built town—is one of lasting disappointment.

The best brick structures of England and of the Continent, are worthy of being more studied, as also the buildings in which alternate courses of bricks, stone, or marbles are used. Why should modern architects shrink from using "white, black, red, brown," or any other colour, if monotony can be prevented, and the eye and mind gratified ?

In using colour, there should be breadth and harmony, that is, "keeping." The laws of colour must be well understood, and these laws must be attended to. As in music, so in outline and in colour, the student must learn well the gamut, and attend to his thirds, fifths, and octaves, or discord will be the result of his labours—and discords in architecture are quite as disagreeable to the feelings as discords in music.

In recommending the use of moulded and coloured bricks, as also terra-cotta, attention may be directed to the annual Architectural Exhibitions in Suffolk Street, London, where specimens of materials may be seen. The catalogues furnish full information, both as to makers' names and places of manufacture.

The time is ripe for originality of design in the use of brick, if our young architect will only grapple boldly with existing difficulties. Manufacturers may be found who will second his wishes, if his plans and sketches are only practicable. They must be practicable not only to the maker, but also to the bricklayer. Any new forms of brick must work in bond, or in course, with common bricks. The dimensions of any new forms in brick, or terra-cotta, should also not exceed the easy manipulation of the material from the clay state to the finished and burned brick or tile ; and the form, in all cases, should be one of strength, both before use and after it has been set in any building. The form and dimensions of a common brick are perfection—there is strength, facility for handling, and adaptability to work any useful bond. Common bricks may also be arranged to form a vast variety of ornament.

In the designs now submitted, vertical lines are, for the most part, used, where existing structures (tall chimneys) invariably batter. There is great beauty in a vertical line.

Most of the designs are for detached structures; and it is desirable that tall chimneys should stand detached, on their own base. A special foundation should then be prepared; and the chimney will not depend on any building for support, nor injure nor be injured by vibration, nor by partial settlement in the foundations. The vertical form adopted almost throughout, may be objected to as offering a larger area for wind to act upon: the wind will not, however, injure a sound structure standing on a good foundation. The force of wind in our greatest storms rarely reaches 30lb. on the square foot; the gravity of any chimney is much greater than this. Eastern minarets and Italian towers stand not only storms of wind, but also shocks of earthquakes.

In no case are quoins shown, either in plinth or in shaft, and their adoption is repudiated to the uttermost. Whatever material is used, must set in course with the bricks, or must form entire courses round plinth or shaft. This rule should have no exception, but should apply from foundation to summit. An external band of stone may be backed up with brick to receive the action of fire or heat; but, in such case, the stone should set in bond with some exact number of courses of bricks, so that the whole may be grouted and flushed into solidity.

In arranging cornices and roofs on chimneys, it may be necessary to use iron bond and iron cramps. In such cases, great care must be taken so to use the metal as to run the least risk from contraction or expansion. It is practicable to combine iron with stone and brickwork, so as to ensure strength and safety; but the combination must not be lightly undertaken nor be carelessly made.

Several modern tall chimneys have fallen in consequence of over-weighting at the top. A tall chimney, top-heavy, is easily made to sway or rock in a storm of wind, until the vibrations increase beyond the power of stability. Tall chimneys should diminish in thickness and in weight of material from base to summit: the top-finishing, in all cases, being as light as is compatible with security and endurance.

The sketches must be taken as hints to students, rather than actual designs to criticise rigidly; any person contemplating the execution of such a structure as No. 3, for instance, on making out enlarged plans of the details, will find that, by simply altering the form of a few brick-moulds, he may have bricks burned to the form required almost as cheaply as plain bricks are manufactured. There should not be any cutting of bricks, if possible, but all face-work should have the fire-skin preserved.

In proposing contrast in colour by brickwork, it is not contemplated to obtain costly bricks from a distance; for the mass of the work the common bricks of a district may be so assorted, and set in mortar of the same tone of colour, as to effect all the contrast required. Moulded bricks for ornamental purposes, being required in small quantities, may be obtained from a distance without adding very much to the whole cost.

Thought and judgment in the design, and care in the execution of any work, will tell more than mere expense in ornament.

The sketches embody certain ideas long entertained as to the infusion of design into tall chimneys.

My thanks are due to the Messrs. Kell, Brothers, for the great attention they have given to the production of the plates in this work; as also to Mr. Mathews, for assistance in the designs. The Messrs. Kell are more than mere lithographers,—some of the architectural features in the work being due to their suggestions.

ROBERT RAWLINSON, C.E.

London, *December*, 1858.

LIST OF PLATES.

I.—Detached Chimney-Shaft in common bricks, sorted, set, and pointed, in alternating bands of two colours. Stone used in base and in entablature. Designed for Wigan water-works (not executed).

II.—Chimney-Shaft in common bricks, sorted, set, and pointed—as shown. Terra-cotta ornaments in entablature.

III.—Decorated Shaft. The main body of the Shaft may be common bricks: the sunk panels and reticulated bands must be of bricks specially prepared: stone plinth, terra-cotta cornice, and cast-iron half roof secured by vertical tie-bolts.

IV.—Square vertical Shaft in common bricks, sorted and set in bands, brick and terra-cotta cornice.

V.—Chimney and ventilating Shaft in bricks of two colours, with terra-cotta ornaments, and open roof of cast-iron.

VI.—Detached Shaft in common brickwork, stone plinth-courses, terra-cotta cornice, and cast-iron roof.

VII.—Detached Chimney-Shaft in brickwork, canted octagonally, terra-cotta cornices, and open roof of cast-iron.

VIII.—Clock Tower and ventilating Shaft in brickwork, terra-cotta cornices, and cast-iron roofs. There must be a central staircase of cast-iron steps.

IX.—Ventilating Tower, or Chimney-Shaft, in brickwork, with terra-cotta cornices and open cast-iron roof. (For original, see Campanile Piazza de' Signori, Verona.)

X.—Detached Chimney-Shaft either of brickwork or thin coursed wall-stone, castellated battlement finishings. Such a Chimney may be erected in or near some of our old county cities or towns.

XI.—Detached Shaft of brickwork of two colours, stone base, terra-cotta battlement and cornice, open cast-iron roof.

XII.—Detached Shaft of brickwork, reticulated terra-cotta bands, stone and terra-cotta finishings and cornice.

XIII.—Brick Chimney with canted angles, open turret, finishing of terra-cotta and cast-iron.

XIV.—Brick Shaft, terra-cotta ornament in cornice, cast-iron roof.

XV.—Shaft: may be executed in brick and terra-cotta, or in thin-bedded wall-stone.

XVI.—Shaft: may be in brickwork, the ornamental portion in terra-cotta. The forms in this design (arches) may be repeated.

XVII.—Water Tower and part of Engine-house; the tower may be of brick with stone dressings, the tank and cornice will be of cast-iron, the roof of tile.

XVIII.—Design for Engine-house, Chimney, and Water Tower. The structures may be brick, the ornament terra-cotta, the balconies, roofs, and tank cast-iron.

XIX.—Design for Pumping Establishment for Town Water Works. Central engine-house, boiler-houses on each side, chimney detached. May be of brick with stone dressings. Tile roofs to engine-house and boiler-houses, open cast-iron roof to chimney.

XIXA.—Design for Water Tower and detached Chimney-Shaft. The tank and cornice of cast-iron, the roof of tile.

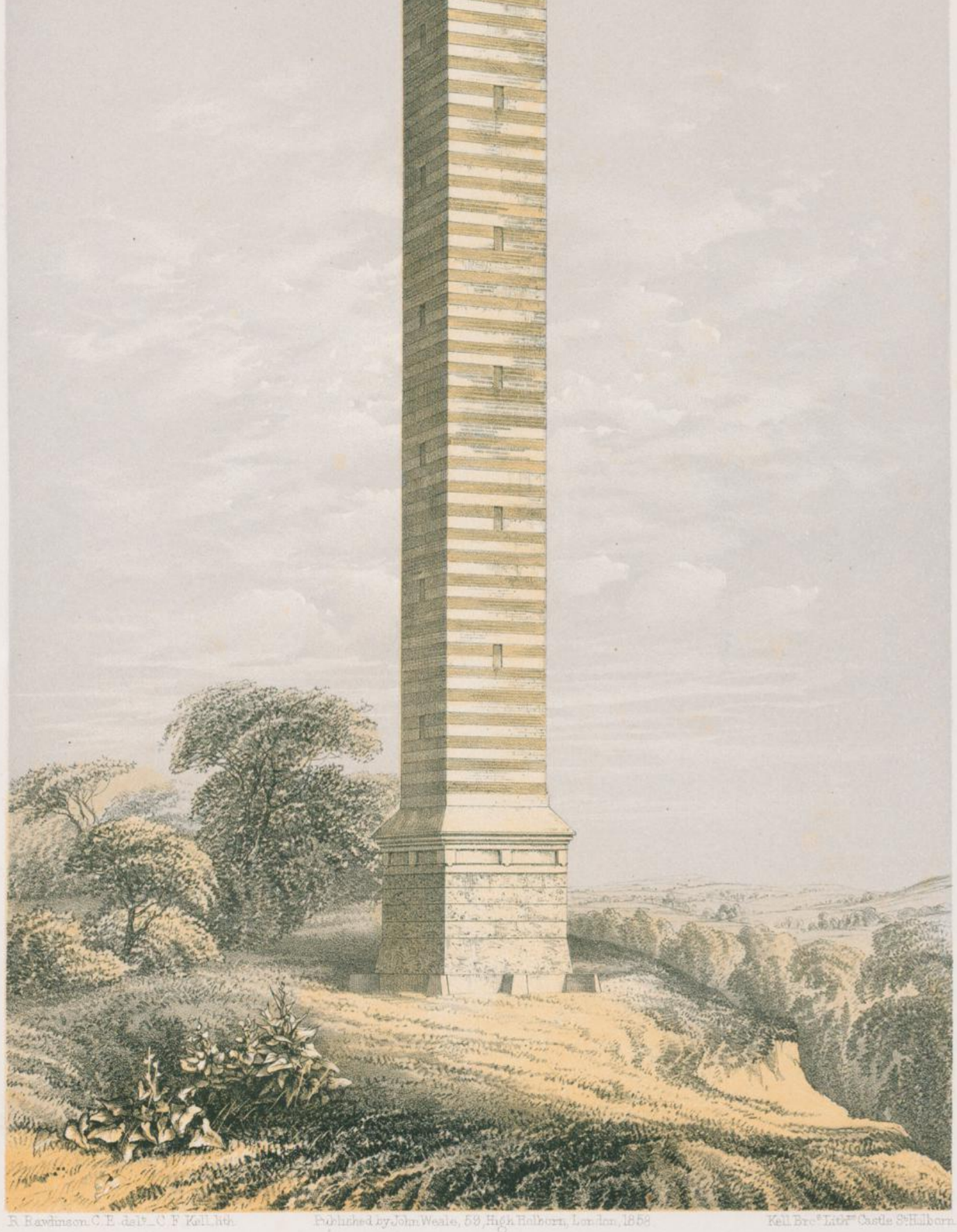
XX.—Engine-house, Chimney, and Water Tower, erected at Worthing. Bricks of two colours have been used, and Caen stone dressings. Roof of chimney is cast-iron (open), tank is of cast-iron, roof of tank of red tile. The tower is 40 feet square, the tank is 12 feet deep, and will contain 110,000 gallons of water. There is a central staircase of cast-iron passing up the tower and through the tank.

XXI.—Six designs for Chimney finishings in brick, terra-cotta, and cast-iron.

XXII.—Details of Chimney-Shaft.

XXIII.—Ditto.

XXIV.—Details of cast-iron Roof.



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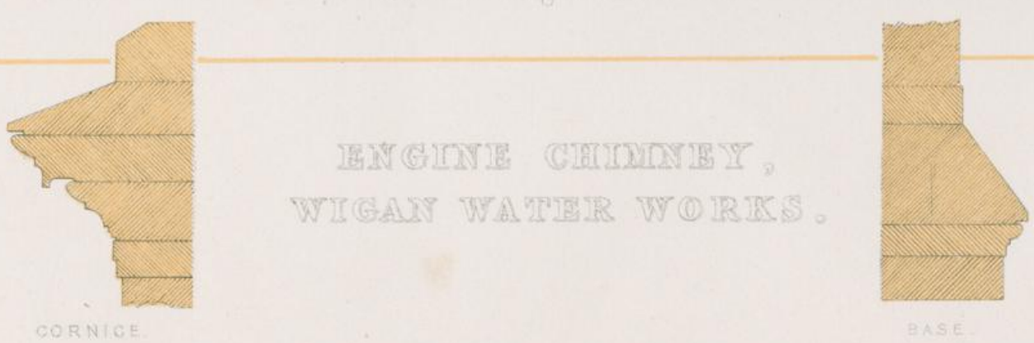

CORNICE.

BASE.

ENGINE CHIMNEY,
WIGAN WATER WORKS.

PLATE No 1.

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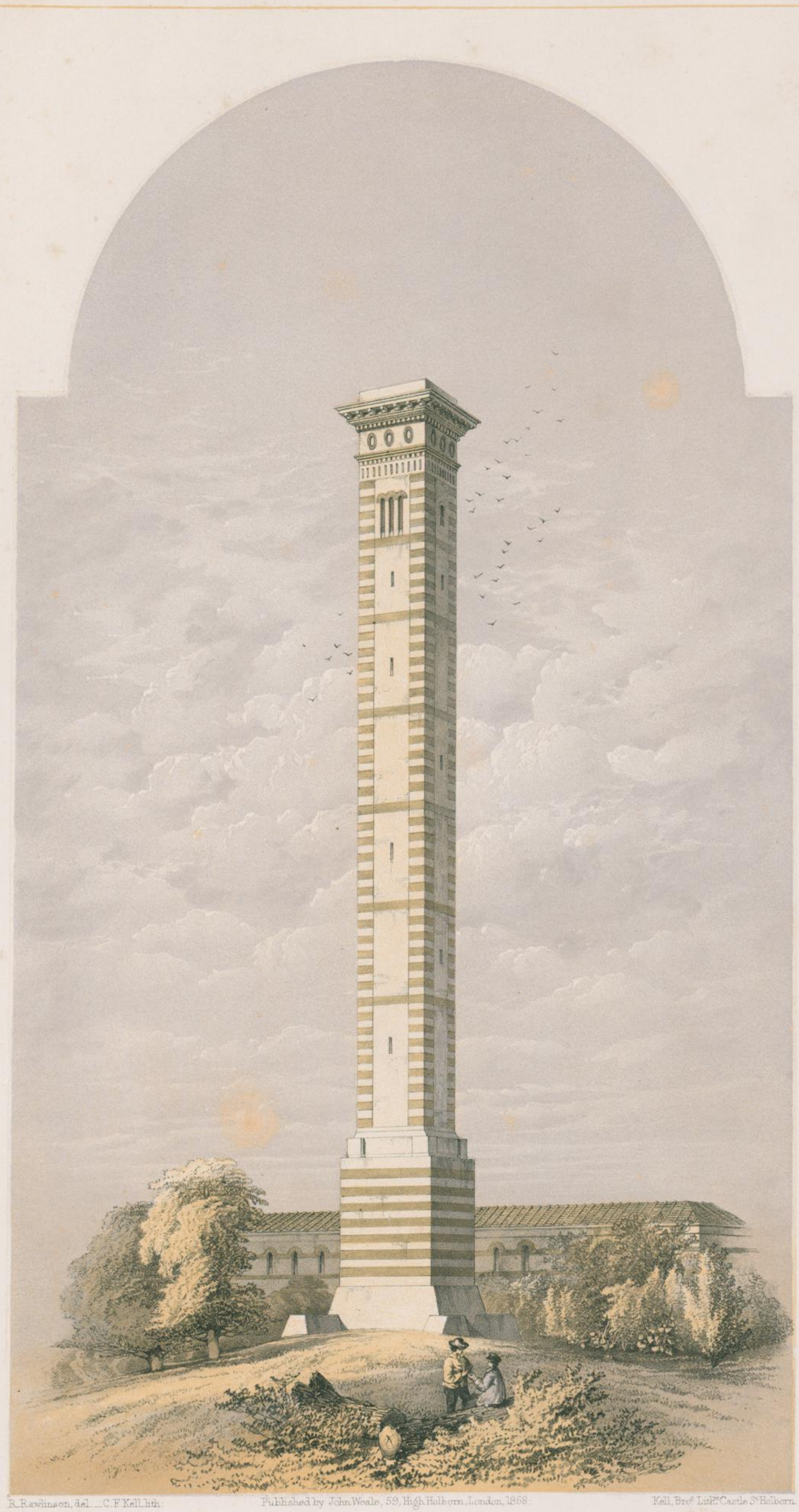

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DETACHED CHIMNEY SHAFT FOR ENGINEERS WORKSHOPS.

R. Rawlinson C.E. del. C.F. Kell, lith.

Published by John Weale, 59, High Holborn, London, 1858.

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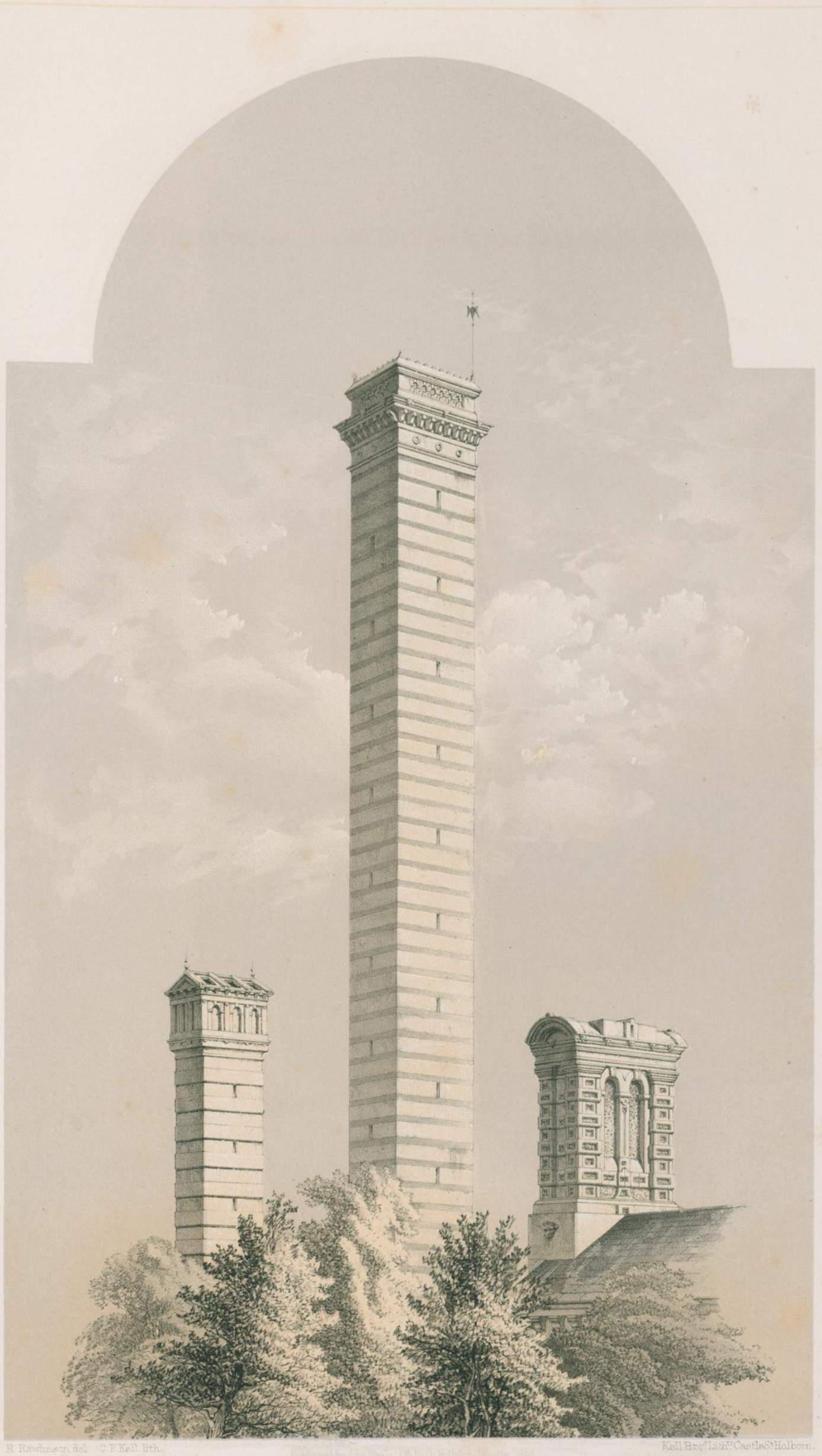
DECORATED CHIMNEY SHAFT.

PLATE № 3.



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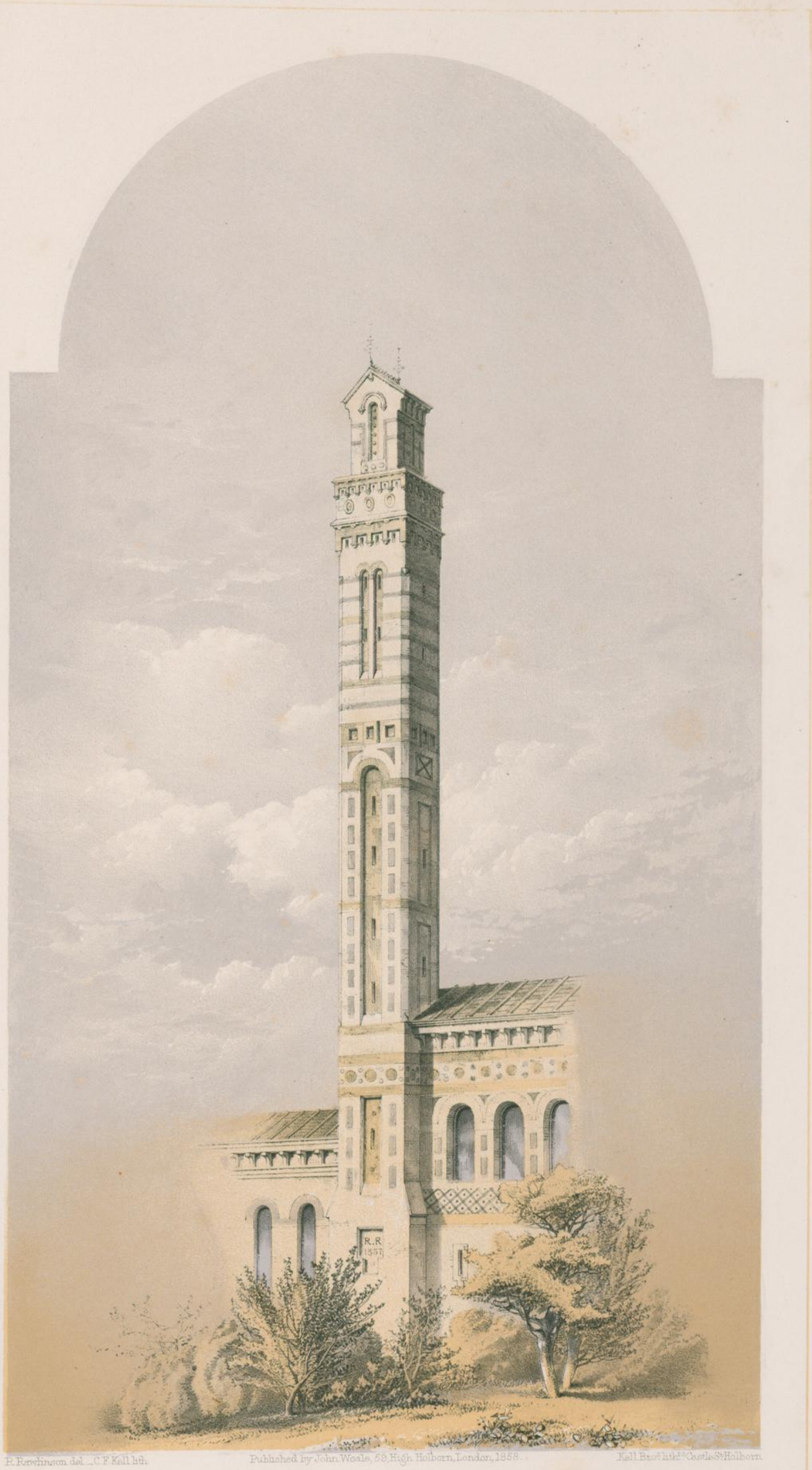
SHAFT FOR SEWER VENTILATION.

PLATE. No. 4.



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CHIMNEY SHAFT FOR BATHS AND WASHOUSES.

PLATE No 5

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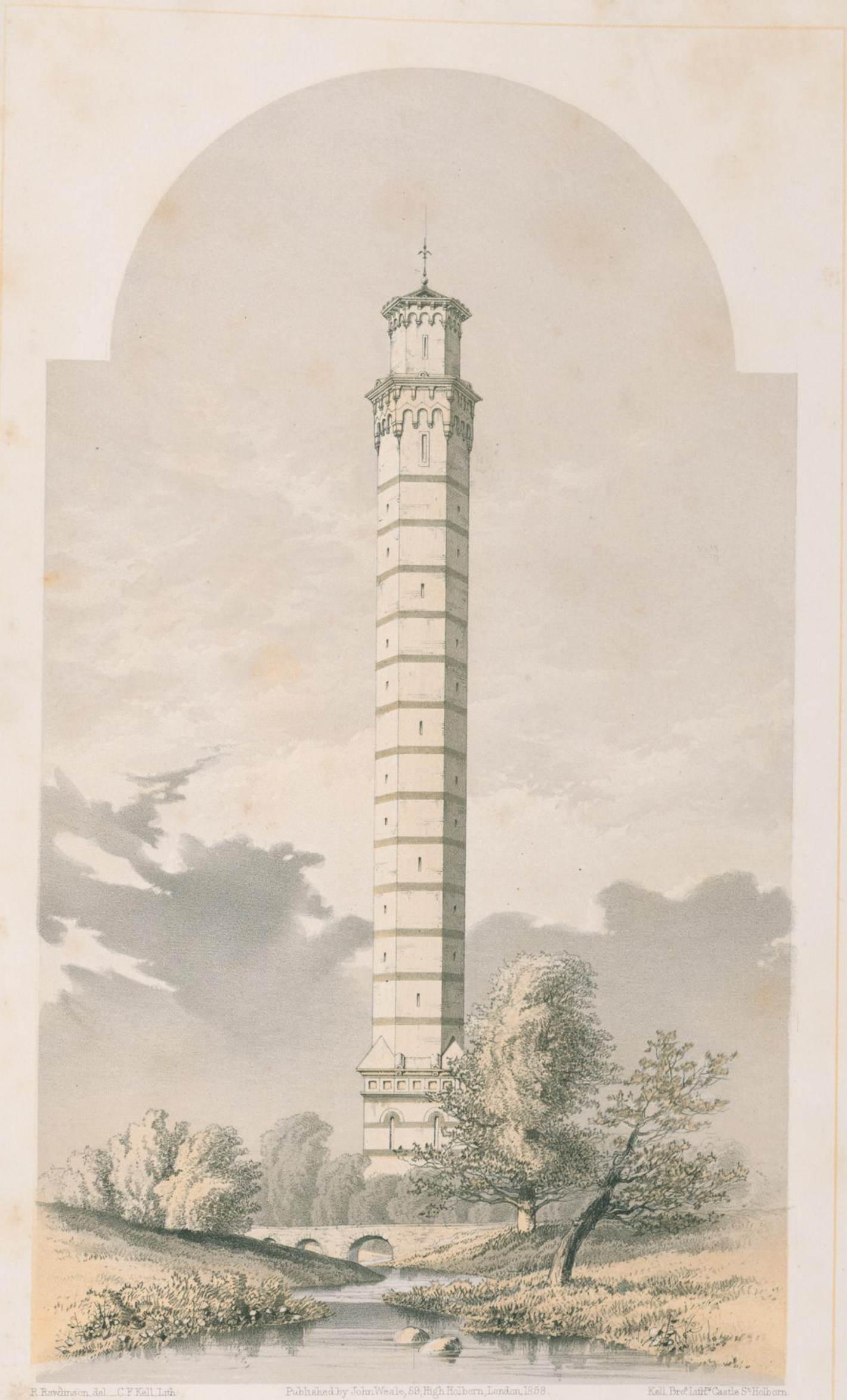
DETACHED CHIMNEY SHAFT FOR ENGINE WORKS.



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DETACHED CHIMNEY SHAFT.

PLATE No. 7.

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CLOCK TOWER AND VENTILATING SHAFT.

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Published, by John Weale, 59, High Holborn, London, 1858.

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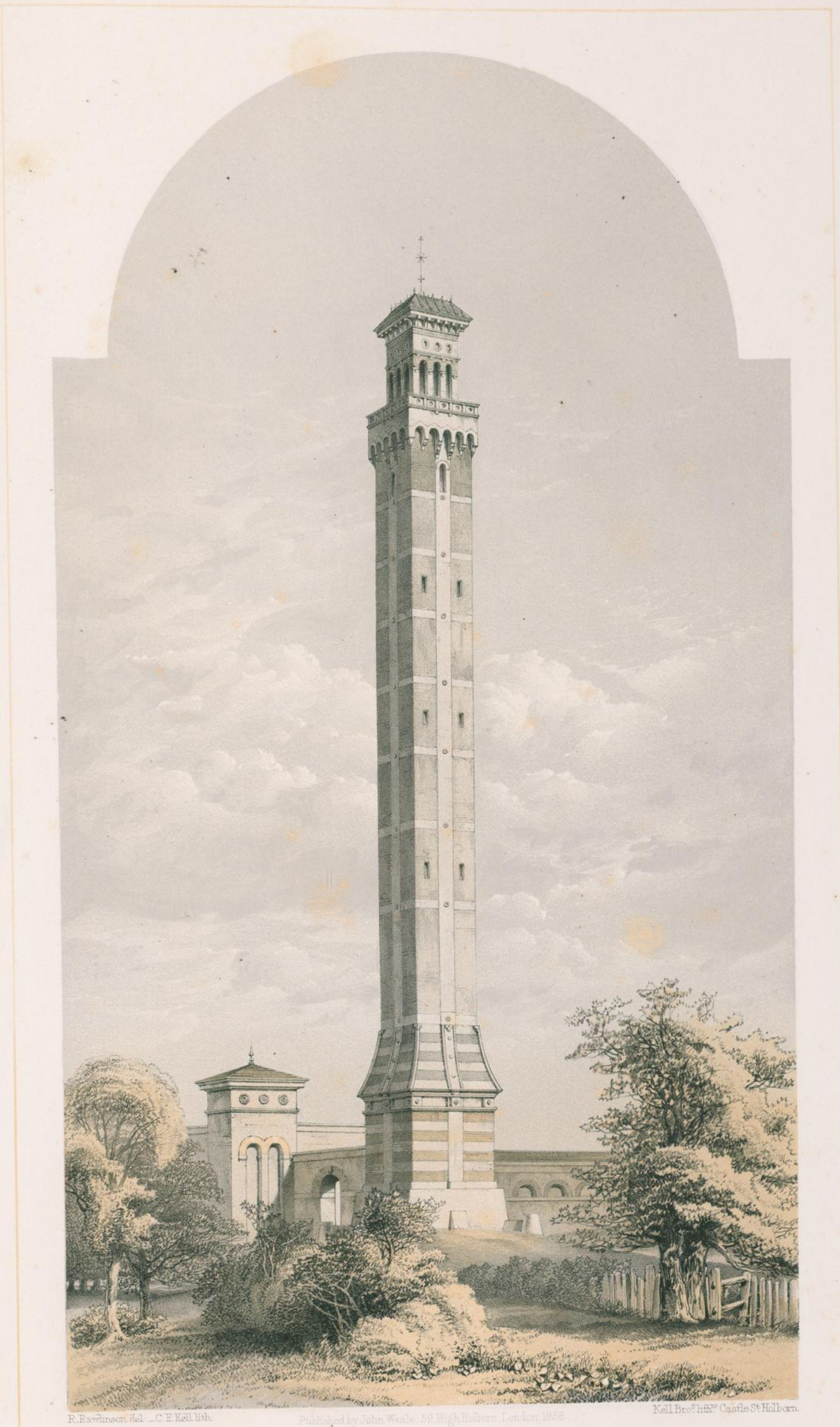
VENTILATING TOWER.

PLATE No. 9

R. Rawlinson C.E. del. C.F. Kell lith. Published by John Weale, 59, High Holborn, London, 1858. Kell Bros. Lith.rs Castle St. Holborn.

CASTELLATED CHIMNEY SHAFT.

PLATE No 10.



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CHIMNEY SHAFT FOR FACTORY.

PLATE N°11.

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CHIMNEY OR VENTILATING TOWER.

PLATE N° 12

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CHIMNEY SHAFT FOR SUBURBAN WORKS.

PLATE Nº 13.

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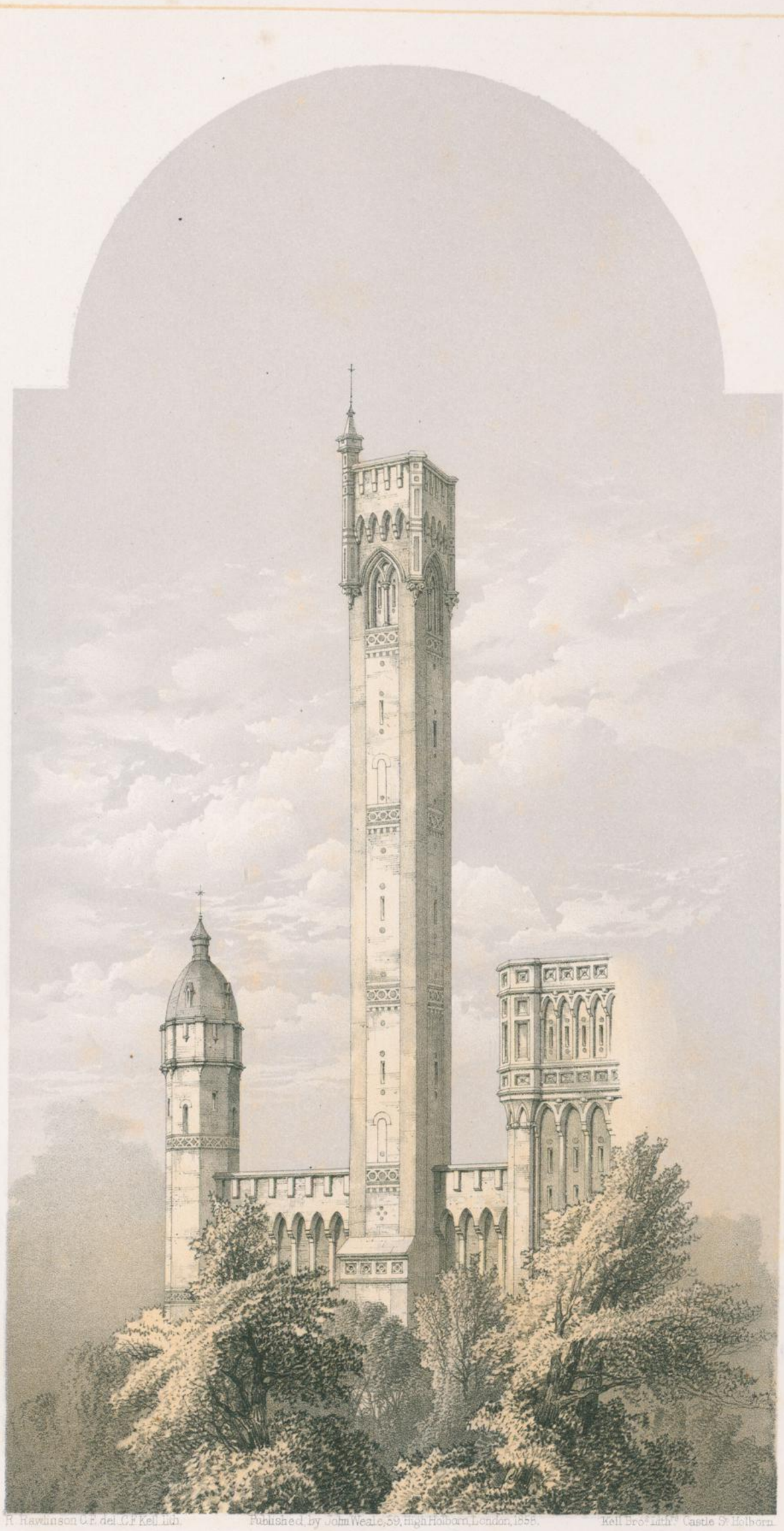
VENTILATING SHAFT FOR A BARONIAL RESIDENCE

PLATE Nº 14



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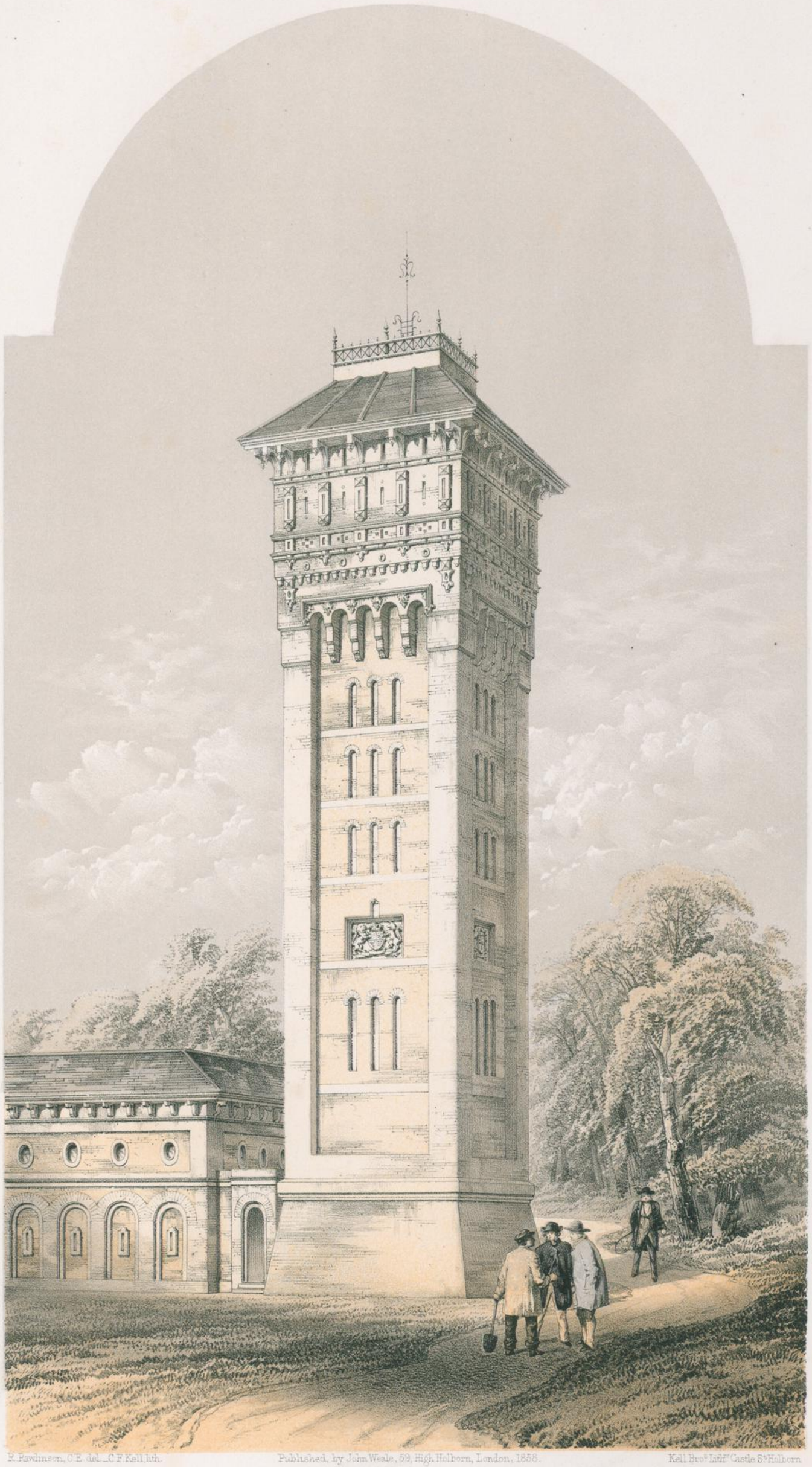
VENTILATING SHAFT FOR COUNTRY MANSION.

PLATE Nº 15.

R. Pawlinson, C.E. del. C.F. Kell lith. — Published by John Weale, 59, High Holborn, London, 1858. — Kell Bros. Lith.rs Castle St. Holborn.

CHIMNEY SHAFT OR VENTILATING TOWER.

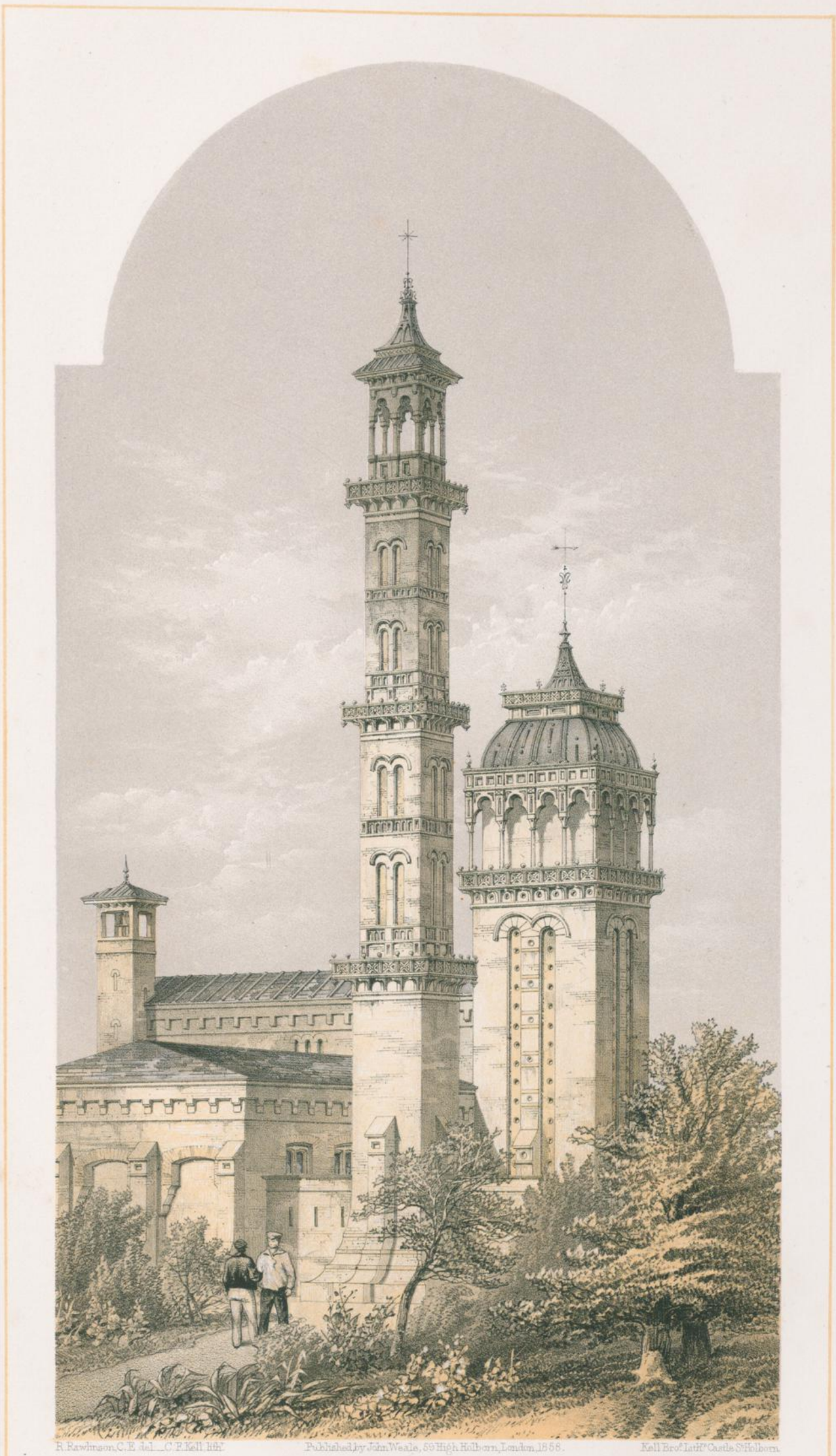
PLATE Nº 16.



R. Rawlinson, C.E. del. C.F. Kell lith. Published, by John Weale, 59, High Holborn, London, 1858. Kell Bro^s Lith^rs Castle St^t Holborn

ENGINE HOUSE AND WATER TOWER, N^o 1.

PLATE N^o 17.



R. Rawlinson, C.E. del. — C.F. Kell, lith. Published by John Weale, 59 High Holborn, London, 1858. Kell Bros. Lith.rs Castle St. Holborn.

ENGINE HOUSE AND WATER TOWER, Nº 2.

PLATE Nº 18.

R. Rawlinson, C.E. delt. C.F. Kell, lith.

Published by John Weale, High Holborn, London, 1853.

Kell Bros. Lith. 7 Castle St. Holborn.

WATER WORKS,

ENGINE HOUSE, BOILER HOUSES AND CHIMNEY SHAFT.

R. Rawlinson C.E. del. C.F. Kell lith. Published by John Weale, 59 High Holborn, London, 1858 Kell Bro's Lith.

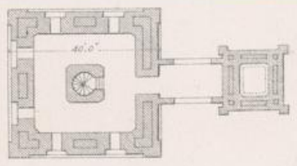
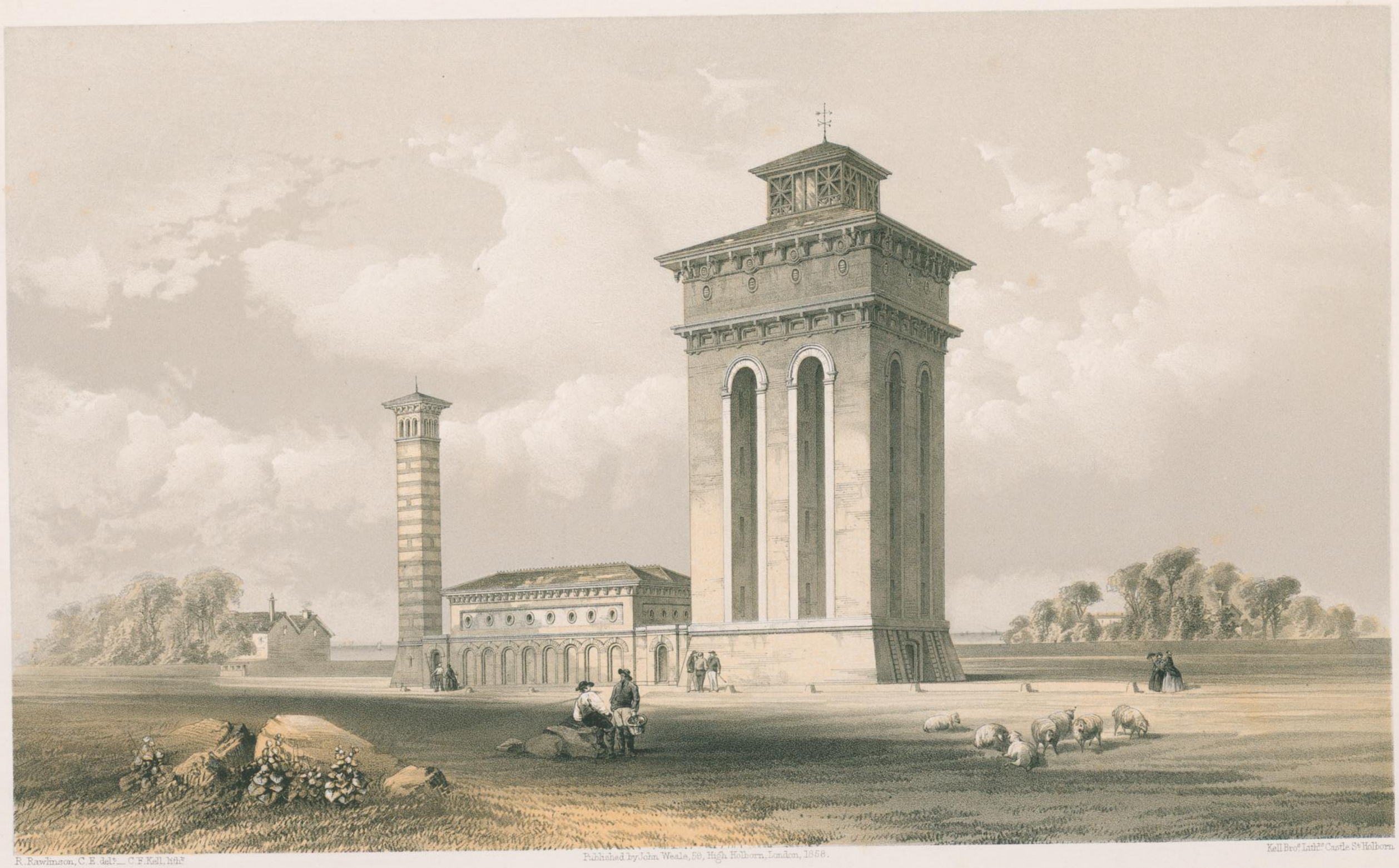
WATER TOWER AND  ENGINE CHIMNEY.

PLATE No 19A



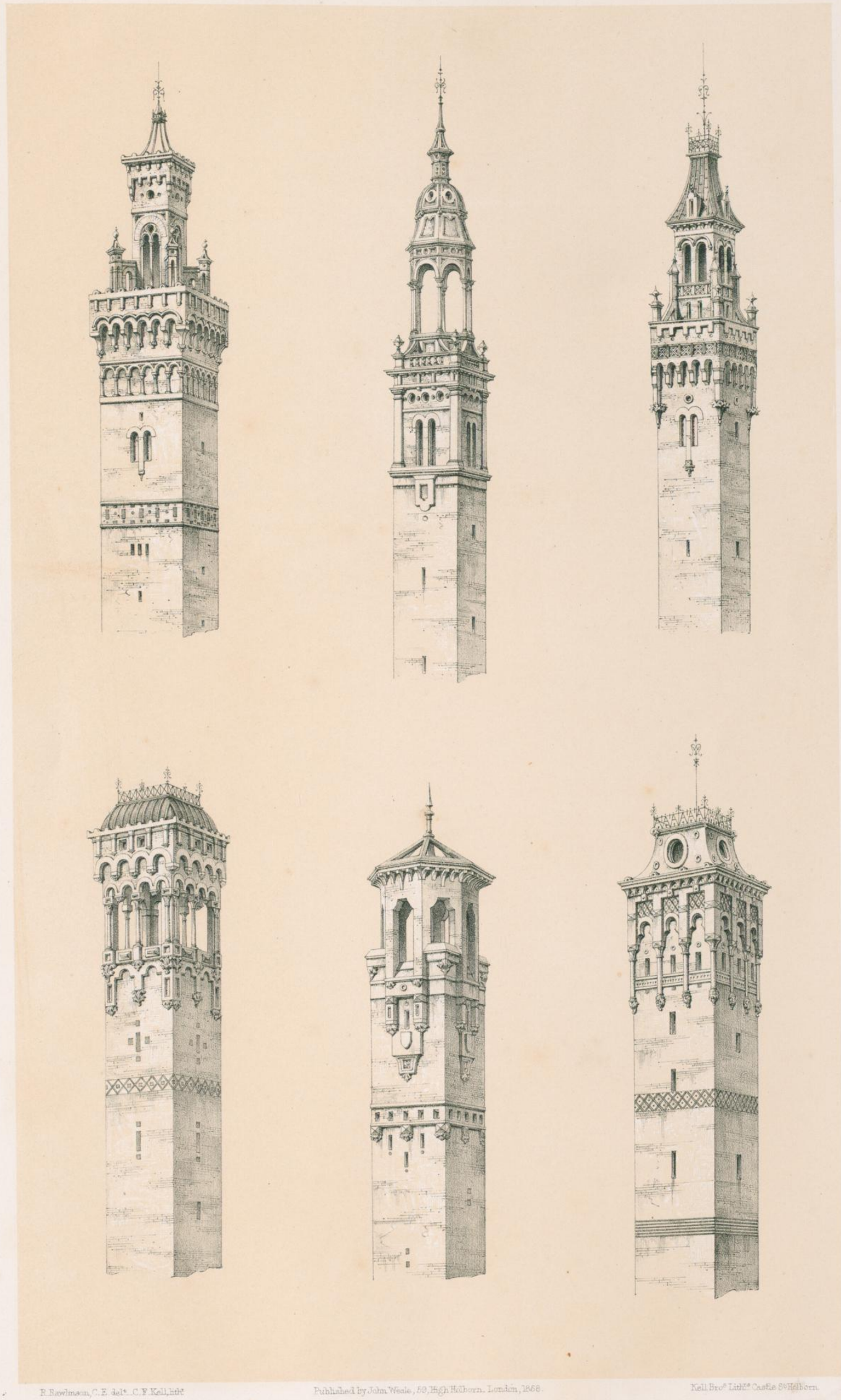
R. Rawlinson, C.E. delt.— C.F. Kell, Lith.r

Published by John Weale, 59, High Holborn, London, 1858.

Kell Bros' Lith.rs Castle St Holborn.

WORTHING WATERWORKS.

PLATE No 20.

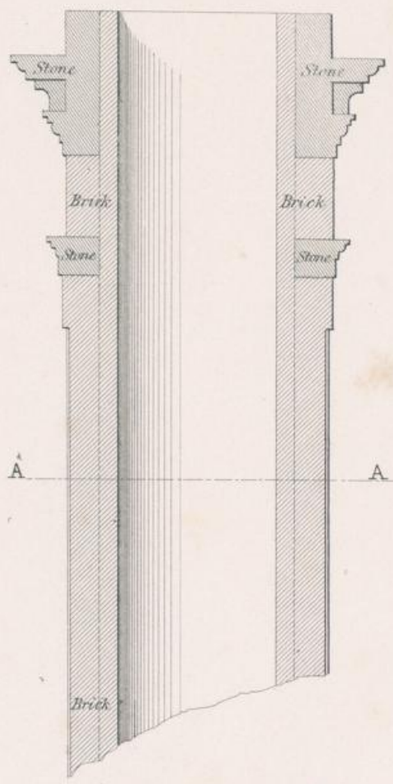


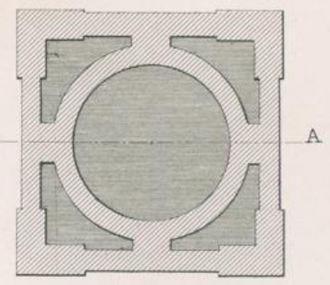
R. Rawlinson, C.E. delt. C.F. Kell, lithr. Published by John Weale, 59, High Holborn, London, 1868. Kell Bros. Lithrs. Castle St. Holborn.

DESIGNS FOR CHIMNEY AND VENTILATING SHAFT TOP FINISHINGS.

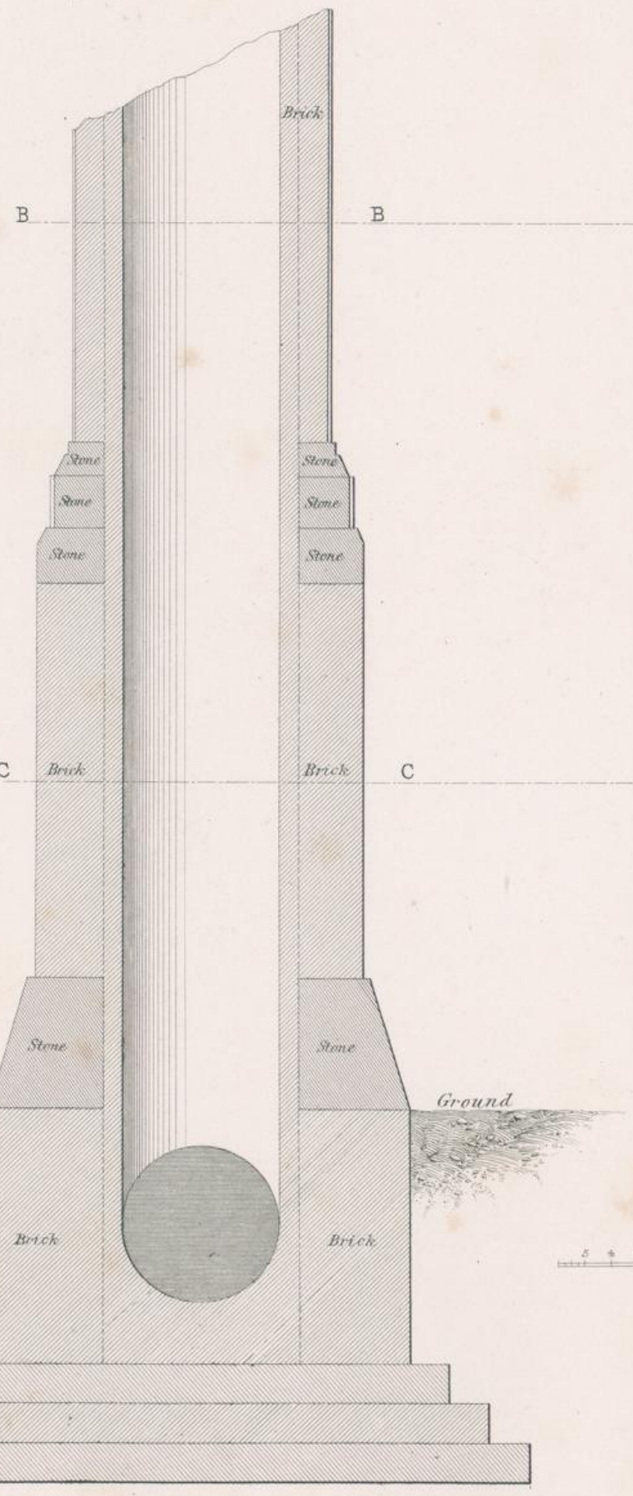
DETAILS OF CHIMNEYS.

No. 22.

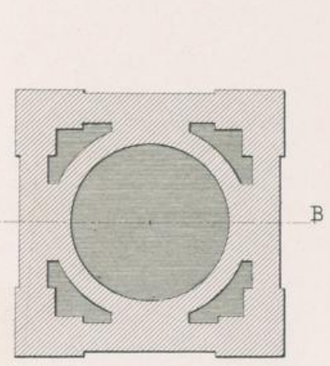




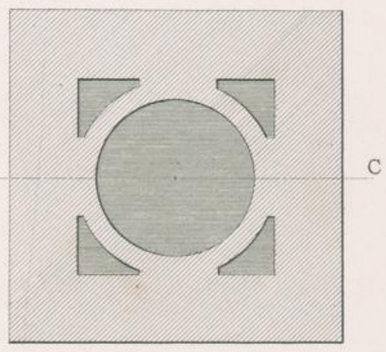
PLAN AT A.A.



SECTION.



PLAN AT B.B.



PLAN AT C.C.

SCALE.

5 4 3 2 1 0 5 10 15 FEET.

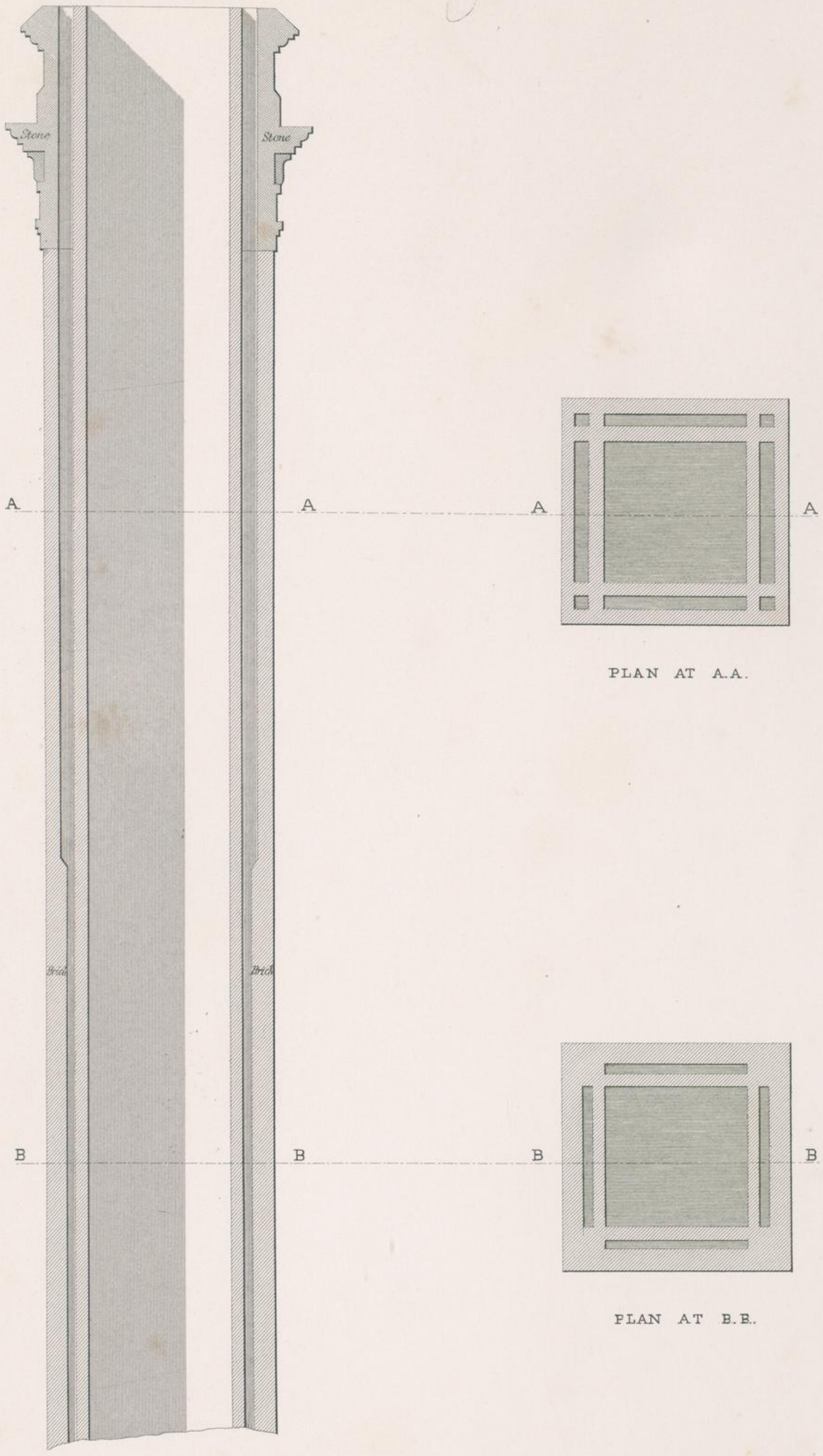
R. RAWLINSON C.E. DEL.

KELL BROS LITH^RS CASTLE ST^ HOLBORN.

Published by John Weale, 59, High Holborn, London, 1858.

DETAILS OF CHIMNEYS.

No. 23.



PLAN AT A.A.

PLAN AT B.B.

SECTION

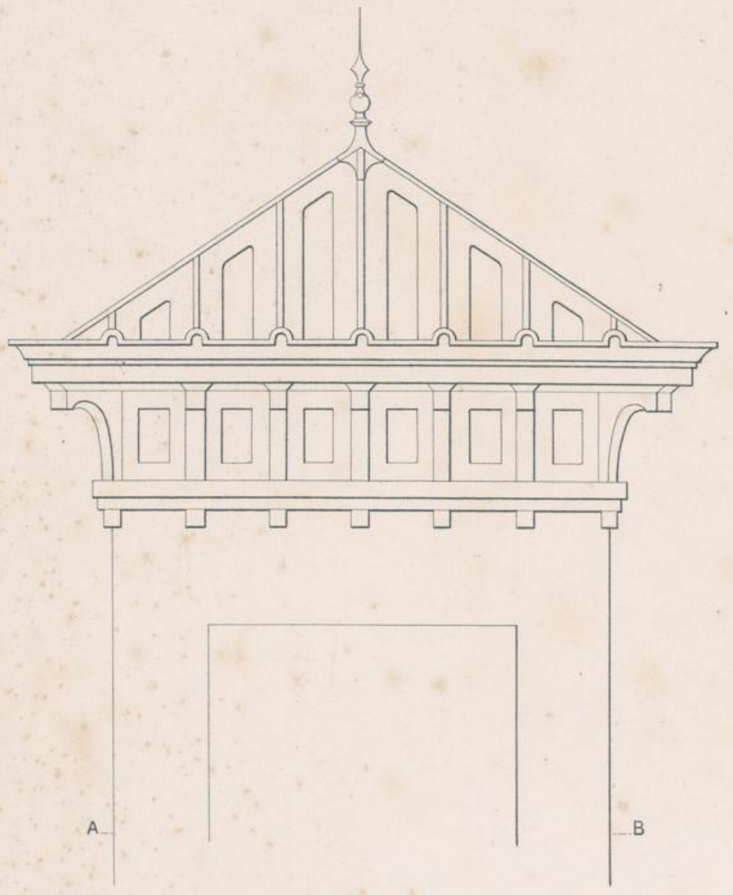
R. RAWLINSON C.E. DEL.T

KELL BRO.S LITH.RS CASTLE S.T HOLBORN.

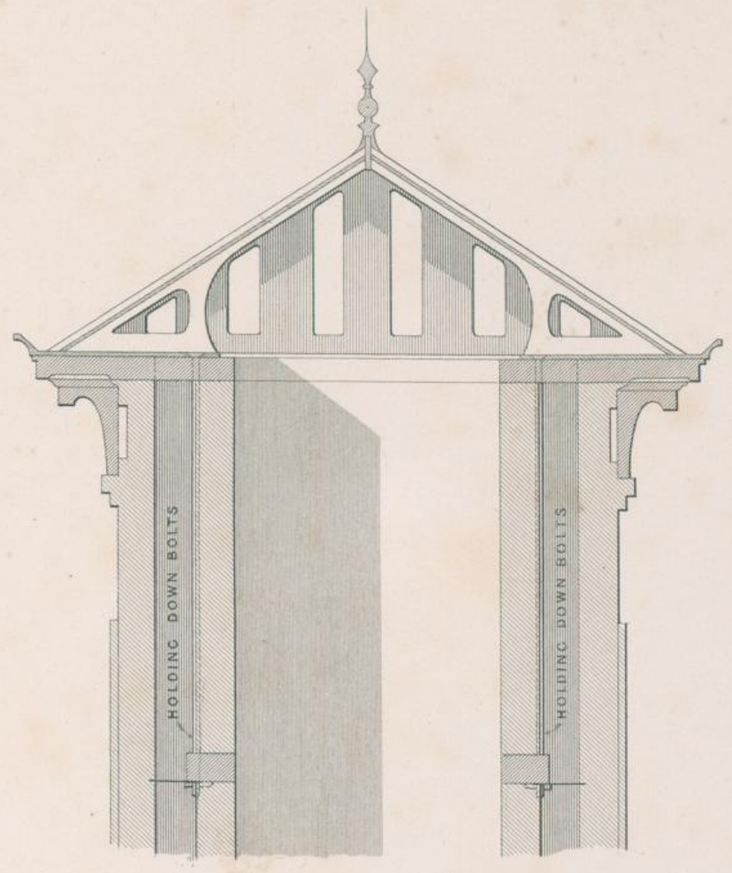
Published by John Weale, 59, High Holborn, London, 1858.

DETAILS OF CAST IRON CHIMNEY ROOF.

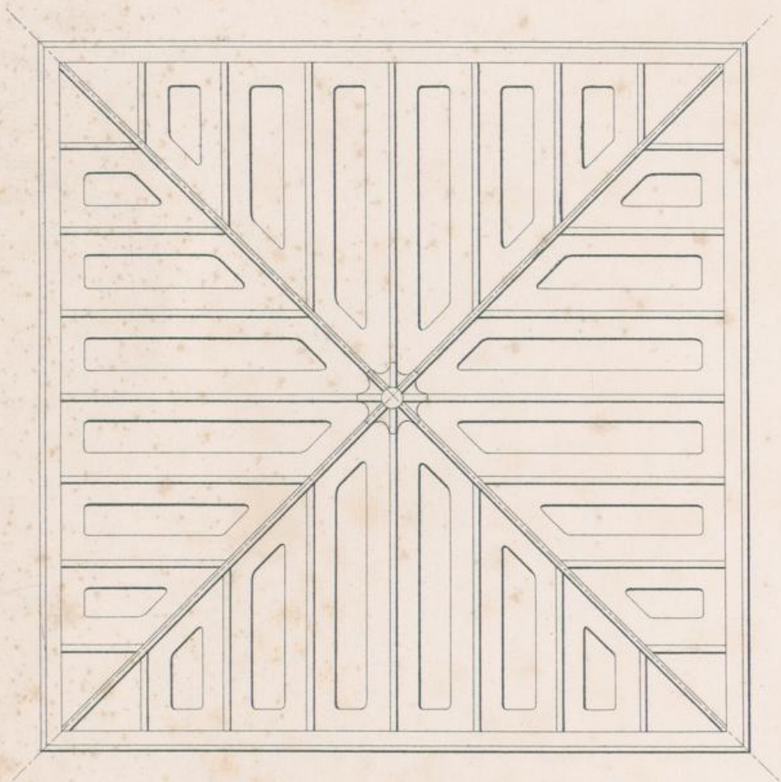
Nº 24.



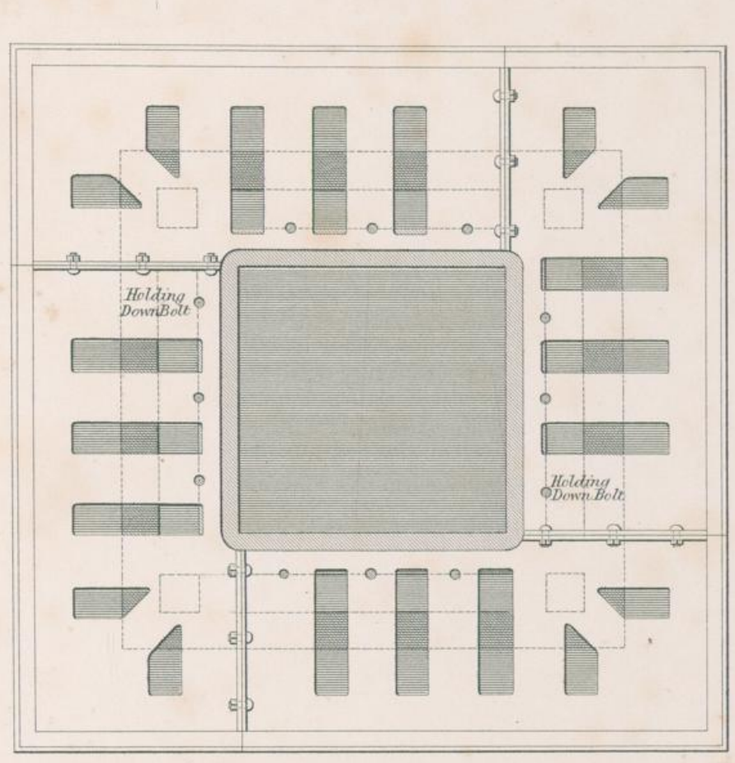
ELEVATION OF CHIMNEY TOP.



SECTION OF CHIMNEY TOP.

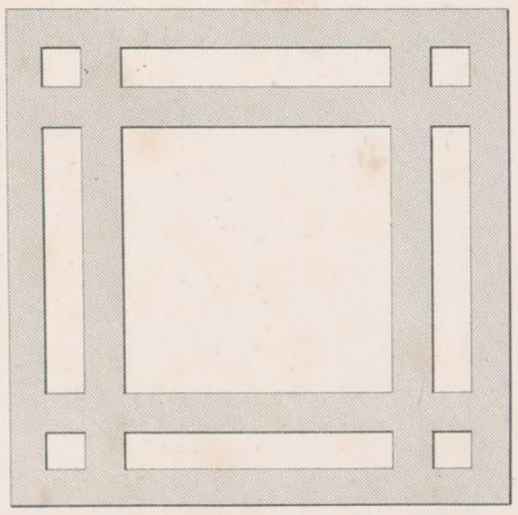


PLAN OF TOP OF FINISHED ROOF.



PLAN OF ROOF BED PLATES.

The Bed Plates will be composed of four quarters bolted together and tied down as shown in section.



PLAN OF CHIMNEY TOP AT A.B.

The Roof will be composed of four quarters jointed at the Ridge Angles and bolted beneath at the Flanges.

R. RAWLINSON, C.E. DEL.

KELL BROS LITH CASTLE ST HOLBORN.

Published by John Weale, 59, High Holborn, London, 1858.

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