THE ENGLISH HOME

BANISTER F. FLETCHER
AND
H. PHILLIPS FLETCHER

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1910

THE ENGLISH HOME

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BY

BANISTER FLIGHT FLETCHER
ARCHITECT, F.R.I.B.A., F.S.I.
BARRISTER-AT-LAW OF THE INNER TEMPLE

AND

HERBERT PHILLIPS FLETCHER
ARCHITECT, F.R.I.B.A., F.S.I., A.M.I.C.E.
BARRISTER-AT-LAW OF THE MIDDLE TEMPLE

WITH AN INTRODUCTION BY
HIS GRACE THE DUKE OF ARGYLL, K.T.

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PREFACE

A long preface would be out of place for this work, as the Duke of Argyll has very kindly written an Introduction which explains succinctly the objects we had in writing this book.

We can only hope that our attempt to show the "why and wherefore" in the building of the home may to some slight extent stimulate the general interest in Architecture.

We have had the manuscript in hand during the last three years, and its publication has been unavoidably delayed owing to various causes.

BANISTER F. FLETCHER
H. PHILLIPS FLETCHER

29 New Bridge Street
Ludgate Circus, E.C.
June 1st, 1910

INTRODUCTION BY HIS GRACE THE DUKE OF ARGYLL, K.T.

OUR Home! How best to build it for comfort and beauty?

So many things go to the making of an ideal house, and yet how little do many of us concern ourselves with its construction or with the reasons for the particular design of each separate part, the nature of the floors we walk over, the walls which protect us from the cold and heat, and the roofs that afford us shelter from the weather!

It is but too true that the education of most of us includes but little study of architecture—the oldest of all the arts—which throughout successive ages has been the outcome of progressive civilization.

It is the one art upon which we are always dependent, whether in the secluded village or the crowded town. The lowly country cottage, the stately town house or castle, all in their place must have their suitable architectural form. In our public schools we are taught something of the dwellers in many lands with various climates, and but little of their dwellings.

But our own habitation where we spend the greater part of our lives often remains a secret as to its construction, which we are mostly content to leave to others, although the practical usefulness of our business premises, the grandeur and dignity of our public buildings and churches, the effective treatment of our bridges, and the general aspect of our streets depend upon the adoption of suitable architectural treatment, the application of sound architectural principles, and the co-ordination of the various parts of the plan.

People are beginning to show a little interest in town-planning as a matter of national concern, and the sequel of this may be that architecture will take its place as a necessary part of any liberal education, for it teaches men not only to know but to *do* the right thing in the right place in the matter of building.

In *Stalky Junior* Rudyard Kipling makes someone say that he thought all floors were of solid wood, instead of having joists or beams of timber at intervals supporting thin floor-boards.

It has been suggested to the Brothers Fletcher that a book written in a terse and popular style and giving concise information about details of the house would be of practical use and interest to the public. Many books have been published dealing with small houses, but they are mostly of the scrap-book type of "pretty pictures" collected by the amateur.

This book attempts to explain the "why and wherefore" of things in building and to draw attention to essentials in design and construction from the point of view of the layman.

Messrs. Fletcher have dealt with sanitary construction at some length in their book upon *Architectural Hygiene* but that work is written more especially for the architect.

It has been their endeavour in this book to use no perplexing technical terms which cannot be easily explained and understood.

It has been sought so to divide the subject as to deal concisely in each chapter with one portion of the house or its adjuncts. The book commences with an historical review of the development of the English Home, and the continuing chapters deal with the details necessary to promote health and comfort in a modern house. A number of examples with short explanations of small homes executed by various architects are given. In addition to the illustrations of houses designed by the authors, Messrs. Arthur T. Bolton, Walter Cave, E. Guy Dawber, Forsyth and Maule, Arthur Keen, E. L. Lutyens, Maurice H. Pocock, A. N. Prentice, M. H. Baillie Scott, Harrison Townsend, and C. F. A. Voysey have kindly lent copies of some of their works for reproduction.

By this means a number of comprehensive and completed structures have been illustrated, showing how various architects have dealt with different problems that have been referred to them. The small illustrations explanatory of the printed matter are placed in juxtaposition therewith, thus obviating as far as possible the necessity of searching for illustrations in other parts of the work, though frequent cross references are given for the use of those desiring fuller information upon any point.

Taking the house from the commencement to the completion, this little book contributes to the right understanding and practical knowledge of all those small things which in these days go to build up the English Home, which is the envy and the ideal of all other nations of the world.

We have in this book two practical architects of large experience giving information and advice in a popular, concise, and convenient form to the increasing number of the general public who take an interest in the design and construction of the houses in which they live. I think they have succeeded in this. The book may also assist the reader in dealing successfully with local builders and craftsmen when initiating small repairs and alterations.

It is possible that the summarized suggestions may help to crystallize the somewhat vague notions of many who wish to build with regard to the kind of structure they deem desirable, and it may give them some approximate notion of the cost it would entail.

It may also enable some of us to have more or less mature ideas of our requirements before we consult with our architects, which will greatly facilitate the preparation of preliminary sketches; for every house should possess its distinctive character, which should reflect the sentiment of the occupant, quite apart from the professional impress of the architect's hand.

ARGYLL

21st April, 1910

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THE ENGLISH HOME

CHAPTER I

AN HISTORICAL REVIEW OF THE ENGLISH HOME

Feudal System—Saxon (eleventh century)—Norman (the latter part of eleventh century and the twelfth century)—Early English (thirteenth century) — Decorated (fourteenth century) — Perpendicular (fifteenth century) — Tudor (the first half of sixteenth century) — The Early Renaissance, Elizabethan and Jacobean (the latter half of sixteenth century and first half of seventeenth century)—The Late Renaissance, Anglo-Classic, Queen Anne and Georgian (the latter half of seventeenth century and eighteenth century)—Modern Architecture (nineteenth and twentieth centuries).

THE evolution of the English Home through the past ages is an integral part of the history of the English people, and provides an index to the progressive social conditions which were responsible for the type of houses erected in each century. The domestic architecture of England developed concurrently with the expansion of its trade, civilization, wealth and power, and reflected in each period the manners and customs of the people, and was influenced by increased intercourse with Continental nations.

Feudal System—The *feudal system* for centuries largely determined the character of the domestic architecture of England. Every baronial seat and manor-house, owing to the ample jurisdiction granted by the Crown to its great tenants, was in reality a miniature legal establishment where the Lords of the Manor, aided by assessors, held their courts-baron and administered justice; and also received the suit and service of their dependents. The feudal Hall, however, besides being a law-court, was also utilized for hospitality and continued to be the chief feature or great house-place of every mansion until the decay of that social system in which it had its origin.

Castles—The castles which formed the homes of the nobility and principal landowners were themselves developed from the square Norman Keep or Tower. The space round this Keep gradually came to be enlarged and enclosed by a wall provided with towers and bastions, outside which was the defensive moat.

Against the inner side of this wall wooden sheds were erected to accommodate the serfs and domestics, an arrangement which appears to have lasted until the middle of the thirteenth century, when the various chambers were collected together into one building, situated in some portion of the ground within the fortification. In course of time the Hall took the place of the inconvenient four-storied Keep, and in its turn became the chief apartment around which others were grouped.

With few modifications, such as the gradual diminution of the defensive character of the building and of the wall of *enceinte*, the same arrangement existed till the time of Elizabeth.

In Ireland, however, from the twelfth to the seventeenth century, almost every house was in the form of a Tower, and was fortified with bartisans (projections for defending the walls) and machicolations. These continued to be the dwelling-places until the time of

Cromwell, and it was only because it was then proved that such Towers were of little avail against gun-powder, that they were discarded in favour of a more convenient type of plan.

The Yeoman's House—The yeoman's house in each period frequently consisted merely of the Hall in the centre with the Solar, Lord's Chamber or Parlour at one end and the Kitchen and offices at the other.

Materials—As transport was both difficult and expensive, the local materials were utilized for building, and this fact alone gave the houses distinctive characteristics according to their different districts. Thus the *stone* houses of Somersetshire, Wiltshire and Gloucestershire, the *brick* houses of the Eastern Counties, especially of Norfolk, Suffolk and Essex, and the *flint* houses in the chalk districts of Norfolk, Essex and Kent, form the special types peculiar to these districts, while *timber* houses were constructed in the neighbourhood of forests, as in Lancashire and Cheshire.

We find too that timber, notwithstanding its inflammable nature, was frequently employed, even when other materials were available. It was the use of this particular material which made it possible to construct the picturesque overhanging upper stories formed of timber uprights with a filling of brick and plaster.

We now turn to the consideration of the evolution of the Home in each successive period.

SAXON (ELEVENTH CENTURY)

During the period known as the Dark Ages, which covers about six centuries from the break-up of the Roman Empire *circa* A.D. 400 to the commencement of the foundation of the Gothic nations *circa* A.D. 1000, dwelling-houses and indeed all buildings, with the exception of some important monasteries and churches, were extremely primitive, and thus corresponded with the habits of the people.

It is unnecessary to commence our research earlier than the Saxon period, for the effect on domestic architecture of the Roman occupation of Western Europe was not permanent, as the villas of the Imperial Roman officers were not constructed in accordance with the local and climatic requirements.

Castles—Among the Saxons, castles were of little account, and were not utilized as residences; they consisted of an earthwork fortification surrounding a central mound, sometimes with a tower built, not infrequently, of wood.

The Hall—The Gothic nations, owing to their common origin and similar methods of life, evolved a distinctive type of dwelling, consisting of the Common Hall or House Place; this latter was a single apartment often some thirty to forty feet in length and about half that in width.

The first essential, due to the rigour of the climate, was shelter from the elements, and this was provided by the Hall or covered enclosure, which continued to be the principal apartment throughout the mediæval period. This is in direct contrast to the ancient Roman House in which the chief feature was the uncovered court or *atrium* derived from the East, where it prevails even to the present day. In this and even in succeeding centuries the Hall sometimes formed the sole living-room, sleeping-room and kitchen for the owner, his family, his guests and his serfs.

Light was admitted through small windows, closed with wicker shutters, and warmth was obtained from the log fire on a central hearth, the smoke escaping through an opening in the roof.

Chamber—In the better class of dwellings a second apartment known as the *Chamber* was sometimes added, and was used during the day as a withdrawing-room for business, and during the night as a private sleeping-room.

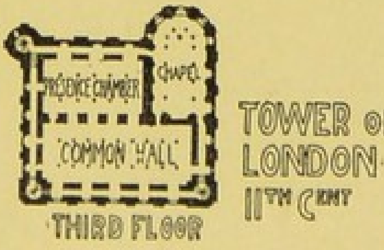
The royal residences, however, were provided with extra accommodation, consisting of the Chapel, Granary, Bakehouse, Storehouse and Kitchen, the latter being usually detached on account of the risk of fire.

NORMAN (THE LATTER PART OF ELEVENTH CENTURY AND THE TWELFTH CENTURY)

Castles—During the latter part of the eleventh and the commencement of the twelfth centuries numerous castles were constructed, and over one thousand were built during the reign of Stephen alone.

The Square Keep, or stronghold, was usually four stories in height, and was surrounded by an inner and occasionally also by an outer "Bailey" (i.e. ward or court) and by a lofty wall with ramparts and a deep moat.

The Royal Castle known as the Tower of London (Ill. 1), constructed by Bishop Gundulf, in A.D. 1078, for William I, is an important example to which many additions were made by later monarchs. It has an Outer Ward protected by a surrounding wall with eight towers and an Inner Ward protected by another wall with thirteen towers.



ILL. 1. PLAN OF KEEP OF THE TOWER OF LONDON.

The Shell Keep is another type supposed by some to be derived from an Anglo-Saxon precedent, in which the buildings were arranged round a polygonal or circular court.

Windsor, Rochester, Alnwick, Warkworth, Berkeley, Warwick, Newcastle, Arundel, Norham, Bamborough, Dover, Richmond (Yorks), Cardiff, Farnham (Surrey), Durham, Chipchase, Scarborough, Oakham (Rutland), Oxford, and Castle Rising (Norfolk), are all examples of the period, which have been either much altered to bring them into line with modern requirements or have been allowed to fall into a ruinous condition.

Monastic Buildings—Monastic buildings were considerably in advance of the primitive castles. Castle Acre Priory, Norfolk, has apartments, such as the Refectory, Dormitory, Library, Scriptorium (Writing-room), arranged around a cloister garth, on the north side of which was the church.

Manor-houses—Manor-houses, Farm-houses and Granges were frequently walled and moated, and appear to have been built on one uniform plan, comprising a Hall with chambers adjacent.

The Hall was frequently the only large apartment in such edifices to accommodate the owner, his retinue and servants.

In Saxon and Norman times the Manor-house was known as the Hall (from the Anglo-Saxon *heall*), which appears to be the origin of the modern term Hall as applied to so many country residences. This apartment, and not infrequently the whole building, was in mediæval Latin termed the *aula*.

Thus the Hall with its central log fire, the Solar or chamber, frequently on an upper story, the Kitchen, the Servery or general service-room, the Larder for preserving (larding) meat, and the Cellar (frequently situated under the Solar), made up a typical Manor-house of the period. In the succeeding centuries this arrangement was adhered to, other rooms being added to correspond with the new ideas of comfort and convenience.

Boothby Pagnall (Lincs) Manor-house and the old house at Christchurch (Hampshire) are examples of this period.

Peasants' Dwellings—The smaller houses of the peasants or serfs, which were gradually grouped around the castles, were of a very simple character, and frequently had only one living-room.

Town Dwellings—The town dwellings often consisted of a ground-floor shop, behind which was the living-room and a yard. An external door sometimes led to a staircase which gave access to an upper floor.

The Jews' House, Lincoln, and Moyses' Hall at Bury St. Edmunds are fine specimens of this period.

EARLY ENGLISH (THIRTEENTH CENTURY)

Castles—The thirteenth century was largely devoted to the enlargement and improvement of existing castles.

The inconvenient four-storied Keeps, although still retained in some cases for use in times of war, were frequently abandoned in favour of a Hall and Chambers constructed in the Inner Ward.

The Hall, which was usually the third story of the Keep and had over it the Chamber or Withdrawing-room, was reached by spiral stairs and was found to be in a very inconvenient position, more especially having regard to the increased hospitality of the period. Many castles therefore still retained the Keep and surrounding walls and defences, and were brought up to date by the addition of a new building on the lines of the Manor-houses which were then being built. Such houses were constructed in the space within the Inner Bailey, and consisted of a capacious Hall, one wall of which formed part of the circumvallation. At one end of this Hall were placed the Kitchen and domestic offices, and at the other the Solar and other family apartments.

The new castles built principally in Wales by Edward I were designed on the new concentric model, in which the Citadel was not the Keep of the Norman period but the Inner Court or Bailey, which contained the residential building ranged around its walls, and formed a private court surrounded by a massive line of towers, and further defended by other lines of circumvallation, which contained the stables and other out-buildings.

EXAMPLES—Caerphilly (Glamorganshire), Beaumaris (Anglesey), Conway (Carnarvonshire), Prudhoe (Northumberland), Pembroke, Leeds (Kent), and Stokesay (Shropshire) are examples of this period.

Manor-houses—There was now a considerable improvement in the arrangement and an increase in the number of the apartments in the Fortified Manor-houses belonging to the Clergy and to the Crown, and during the reign of Henry III licences to "crenellate" or fortify Manor-houses were largely issued. Yanwath Hall (Westmorland), Charney Bassett (Berkshire), and Little Wenham Hall (Suffolk) are of this period. Such Manor-houses were preferred as permanent family residences to the inconvenient Keeps of the earlier period. Much information concerning those which belonged to the Crown is to be obtained from the Liberate rolls of Henry III, and we first hear of the Buttery, Pantry, Larder, and Wardrobe, but these were more commonly found in the fourteenth century and are there described (see p. 14).

The Hall—The Hall was still the principal living-apartment and also formed the general dormitory, in conjunction with the lofts and stables which were still utilized by the retainers.

Family Apartments—The apartments adjacent to the Hall were sometimes so arranged as to form three sides of a quadrangle, as at Charney Bassett (Berkshire), where a Chapel or Oratory adjoins the Solar or Upper Chamber.

The apartments were all approached through one another, and thus formed thoroughfare rooms. The fireplaces were few; the Hall still preserving its central hearth; other rooms being probably heated by portable braziers.

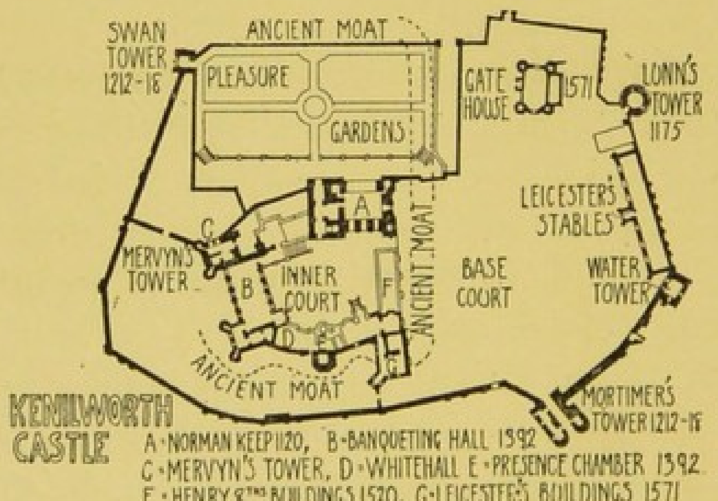
Windows—Windows of domestic buildings appear to have been first glazed in this century, but glass was a luxury and was still used in conjunction with wooden shutters, such as may be seen in the poorer districts of old Continental towns. The absence of glass in domestic buildings was due to the fact that none was manufactured in this country until the fifteenth century, and it is not till A.D. 1439, in connection with the Beauchamp Chapel (Warwick), that any mention of English glass occurs. Up to this period it had been obtained from Normandy, the Low Countries and Venice in exchange for wool—the English staple production—but owing to its fragile character there had not been any extensive importation of it.

Furniture—The walls were generally bare, without either tapestry or wainscoting. The furniture was of the rudest description, and was limited to tables resting on trestles and benches and forms made by carpenters on the spot. The bed was occasionally of the tester (*testier*) type, i.e. provided with a canopy for the protection of the head.

Floor Coverings—The Hall Floor was still usually of clay. Carpets were introduced from Spain by Eleanor of Castile, but were extremely rare, and could only have been used in the better type of houses, for the poorer classes had only the barest necessaries.

DECORATED (FOURTEENTH CENTURY)

Castles—Castles were now constructed upon the model of the Manor-houses of the day. Kenilworth



ILL. 2. PLAN OF KENILWORTH CASTLE, WARWICKSHIRE.

Castle, which came to John of Gaunt by marriage in A.D. 1362, is an example of a castle which was much altered during this period. The Norman Keep was retained as a relic of the past and as a means of defence, but was not incorporated in the new buildings which were constructed round the Inner Court. These had a fine entrance porch, and there was a magnificent banqueting-hall with screens and dais, family apartments, kitchen and offices (Ill. 2). The castle was further altered two centuries later by the Earl of Leicester.

Pele Towers—The fortified houses known in the border counties of Wales and Scotland as *Pele Towers* were in many cases merely the original Keep round which the later buildings were grouped. The ground floor of the Pele Towers was usually vaulted, the upper stories having wooden floors and roofs with the staircase in the thickness of the wall.

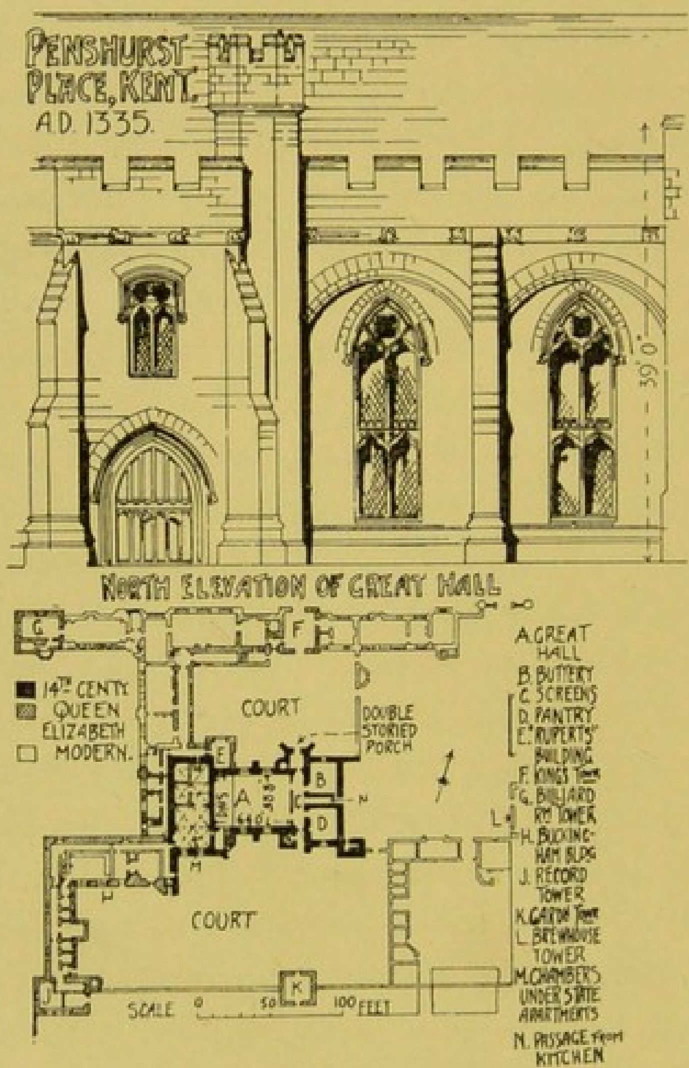
Manor-houses—A characteristic Manor-house of the period was built round either three or four sides of a quadrangle, and the entire space thus occupied by the court and buildings was surrounded by a moat.

The gatehouse on the entrance side was protected by a portcullis and drawbridge, and the whole presented a castellated appearance. On the side opposite the entrance was the porch leading to the Hall, with the Kitchens and Offices arranged on one side, and the family apartments and chapel on the other (Ill. 3).

A Porch led into the screens (Ill. 3c), a passageway or vestibule which was separated by two doors from the Hall itself, and by three doors on the other side from the Kitchens and Offices. Over this passage was the Minstrels' Gallery.

In the Vestibule there was usually a lavatory basin with water-drain, for washing the hands before and after meals.

The Hall—The Hall, which had already taken the place of the older Keep, and had become the central feature of these buildings, attained its highest development, and perfection in this century. The Royal Palace or Hall of Westminster, with its lofty walls, large traceried windows and elaborate timber



ILL. 3. PLAN AND ELEVATION OF PENSHURST PLACE, KENT.

roof, is as fine as any ecclesiastical edifice of the period.

The Lord of the Manor still held his Court in the Hall (Ill. 3), and his vassals and serfs met at one large table for meals in this feudal period when the English peasantry were slaves, the absolute property of their lord, "to be bought and sold as the livestock of an estate." The Hall, as in the previous century, frequently formed the sleeping-place for the retainers, who were, however, sometimes lodged in dormitories or in the stables.

It was also still the general custom for the family, the guests and retainers to take their meals in the Common Hall, where the family were seated at the high table on the raised dais (Ill. 3 A) at the opposite end to the screens; but as time went on there was a desire for greater privacy, and so the family dined in one of the smaller rooms.

Family Apartments—The Family Apartments were also gradually increased in number in order to afford more privacy.

The old Solar, also known as the Lord's Chamber or Parlour, was increased in size and became known as the Withdrawing-room (hence Drawing-room), and was frequently situated behind the dais on the upper floor, with an opening which enabled the master to have surveillance of the proceedings in the Hall below. There was sometimes a Cellar or a second Parlour under this apartment on the ground-floor level.

A Lady's Chamber (or bower) was now often provided in the larger houses in proximity to the Withdrawing-room, and no doubt frequently also answered the purpose of the best bedroom.

Bedchambers—Besides the Withdrawing-room and Lady's Bower which usually contained beds, there were a number of Bedrooms in these larger houses, many of which were no doubt provided with several beds according to their size.

Bathroom—This room appears to have come into existence in a very primitive way, and was provided merely with a large tub and a lead-lined stone laver.

Wardrobe—The Wardrobe served as a store for clothes instead of the chests, and this room was also used for the making of the various garments.

Chapel—The Chapel had occasionally two stories in its western portion, the upper being used for the family and guests, the lower for the retainers and domestics. A small chamber was frequently attached for the use of the priest, chaplain, or friar, as at Broughton Castle.

Kitchen and Offices—Of the three doorways (see p. 11) in the screens leading to the service department, the central one often opened into the Kitchen, or to a passage leading to the same (Ill. 3 N). The Kitchen in the Bishop's Palace at Chichester and the famous monastic Kitchen at Durham (dating from A.D. 1368) are well-known examples. Kitchens were, however, frequently detached, probably as a security against fire, as in the Abbot's Kitchen at Glastonbury, and also at Raby Castle, where the Kitchen is still in use. One of the other two doors opened into the *Buttery* (Ill. 3B). The word buttery is derived from the French *bouteille*=a bottle, hence the word butlery or buttery as applied to the room where the wine bottles and other vessels were kept, and the word butler (i.e. bottler) as applied to the man in charge. The term is still employed in colleges. The remaining door opened into the *Pantry* (from the French *pain*=bread), which was the room in which the bread, butter, cheese, also platters and salt-cellars, etc., were kept (Ill. 3 D).

An important room, not usually reached from the screens, was the *Larder* (*Lardarium*), in which the meats were larded or preserved, and which also formed the storeroom for the cook, the preserved meat being brought into the kitchen in such quantities as were required. Sometimes salting was preferred, in which case the apartment was known as the *Salsarium.*

Fireplaces—Wall fireplaces with corbelled chimney hoods became more usual in this century, but although these were found in the Withdrawing-room and smaller apartments, the Hall frequently had only the central fire placed on a hearth.

Charcoal, wood and turf were the most usual fuels, but coal appears to have been used to a certain extent, although it was from time to time prohibited as a nuisance.

Windows—Glazed windows were still rare except in the most important houses owing to the costliness of glass and the fact that it was not then manufactured in England (see p. 9).

Walls and Floor Coverings—Rushes and straw, sometimes mixed with sweet herbs, formed the usual carpeting, but the dais in the Hall frequently had a wooden floor. The walls were now hung with tapestries and trophies of the chase.

EXAMPLES—Penshurst Place, Kent (Ill. 3), of the period of Edward II, is a typical example of a fine Hall with raised dais and bay window at one end and the screens at the other, while the open timbered roof has still the louvre or opening for the escape of smoke from the central fire.

Ightham Mote (Kent), Raglan, Langley and Haworth Castles, Sutton Courtenay Manor-house (Berkshire), Prior Crawden's House, Ely, parts of Broughton Castle (Oxfordshire), and Ludlow Castle (Shropshire) are smaller examples of the Manor-house type.

Town Houses—The smaller town houses of the period had most commonly the lower vaulted story of stone and the upper part of wood-framing as may be seen at Winchelsea, where, however, the original timber upper part has disappeared.

PERPENDICULAR (FIFTEENTH CENTURY)

Important Historical Events—During the fifteenth century many new influences affected the social condition of the people and naturally left their mark on the architecture of the time. Most powerful among these new factors were the Renaissance in Italy, the dispersion of scholars from Constantinople, the wider establishment of scholastic foundations and the invention of printing with its consequent increase of knowledge and higher standard of intelligence. At the same time that this increase of opportunities gave the people a wider mental outlook the use of the mariner's compass opened up distant parts of the world. Wealth was largely increased by the discovery of India and America and by the progress of industrial arts; while the commercial classes grew in importance through the establishing of Trade Guilds and the granting of commercial charters.

Mention must also be made of the effect of the use of gunpowder, which rendered ancient castles obsolete as defensive strongholds and thus incidentally strengthened the power of the Crown against the barons.

There was also a gradual reduction in the number of feudal dependents or retainers, for the duties which to a large extent had heretofore been performed by them were now carried out by independent craftsmen who lived in dwellings of their own outside the castle.

The serfs became the hired labourers, and had greater freedom than their predecessors.

Castles—The castles of the border counties, such as Alnwick, however, still retained the same military character owing to the troubled state of these districts, so that the Border Manor-house or Pele Tower (see p. 11) was built on the old lines even as late as the sixteenth century.

Warwick Castle, dating from the end of the fourteenth and the beginning of the fifteenth century, retained features which before the invention of gunpowder must have rendered it wellnigh impregnable. Among these were the portcullis, which we believe is still used every night, the walls of *enceinte*, the battlements and *allures* behind them, bastions and machicolations from which hot tar, stones and other missiles could be dropped on the besiegers.

The Hall, as in other examples of the period, had its former prominence somewhat diminished by the provision of separate Dining- and Drawing-rooms.

The remains of Hurstmonceaux Castle (Sussex), Lumley Castle (Durham), Warkworth Castle (Northumberland), Tattershall Castle (Lincolnshire) are other examples which date from this period.

Manor-houses—The Manor-houses of the period on the borders of Scotland and Wales, although still fortified to a considerable extent, show the conflict between the increasing desire for domestic comfort and the occasional necessity for resisting attack. The authority of the Crown and increased efficiency of armaments rendered the fortification of the houses useless; so that when the gatehouse, battlements and towers of the earlier period were still retained, they were more as ornamental features than for defence.

The Entrance Porch, the Screens with Minstrels' Gallery above and the brazier in the centre of the Hall were still sometimes kept, while newer features were introduced, such as the large bay window at the side of the dais, and the wall fireplace.

The Hall no longer appears to have been used as a general dormitory in this century, although when the house was crowded on special occasions the retainers no doubt still slept upon straw laid down for the purpose.

Family Apartments—The Withdrawing-room and Lady's Bower, which in the previous century had contained beds, were now in many cases reserved entirely as Sitting-rooms.

The Bedchambers, such as the Camera (for one bed), Cubiculum (for two or three), and the Dormitorium (for many), increased in number as the Hall diminished in importance, showing a desire for greater comfort and refinement.

Wardrobe Closets, Washing-closets (*eweries*) and Cupboards were common ; the latter were used instead of chests and lockers.

The Kitchen and Offices—The Kitchen, which in the previous centuries was often detached from the main building, was now for greater convenience frequently connected with it. Some fine examples exist at Stanton Harcourt (Oxfordshire), New College (Oxford), Christ Church (Oxford), Hampton Court and Berkeley Castle.

The Buttery and Pantry in this century were often formed as one, hence the compound term Butler's Pantry. The word buttery is still used in collegiate establishments, but while the office of the butler is retained that of the pannetier is lost.

It also became the custom to provide a Scullery (*scutellarium*), Bakehouse (*pistrina*), Brewhouse, Dairy and Mill, while granaries and outbuildings became more numerous.

Stables were sometimes built apart round a special court or stable yard.

Furniture—Original furniture of the period is rarely seen, and our knowledge of it is obtained principally from illustrated manuscripts. Chairs were not commonly used, but window recesses had stone benches on each side such as still exist in college rooms at the Universities, and these were the favourite nooks and corners of the apartments.

Tables were principally formed of boards and trestles, and chests were also used for this purpose.

The floors were still covered with straw, rushes or matting (see pp. 10 and 15), carpets not having yet come into general use.

Examples—Wolterton Manor-house at East Barsham (Norfolk) is very complete as an example of the development of this period. It has a fine detached gatehouse, while the main building contains the Porch, Screens and Hall with Bay Windows. The family rooms are reached from the dais and the Kitchen and Offices from the Screens. South Wraxall Manor-house and Great Chalfield (both in Wiltshire) are fine examples of convenient dwelling-houses erected in a peaceful county, with scarcely any attempt at fortification, although the latter house is surrounded by a moat.

Oxburgh Hall (Norfolk), a moated quadrangular example,[1] Haddon Hall (Derbyshire), with a double

[1] See Plate 131 of *A History of Architecture on the Comparative Method* (5th Edition) for a plan of this house.

Court partly built in the Elizabethan period, Hever Castle (Kent), a castellated moated house, and Ockwells (near Windsor) are other examples of the change from the older fortified castle to the newer and more fully developed dwelling-house.

The Bishop's Palace, Wells, is an ecclesiastical structure which still has its separate wall of *enceinte*, with gatehouse and moat.

Town Houses—The smaller Town Houses underwent considerable improvement; but as they were mostly constructed of wood, few remain, although some are still to be seen in Coventry, in the Butcher Row at Shrewsbury, in Chester and other old towns.

Peasants' Dwellings—The Peasants' Dwellings probably showed little improvement on the preceding centuries, as in many cases they merely consisted of a single apartment used as living-room and bedroom by the whole family. The accommodation appears to have improved in the latter part of the century, when the dwellings may have resembled the Irish Cabins of the present day, which frequently have two rooms separated by the chimney-stack.

TUDOR (FIRST HALF OF SIXTEENTH CENTURY)

The latter part of the fifteenth century and the first half of the sixteenth century were remarkable for that phase of national architecture known as Tudor. During this period there was a growing demand for houses for the new and wealthy trading families, which in the reign of Henry VII were taking the place of the old nobility, many of whom had disappeared during the Wars of the Roses, between the years 1455 and 1485. The suppression of the monasteries (A.D. 1536–40) enabled Henry VIII to distribute vast sums of money and great tracts of land among his courtiers, many of whom were also rich and prosperous citizens, who gratified their ambition as landed proprietors by the erection of houses suitable to their newly acquired rank.

Manor-houses—The Tudor Manor-house of the sixteenth century was a continuance of the fifteenth-century type; the rooms were grouped round a quadrangular Court, as at Compton Wynyates (Warwickshire) and Sutton Place (Guildford). The typical examples have battlemented parapets which, although no longer useful for defence, were still retained as ornamental features. The entrance to the Courtyard was usually in the centre of one side under a gatehouse which gave it prominence. On the opposite side of the Court was the entrance porch leading to the Screens and Hall, while the various living-rooms and offices were ranged along the two remaining sides. Such rooms were usually "thoroughfare" rooms, and in some cases were also entered from the Courtyard.

The Great Hall (see pp. 4, 9, 11, and 18) declined still further in importance, *pari passu* with the state and grandeur of the hereditary landowner, but it was still the principal apartment and formed the central feature of the plan. Its decrease in size was in some measure due to the reduction of the number of military retainers by legal enactment, and also to the fact that many industries formerly carried on in the feudal house were transferred to craftsmen who lived and worked in the village instead of in the great house. The better accommodation provided by inns may also have contributed to this change.

The side fireplace with its richly carved overmantel was now fast developing into an important decorative feature, and was indeed generally used in all the principal rooms.

Family Apartments—In addition to the Withdrawing-room and the Lady's Bower (Boudoir), the Study, the Private Dining-room, the Summer and Winter Parlours are also mentioned in connection with some of the larger houses. Bedchambers were more plentifully provided, and in some instances would certainly have been considered sufficient for our own day. Hengrave Hall (Suffolk) (A.D. 1538) had no fewer than forty bedrooms.

Generally speaking, rooms still continued to be thoroughfare rooms, although in Hengrave Hall we find a corridor introduced round the internal court. The ceilings of the Hall and Living-rooms were frequently ornamented with richly moulded plaster ribs dividing the surfaces into panels of various shapes.

Furniture—It is very difficult to trace authentic examples of the Tudor furniture of this period, but there are notable exceptions with regard to that appertaining to some of the churches, which are often still found in a good state of preservation, such as the choir stalls of Christchurch, Hampshire,

Kitchen and Offices—The offices increased in number, and the inventory of Hengrave Hall mentions many new uses to which they were assigned. Thus we read of the Hind's Hall, Kitchen, Pantry, Dry and Wet Larders, Pastry-room, Scouring-house, Still-houses, Laundry and Linen Room, Wardrobe, Wine-cellar, Outer Cellar, Dairy, Cheese-room, Brew-house, Bakehouse, Malthouse, Hophouse, Fish-house and many others.

From this list it will be seen that many offices were provided which in these days would not be necessary, owing to the ease of communication and accessibility to external sources of supply.

Gardens—Gardens were laid out in accordance with simple theories, based upon a definite plan embracing some architectural design in the way of steps, balustraded terraces and the like. A Bowling-green was often introduced into the gardens attached to the larger houses.

EXAMPLES—Compton Wynyates (Warwickshire) (A.D. 1520) consists of a complete quadrangle, entered on one side through a gateway opposite to the door of the screens on the other side of the Court. The lofty Hall has a fine bay window, and there are several staircases, the principal one being added in a later period. This is a picturesque example in which there is considerable irregularity of disposition, especially in the case of the entrance, which is not central to the court or façade.

Sutton Place, Guildford (A.D. 1523–5), is another example of the quadrangular type, but the entrance side has been removed. There was more attempt at symmetry in this example, for the entrance to the Hall is on the axial line, and an extra bay window was placed in the angle of the Courtyard to balance the Hall bay at the corresponding angle. The rooms round the Court must have been thoroughfare rooms in this example, as no space exists for a passage or corridor. The windows are still cusped in the late Perpendicular manner, and the battlemented parapet is a feature of the design.

Hengrave Hall (Suffolk) (A.D. 1538) also supplies an early example of special planning to produce a symmetrical façade.

Layer Marney Towers, Essex (A.D. 1500–26), a terra-cotta building; Moreton Old Hall, Cheshire (A.D. 1559), a half-timbered structure, and many smaller houses in the towns and provinces may be attributed to this period.

THE EARLY RENAISSANCE PERIOD: Elizabethan and Jacobean (the latter half of sixteenth century and first half of seventeenth century)

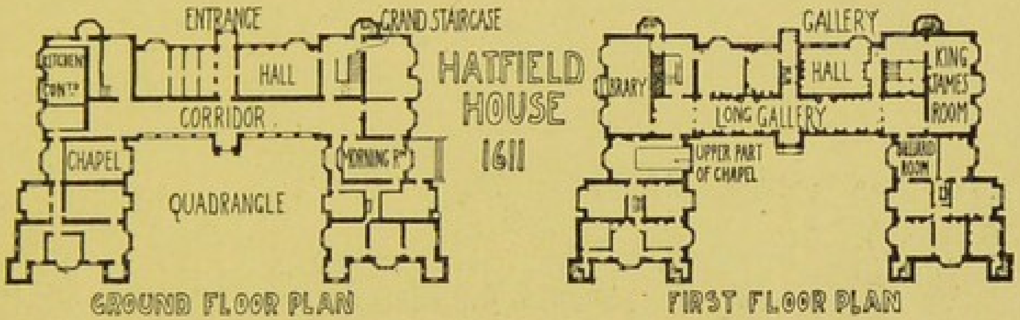
Next come the Elizabethan and Jacobean styles, which together form a transitional type of art connecting the Tudor style with the Anglo-Classic art of Inigo Jones. The Elizabethan style coincides with the final settlement of the Reformation by Elizabeth, the patriotic outburst caused by the defeat of the Spanish Armada in A.D. 1588, and the literary period of Spenser, Shakespeare, Burleigh and Sir Philip Sidney.

The settlement of foreign craftsmen in England, caused by the massacre of S. Bartholomew (A.D. 1572), also helped to introduce the new form of architectural art as practised for some time previously in France.

The first English book on the new style of architecture, as it was called, was published in A.D. 1563 by John Shute on his return from Italy.

The Country Mansions—The period is specially remarkable for the erection of a large number of country residences in which many Gothic features, such as mullioned windows, towers, oriels and large chimney-stacks, were retained, but were ornamented with Renaissance detail.

Two general types of plan were in use. The smaller type, derived from the simple mediæval manor-house, consisted as before of a Hall placed centrally with Kitchen and offices at one end and family apartments at the other. The larger type was evolved from the quadrangular mediæval plan, which the Elizabethan and Jacobean architects modified by omitting one side. This resulted in an



ILLS. 4 AND 5. HATFIELD HOUSE, HERTS.

"E"-shaped plan, securing sunlight and a freer circulation of air into the Court, as at Hatfield House (Ills. 4 and 5).

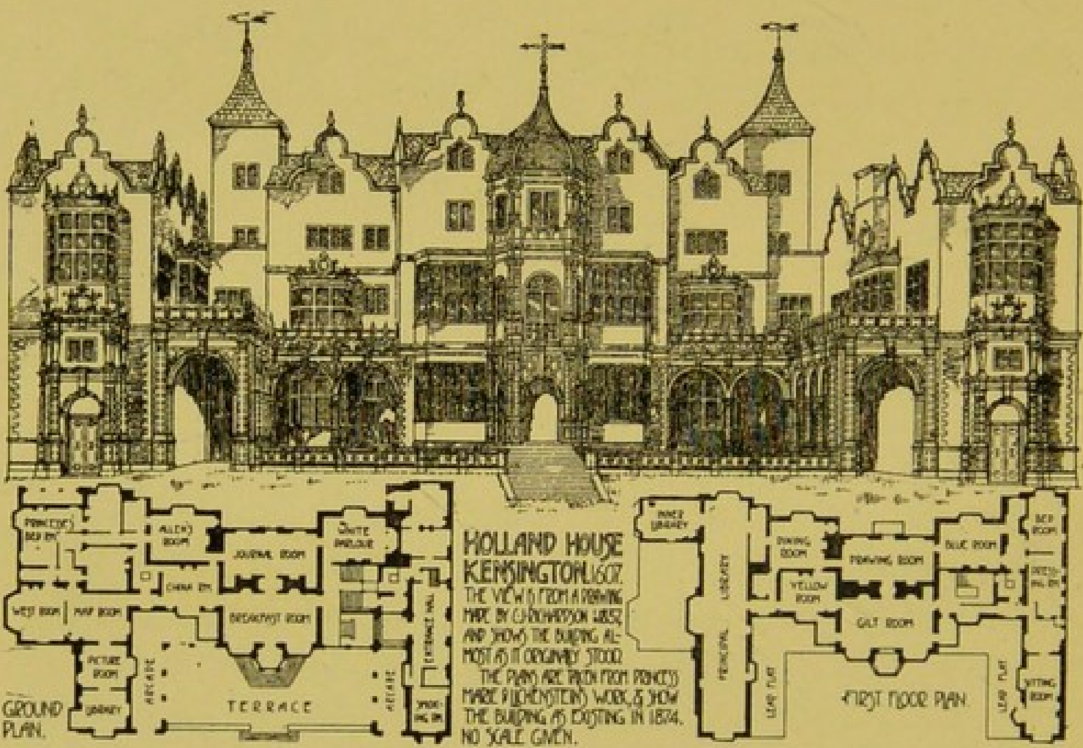
The "H"-shaped plan was evolved by extending the wings as at Holland House, London (Ill. 6).

Other fanciful plans showing extreme originality were also employed, as, e.g., Longford Castle, a triangular house attributed to John Thorpe.

The Hall—The Great Hall was not universal in this period, and even when found does not occupy such a disproportionate space as formerly, being, in fact, retained from the mediæval period in order to give a certain state and dignity to the house, although the spirit and meaning of its old character had departed.

The old college Halls of the Universities and the Inns of Court of London still retain the old arrangement with dais and high table, but these would appear to have had their origin in early monastic institutions and not in the feudal system which produced the Hall of the mediæval period.

The Hall was usually lined to a height of eight or ten feet with oak panelling, while above were arranged the trophies of the chase, armour, ancestral portraits, family relics and heirlooms.



ILL. 6. PLANS AND ELEVATION OF HOLLAND HOUSE, KENSINGTON.

The carved oak screen and Minstrels' Gallery, the raised dais and lofty bay windows, the imposing fireplace richly carved with the owner's coat-of-arms, and the ornamental plaster ceiling are well-known features.

The Staircases—Staircases are important because the chief living-rooms, which were frequently on the first floor, demanded an easy means of approach, and they are numerous because the Hall was frequently two stories in height, thus dividing the upper floors into two parts, access to which was only obtained by separate staircases. They are generally placed in connection with the Hall, and with their heavily carved newels, pierced balustrading and rich carving give an air of spaciousness and dignity to the interior.

The Long Gallery—There is no feature more characteristic of the period than the Long Gallery from which the modern term picture gallery appears to be derived. Their origin is doubtful, but they may have been used for exercise or for the display of objects of art; for the fashionable pastime of "collecting" seems to have commenced about this period. They undoubtedly sometimes served as a means of communication between the wings of the upper floors of the house, when the Hall was two stories in height. They were situated on the upper floor, and often extended the whole length of the house. The proportions of the Long Gallery vary from those of the Great Hall, in being comparatively low and narrow in proportion to their length. This effect, however, was frequently relieved by projecting room-like bays, like those at Haddon Hall, which are as much as fifteen feet by twelve feet.

The walls usually had oak panelling for their full height, and the plaster ceilings were richly modelled.[1]

Family Apartments—The Dining, Withdrawing-room, Chapel, Bedrooms and offices were based on those of the mediæval period, but arranged with greater regard to convenience.

[1] For lists and dimensions of some Elizabethan Galleries, see *A History of Architecture on the Comparative Method* (5th Edition), p. 555.

Furniture—The oak furniture, chairs, tables, sideboards, chests and bedsteads of the period form very important features of the house, being constructed in the prevailing architectural style, and therefore adding to the unity and completeness of the general design.

Carpets appear to have been imported from Turkey and to have come into general use in the reign of Elizabeth.

The Formal Garden—The art of Italian landscape gardening now made its influence felt in the planning of the Formal Garden. This was set as a frame round the more important houses, and with its series of forecourts, parterres, arcades, fountains and terraces it gave a complete and finished appearance to the house.

EXAMPLES—Amongst well-known examples of Elizabethan and Jacobean houses are Kirby (Northants), A.D. 1570–5; Knole (Kent), A.D. 1570; Burghley (Northants), A.D. 1575–89; Hardwick Hall (Derbyshire), A.D. 1576–97; Longleat (Wilts), A.D. 1567; Bramshill (Hants), A.D. 1607–12; and Hatfield House (Herts), A.D. 1611.

The Charterhouse and the Inns of Court in London, the Colleges at Oxford and Cambridge, already referred to on page 25, are also good examples. Sir Paul Pindar's house, the front of which is now in the Victoria and Albert Museum, is a fine specimen of a small town façade.

THE LATE RENAISSANCE PERIOD: Anglo-Classic, Queen Anne and Georgian (the latter half of seventeenth century and eighteenth century)

During this period the influence of the work of Palladio on the great English architect, Inigo Jones, resulted in a breaking away from the English model; so much so that the new style is termed "Palladian" and resulted in an architectural revolution, such as was effected by Brunelleschi in Italy.

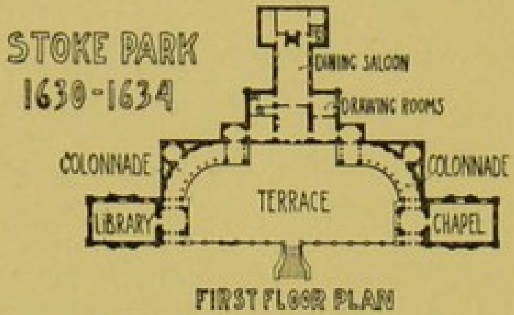
The "Orders of Architecture" were used to give importance and dignity, and were employed in the smaller houses in the entrance doorways, fireplaces and wall-surfaces, etc.

The fireplace with open dog-grate, after Jacobean models, was often richly treated with columns, while the overmantel had carved festoons with coat-of-arms, the whole design being in harmony with the treatment of the walls.

Architecture was also to a certain extent taken up as a fashionable study, as may be seen in the erection by the Earl of Burlington of the well-known villa at Chiswick, which was a copy of the Villa Rotonda at Vicenza by Palladio. It is an Italian country house quite unsuited to the English climate, and has had no effect on the traditional architecture of this country.

Anglo-Classic Period: The Country Mansions—A large number of mansions were erected which exhibit a stateliness and grandeur well suited to their purpose as country seats for the English nobility, although the practical requirements of domestic convenience were still frequently ignored.

The "E" and "H" shaped plans of the preceding period were now superseded by the Italian type of plan introduced by Inigo Jones, as evidenced in his design for Stoke Park (Ill. 7), which consists of a central block containing the principal apartments, which were placed above a basement story. These rooms were reached by an external flight of steps.



Ill. 7. Stoke Park, Northants.

On either side of this central block were wings containing the Kitchens, offices, and Stables frequently connected to the main building by colonnades.

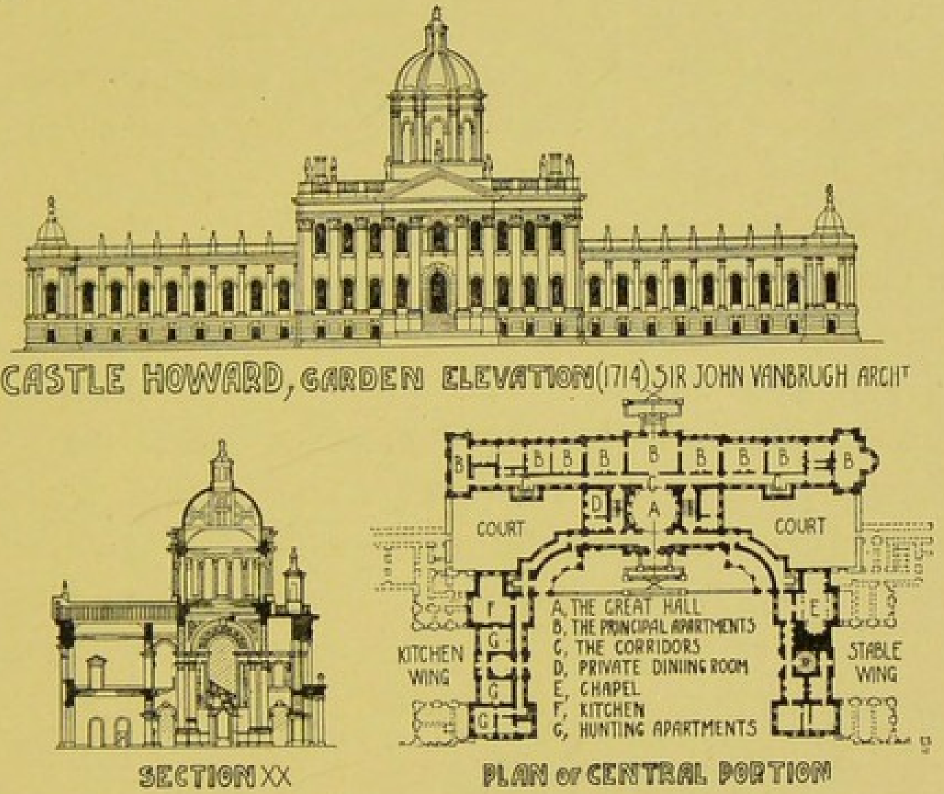
The principal entrance was sometimes provided with a two-storied portico, which, however, is unsuitable to the English climate, as it causes the rooms behind to be dark and unhealthy, and so it has in many cases been removed.

The Elizabethan Hall was succeeded by a thoroughfare room forming the Entrance Hall, as seen at A in Ill. 8.

Behind the Entrance Hall was the Saloon, an Italian modification for country villas of the open *cortile* of the larger town palazzi, and this often formed a large apartment in the centre of the garden façade, with the principal living-rooms ranged on either side (see B in Ill. 8); such rooms were sometimes octagonal or circular on plan.

Examples—Inigo Jones designed Raynham Hall, Norfolk (A.D. 1630), the Queen's House, Greenwich (A.D. 1639), Coleshill, Berks (A.D. 1650), and Chevening House, Kent (since destroyed).

Sir Christopher Wren continued the same ideas of planning, but his designs were principally of the central block type. Amongst his reputed domestic works are Groombridge Place, Kent; Belton House, near Grantham (A.D. 1689), and Marlborough House, London (A.D. 1698), with wings added later; besides considerable additions to Kensington Palace and Hampton Court.



ILL. 8. PLAN SECTION AND ELEVATION OF CASTLE HOWARD, YORKSHIRE.

Queen Anne and Georgian Period: The Country Mansions—A large number of mansions were erected in the eighteenth century by later architects, among whom may be mentioned Nicholas Hawksmoor, Sir John Vanbrugh, William Talman, William Kent, John Carr of York, Colin Campbell, Isaac Ware, George Dance, the Brothers Adam, John Wood of Bath, Sir William Chambers and many others.

The Italian type of plan still prevailed, the Entrance

Hall and Saloon forming the nucleus of the central block, which contained also the principal living-apartments.

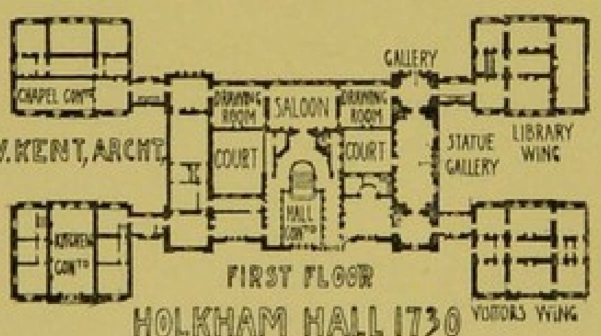
Wings on either side containing Stables and Kitchens were still arranged as at Castle Howard (Ill. 8), but sometimes also four wings were arranged symmetrically as at Holkham Hall (Ill. 9) and Kedlestone Hall.

The Jacobean Long Gallery still survived in a modified form in some of the larger houses, as at Holkham and Blenheim.

Little advance was made with regard to privacy and the convenient arrangement of the apartments, for corridors are seldom found and thoroughfare rooms were usual.

Compactness was frequently not much studied, the Kitchen in the East Wing at Blenheim being one hundred yards from the nearest Dining-room!

The accommodation shows an improvement on that given in the account of Hengrave Hall, and begins to accord more with modern ideas. The Dining and Drawing-rooms, which are henceforward common to all homes, are supplemented in the larger examples with Morning-rooms,



Ill. 9. First-floor Plan of Holkham Hall, Norfolk.

Libraries, Business-rooms, Boudoirs, Ball-rooms, Music-rooms, Billiard-rooms and Conservatories.

Bedrooms were again increased in number, and occasionally they were grouped for visitors in a separate wing, as at Holkham (Ill. 9).

Staircases leading to the Bedrooms on the upper floor were usually symmetrical (Ill. 8), on either side of the Entrance Hall, and the various apartments were grouped with special regard to symmetry and stateliness at the expense of practical utility and convenience.

Pope satirized this prevailing idea in the following lines :—

> " 'Tis very fine.
> But where d'ye sleep, or where d'ye dine?
> I find by all you have been telling
> That 'tis a house and not a dwelling."

The modern science of sanitation was still in a very backward state; the supply of lavatories and bathrooms was limited, and such as existed were badly placed, insufficiently ventilated and inadequately drained.

Formal Gardens—These houses of the late Renaissance were surrounded by formal gardens laid out on geometrical lines ornamented with sculptured figures and vases and with flights of steps and fountains, forming an ideal setting for a country house.

EXAMPLES—Many of these mansions are illustrated in the volumes of the *Vitruvius Britannicus* and indicate a passion for symmetry, together with a waste of space and inconvenience of disposition; but no one can deny the magnificent effect of many of these stately compositions.

Castle Howard, Yorkshire (Ill. 8), Blenheim Palace (Oxfordshire), which is peculiar in having internal courts, Seaton Delaval (Northumberland), all have detached wings containing Kitchens, Stabling, etc., with two connecting portions of quadrant forms treated as colonnades. Holkham Hall, Norfolk (Ill. 9), and

Kedlestone Hall (Derbyshire) are larger examples with four detached wings.

Examples of the smaller country mansions which have no wings are Melton Constable (Norfolk), Eltham House (Kent), Thorpe Hall (near Peterborough), Honington Hall (Warwickshire).

The Smaller Houses—A large number of the smaller houses for the rapidly increasing middle class were erected in and around London and almost every provincial town; and their simple and practical plans are in striking contrast with the stately and grandiose mansions we have already dealt with.

These smaller houses, frequently occupied nowadays by the country doctor or solicitor, are usually of the block type, approximating either to a square or double square on plan. The centre third of the house is usually occupied by the Outer Hall, staircase and Inner Hall; and on either side of this central portion are arranged the various rooms and offices.

The general appearance of the smaller Queen Anne and Georgian house has often been described in the novels of Thackeray, Dickens and others.

It is frequently set back from the road behind simple iron railings, and consists of a long, straight two-storied front raised upon a basement containing the Kitchen and offices.

The principal features are the sash-windows symmetrically arranged with stout wooden bars (see p. 64, Ill. 20), the central doorway with side consoles, entablature and pediment, displaying the owner's coat-of-arms, and a boldly projecting consoled cornice protecting the walls from the frequent showers of this rain-swept country.

The house is generally crowned with a plain hipped roof, with simple dormer windows which complete the *ensemble* of an unpretentious work of art in consonance with eighteenth-century civilization.

Many of the smaller examples in towns, owing to the cost of land, are attached buildings, and depend mainly on the distribution of their windows and well-proportioned entrance doorways for effect.

Furniture—Walnut was much used for furniture during the latter part of the seventeenth century, and the effect of the Restoration and Dutch influence, is evidenced in the designs. Mahogany appears to have replaced walnut for furniture about A.D. 1720. Chippendale in the first half and Heppelwhite and Sheraton in the second half of the eighteenth century continued the traditional methods of craftsmanship, combined with sturdy Renaissance columns and scrolls in harmony with the architecture of the period.

The system of veneering also came into general use, and the preference for classical designs affected even the most ordinary pieces of furniture, and produced in the latter part of this period and the first quarter of the nineteenth century what has been called the Composite Age.

MODERN ARCHITECTURE (NINETEENTH AND TWENTIETH CENTURIES)

The Break-up of Tradition—The nineteenth century was in the main a century of revivals of past styles of architecture, and was remarkable for the break-up of tradition, due in large measure to the prevailing freedom of thought and desire to evade the restraint of authority.

In the early part of the century the traditional Georgian art was in vogue, but this gave way to the

Greek, Gothic (Tudor) and Elizabethan styles, which were employed successively and indiscriminately in domestic architecture, and resulted in the great confusion known as the Battle of the Styles, in which classic principles, based on regularity, stateliness and balance of parts, were opposed to the Gothic principles based on irregularity, unfettered freedom and convenience.

The Greek Revival—During the years A.D. 1750–1825, Homer and the Greek authors usurped the pedestals of the Latin authors, which had held sway since the Renaissance. This produced an enthusiasm for Greek literature and art, which was emphasized by the publication of Stuart and Revett's *Antiquities of Athens* and other works. The importation (A.D. 1801–3) of the Elgin Marbles from the Parthenon at Athens also assisted in this direction.

The Greek Revival, however, had little or no effect on the planning of domestic buildings, for not even the fervour of the Revivalists could make people bold enough to adopt the Pompeian classical type of plan.

Frequent sacrifices of convenience were, however, still demanded, in order to comply with that general principle of regularity which was required, especially in the larger houses, which were still provided with small wings for extra accommodation.

Domestic offices were still in the Basement, but were eventually brought to the ground floor, even when the Basement was retained for cellar purposes.

The villas of Regent's Park, London, by Nash, are familiar examples, and some of them are on quite a large scale, although executed with stucco-faced walls which have been held up to scorn.

The Gothic (Tudor) Revival—The changes of politics and the cessation of the land and sea wars that had engaged the forces of Europe from 1789–1815 tended to bring about a change in the ideas of Europeans between the years 1815 and 1850.

The study of the Middle Ages, owing to the writings of Sir Walter Scott, Goethe and Victor Hugo, became fashionable, and this helped to produce the Gothic Revival in art, which was aided, in A.D. 1819, by Rickman's "Attempt to discriminate the Gothic styles." The writings of Pugin, Brandon, Britton and others also helped forward the movement.

In the first instance, the revival seems to have been brought about by a desire to produce the decorative treatment of the Gothic style, but the chief reason which caused the Tudor style to be used was its adaptability of plan to modern requirements.

Attention was also ably drawn to the Gothic period by Sir Charles Barry's designs for the Houses of Parliament, in which a stately classic plan was clothed with a Tudor dress.

The Elizabethan Revival—A somewhat later phase, still on the same lines as regards the plan, was the Elizabethan revival which was a reversion to an eminently useful and national type of art.

This revival answered the practical requirements of everyday life, in which convenience entirely governed the design, and symmetry was not considered essential, except so far as it resulted from the requirements of the plan, which still, however, continued in many instances to follow the old Georgian type.

Conclusion—To attempt, however, to enumerate even a selection of the types of houses erected during the nineteenth and commencement of the twentieth centuries would, of course, be impossible. The principles of plan as now established lay great stress on the hygienic distribution of the various apartments and the special attention given to sanitary requirements (see chap. III., p. 46).

The convenience and completeness of the domestic departments—due, no doubt, to the servant problem—also form a conspicuous *motif* in modern house plans. The reader is referred to examples by modern architects illustrated and described in chapter XVIII., page 246.

In whatever style—Greek, Gothic or Renaissance—the architect works, he should use it in an eclectic manner so as to answer the requirements of his client, and he should not be fettered by style, if it does not coincide with convenience.

A brief review has now been made of the various stages of development by which the Englishman's home has attained that degree of comfort which is acknowledged to be unrivalled throughout the world. We will now deal in detail with the making of a modern home.

CHAPTER II

THE SITE

Where to Live—A Healthy Site—Subsoil Drainage—Kinds of Soil—Position of Site—Points to consider in selecting a Site.

WHERE to Live—The first problem to be solved in the choice of a site is whether to live in town, suburb or country.

If one decides to live either in a suburb or in the country and has to go to business every day in town, a good service of trains or a motor-car is essential; but on the other hand if only occasional visits to town are necessary, the above desiderata are not so important, and consequently there is a wider range in the choice of a site.

Some people may own more than one residence, but such are by no means necessarily the happiest of mortals, and the owner of a comfortable house, carefully planned and erected in simple taste upon a well-selected site, need envy no one his numerous *pieds-à-terre.*

A flat in London and a little place in the country is considered by many an ideal arrangement, but those who have tried it know that it has numerous disadvantages, and the question of servants frequently makes it extravagant and unsatisfactory. It means, moreover, the duplication of many personal necessaries, and considerable irritation may be caused by finding that things are in one house when they are required in the other.

A Healthy Site—Healthy conditions and surroundings are the first essentials for any site, for no amount of care in the construction of a house will altogether avail if its situation is unhealthy. In many cases selection is not possible and some particular spot may have to be utilized. Then it is especially necessary to turn the peculiar circumstances to the best advantage, and it may save many heartburnings later on if an architect be consulted early in the matter.

The healthiness of the site depends largely on its surroundings, the nature of the subsoil, vegetation and sources of contamination in the immediate vicinity. In addition, the temperature, rainfall, moisture of soil and the nature of the prevailing winds materially affect it. The general climatic conditions of a district cannot be altered, but they may be modified by drainage and by the judicious plantation or removal of trees. Many diseases such as phthisis and affections of the respiratory system, including bronchitis, pneumonia and whooping-cough, appear to be derived from or fostered by dampness, which is also conducive to rheumatism, neuralgia and catarrhs.

All authorities agree that the condition which principally governs the healthiness of a soil is the relation which the ground air (i.e. air in the soil) bears to the ground water (i.e. moisture in the soil), and this depends mainly upon the rainfall, which varies greatly in different parts of the country. The principal evil is damp, caused by the evaporation of the moisture in the soil, which lowers the temperature of the air and is therefore injurious. This moisture is bound to rise, unless the level of the ground water is kept sufficiently below its surface ; for the lower the water is in the soil the less the evaporation and the warmer the adjacent air.

Subsoil Drainage—Subsoil drainage facilitates the passage of the surface water into the ground beneath, and thus reduces the amount of the evaporation. This is usually effected by means of unglazed, unjointed agricultural drain-pipes, butted against each other, and generally placed about three feet six inches below the surface of the ground with a good fall to a ditch, stream or river. The lines of pipes are placed at distances which vary from three feet to six feet apart, according to the nature of the soil, for it is obvious that in a sandy soil a single drain will lower the level of the ground water over a larger area than in a stiff clay soil, where drains must be placed closer together. Some authorities hold that ground water should not be allowed nearer than five feet from the surface, but this appears to involve unnecessary expenditure. The drains, it need hardly be said, should be entirely independent of any drain used as a vehicle for sewage.

Drained and undrained sites have been tested by various authorities, and many years ago Sir Douglas Galton found that a well-drained field had a temperature of as much as six or seven degrees Fahrenheit higher than an adjacent undrained field.

Kinds of Soil—Rock is an impermeable formation which makes in many respects an admirable site for houses, but care must also be given to the surface soil, as it may consist of decaying organic matter. This was found to be the case at the Peninsular Sanatorium near Hong-Kong, where, although the site is of granite formation, a severe epidemic broke out amongst the troops quartered there, owing to the nature of the soil on the rock.

Clay soil is generally impervious and holds the surface water, and is consequently bad unless carefully drained. The suitability of this soil depends largely upon the subsoil, and if the latter be of gravel and the clay not very deep, it may form an excellent site to build upon.

Houses near some towns have to be built on such soils, and provided they are properly drained they can be made at least unobjectionable, although clay, being a good conductor, is generally rather cold.

Gravel, free from loam and with a pervious subsoil, is generally considered good for building sites, as it allows the surface water to rapidly drain away. Porous soils may, however, be objectionable if there is an impervious stratum beneath, which holds the water as in a basin.

Marshy soils, including muddy sea-beaches or river banks, are unhealthy and even dangerous, and are shown by statistics to be responsible for malarial and other affections.

Made ground—i.e. ground which has been used as a dust and refuse shoot—is frequently found on the outskirts of towns and in the suburbs, and is, of course, unhealthy to build upon.

Chalk, if permeable and free from clay, is generally considered to be healthy, but many chalks are impermeable, and therefore damp and cold.

Position of Site—Having touched on the various soils, the position of the site with regard to health may be briefly dealt with.

It has been well stated that ground at the foot of slopes or in deep valleys which receive drainage from higher levels should be avoided, as it predisposes people even in temperate climates to epidemic diseases. High positions exposed to winds blowing over low marshy ground, although some distance away, are in certain climates unsafe, because of the liability to induce fevers.

Points to consider in selecting a Site—The suitability of a building site can be tested by bearing in mind the following points which are here tabulated for reference :—

1. The local climate should be healthy.

2. The soil should be dry and porous.

3. The ground should fall in all directions to facilitate drainage. If possible a position on a steep slope should be avoided, as high ground near a building causes the air to stagnate. This was proved very conclusively at Balaclava, where the mortality in the soldiers' huts which were placed on a steep slope was much higher than in those which were otherwise situated.

4. There should be a free circulation of air in the district, and muddy creeks and ditches, undrained or marshy ground should not be close to the house, or in such a position that the prevailing winds would blow the damp exhalations over the buildings.

5. If the site be an exposed one it may be sheltered from the north and east by trees, which should be at a sufficient distance, however, to avoid causing stagnation of air or dampness. As a general rule trees should not be nearer to a house than at least their own height.

6. The healthiness may be further tested by the rate of mortality in the district, and in the case of a health resort consideration should be given to its disease-curing properties.

7. The proximity of such unpleasant places as sewage farms, soap works, brick kilns, tanneries, cement works and lime kilns (which emit carbonic acid, etc.), slaughter-houses, refuse depots and stagnant ponds should be avoided. A cemetery also has a very depressing effect on many people, and according to Dr. Whitelegge, there is evidence of increased sickness and mortality among persons residing close to a crowded graveyard, the air of which contains an excess of carbonic acid. Sites near public-houses and schools are noisy, and often have a bad effect on the nerves of delicate people.

8. The drainage system in the district, including the position of the outflow and the method of sewage treatment, should be ascertained. Also whether the conduit is constructed on modern principles, with proper ventilation and with no backflow during high tides.

If the site is in the country, where there is no drainage system, a cesspool or septic tank must be used, and there must be a convenient position with a good fall for such treatment and sufficiently distant from the source of the water used in the house.

9. The water supply is of the greatest importance, and it is necessary to know whether this can be obtained from a Water Company's Main or from an adjacent river or well, or if an artesian well will have to be sunk. We know a case where a man paid thousands of pounds for a site before taking professional advice, and then had to purchase adjacent land to secure the necessary water-bearing strata.

10. The question of lighting is important, and inquiries should be made as to the accessibility of electric and gas mains, or the possibility of utilizing

waste water to provide power for an installation of electric light.

11. If the owner is of a sporting nature, information should be obtained as to the nearest meets of harriers, fox and stag hounds, and the proximity of fishing, golfing, polo, etc. Records of shooting-bags on the estate might also be obtained.

12. The train service, postal arrangements, shopping possibilities and cost of installing telephone should also be considered.

13. Sites near a main road should as a rule be avoided owing to the nuisance of motor traffic.

14. It is well to inquire whether any part of the neighbourhood is likely to be handed over to the speculative builder, for this might result in the erection of a class of house which would change the character of the neighbourhood.

15. The proposed tenure of the land—freehold, copyhold or leasehold—must also be borne in mind, and it is sometimes convenient to get an agreement for a lease with an option of purchasing the freehold, within a given number of years, at a stated price.

16. The amount of the rates and taxes should also receive attention, as in some districts these are almost prohibitive.

It will be seen that the choice of a site is an important question, and when one has been found probably the best thing to do is to obtain an option for a given time upon it, and then to seek expert advice.

CHAPTER III

THE PLAN

General Principles (Provision for Daylight, Disposition of Windows, Prospect)—Verandas — Corridors — The Rooms (Entrance Hall and Staircase, Dining-room, Drawing-room, Library, Morning-room, Smoking-room, Billiard-room, Lavatories, etc., Bathroom)—Kitchen quarters (Scullery, Pantry, Larder)—Bedrooms—Types of Plans.

GENERAL **Principles**—The plan of any building must depend upon the site, and only general principles which indicate special points to be observed can be laid down.

The first principle is that the sun should enter every living-room at some period of the day, for it is just as important to the air of a room as water is to the human body, and no apartment can be considered healthy which is not periodically disinfected by its rays. It is indeed generally an easy matter to ensure this, and even old and badly planned houses can often be made healthy by the judicious insertion of windows to admit the sun's rays. Even in awkwardly situated rooms it is often possible to put in a small sun-window, which adds much to the cheeriness of the house, and affects in no small degree the health and spirits of the occupants.

Provision for Daylight — A sufficient and abundant supply of daylight should be provided for every room, the exact amount varying with regard to any obstruction which may be contiguous thereto. We consider this question in chapter XIV., which deals with lighting.

Disposition of Windows—Much may be done by the skilful disposition of the windows; an odd number of windows in an apartment is generally preferred, in order to avoid a pier in the centre of a wall which would cast a shadow right across the room. No dark corners for the accumulation of dirt should be allowed, for "Out of sight, out of mind," is a saying which should be remembered in all matters of sanitary planning.

Prospect—The view to be obtained from the rooms and any special characteristics of the site must not be forgotten; and, indeed, in the country they should be a factor in determining the general position of the rooms. The hygienic value of a view over a pleasing landscape should not be lightly disregarded.

It is evident that in many houses the points of the compass have not been properly considered. We must remember that the sun is south at noon all the year round, and that the rooms should in general be so planned as to trap its rays. In England northern and north-eastern aspects are cold, southern are warm, and north-western and south-western aspects are subject to boisterous winds, often accompanied by driving rain. The south-eastern aspect is dry and mild, and is perhaps best suitable for most of the living-rooms, while a north-eastern aspect is best for the kitchen and offices.

Verandas—A Veranda (or Loggia) is a feature which in modern domestic buildings should be introduced with discrimination in Great Britain. Owing to our climate, with its comparative dreariness and absence of sunlight, it is usually best never to light a room solely by windows which have a covered Veranda in front of them, for an apartment lighted only in this way will generally be dark and unhealthy.

Some of the plans of houses that we give (Ills. 221, 233, 247) show Verandas, but in all cases it will be seen that such rooms are also lighted by other windows.

Corridors—Corridors should be well lighted and ventilated from the outer air, and planned with due regard to economy and efficiency. Compactness is necessary, so that the various rooms may be sufficiently close and not separated by long passages. The success of a plan depends largely upon the convenient disposition of the various rooms, and this we will now consider in detail.

The Rooms: Entrance Hall and Staircase—The Entrance Hall and Staircase are usually best placed on the north side, so that the sitting-rooms may face south. A good square Hall, containing an open newel staircase, well lighted by a large window and warmed by an open fireplace which gives it a home-like effect, can on occasion be used as an extra sitting-room or lounge as shown in Ills. 202, 221, 226, 242, 259, 297, 300, 310 and 329. Sometimes the Hall can have a recess to serve as a dining-room as shown in Ill. 307.

The long, narrow passage, dignified by the name of hall, in many town houses is dreary and draughty, instead of cosy and comfortable. In planning a Sitting-hall care must be taken to avoid draughts by the arrangement of the rooms round it, and the Staircase should not interfere unduly with the use of the Sitting-hall. The stairs should be at least three feet six inches wide, to allow room for two persons to pass one another. In order to prevent over-fatigue to delicate people, they should not be designed in longer flights than ten steps without a landing. The construction should be strong enough to avoid objectionable creaking, which interferes with the quietude so essential to a well-ordered house.

The proportion of height to width of tread is important. The rule that twice the height of the riser added to the width of tread should equal twenty-four inches will be found to give a comfortable proportion.

Dining-room—The Dining-room aspect should usually be north, east or north-east. If also used as a Breakfast-room, it should certainly have a few points of east, so as to get the morning sun, and this can be effected by means of a bay window (Ill. 267). A western aspect should be avoided, as the level rays of the sun on a summer evening tend to make the room hot and unpleasant at a time when it should be cool. The Dining-room should of course be near the kitchen quarters, but separated by a well-ventilated Servery, so arranged as to exclude kitchen smells. A recess for the sideboard may be formed (Ill. 226) at the end near the serving-door or hatch, which should always be provided.

Drawing-room—The Drawing-room should have a southern aspect, but anything between south and west is suitable. The room should be bright and cheerful with plenty of window-space, and with bay windows to form attractive corners. It may open on to the flower garden or be formed in connection with a Conservatory as shown in Ills. 221, 226, 233, 242, 251, 267, 279, 293 and 310.

Library—The Library should be in a quiet and retired position for purposes of study, and is best with a north or eastern aspect, as dryness is an important consideration, but if possible a sun window should be provided.

Morning-room—The Morning-room should have a south-east aspect in order to catch the morning sun as shown in Ill. 293, but if due east it is as well to add a bay window, so as to obtain in addition the southern sun. A north-western aspect should be avoided.

Smoking-room—A Smoking-room may sometimes in small houses be planned in connection with the garden, but much depends upon the idiosyncrasies of the owner, as some people do not object to smoking in any part of the house.

Billiard-room—The Billiard-room is best in a retired position, and it is often possible to plan the ground-floor Lavatories in connection with it. The ventilation of the Billiard-room is an important subject, which is dealt with in chapter xv., page 218.

A toplight is undoubtedly the best: that of a lantern type with glass sides is preferable, as it is less liable to leak. We have often, however, to be satisfied with sidelights, but this is not so inconvenient when the room is used mostly in the evening, as is often the case.

Lavatories and Water-closets—Lavatories and Water-closets should be planned with special regard to privacy. A Lavatory and W.C. are generally placed on the ground floor in proximity to the front or garden entrance, and this is a suitable position provided that it is properly screened (Ills. 242 and 283).

An ideal position for the Lavatories and W.C.'s is in a sanitary wing, cut off from the main building by cross-ventilation lobbies, but this is not often carried out on account of the disinclination to mark these conveniences too prominently, and owing to the extra expense involved. A ventilating lobby can, however, generally be arranged, or one can be formed by placing the Lavatory itself between the passage and the W.C. (Ills. 10 and 15).

Bathroom—The Bathroom on the first floor may have a lavatory basin with hot and cold water, and thus help to economize labour. There is no need to overdo the size of a Bathroom, as one eight feet square is, as a rule, quite large enough. The Bathroom should if possible be provided with a fireplace, as it provides ventilation for carrying off the steam.

Wherever possible, for the sake of economy, Water-closets, Bathrooms, Lavatories and sanitary fittings should be placed over each other on each floor, so that the wastes can discharge into the same down-pipes. Bath wastes should be placed near the highest point of the drain, so that their discharge may act as a drain-flush.

Kitchen and Offices—The Kitchen should be planned with a view to cross-ventilation, so that smells from cooking may not find their way into the house. The aspect should be north or east, as both are cool and dry, and the position should be convenient for access to Dining-room and front entrance (Ills. 221, 226, 259 and 302). The cooking-range should be planned so that the light comes from the side (Ills. 10, 12, 226 and 316), to enable the cook to see what she is doing. Neglect of this precaution is a common failure in house-planning, and it would seem that some designers think that as long as light is introduced into the Kitchen the position of the windows is of small consequence.

Scullery—The Scullery should have a cool aspect, and be in connection with the Kitchen. The sink should be in front of a window, and of glazed stoneware in preference to stone, for the latter after a time becomes objectionable by being impregnated with grease.

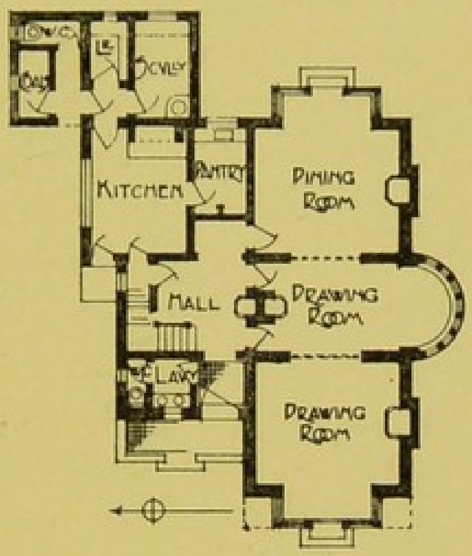
The wall above the sink should be lined with glazed tiles for a height of two feet, so that the splashings may be easily washed off. The flooring should be impervious, and tiles are therefore suitable for this purpose and are neat in appearance.

Pantry—The Pantry, which is used for the cleaning and storing of china, glass and silver, should be near the Kitchen, and may form part of the service-room (Ills. 259 and 316). It should either be fitted with a glazed stoneware or a lead-lined sink, and hot and cold water should be laid on.

Larder—The Larder should face north for coolness and have two windows, to create a through draught, and thus prevent stagnation of air. The windows should have perforated zinc gratings to keep out flies and insects.

Bedrooms—The Bedrooms should be planned, where practicable, so as to get as much morning sun as possible, and therefore east, south-east or south are all good aspects. As old Dr. Fuller said in the seventeenth century, "An east window gives the infant beams of the sun before they are of sufficient strength to do harm, and is offensive to none but a sluggard." Beds should not be placed in a direct draught between the door and fireplace; they should not face the light nor be too near the window; but they should be in a position where air can freely circulate.

A ventilation flue is required by all sanitary authorities in bedrooms which have no fireplace, but the latter should be provided where possible.

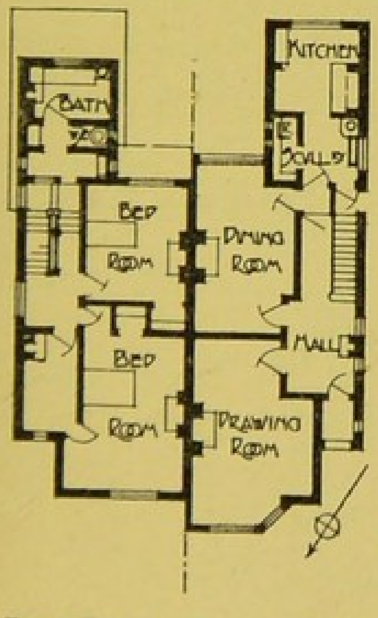


Ill. 10. A Suburban House.

The position of the dressing-table, wardrobe and wash-stand should also be considered, and the doors and fireplace planned with regard to these fittings.

Types of Plans—The plans throughout the book have been selected as showing various types of houses, but each building should be designed with reference to the exigencies of site and surroundings and the personal idiosyncrasies of the owner.

The following plans, however, may show some of the principles which should guide us in certain cases.



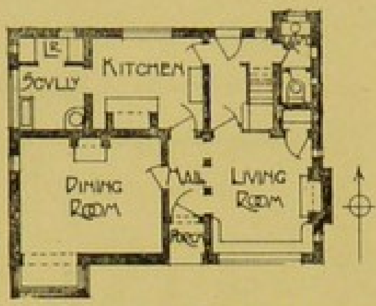
First Floor. Ground Floor.
Ills. 11 and 12.
A Semi-detached House.

Ill. 10 shows a detached house for a narrow suburban site, with three rooms communicating.

It indicates an attempt to give the hall a more inviting character by making it square in shape and by the addition of a fireplace. The lavatories are cut off from the houses as much as possible, and are shown in connection with the front entrance.

Ills. 11 and 12 are the ground and first-floor plans of a pair of semi-detached houses. On the ground floor a square hall with fireplace is given, and the service from kitchen to dining-room is so arranged that the smell from the cooking is intercepted by the scullery.

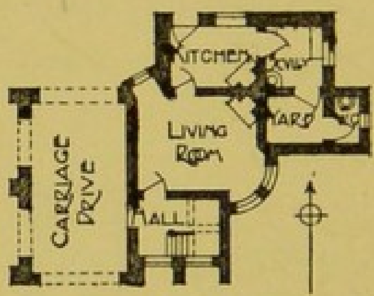
Ill. 13 is a ground plan of a small inexpensive bungalow containing two reception-rooms (i.e. dining- and living-room). In this type there are no passages, and the stairs are screened off from the hall. The water-closet is entered through the lavatory, and has in addition a ventilating lobby. The kitchen quarters are fairly convenient for the front door and dining-room.



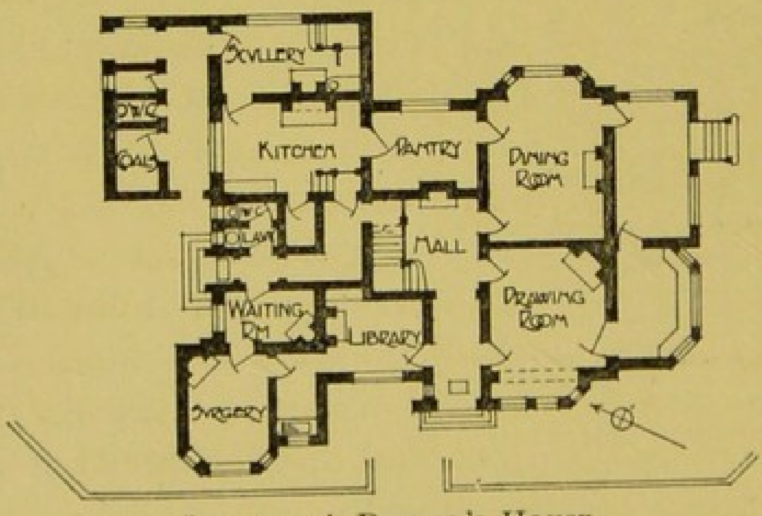
Ill. 13. A Bungalow.

Ill. 14 is the plan of an entrance lodge. The unusual shape of the living-room is necessitated, because a look-out window commanding the main road and private drive is required. Bedrooms are placed over the carriage-drive entrance.

Ill. 15 is the ground-floor plan of a doctor's house.



Ill. 14.
An Entrance Lodge.

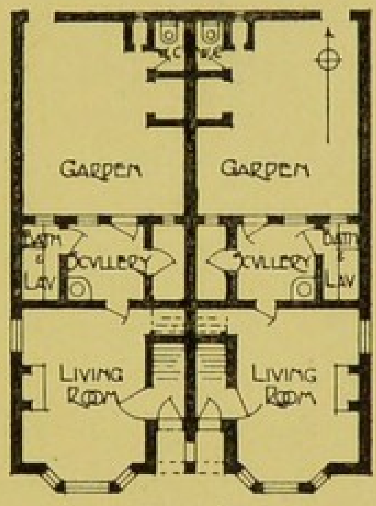


Ill. 15. A Doctor's House.

There is a large square hall with fireplace, lit from windows high up in the pantry wall. The consulting-room (library) surgery and waiting-room are self-contained and yet in communication with the house. The surgery entrance is in connection with the waiting-room, as are also the lavatories. The library is in touch with the front door.

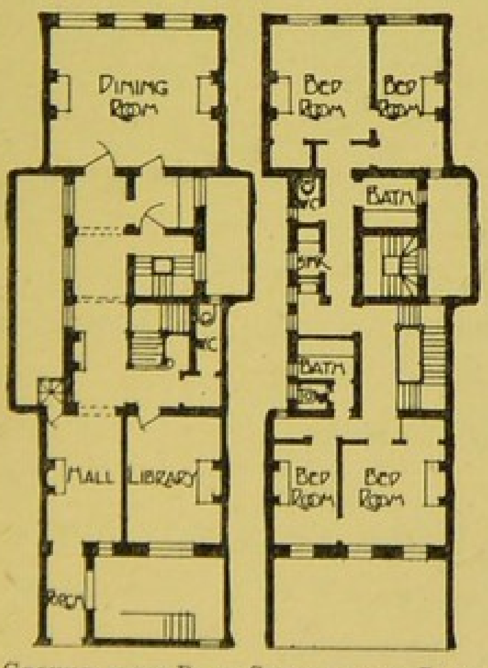
The pantry acts as a ventilating lobby between the dining-room and kitchen.

Ill. 16 represents a pair of workmen's cottages or two houses of a terrace of small dwellings. A large living-room and scullery are provided, in connection with which is a bathroom.



ILL. 16.
WORKMEN'S COTTAGES.

A bathroom used to be seldom found in a workman's cottage, but it is perhaps more necessary in this class of dwelling than in any other, owing to the nature of the work carried on by the artisan. The bath, being close to the scullery, can be readily supplied with hot water, and the room becomes, in fact, a lavatory and bathroom combined.

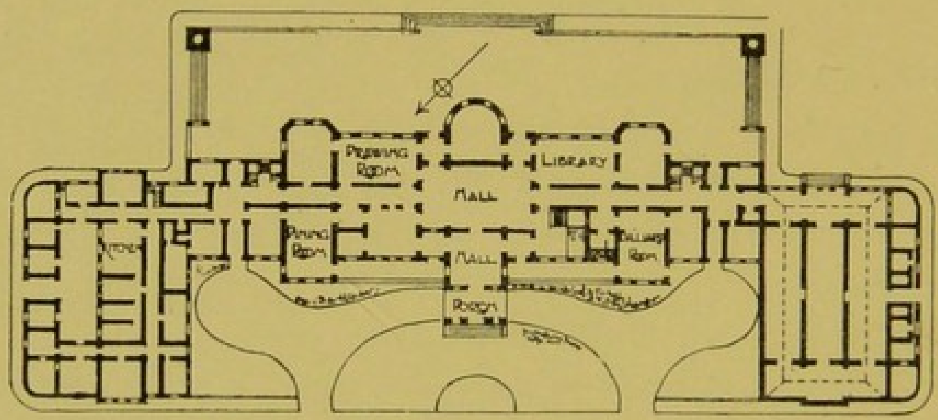


GROUND-FLOOR PLAN. SECOND-FLOOR PLAN.
ILLS. 17 AND 18. A TOWN HOUSE.

Ills. 17 and 18 are the ground and second-floor plans of a town house, the first floor being omitted, because it is given up to the reception-rooms, which need no explanation.

The ground floor has a good outer and inner hall with fireplace. The stairs to basement enable the servants to get to the front door without traversing the inner hall. A vaulted passage seven feet wide leads to the dining-room at the rear of the site. A small cloak-room and lavatory are placed under the stairs. The serving-room and service stairs are conveniently near the dining-room. On the second floor are two suites of rooms—front and back—with baths and lavatories in connection therewith.

It will be noticed that only lavatories, bathrooms and water-closets are lighted from internal areas.



Ill. 19. A Large Country House.

Ill. 19 is the ground plan of a large country house, which is so planned that all the living-rooms may, as far as possible, get the sun's rays at some portion of the day, and the kitchen block wards off the cold north-east winds. The dining-room is easily served from the kitchen quarters and faces north for the sake of coolness.

A morning-room leading off the drawing-room is provided, and this can also be used as a breakfast-room. The billiard-room is in connection with the ground-floor lavatories. The conservatories and winter garden form the south-west block, and are placed so that the sun is on them during the whole of the day.

Other types of plans are given in chapter XVIII., page 246, to which the reader is referred.

CHAPTER IV

THE EXTERIOR

General Principles of Design—Walls: [(*a*) Brick; (*b*) Stone; (*c*) Concrete; (*d*) Weather Tiling; (*e*) Rough Cast; (*f*) Half-timber; (*g*) Weather Boarding]—Windows: [(*a*) Sashes; (*b*) Casements; (*c*) Dormers; (*d*) Shutters]—Doorways—Cornices—Roofs: [Tiles; Slates; Stone Slabs; Shingles; Thatch]—Turrets—Chimneys—Optical Corrections.

GENERAL **Principles of Design**—The external and internal designs form the most important considerations after convenience in planning, and should possess an air of restfulness in keeping with the essential objects of the home. The exteriors of some of the old farmhouses, which are fast disappearing, possess those attractive qualities of repose and simplicity which have provided *motifs* for many of the best modern houses, but the narrowness of the sites in the neighbourhood of towns, especially near the metropolis, owing to the value of the road frontage, often renders it very difficult to produce a satisfactory exterior on such lines.

An architect's best preparation for this class of design is the sketching and measuring of old farmhouses in and around English villages, where gradual growth has brought about effective grouping, combined with simplicity of detail.

The most prevalent fault in modern architecture is the striving after picturesqueness for its own sake, which generally results in crowding the building with miniature features which are supposed to give scale, but of which the net result is often a toylike structure, with a fussy and strained effect, which is an outrage on good taste. It is perhaps a question whether any design of intentional picturesqueness has ever equalled the accidental grouping that is sometimes found in old houses, whose history clearly shows that there was no deliberate intention to produce the total result.

One leading principle in this class of design is that the building should have the long and low effect which is so much admired in the old farmhouses, and is so different from the ugly, cubical, boxlike structure which was the fashion in the Early Victorian period.

The internal height of the rooms is a very important matter, and it is a good rule to follow to make them as low as you dare. The subject is dealt with at length in chapter VI., page 91. It is best, however, to consider external design in relation to the various parts of the building, such as walls, windows, doorways, roofs, turrets and chimneys; but a pleasing result is sometimes produced by keeping down some parts of the design to the height of one story, as in Ills. 241, 299, 321, 324.

Walls—The base of walls should be treated so as to give an appearance of strength, and there are many ways of doing this, one method being to project the lower portion. This projection should be of sufficient width and height, and is sometimes made to coincide with the sills of the ground-floor windows in order to obtain an effective proportion. In place of any projection at all a stone or rough granite base may be formed as shown in Ill. 257, and other treatments are seen in Ills. 214, 241, 258, 315 and 324.

(*a*) **Brick**—Bricks are probably the most usual material for walls, and the effect is much improved by using those which have different shades of colour. A variety of tints can be obtained by mixing bricks burnt by wood fires, called bavins, with the ordinary red kiln-burnt bricks, and if judiciously selected, the result is very pleasing. If local bricks of good quality and colour can be obtained they should certainly be used, and it is well to remember that sand-faced hand-made bricks are far superior in appearance to machine-made bricks. They are well worth the extra cost, especially in small houses where little ornament is used, and where the appearance depends mainly on proportion and on material employed. In brick houses of Georgian design stone quoins at the angles are frequently employed (Ill. 246, p. 281).

(*b*) **Stone**—In districts where stone is plentiful, it is of course used either as ashlar or rubble masonry, and forms a restful change to those who have been accustomed to seeing brick houses. In certain districts, such as Cumberland, the rubble walls are constructed without mortar on the external face, and this treatment gives a very beautiful rough texture to the wall surface. In some districts, such as Norfolk and Suffolk, the main portion of the walling is of flint, split and roughly squared, the quoins being formed of stone.

(*c*) **Concrete**—Concrete has been used in certain cases, but it is generally admitted that it is usually not less expensive than ordinary brick-walling, while it is often faced with some other material.

(*d*) **Weather Tiling**—Weather tiling is an effective facing material for walls, as may be seen in many old English examples, and is shown in modern houses in Ills. 241, 258, 262 and 315. The method of securing the tiles to the wall is shown in Ill. 24.

(*e*) **Rough Cast** — Rough cast or Harling, as it is called in Scotland, forms a very pleasing finish and has several advantages, including that of helping to keep the walls dry. The materials used are stated in chapter v., page 77, and examples of this treatment are shown in Ills. 201, 214, 220, 224, 240, 247, 274, 278, 282, 306, 322 and 324.

(*f*) **Half-timber**—Walls formed of timber uprights with brick and plaster filling are picturesque, but the method of forming them with thin facing boards in lieu of solid timber framing should be avoided, as it will not last and is sure to give trouble.

Examples of Half-timbering are shown in Ills. 232, 241, 253 and 257.

(*g*) **Weather Boarding**—Properly tarred or treated with preservatives, weather boarding is also used in country districts with good effect, especially in small cottage work.

Windows—The type of window adopted by the architect, whether it is of the sash or casement variety, is such an important feature in the design, that architectural style for small buildings can almost be divided into sash-window and casement-window architecture, but it will be well to deal shortly with a few general principles applicable to all windows.

Ground-floor windows should generally have the glass line about two feet six inches from the floor (some prefer it even two feet), so that a person can look out when sitting in an easy-chair. Bedroom windows should have the glass line rather higher, e.g. three feet six inches or even four feet, in order to secure sufficient privacy. The top of the windows on all floors should finish as near the ceiling as possible, in order to ensure ventilation and give a bright and cheerful character to the interior.

The question of window bars is generally a source of much discussion with clients who are sometimes in favour of large sheets of plate glass, which are bare and uninteresting, while windows with well-proportioned divisions give scale and add to the apparent size of the house. A practical reason in favour of window bars is that the panes if broken are easily and cheaply replaced.

Divisional bars are, however, objected to by some, because it is said they obstruct the view and diminish the light, but the latter objection can easily be overcome by increasing the size of the window. With regard to the former, it is a matter of doubt whether it does not improve the outlook in general. The window bars, in fact, frame in a series of pictures, each contrasting with the other, and give to the interior a homely air and feeling of security against the elements which is wanting in a room with large sheets of glass.

The bars should be at least 1¼ in. in width in small buildings—Sir Christopher Wren in his larger structures made them as much as 2 in. wide. The size of the openings formed by the vertical and horizontal bars requires careful consideration, but a proportion of 5 in. in width to 8 in. in height will generally be satisfactory.

(*a*) **Sashes**—The windows of the Georgian style were mostly of the sash type, i.e. in two parts, made to slide up and down by means of pulleys and weights. This form appears to have been first brought into this country in the reign of William and Mary, and its utility appealed quickly to the practical British mind.

In consequence of an uneven number of divisions, the upper and lower sashes are sometimes of unequal height, and in this case the upper sash should be the smaller.

The sash window is held by some to be inartistic, and it does not always lend itself to poetic fancy, for we cannot imagine Romeo conversing with Juliet through a sash window; but rather from the casement or lattice window of Shakespeare's time.

Sashes require a more formal treatment than casements, and should not differ much in height or width throughout the design, or an unpleasant effect is produced. Different examples of the use of these windows are shown (Ills. 201 and 246). A detail drawing of a typical Georgian sash window is shown in Ills. 20, 21 and 22 on the following page.

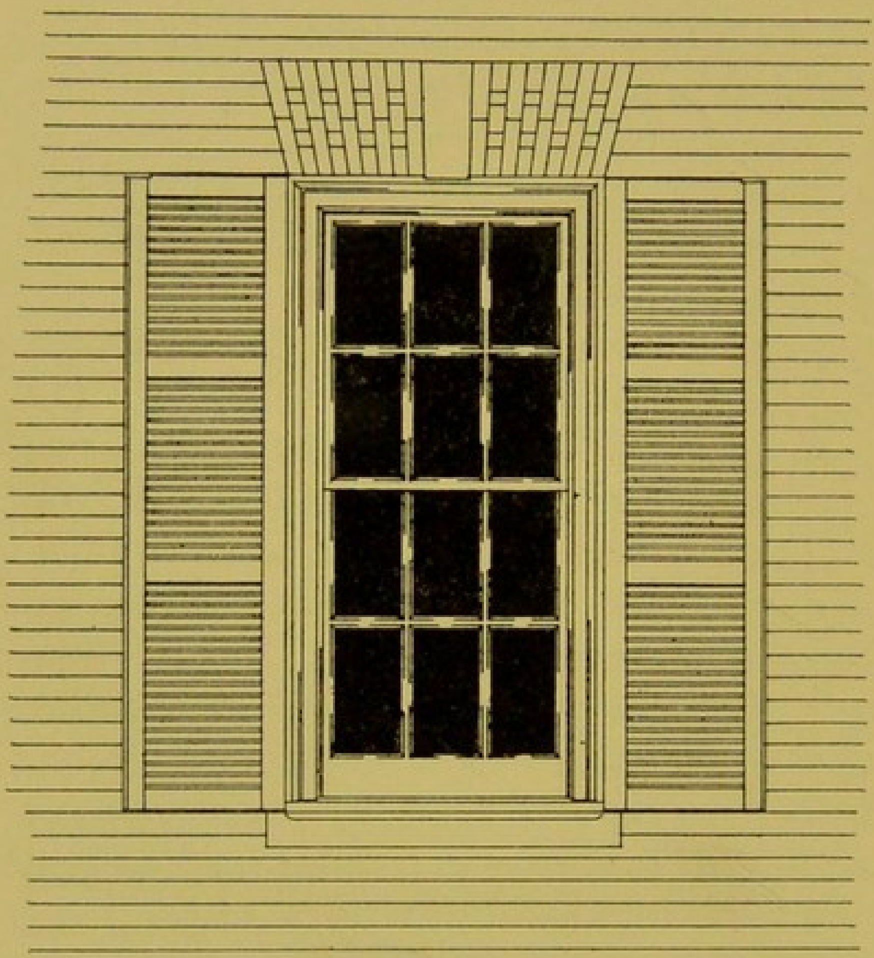
The face of the window frame should be from one to two inches from the external face of the wall as shown, thus leaving internal space for a wide window seat, and adding to the sense of comfort and security by giving a greater internal thickness of wall.

The external appearance of the window with the frame almost flush with the face of the wall is also more effective than when hidden behind brickwork, as the white paint of the woodwork contrasts well against the red brickwork or green shutters.

The sash window has the advantage, not possessed by casements, of enabling a room to be ventilated without draught, by the provision of a deep inner bead at the bottom, which permits the lower sash to be slightly raised, thus admitting fresh air between the meeting rails as shown by the arrow on Ill. 22.

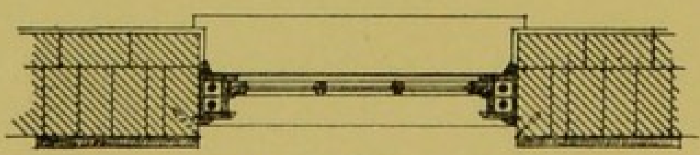
(*b*) **Casements**—Casements, as before stated, are often more in harmony with country buildings, as they are simpler and cheaper and require a less formal

GEORGIAN SASH WINDOW.



Ill. 20. Elevation.

Ill. 22. Section.



Ill. 21. Plan.

treatment. They are hung to stone or solid wooden frames, usually about one foot six inches to one foot eight inches apart centre to centre, and look reposeful and in harmony if arranged on the long and low principle as seen in Ills. 240, 258, 262, 274, 296, 299, 306 and 322.

In very high windows transoms are sometimes required to stiffen the mullions near the centre of their length, but they are best avoided, as they take away from the reposeful effect of the upright mullions. If they are used they should be at least six feet from the floor, so as not to interfere with the sight line.

One of the upper panes in each room should be made to open independently, so that sufficient ventilation can be effected in cold weather without opening the whole casement, or if a fanlight is provided above the transom it can be hinged at the top to open outwards.

Leaded glass is frequently used with wooden casements, but it is cheaper and quite as effective to have the small squares formed by the wooden bars as already mentioned for sash windows. Where the mullions are of stone, as in the hall windows shown in Ills. 225, 232, 241 and in other windows illustrated in 321, 322 and 324, the casements which are to open should be formed of wrought-iron or steel; and the leaded lights of those which are not to open can be fitted direct to the stonework. French casements are dealt with in chapter VI., page 98.

(*c*) Dormers—Dormer windows are necessary for lighting the rooms in the roof, and if of simple character and grouped together, with odd panels filled in with rough cast, as shown in Ills. 241 and 247, they produce a quiet and pleasing effect. They take the place of gables, but cause the area of the room to be diminished, as they must be set back from the face of the wall as in Ill. 208 until a height of three feet from the floor has been reached for the window sill.

(*d*) **Shutters**—The use of sun shutters has often been carried to excess, as, for example, when placed on the northern façade of a house, for in this position they can never fulfil their duty as a protection against the sun, and thus form an instance of illegitimate striving after effect.

Doorways—The front doorway is a feature which lends itself to special treatment, and should generally be emphasized so as to give it importance and an inviting aspect; shelter of some sort should be provided for the visitor between ringing the bell and gaining admission. This may be effected by a recessed opening as in Ills. 225, 232, 241 and 287, or by a small projecting roof as in Ills. 247 and 299, or by a simple treatment in the form of a porch with a carved projecting hood similar to those of the Georgian period.

The entrance doorway in a small house need not usually be higher than six feet six inches; the porch should be not less than four feet in length and may be as wide as five feet as in Ills. 211, 221 and 226. The door itself may, if necessary, be hung in two unequal widths, and the smaller portion need only be opened for special purposes as shown in Ill. 242.

It is often necessary to introduce more light into a large hall than can be effected through a fanlight, and in that case a range of mullioned windows may be designed with the entrance door as in Ills. 225, 232 and 241.

Cornices—One important fact can be learnt from the study of the best art of the past, viz. that a bold crowning cornice is a most effective termination to a building and will give it character and interest. A building of simple design often becomes a fine composition by means of a well-proportioned cornice, as is seen in the plain yet masterly design, by Inigo Jones, of St. Paul's Church, Covent Garden, which he himself called the handsomest barn in Europe.

The stone or wood cornices of the Georgian period do not exhibit much inventiveness, but they were well constructed and projected from two to three feet. They thus serve a useful purpose in keeping the building dry by preventing falling rain from soaking down the walls and entering the windows on the upper floor.

Ills. 208 and 246 have this principle in view, and the central feature of the latter house is typical of Georgian architecture; the cornice is carried up into a deep pediment, with a low window lighting one of the upper rooms.

Roofs.—The design of the roof should give unity to the structure, and much depends upon the general treatment adopted. In the smaller type of house a roof covering the whole structure makes for simplicity and repose, while numerous gables and ridges produce a restless feeling which it is desirable to avoid.

Gables, when employed, should be of simple outline, with the tiles or slates of the roof projecting, and thus keeping the walls dry, as in Ill. 232, for if gable walls are carried up above the roof surface lead flashings are required, which causes an additional expense.

Hipped roofs are those which are set back from the face of the wall, as in Ill. 208. The wall in this case is terminated by the eaves gutter. Gables and hipped roofs should not, as a rule, be employed together in the same design, as this would produce a confused result.

The best method of forming the eaves of a sloping roof is to let the slope overhang the wall two or three feet (Ills. 282 and 289), as this gives a good shadow and properly protects the wall from falling rain.

Horizontal parapets are required as a protection for flat roofs or roofs of an unusual height above the ground which cannot be reached by a ladder. The parapet requires an expensive lead gutter, and forms a lodgment for snow and rain-water such as does not occur in the ordinary eaves gutter.

The most appropriate materials for covering sloping roofs are tiles, slates and stone slabs.

Tiles—Tiles are generally about 10½ in. by 6½ in. and ½ in. thick, and are either plain or moulded to various patterns. They are now usually formed with nibs on their upper end to rest on battens, every third course being nailed with copper or galvanized iron nails. The tiles should be laid so that the gauge is not less than four inches, in order to ensure that rain does not enter through the joints (Ill. 37).

Tiles are of various manufacture, but it is well to use local materials where possible. Broseley tiles of various colours, such as red, strawberry, brown, brindled, and blue, have acquired a special reputation for being hard and impervious to moisture. Sand-faced, hand-made tiles, such as those to be obtained in Berkshire, Kent and elsewhere, are to be preferred to machine-made tiles, as though more absorbent they weather better. The hard, uninteresting appearance of the machine-made tile can be avoided by the judicious mixing of old tiles with the new, for they will soon tone down together and give additional texture and colour to the building. If new tiles are used alone it is well to get variety of colour, and not to insist, as is so often done, that colour should be uniform throughout. Pantiles are mentioned on p. 88.

Tiles are warmer in winter and cooler in summer than most other roofing materials, and this is an advantage which ought to weigh with the architect.

Their weathering properties and picturesque effect add much to the homely appearance of the house. Artists well know the value of a weather-stained, many-tinted tile roof, which, when covered with lichen, adds to the charm of many an old English cottage.

Tiles have the disadvantage of being heavier than slates, and they absorb more moisture, which is liable to be communicated to the rafters, but this can be largely obviated by using only those which are thoroughly burnt.

Slates—Slates are a species of argillaceous rock which, owing to lateral pressure, has become laminated, causing it to split easily in thin sheets along its plane of cleavage. Slates suitable for roofing purposes are found in many parts of England and Wales, but the quality and texture vary a good deal with the locality from which they are obtained.

Bangor slates should be avoided, for they are of an unpleasant and gloomy blue-purple colour, which never tones to an agreeable hue. Irish slates are, as a rule, somewhat thicker and coarser, especially from the quarries of Kilkenny and Killaloe.

English slates are thick and have a rough surface with jagged edges. They are obtained from Westmorland, Lancashire and Cornwall, and are infinitely preferable to any others, as they are of a beautiful grey-green colour, which gives a bright and cheerful appearance and forms a pleasing contrast with red-brick walls. They should be laid in courses diminishing in size towards the ridge, which helps to give scale to the design. There is also a practical advantage in this, because as the bigger slates are at the lower part of the roof, over which most of the rain-water passes, there are fewer nail-holes for the possible entry of rain.

Slates are in some cases preferable to tiles in exposed situations, as they are less absorbent and can be used with a roof of lower pitch, but, as they are conductors of heat, they make the upper rooms cold in winter and hot in summer.

Stone Slabs — Stone slabs, or tile stones, as they are sometimes called, are largely used for roofing purposes in Devonshire, Gloucestershire, Somerset, Northants, Oxfordshire and Sussex. They make a picturesque and durable roofing material; they are thick, heavy and non-conductors of heat, and thus keep the house cool in summer and warm in winter. Ill. 247 shows their use in roofing a small country house.

They are usually about 1 in. thick, laid in diminishing courses varying from 4 to 12 in., and are torched, i.e. pointed, on the under side with mortar composed of stone chippings and lime. The ridge should be formed out of solid sawn stone, and the valleys are usually of taper or triangular slabs, producing a soft curve, which forms one of the special charms of this roofing material.

Shingles—Shingles of hard wood, such as oak or larch, are the same shape as tiles, but 12 in. long and 6 in. wide and about $\frac{1}{4}$ in. thick, and are mainly used for small roofs of turrets, bay windows or summer-houses. In the course of time they weather to a beautiful grey tint, but care should be taken, in order to make them durable, that they are split and not sawn or planed.

Thatch—Thatch is undoubtedly picturesque, but it is insanitary and easily catches fire, and is seldom employed in new buildings. Reed-thatching, as carried out in Norfolk and elsewhere, is by far the best and most lasting variety. The old class of thatcher is indeed dying out, and it is difficult in most parts of the country to get thatching properly executed. It is sometimes employed with great success, as in the little cottages at Astonbury (Ill. 278).

Flat roofs, and the nature of lead, zinc and copper with which they are usually covered, are dealt with in chapter v., page 89.

Turrets—Turrets are frequently designed to hold clocks or bells or to serve as observatories (Ill. 262), and they can be very effective features. The architects of the Georgian period have left many fine examples. Modern turrets are often far too small for the position they occupy, and it must always be remembered that they are usually at the highest point of the building, and are therefore foreshortened, and appear reduced in size owing to the distance from the eye. An insignificant turret reminds one of a man wearing a hat which is much too small for him, but care must be taken not to pass to the other extreme of a lady with a picture-hat.

Chimneys—Chimneys should be treated in a bold and effective manner so as to aid the skyline, which is a most important element of the design. This is more apparent at night or on a misty day when general proportion only can be seen. Chimneys are now designed so much with regard to economy that they have lost much of their old-time importance, and are frequently not high enough for appearance or even for creating sufficient draught in the flues.

A chimney never looks so high in execution as it does on a drawing, and allowance therefore has to be made for this by the architect. It must also be remembered that in low-lying sites, and wherever overshadowed by trees or buildings, additional height must be given.

Another important point is that flues should be grouped together as much as possible, for it is far better to have two or three good-sized stacks than several small ones, as seen in Ills. 246, 257, 262, 274 and 295.

A flue 9 in. by 9 in. in area is large enough for all ordinary domestic fires, but in order to get a more dignified effect they may frequently be made 14 in. by 9 in. They should be encased by 9-in. walls, although 4½-in. walls are more usual, for the extra width gives not only a sturdier appearance, but also additional strength to withstand wind pressure and prevent the ingress of driving rain, which will certainly prevent the flue from drawing properly. Chimneys on inside walls generally draw better, as they are more protected.

Optical Corrections—The effect of distance from the eye or foreshortening must be constantly borne in mind in designing any structure.

The appearance of the finished structure can only of course be gauged by experience gained in actually designing and carrying out previous buildings, and by the intelligent study of old buildings. It can readily be understood, however, that a sloping roof will in appearance be much lower in execution than on a geometrical drawing, in consequence of the ridge being much further from the eye than the eaves.

From the time of the Greeks optical corrections have been employed in architectural design, and these corrections have to be considered much more thoroughly in larger buildings than in those we are now dealing with.

There are, however, occasions when they must be borne in mind even in smaller buildings if a satisfactory result is desired, as, for instance, when using long horizontal beams, which always appear to drop in the centre unless slightly cambered.

CHAPTER V

CONSTRUCTION

General Principles—Foundations—Walls (Hollow Walls; Wall Facings)—Damp Courses: [(*a*) Horizontal; (*b*) Vertical]—Dry Areas—Chimneys—Floors: [(*a*) Ordinary Floors; (*b*) Fire-resisting Floors; (*c*) Reinforced Concrete Floors]—Roofs: [(*a*) King-post; (*b*) Queen-post; (*c*) Hammer-beam—Inclination for different Roof Coverings—Flat Roofs—Gutters].

GENERAL **Principles**—It is a curious fact that while so many of us are particular about our diet, clothing and mode of life, we often pay but little regard to the houses in which we spend the greater part of our lives.

When most of us have had the drainage system of our houses tested, we seem quite content to take the rest on trust, although sickness and disease are probably caused quite as often by inefficient construction as by defects in drainage.

Dampness is the principal enemy to be contended with, and it must be kept out of any building which is to be healthy and fit for occupation. The construction of the house should also be considered with regard to stability and resistance to changing atmospheric conditions. Due regard must be had to the fatigue of the different materials, whose future behaviour should be provided for by a margin of safety.

Local materials should be utilized as far as possible, for it is piteous to see building materials, upon which heavy freights have had to be paid, transported to districts where materials of good quality are abundant.

The site of the structure should in the majority of cases be covered with six inches of Portland cement concrete, and the top of this floated over with one inch of neat cement, in order to prevent any damp air rising into the building. The Model By-laws of the Local Government Board provide for this sanitary requirement; and it has been demonstrated that families have often been more or less poisoned by vapour drawn up through the ground into their dwellings.

We will now deal briefly with the construction of the different portions of a building.

Foundations—Trial holes should always be bored over a proposed building site for the purpose of finding out its exact nature, and this will sometimes prove an additional advantage to the client, as suitable sand and gravel may thus be found that can be used for the mortar and concrete, thus saving the cost and cartage of obtaining it from elsewhere.

Each individual case must be treated on its own merits, but excavations in most instances should be continued until a firm foundation at least three feet six inches below the surface of the ground is reached.

Buildings are sometimes erected on reinforced concrete rafts, which have been found necessary owing to unusual local conditions; in other cases timber or concrete piles have been used, while brick piers connected by arches are both economical and satisfactory.

The base of all walls should be formed with projecting footings twice the thickness of the wall, in order to form a wide base (like the feet of human beings and animals) on which to spread the weight; and beyond this the concrete should project six inches on each side as seen in Ills. 23, 25, 26, 27 and 28.

Portland cement concrete should generally be used in foundations, and should not be mixed in less proportions than one part of cement to six of aggregate, the latter being composed of hard gravel or bricks broken to pass through a two-inch ring, sufficient sand being added to fill up the interstices. Good blue lias, or other hydraulic lime, may sometimes be substituted for Portland cement.

Walls—Walls are usually either of brick, stone or the other materials which have already been briefly discussed in chapter IV., page 59.

They should as far as possible have non-absorbent properties which can be tested by placing the material in water and weighing before and after immersion, so that the amount of water absorbed can be ascertained.

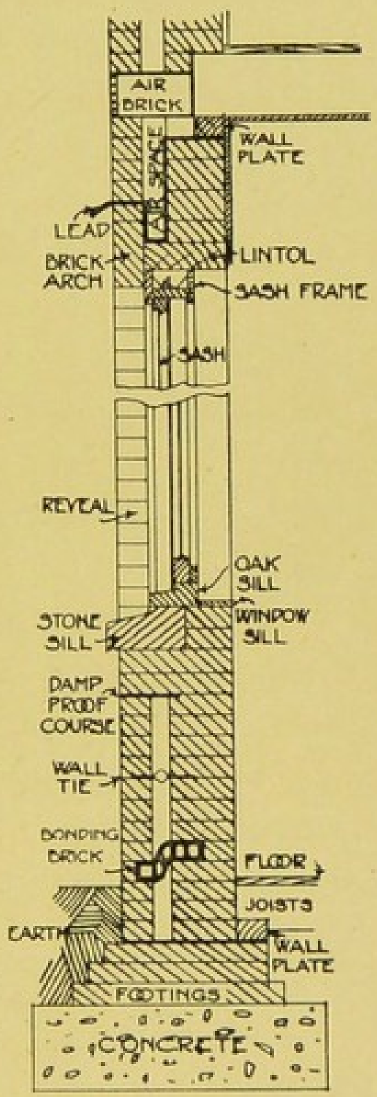
This absorption varies considerably with different materials, as seen in the approximate table given below:—

Granite . . .	absorbs	1	per	cent	of its	weight.
Blue Staffordshire bricks	,,	6	,,	,,	,,	,,
Ordinary London stocks	,,	7½	,,	,,	,,	,,
Hard stocks . . .	,,	10	,,	,,	,,	,,
Portland stone . .	,,	14	,,	,,	,,	,,
Bath stone . . .	,,	17	,,	,,	,,	,,

A brick backing not less than nine inches in thickness is generally placed behind all stone walls, and care should be taken that this backing is thoroughly bonded with the stone facing, one through stone for every square yard of wall surface usually being sufficient.

Hollow Walls—Hollow walls are useful in exposed situations, the two portions forming the inner and outer walls being placed about 2½ in. apart and connected together with bonding bricks or metal wall-ties at intervals, as seen in Ill. 23.

Authorities differ as to whether the one-brick or the half-brick wall should be placed externally, and there are advantages in both methods; although it seems better construction to put the half-brick wall outside, so that the floor and roof timbers can rest on a solid one-brick wall as shown in Ill. 23. The vitrified bonding bricks which are sometimes used to bind the two thicknesses together should be of the form shown in Ill. 23, in order that rain may not be drawn from the outer to the inner wall, and so nullify the advantage gained by having the cavity.



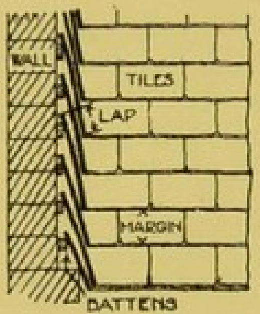
ILL. 23. A HOLLOW WALL.

Ill. 23 also shows how the head and sill of a window in a hollow wall should be protected from any damp which may find its way into the hollow space.

Wall Facings—Brick walls, especially on exposed sites, are often protected from driving rains by being rendered in cement, which, although not always satisfactory in appearance, is certainly effective.

Rough cast is also used for this purpose, and if applied with simplicity and taste, forms a very pleasing and effective resistance to the damp (see chap. IV., p. 61).

The following is a good specification for pebble-dash rough cast in two-coat work. The first or backing coat is composed of two parts of cement to five of pit-sand, but more cement is required for a hungry variety of sand; and the finishing coat is composed of 6 parts of selected pebbles, $1\frac{1}{2}$ of cement, $\frac{1}{2}$ of sand and 1 of slaked lime, the total thickness on the walls being about $\frac{3}{4}$ in. Other varieties of rough cast are formed with the surface left rough from the trowel or treated with a stiff broom, to give it texture. The whole may with advantage be brushed over with a wash made in the proportion of 28 lb. of boiled Russian tallow to 36 gallons of yellow ochre and slaked lime.



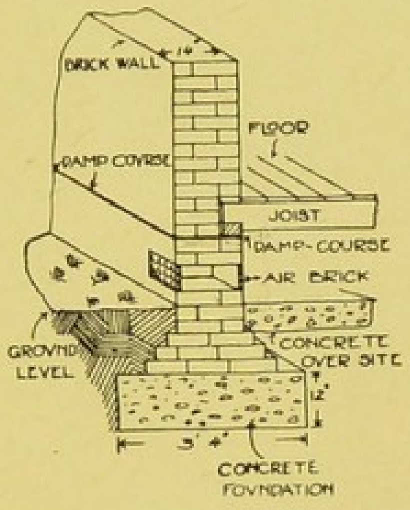
ILL. 24.
WALL TILING.

Weather tiling, as shown in Ill. 24, is an excellent method of keeping walls dry against driving rains (see chap. IV., p. 60).

Damp Courses—As before mentioned, the principal consideration in the construction of houses is to ensure equable temperature and to keep out cold and damp, which latter may be effected by means of (*a*) horizontal and (*b*) vertical damp courses.

(*a*) **Horizontal Damp Courses**—The horizontal damp course is required to prevent damp being drawn up into the walls by capillary attraction, much in the same way as moisture is drawn up by a sponge. It should be formed of some non-absorbent material, fixed not less than six inches above the surface of the ground, and all wall plates and flooring must be placed above it in order to be protected from the damp. Ill. 25 shows a horizontal damp course with air-bricks inserted at intervals to ventilate the space underneath the floor, and thus to guard against dry-rot.

There are several materials which are used as damp courses, of which the following are the principal ones in use :—



Ill. 25. A Horizontal Damp-proof Course.

1. Two courses of slates, breaking joint, and set in cement, form a usual and effective material, but the objection frequently raised against it is that the slates are liable to crack with the slightest settlement, although the fracture will not always materially affect their efficiency.

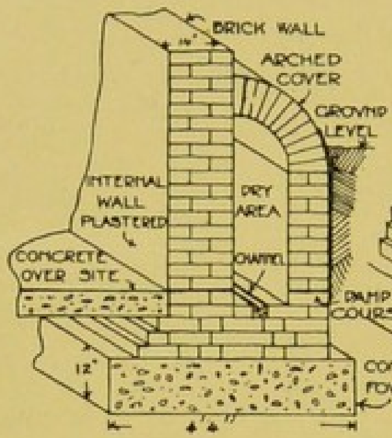
2. Asphalt, which should be one of the varieties of rock asphalt, forms a very good damp course and should be applied in two layers of $\frac{3}{4}$ in. each.

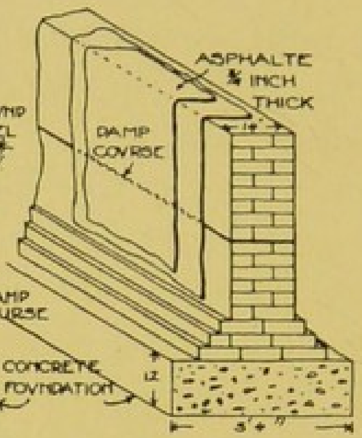
3. Lead is sometimes used to form a damp course, but owing to its cost is not often employed.

4. Patent bituminous felt compositions laid with lapped joints are used, and being elastic in character, remain effective in the event of a slight settlement in the building.

5. A course of vitrified fire-clay air-bricks built in cement prevents the rising of damp and at the same time ventilates the space under the ground floor, thus preventing any tendency to dry-rot in the timbers. In putting damp courses into old buildings where they have been omitted, this is often the best and cheapest method, as a course of bricks can be cut out in sections all round the building and the air-bricks inserted.

(*b*) **Vertical Damp Courses**—Vertical damp courses are provided to prevent damp entering a wall from adjacent wet ground; hollow walls (already dealt with) and areas can also be used for this purpose. An



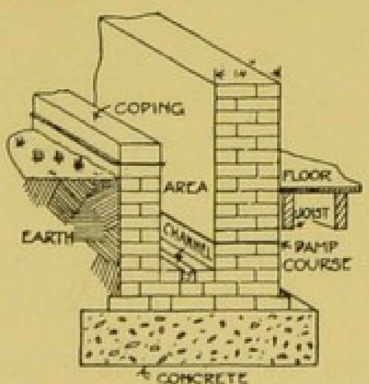


ILL. 27.
A COVERED DRY AREA.

ILL. 26.
A VERTICAL DAMP-PROOF COURSE.

asphalt lining in two thicknesses of ¾ in. each is shown in Ill. 26.

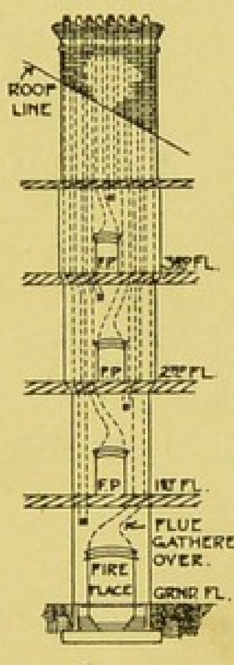
Dry Areas—A dry area, placed outside the wall and left open, is shown in Ill. 28, and a dry area, drained, arched over and ventilated, is shown in Ill. 27. This dry area may be from 2½ in. to 12 in. wide, and the cavity should be carried up 6 in. above the surface of external ground, and a damp course inserted at its base, as seen in Ill. 27.



ILL. 28.
AN OPEN DRY AREA.

Chimneys—Chimneys should be built in cement mortar, and in order to render the flues as dry as possible, they should be surrounded with walls one brick in thickness. A damp-proof course just above the junction with the roof should be provided, so as to prevent rain-water soaking through to the roof timbers.

The stacks should be carried up at least three feet above the ridge of the roof, and the flues gathered over, as shown in Ill. 29, in order to prevent the tendency to down draughts, which arises when the chimney-pot and fireplace are in the same vertical line.



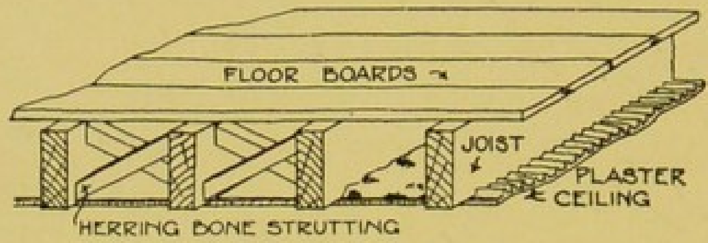
ILL. 29.
THE GATHERING OF FLUES.

There are many patent chimney-pots and cowls for the cure of chimneys that will not draw properly, and in low-lying sites we have found some to be of service, but the secret of a good draught lies mainly in the skilful construction of the flues themselves.

The general architectural treatment of chimneys is considered in chapter IV., page 71, and the construction of the chimney hearth is shown on Ills. 148 and 149.

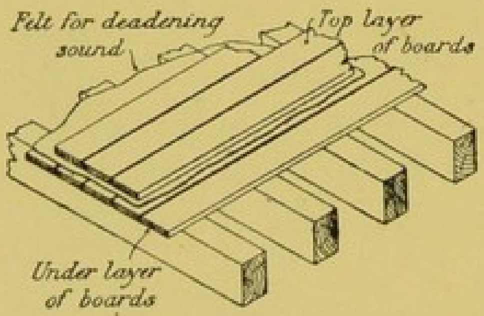
Floors—Floors may be considered under the following headings: (*a*) Ordinary floors; (*b*) Fire-resisting floors; (*c*) Reinforced concrete floors.

(*a*) **Ordinary Floors**—Ordinary floors are constructed with wooden joists, placed about one foot apart, and covered with floor boarding on the upper side, and with lath-and-plaster ceiling on the under side, as shown in Ill. 30. This form of floor is unhealthy because of the accumulation of dirt which collects in the spaces beneath the boarding, for every time such a floor is washed it means the addition of more filth to that which has already passed through the open joints of the floor boards, and found a resting-place on the plastered ceiling beneath (Ill. 30). Such floors when used should be covered with grooved - and - tongued or ploughed - and - tongued



ILL. 30. A TIMBER FLOOR WITH HERRING-BONE STRUTTING.

boarding, which will, to a certain extent, prevent dust and dirty water from falling between the boards. Ill. 31 shows a floor in which the usual lath-and-plaster ceiling is omitted, and this method is further alluded to in chapter VI., page 101. The timber joists are visible from the room below, and give a certain homely effect, as seen in Ills. 229 and 230, while obviating the insanitary drawbacks of the ordinary floor. Two thicknesses of boarding with a layer of non-conducting material between them are placed on the top of the joists.



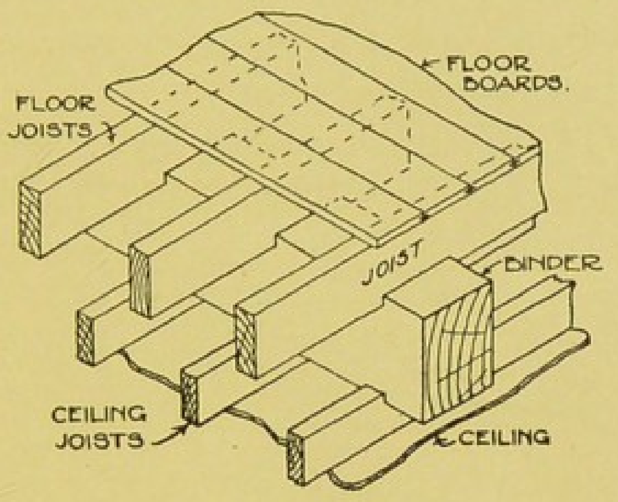
ILL. 31. HYGIENIC FLOOR.

A rough guide for the depth of the joists placed a foot apart and between two and three inches in thickness is :—

$$\frac{\text{Span in feet}}{2} + 1 \text{ in.} = \text{depth of joist in inches.}$$

Where the bearing exceeds eight feet, the joists should have one row of herring-bone strutting as shown in Ill. 30, and when the span exceeds twelve feet there should be two rows.

Double floors in which binders are introduced are occasionally used over large rooms, and in such cases separate ceiling joists are sometimes used, as in Ill. 32.



Ill. 32. A Double Floor.

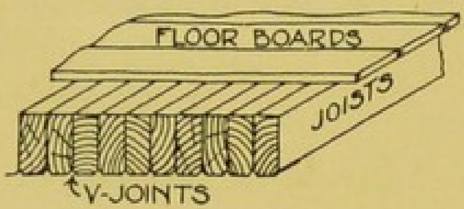
Steel joists are now generally employed in lieu of the wooden binders, and the joists then rest on plates bolted to the webs of the girder.

In order to prevent dry-rot in wooden floors ventilation is always necessary where there is a space between the floor boards and ceiling (Ill. 30), also with ground floors having a space between the floor boards and ground (Ill. 25), and floors have constantly to be relaid in old buildings because of the neglect of this precaution. The ventilation is effected by means of perforated iron gratings as shown in Ill. 25, or air-bricks built into the outer walls and so arranged that cross-ventilation is produced.

Dry-rot almost invariably arises where dampness, stagnation of air and warmth are in combination, and the most extraordinary instances occur of the destructive effects of this disease in timber. When once thoroughly started its ravages are remarkable and it will spread across brick and stonework, and, in fact, almost any material, in order to attack adjacent timber. Directly it is discovered it should be ruthlessly dealt with, all affected parts cut away and all adjoining materials thoroughly scraped and treated with corrosive sublimate or other strong disinfectant.

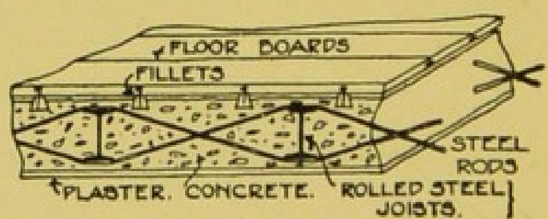
(*b*) **Fire-resisting Floors** — Fire-resisting floors formed upon hygienic principles should be used where possible, so that dust and vermin may not be harboured in cracks and crevices.

Ordinary wooden joists placed side by side form a fire-resisting floor (Ill. 33). In this case the floor boarding is nailed direct to the upper surface of the joists, which are left exposed on the under side with a V-joint formed between them as shown or with dovetailed grooves formed so that plastering may have an effective key.



Ill. 33.
A Fire-resisting Timber Floor.

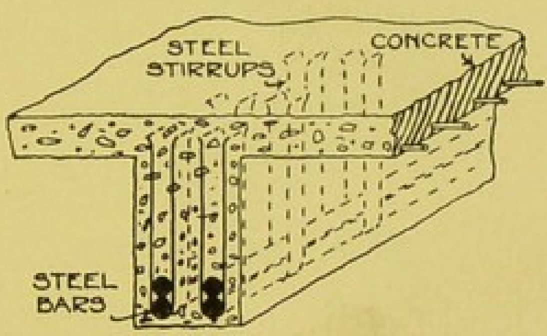
There are many kinds of steel and concrete fire-resisting floors. One of the best, which costs little more than the ordinary combustible wooden floor, consists of steel joists placed about two feet apart, and the space between filled up with six or seven inches of concrete (Ill. 34). The concrete projects about one inch below the bottom flange of the girders, so as to protect them from fire and to enable the ceiling below to be plastered. Steel rods are often used as shown, in order to increase the tensile strength of the floor.



Ill. 34. A Steel and Concrete Fire-resisting Floor.

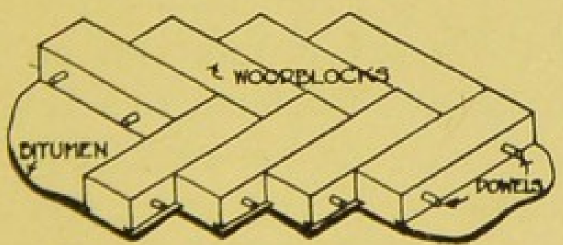
The floor boards can be nailed direct on to the concrete or may rest on fillets of dovetail section about three inches by two inches, laid flat and fixed thereto. The space thus formed is useful for gas and water pipes, but it is objectionable as it forms a convenient place for dust and dirt. Care must be taken that the concrete is thoroughly dry if the boards are nailed direct to it, otherwise dry-rot may result.

(*c*) **Reinforced Concrete Floors**—Where steel bars are used in conjunction with concrete floors, the latter are said to be "reinforced," and one method is shown (Ill. 35) where steel bars are placed near the under side of the floor in order to take the tensional strain where it is greatest. There are many forms of patent bars and stirrups for such floors now on the market.



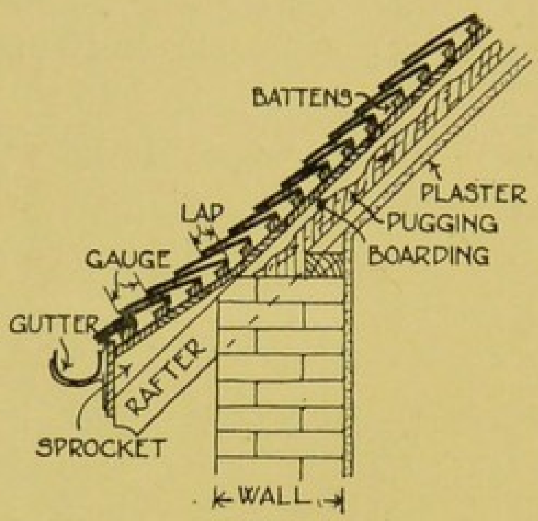
Ill. 35.
A Reinforced Concrete Floor.

Solid wood blocks (Ill. 36) may be laid direct to the concrete, but floor coverings are dealt with more fully in chapter VI., page 91, and are also mentioned in chapter XVI.



Ill. 36. A Wood-block Floor.

Roofs — Attics with sloping ceilings are for economy's sake sometimes used in the roof; they are not considered good from a hygienic point of view, because they are usually cold in winter and hot in summer. Care must be taken to provide an air space between the ceiling of the room and the outer covering of the roof; or, if the whole of the room is in the roof, to fill in between the rafters with pugging of silicate cotton, slag-wool, or other non-conducting material (Ill. 37). Roofing felt or Willesden paper should also be used under the slates or tiles. In all cases it is advisable to have rough boarding as well as battens under the slates, as the continuous wood surface is a non-conducting medium. The eaves of roofs should project boldly (Ills. 37, 208, 225, 246 and 278), so as to protect the wall from rain, and at the same time give a good finish to the design, as mentioned in chapter IV., page 67.

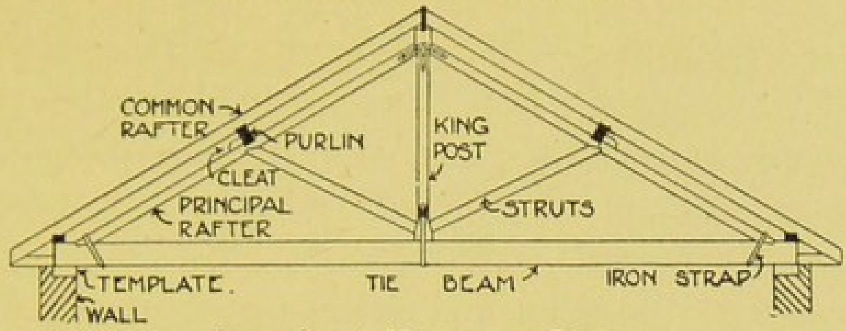


ILL. 37. EAVES OF ROOF.

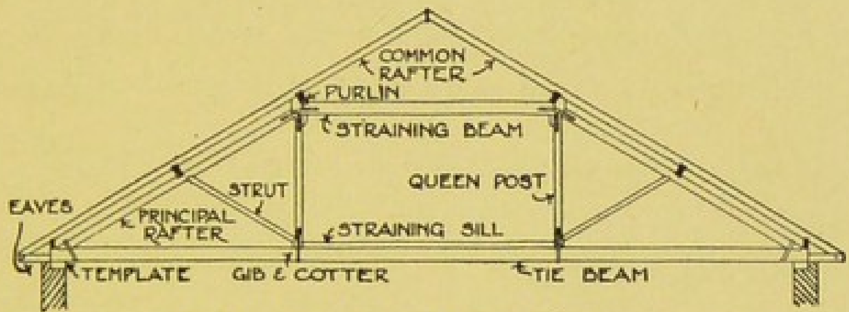
It is not necessary to go deeply into the construction of the various forms of roof, because in the class of house we are discussing they are generally of a simple character.

The couple roof, in which the rafters rest on a wall plate and have their upper ends fixed to a ridge piece, is usual in small buildings. A horizontal beam, called a collar, is spiked to each pair of rafters to counteract their tendency to spread and push out the walls. This form should not be employed for a greater span than fifteen feet, unless purlins, i.e. horizontal timbers, can be arranged to rest on the partition walls to support the rafters in the centre of their length.

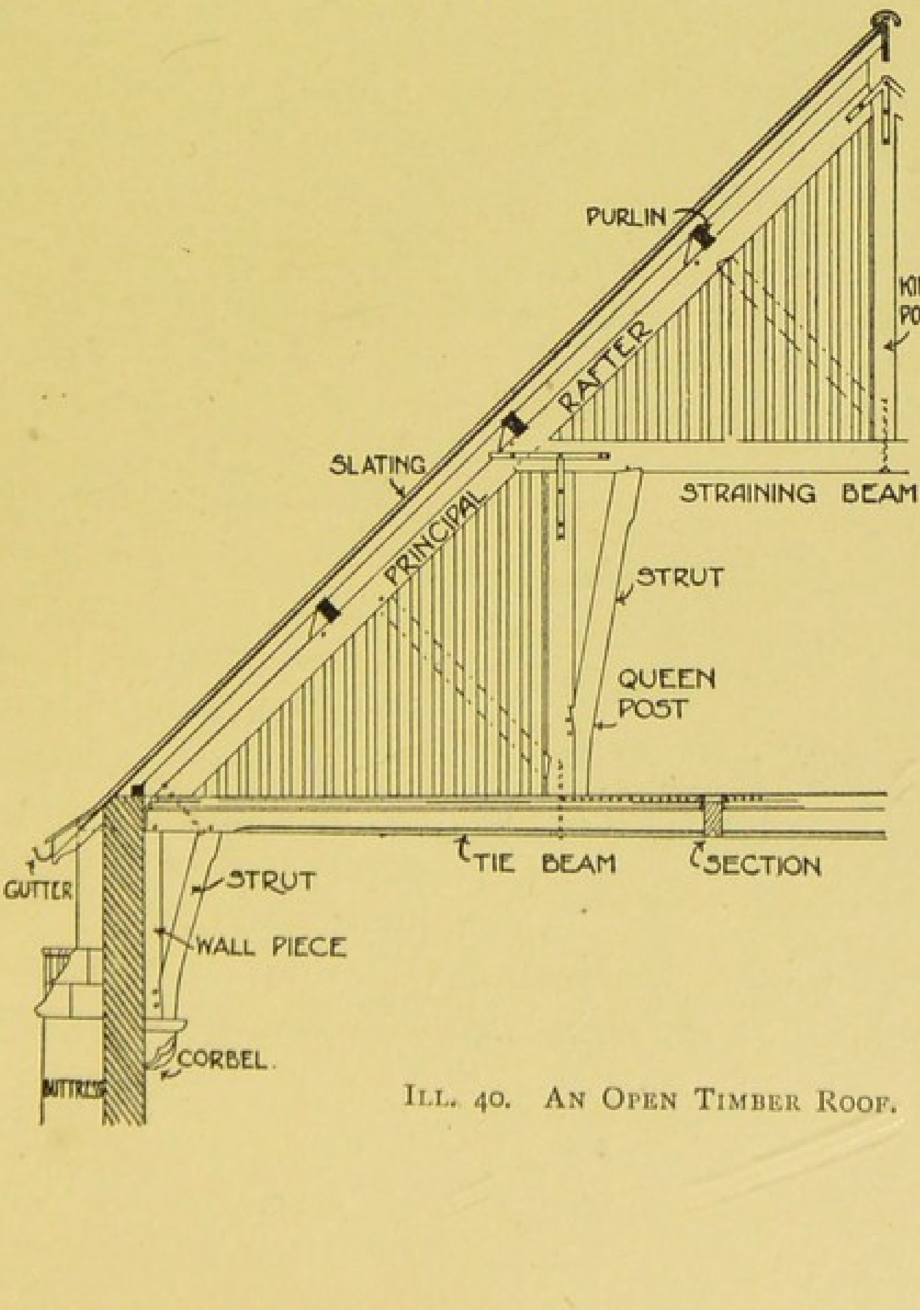
(*a*) **King-post Roofs**—It is desirable, if this cannot be arranged, to adopt a king-post truss (Ill. 38) for spans up to thirty feet, which consists of a tie-beam, principal rafters, king-post, struts and purlins.



ILL. 38. A KING-POST ROOF.



ILL. 39. A QUEEN-POST ROOF.



ILL. 40. AN OPEN TIMBER ROOF.

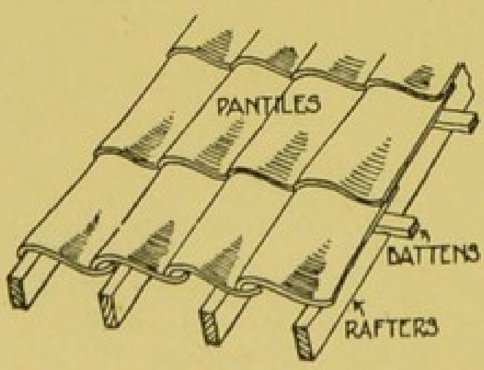
(*b*) **Queen-post Roofs**—The queen-post truss (Ill. 39) should be adopted when the span is above thirty feet.

(*c*) **Hammer-beam Roofs**—In large halls or billiard-rooms an open roof of the hammer-beam type may be adopted, as shown in Ill. 40.

A table of the least inclinations necessary for different roofing materials is given below, but in order to obtain rooms in the roof, or for the sake of appearance, these inclinations are sometimes increased in practice.

Angle of Inclination for Different Roof Coverings.

Kind of Covering.	Inclination to the Horizon.	Height of Roof in Parts of Span.
Copper	3° 50′	$\frac{1}{30}$
Lead	3° 50′	$\frac{1}{30}$
Zinc	4° 0′	$\frac{1}{29}$
Slates (large) . . .	22° 0′	$\frac{1}{5}$
,, (ordinary) . . .	26° 33′	$\frac{1}{4}$
Asphalted felt . . .	3° 50′	$\frac{1}{30}$
Thin slates of stone or flags .	29° 41′	$\frac{2}{7}$
Pantiles	24° 0′	$\frac{2}{9}$
Thatches of straw, etc. .	45° 0′–60° 0′	$\frac{1}{2}$–$\frac{2}{3}$
Plain tiles	45° 0′	$\frac{1}{2}$



Ill. 41. Pantiling.

Materials for roof coverings were dealt with in chapter iv., page 68, but pantiles have not been referred to, for, as a rule, they are only used for outhouses, which do not require to be made absolutely watertight. They are fixed on laths, as shown in Ill. 41, and are "torched" or pointed on the under side with lime-and-hair mortar.

Flat Roofs—Flat roofs are generally covered with lead, copper or zinc, but this method is gradually being superseded by steel and concrete covered with asphalt, for the difference in cost is slight, and the durable properties much in favour of the latter materials. The table given above shows that lead roofs should be almost flat, otherwise the lead is liable to creep or crawl down the slope of the roof owing to the heat of the sun.

The edges between two sheets of lead are dressed over semicircular wooden rolls about two feet three inches apart, laid in the direction of the slope.

Drips are formed at the junction of the ends of the lead sheets about every eight feet along the slope of the roof. Nailing should be executed with copper nails (not iron), to prevent any galvanic action being set up between the lead and iron, and to obviate the destruction of ordinary iron nails by oxidation.

Copper is generally used for small ornamental roofs, such as over turrets and bay windows. It oxidizes by the action of the air, and verdigris, forming on the surface, gives a splash of bright green colour, which forms a protection to the copper itself.

Zinc is laid much the same way, but as it expands more than any other metal, great care should be taken to allow for this. The sheets should be held in position by zinc clips, and should be not less than 14 gauge for good work. It is, of course, much inferior to copper or lead.

Gutters—Iron eaves gutters (Ill. 37) should be fixed so as to quickly convey the water to the iron or lead rain-water down pipes.

Lead gutters to parapets should not be less than 12 in. wide, in order to give room for a person to walk along them without damaging the slates or tiling. They should be laid with sheet lead weighing at least 6 lb. to 8 lb. per superficial foot, and constructed with a fall of not less than 1½ in. in 10 ft., with 2-in. drips at required lengths, and with a cesspool formed at the end of the gutter, having a pipe connected to the rain-water head at the top of the down pipe. A wire domed cover should be fitted to the outlet to prevent it becoming stopped up with leaves or debris.

These gutters should have snow-guards formed of transverse bearers and strong battens, ½ in. to 1 in. apart, according to the width of the gutter, so that after a heavy fall of snow a clear way underneath the same may be left for the water to pass to the down pipe.

Snow-guards are effective safeguards in protecting the gutters from workmen when engaged upon repairs; and they also protect the lead gutters from the heat of the sun, and minimize expansion and contraction to a considerable extent.

CHAPTER VI

THE INTERIOR

General Principles—Floor Coverings (Tiles, Marble, Mosaic, Oak Battens, Wood Blocks, Parquet, Carpets, Cork Carpets)—Wall Coverings (Papers, Distemper, Paint)—Doors—Windows—Fireplaces—Ceilings.

GENERAL **Principles**—The interior should be designed so that it may be as perfect as possible from a sanitary point of view, for surely the health of those occupying the house should be considered before everything else, although many interiors are apparently carried out with little regard to this most important point.

Having satisfied this requirement the interior should then be treated so that it will satisfy and appeal to the artistic taste of the owner and his family.

It is difficult to imagine why rooms of a greater height than eight feet six inches or nine feet should be necessary for the smaller class of country house, for they are not necessary from a hygienic point of view, yet money is often needlessly thrown away in constructing rooms of excessive height, which militates against the long and low principle in design referred to in chapter IV., page 59.

Floor Coverings—We have elsewhere dealt with the construction of various types of floor (see chap. V., p. 81).

Tiles, marble, mosaic or some substance of a non-absorptive character, should be used for the floors of halls

(Ill. 239), bathrooms, kitchens, sculleries, larders, water-closets, lavatories and conservatories, so that they may be washed down frequently.

Lavatories, bathrooms and sculleries should in addition have their floors laid to an inclination so that when washed down the dirty water may be led by means of a duct pipe into a rain-water head or gully trap.

Generally speaking, floors should be as non-absorbent as possible, although for the sake of warmth to the feet they are generally formed of wood.

Oak Battens or other hard wood with rebated and tongued joints make a very good floor, as shown in Ills. 205, 206 and 216, and absorb little moisture, but, owing to expense, deal or pitch-pine battens stained and varnished are often substituted.

Wood-block Flooring, as shown in Ill. 36 and referred to in chapter v., page 85, may also be used.

Rooms in the cheaper class of house may have the surrounds of the deal flooring stained and varnished or painted three or four coats of good oil colour and then varnished, and this will last for years.

A parquet floor of hard wood is excellent from a sanitary point of view, as it ensures a uniform and impervious surface. When it is not possible to lay it over the whole of the room it may be formed as a margin round the sides, with ordinary boarding in three-inch strips for the remainder. There are some forms of parquet floor which can be laid down and easily removed if required without damage to the under floor. Parquet flooring should be washed with an antiseptic such as spirits of turpentine, after which it should be polished with turpentine and beeswax mixed with a little household soap, which mixture fills up the pores of the wood. This polish can be made by melting the ingredients together until a consistency of vaseline is obtained, when it should be laid on and well rubbed and polished with a rag and stiff brush.

Carpets are receptacles for dust and dirt, especially those which are fitted into every nook and corner of the room. As custom in England prescribes a carpet, it is best to have a central Turkey carpet or even a rug, which can then be frequently taken up and properly shaken in the open, and not left, as a fitted carpet usually is, with all its accumulation of dirt from one spring cleaning to the next.

The drawing-room and hall need not necessarily have a central carpet, but rugs may be placed over the parquet or oak batten floor where required, as shown in Ills. 190, 196, 206.

Bedroom floors may be stained and varnished and a rug put by the bedside so as to be warm to the feet on stepping out of bed.

Cork carpet glued directly upon the finished cement face of the concrete covering the site has been successfully used, thus saving all the cost of flooring (Ills. 236, 237). It is absolutely necessary, however, that the concrete should be thoroughly dry and the cork carpet seasoned and guaranteed by the maker. This form of covering makes an excellent finish, for it is warm to the feet and, if properly laid, takes the place of the ordinary carpet, except perhaps that a few rugs can be added if desired. It looks best when of a plain colour without any attempt at patterns, and may be cleansed either by washing or by polishing with the beeswax mixture already referred to.

Wall Coverings—The construction of walls generally is dealt with in chapter v., page 76. Internal walls if not of brick are formed usually of upright timbers called studs and brick nogging, but where formed of studs, the space between may be plugged with slag-wool, which is vermin-proof.

A picture-rail should be provided to every room, as shown in Ills. 238 and 239, and may generally be made to line up with the top of the doors and the casement windows, as shown in Ills. 236 and 313, but must be stopped against sash windows which are generally higher, as shown in Ill. 200.

The suggested wall treatment of various rooms is discussed in chapter XVI., page 220.

Hollow spaces behind wood skirtings should be avoided, for these become the homes of mice and other vermin and allow of the collection of dust and filth.

A much more sanitary arrangement is to form a skirting of solid cement moulded to a simple design, and thus leave little projection for dust to rest upon.

Ill. 313 shows a small low skirting which serves also to keep the chairs from damaging the walls.

There is no doubt that the ordinary plastering on walls is of a very porous nature; therefore bathrooms, W.C.'s, kitchens and sculleries, which are subject to damp and steam, should be finished with a non-absorbent material, such as tiles, or Keen's, Parian or Portland Cement, which may be painted.

Wall-paper, being of an absorbent nature, is in consequence unhealthy, but if of good colour and design has a warm and cheerful appearance, which adds to the furnished appearance of the rooms and relieves the bareness of the walls. Avoid flock and other papers of a similar character, as they are most insanitary and act as dust collectors. The pulp or ordinary papers are most commonly in use, and great improvement has in recent years been made in their manufacture. They are sold in pieces twelve yards long and twenty-one inches wide. Wall-papers should not be too pronounced in their design, and should not, as a general rule, be decorated with more than two colours. The paper should not be chosen from a pattern-book but from the roll, as its appearance in small pieces is deceptive.

It is hardly necessary to state that, in repapering, every scrap of old paper should be taken off the wall, which should be well rubbed down and the plastering made good before any new paper is hung.

Stamped leather and imitation leather papers of improved design have been manufactured largely in recent years, and as they only require washing down periodically they are good from a sanitary point of view. The Japanese embossed leather papers are hand-made and are very good both in colour and execution, and are useful for dadoes, friezes and also for ceilings, as they resist the action of gas and smoke. Some imitation Japanese leather papers are made from the bark of the mulberry tree, damped and beaten into wooden moulds, then lacquered and coloured by hand. This produces a resemblance to the old stamped leathers.

There are many kinds of special materials, such as Lincrusta Walton and Tynecastle Tapestry, which latter consists of a coarse canvas face backed up by stout paper. We have frequently used rough canvas (scrym), which is strained and glued to the walls and then painted or decorated as desired. It looks well with panelling as shown in Ills. 195 and 196.

Distemper is a mixture of whitening, size and water, to which colouring matter may be added in the same way as with oil colours. It is only pervious to a very slight extent, and is therefore superior to paper from a sanitary point of view, and forms an admirable material for the walls of bedrooms and nurseries, as it is inexpensive and can easily be renewed. It is also frequently used for sitting-rooms, and can be very effective in cheerful colours. There are many patent distempers each claiming special attributes, the principal one being the possibility of washing down without removing the surface.

Paint is one of the best materials for treating walls, being practically impervious and therefore good from a sanitary point of view. It is easily washed, and is of course considerably cheaper than the leather papers already described. Many firms advertise enamels, which are said to have wonderful properties. The basis of all is zinc-white, which does not turn yellow in the way lead colours do, and the quality depends to a large extent upon the varnish with which it is mixed.

Some people prefer that the finishing coat be flatted (that is, mixed with turpentine only), for this takes away the objectionable gloss.

In rooms having exposed situations it is often found that considerable condensation occurs on painted walls owing to the warm air of the room striking the surface of the cold walls, and thus depositing moisture thereon.

Internal woodwork should usually be treated in tones in harmony with the surrounding work, and may be finished with a varnished surface, when it lasts well and can be cleaned down with a cloth.

The present fashion of having everything enamelled white has many points to recommend it, for it has to be kept fairly clean or it looks dirty and unpleasant. Better value is obtained than by using colours, and there are no pitfalls for bad taste in comparison with those which beset a colour scheme.

Examples of different methods of panelling are shown on pages 237, 238, 243, 244, 271, 281, and 292.

Doors—The treatment of doors is an important matter, as they occupy a prominent position, and being constantly in use are brought much into notice.

They may be from 6 ft. 6 in. to 7 ft. in height and from 2 ft. 6 in. to 3 ft. in width, and should be hung so as to act as a screen to the room when opened.

It is well to get away from the ordinary stock four-panelled doors which are imported in enormous quantities from Sweden.

As cheapness has to be considered in many cases, it would be a negation of progress to object to a machine-made door, and we have had to use these Swedish doors, where clients would not authorize the necessary expenditure for hand-made work. Hanging them upside down gives a height of about 4 ft. 5 in. to the top of the lock rail, which looks better than its usual height of about 3 ft. 3 in. There are indeed machine-made doors of good design, though, of course, a door made to an architect's design should bear a character of its own in keeping with the remainder of the house, and may be likened to a well-cut suit of clothes in comparison with a ready-made garment. A thickness of 1½ in. is usually sufficient for internal doors, and mouldings are best omitted in the smaller houses, as the panels finished square look well and are more in keeping with their simple character.

Ill. 205 shows a birch door stained dark brown, which contrasts well with the white paint of the rest of the woodwork.

Ills. 319 and 327 show ledged and braced doors with strap hinges specially designed to give character to the houses.

Plain brass rim-locks and handles (Ill. 236) with simple finger-plates give an effective but quiet finish to the door, and are less expensive than mortise locks, and have a decorative value not possessed by the hidden character of the latter.

The front entrance door should be of ample width, so as to give an inviting appearance from the exterior; and is sometimes designed in two portions of unequal width, the larger one for general use, while both may be opened on occasions of entertainment when many people are likely to be using the entrance (Ills. 233 and 242).

The doors to the kitchen, scullery and offices may be merely ledged and braced and provided with rim-locks and Norfolk latches, with cross garnet or strap hinges, which are very suitable for the purpose, and carry out the idea of simplicity.

Windows—The comparative advantages of sash and casement windows have already been dealt with in chapter IV., page 61, and need not be further discussed from the internal point of view.

French casement windows which extend to the floor level are sometimes preferred, especially in drawing-rooms or those rooms looking on to a garden; so that people sitting inside can get a good view and obtain easy access to the garden, but windows of this type generally make the room cold and draughty, and should be used with caution.

Fireplaces—In no other department of internal design has so much improvement been effected in recent years as in the design of the fireplace, and as it is the central point of attraction in the room it certainly demands the best efforts of the architect.

Various kinds of grates and stoves are dealt with in chapter XIII., page 176, and it is only necessary to say that as little iron as possible should be used in the construction of the fireplace, and in many instances iron bars have been omitted altogether and the coals placed direct on the brick hearth. It would be invidious to point to any special manufacturer, as nearly all now recognize the fact that the forms of grate designed by Dr. Pridgin Teale some years ago represent the scientific application of sound principles to the domestic hearth.

The stove itself is frequently surrounded by a frame or is treated in some architectural manner, as will be seen on reference to Ills. 216, 230, 236, 288, 312, 313, 318, 319.

The Dining-room Ingle-nook shown on plan in Ill. 233 has a grate which is surrounded by a plain beaten copper frame and hood, as shown in Ill. 237. On either side recesses are formed in the wall for a tobacco jar or the like, and above are a series of small cupboards and openings for the display of china.

The nook is lined with red bricks, and with its plain low settles on either side forms a really comfortable lounge, with side window for reading.

The Dining-room shown on plan in Ill. 226 has a more formal treatment, as seen in Ill. 230, with tiled surrounds and overmantel, the space over the ingle being utilized for small cupboards for cigars, etc.

The Ingle-nook in Inner Hall (Ill. 238) has a "Tilt-fire" grate with a beaten copper hood, the smoke being carried up in the copper flue till it reaches the brick chimney-stack at the first-floor level. This stove has no mantel, and it can be removed during the summer months if desired.

The Dining-room overmantel in a house at Potters Bar (Ill. 245) has panels into which various coloured woods are introduced to form a geometrical pattern.

The Dining-room Ingle-nook shown in Ill. 313 has a fire with tiled surround and a plain overmantel carried up to the picture-rail, with small windows on either side.

The Drawing-room fireplace in Ill. 236 has a circular raised hearth and hammered steel frame and hood, above which is a simple deal mantelpiece.

The Drawing-room fireplace in Ill. 194 is still more formal in character, the overmantel being designed especially as a frame for a picture, the whole being enclosed in an architectural setting, reminiscent of the later Renaissance manner.

The Parlour fireplace shown in Ill. 219 has a recess which takes the place of the overmantel.

Larger houses require a more formal treatment, and the Hall fireplace in Ill. 188 shows a dog-grate surrounded by a treatment of Ionic pilasters and entablature, and provided with a sitting or club fender, which is certainly a comfortable feature in a hall. The Study (Ill. 189) and Drawing-room (Ill. 190) fireplaces are further examples to which some architectural treatment has been given.

We have now stated a few general principles relating to various internal features, and have, in chapter XVI., discussed briefly the general scheme of decoration which may be adopted in each room.

Ceilings—The plaster ceiling may be distempered, painted or papered. The unvarying monotony of the old whitewashed ceiling with its inartistic centre flower is much improved by the use of moulded ceiling ribs of fibrous plaster or modelled canvas. When ribs are used they should have but little projection in order not to bring down the ceiling, and thus make a room appear lower than it is.

Enamelled metals are suitable for some ceilings, especially those of dining, smoking or billiard rooms, as they effectually withstand the action of the heat, gas fumes or smoke, and can be cleaned down with a damp cloth. The plates, which are generally three or four feet square, have a surface pattern, and are fixed to the under side of the joists or boarded ceiling, the joints between the plates being covered with a moulded rib.

The ordinary plaster ceiling may be omitted and the floor joists are then visible, as in Ills. 31, 195, 229 and 230, the space between them adding to the cubical capacity of the room, instead of forming dust-traps as mentioned in chapter v., page 81. This simple method of construction is effective and satisfactory, the floor timbers openly doing their work instead of being hidden behind a plaster ceiling.

The joists, which in this type of ceiling should have a broader proportion than usual (say seven by four inches), need not necessarily be planed, but can be left from the saw and toned to a dark colour or even coated with Stockholm tar. Some additional interest can be given in this type of floor by arranging larger beams into which the smaller joists can be framed, as in Ills. 196, 312, 317, 318 and 320. If this type of floor is adopted, special precautions have to be taken to prevent the passage of sound through the floor of one room to the other, as mentioned in chapter v., page 82.

CHAPTER VII

WATER SUPPLY AND FITTINGS

Sources of Supply (Rain Water, Lake Water, River Water, Spring Water, Well Water)—Pumps—Artesian Wells—Physical Properties—Consumption of Water (Impurities, Distillation, Boiling, Nitrification, Filtration, Household Filters) — Examination — Storage — Hardness—Distribution (Hydraulic Ram, Water-wheel and Turbine Pumps, Underground Cisterns, Unions and Junctions, Taps, Hydrants, Domestic Fire Extinguishers).

SOURCES **of Supply**—The origin in the first instance of all sources of water supply must be the rainfall, though the actual source utilized for methods of supply in various instances may be by (*a*) rain water; (*b*) lake water; (*c*) river water; (*d*) spring water, and (*e*) well water.

(*a*) **Rain Water** itself is pure, and where it does not come in contact with injurious matter it is the best form of supply, but freedom from contamination can seldom be obtained except in sparsely populated and rocky districts.

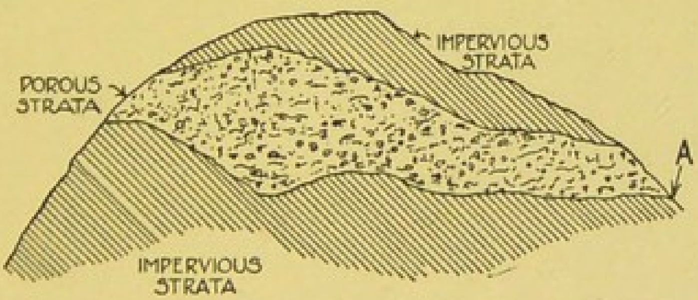
The amount of rainfall per annum varies in different localities in the British Isles from under twenty-five inches to over eighty inches, the lowest average fall being in the south-eastern counties of England, and the highest being in the western part of Scotland. Part of the rainfall sinks into the ground, and the remainder is either evaporated or carried along the surface of the ground to form rivers and lakes. Rain water should never be allowed to run to waste, as it is most agreeable for washing purposes, and in some instances it has to be used for dietetic requirements.

Rain-water separators, which run the first washings of the roof to waste and then divert the pure water to storage, are to be recommended, as they ensure the supply being more or less clean.

(*b*) **Lake Water** derives its supply from the surface water previously mentioned, and also from springs, but it is liable to have foreign matters in suspension and solution.

(*c*) **River Water** is derived from the same sources and is very liable to pollution, from animal and vegetable impurities and also from the drainage of manured farm land, etc.

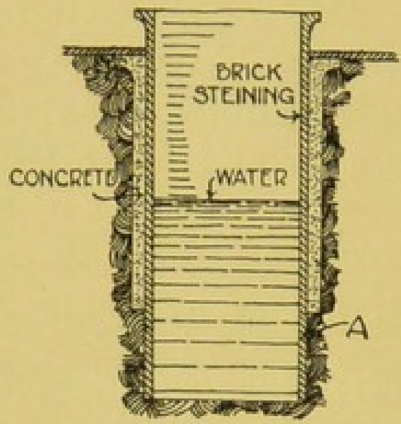
When, in addition to this sewage from towns and villages and trade effluents are received, the danger of this form of supply is sufficiently evident.



ILL. 42. SECTION SHOWING SOURCE OF SPRING WATER.

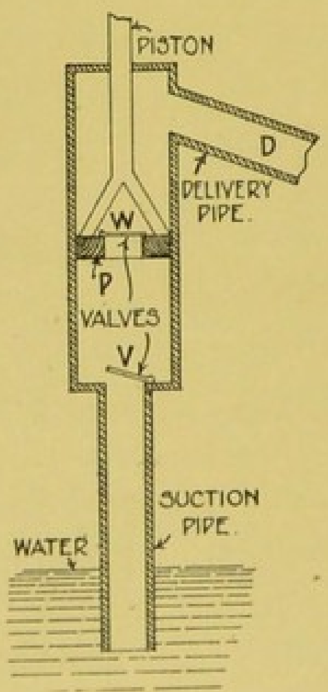
(*d*) **Spring Water** is generally found where an impervious bed underlies porous strata, and an outlet is obtained as at A in Ill. 42. The purity of water from this source depends upon the nature of the soil through which it has passed.

(*e*) **Well Water** may be from either shallow or deep wells; that from the former is very liable to pollution from organic matter washed through the soil. An impervious lining (steining) should always be used for these wells, to minimize the risk of surface pollution, as shown at A in Ill. 43, and this lining should also be taken above the surface level to prevent refuse falling in from the top. A cover should be provided, and the water should, if possible, be drawn up by some form of pump (three forms of the latter are shown in Ills. 44, 45 and 46), and not by the old-fashioned bucket and rope, as these are liable to become foul and thus taint the water.

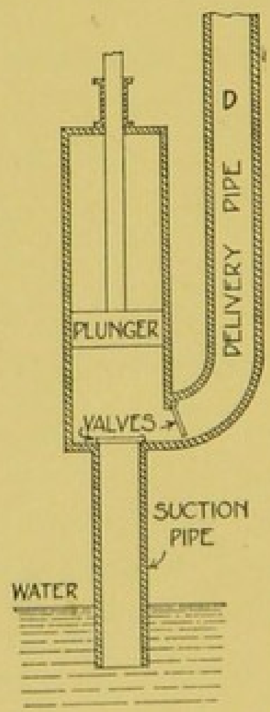


Ill. 43. Section of Well.

Pumps—Ill. 44 shows a section of an ordinary lifting pump, in which, as the piston P is raised, the

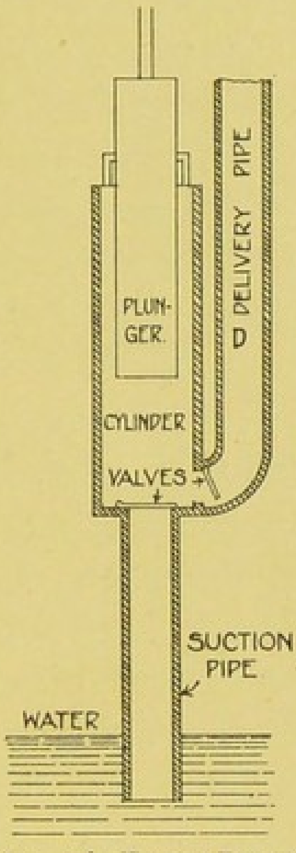


Ill. 44. Lifting Pump.



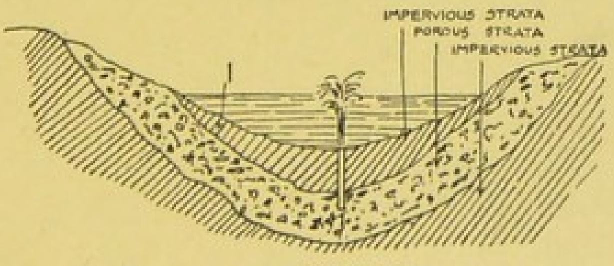
Ill. 45. Force Pump.

valve V is opened and water is drawn up into the cylinder, and at the next stroke it is drawn through the valve W and is thus conducted to the delivery pipe D. Ill. 45 is a section through a force pump, in which the plunger is solid, and the water after being raised in the cylinder is forced up the delivery pipe D. Ill. 46 is a force pump with a plunger in lieu of a piston, and is generally preferred because the packing is easily renewed.



Ill. 46. Force Pump.

Artesian Wells — Deep wells are often made by artesian boring, which consists in forcing an iron tube of small diameter through the impervious strata to the porous strata below, as shown in Ill. 47. This was first done at Artois, in France, hence the name artesian. Water derived from this source is generally good owing to the depth from which it is drawn. It will be seen from this sketch that the impervious strata (1) extend above the level of the sinking, and consequently the water will be forced up the pipe to the height that is anywhere maintained in the porous strata. Borings in sandstone or limestone usually give large and con-



Ill. 47. Artesian Well.

stant supplies, while wells in shallow sand or gravel beds, and even chalk, often fail in dry seasons.

Physical Properties—A cubic foot of water may be taken as weighing 62·5 lb. and a gallon as weighing 10 lb. A fundamental property of the fluid is that the pressure exerted by it on any plane is always in a direction at right angles to that plane, and pressure exerted anywhere on water is transmitted equally and undiminished in every direction. Liquids maintain their level even though the continuity of the surface be interrupted, or, in more popular phraseology, they find their own level. Water may be taken for practical purposes to be incompressible, and this property, together with the power of transmissibil ty of pressure, is advantageously applied in the hydraulic ram dealt with on page 114.

Consumption of Water—It has been computed that the ancient Romans must have used over three hundred gallons per head per day, owing chiefly to their elaborate public baths.

In these days, however, from thirty-five to fifty gallons per head is usually considered sufficient in towns, and from twenty to twenty-five in rural districts. It is to be hoped, however, that the question of supply will be looked upon in a more generous light in the future, as the health of a community must depend to a large extent upon its water supply.

The following table gives the daily average number of gallons consumed per head in several cities :—

Washington	158
Middlesborough-on-Tees	140
Karlsruhe (Germany)	130
New York	100
Chicago	75
Montreal	55
Glasgow	50
London	35
Paris	28

Impurities—Water nearly always contains foreign matter in suspension and solution, absorbed gases, microbes and other living organisms, but for dietetic purposes water should not contain more than a certain percentage of these impurities. Matters in suspension may be removed by filtration and settlement, those in solution by distillation, aëration, precipitation and by the aid of nitrifying organisms. Absorbed gases may be expelled by boiling and distillation, and living organisms may be reduced by filtration and settlement.

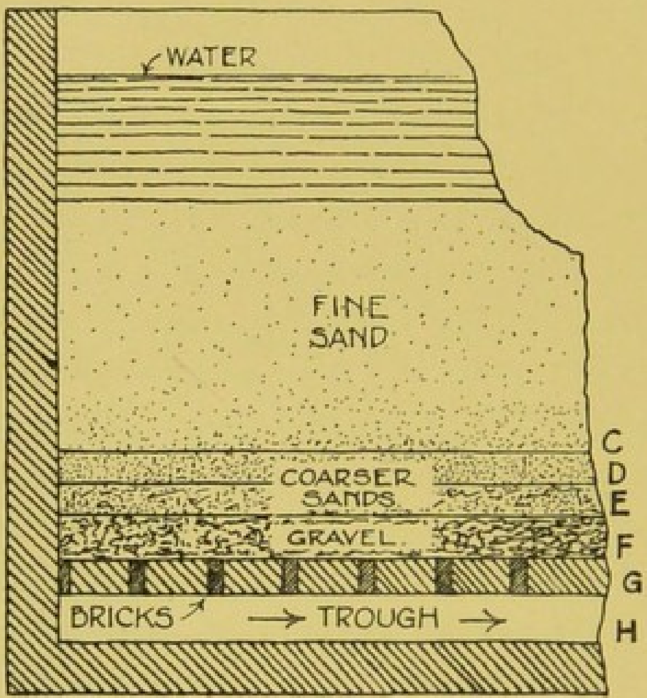
Distillation—This is effected by evaporating the water and condensing the steam. Distilled water is unpalatable, but becomes less unpleasant on aëration, which may be accomplished by exposing it to the air in thin streams and allowing it to drip over a series of trays.

Boiling—This removes temporary hardness and destroys microbes, but drinking water treated in this way also requires aëration afterwards, otherwise it is unpleasantly flat to the taste.

Nitrification—By this process, owing to the action of microbes, nitrogenous organic matter is oxidized with a formation of nitrates.

Filtration—This gets rid of suspended matter and oxidizes organic substances. Dr. Percy Frankland has shown that over ninety-five per cent of microbes were removed from Thames water by sand filtration. Sand filters are mostly used by the larger water companies, and an example is shown in Ill. 48, in which C represents a bed of clean sharp sand about three feet six inches thick, D another layer of sand somewhat coarser than C and about four inches thick, E another layer of sand still coarser than D and about three inches deep. F is a bed of gravel about six inches deep, and G is a course of bricks laid with open joints to allow the water to pass through to the trough H, which conveys it to the storage reservoir. Magnetic carbide of iron covered with a layer of sand has also been successfully used for filters, but to be effective this must be used on the intermittent principle to allow of aëration.

Household Filters—Until quite recently filters were almost solely designed for the purpose of removing



ILL. 48. SECTION OF SAND FILTER.

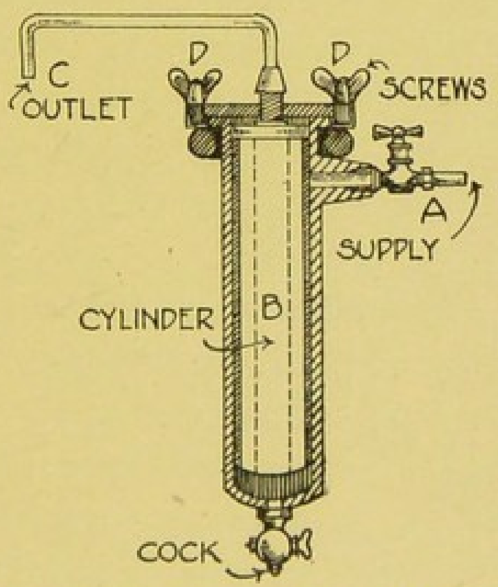
suspended matters, to lessen hardness and to reduce the danger from organic matter. Owing, however, to the fact that ordinary charcoal filters are seldom cleaned because of the troublesome nature of the process, they usually do more harm than good. In fact, it is scarcely too much to say that the old-fashioned filter was often a disseminator of disease. The removal of micro-organisms has been the objective of the more recent types of filters, and it was mainly because the old filters were recognized as being merely breeding-places for germs that investigations were instituted.

The Berlin Inquiry of 1886 gave great prominence to the filtration of water for domestic purposes, and that made for the German War Office in 1895 by Dr. Plagge drew particular attention to the Pasteur Chamberland and Berkefeld filters.

The Pasteur Chamberland filter is made of a porous porcelain tube through which the water is forced under pressure. The residue left on the outside of the tubes can easily be removed, and the tubes themselves should be sterilized periodically by boiling.

At Darjeeling 9500 of these tubes are in use in the municipal water-works, and the supply given is 150,000 gallons a day.

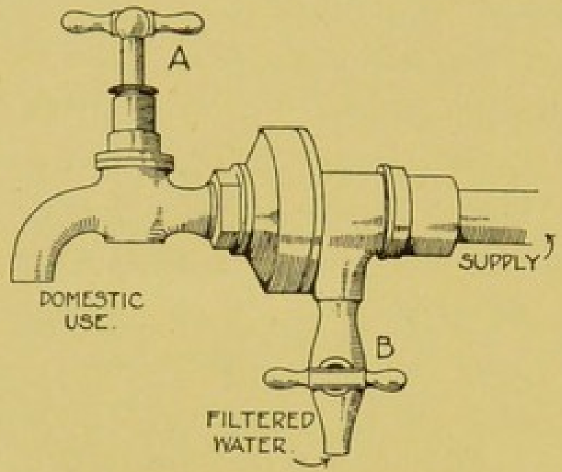
The Berkefeld filter is made upon similar lines, and a section is given in Ill. 49. The water supply is connected by the tap A and flows into the outer covering of enamelled iron through the hollow cylinder B, from the interior of which it is delivered to the outlet pipe C. By means of the thumb-screws DD the cylinder of kieselguhr may be removed for cleansing or sterilizing by boiling.



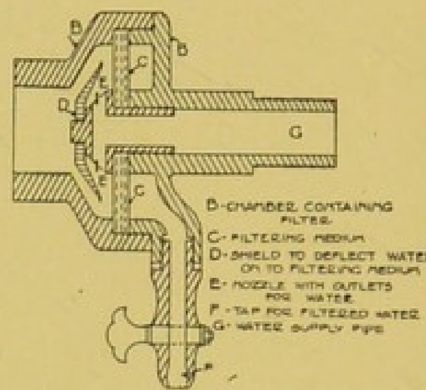
Ill. 49. Berkefeld Filter.

These types of porcelain cylinder filters are, no doubt, efficient if the cylinders are kept thoroughly clean. They are known as pressure filters, as their action is due to the force of the water from the main.

A patent automatic self-cleansing filter has been recently introduced, and is said to produce satisfactory results. Ills. 50 and 51 show the construction in which by opening tap B and shutting tap A the



Ill. 50. Elevation.



Ill. 51. Section.

Automatic Self-cleansing Filter.

filtered water is obtained. By shutting B and opening A ordinary unfiltered water is obtained for household purposes, and the filter is cleansed thereby automatically.

All water for drinking purposes should be drawn direct from the main supply pipe and not from any storage cistern.

Examination of Water—The following simple tests may be made by any one. Samples should be collected in long tubes two or three inches in diameter which should have been previously rinsed out with a little dilute hydrochloric acid and afterwards with some of the water which it is desired to examine. If river or lake water is the subject of the inquiry, the samples should be taken at various points and beneath the surface, so as to exclude scum, etc., and a note should be made in each instance of the exact locality from whence they are taken. The tubes should be well stoppered and placed in the light, but an inch or two should be left from the surface of the water to the under side of the stopper. They should stand for not less than twenty-four hours and then be examined to see if vegetation is encouraged ; this may be detected by the smell. If this is not apparent, slightly warm the tubes and test them again. A similar tube should be filled with distilled water and placed alongside the others on a sheet of white paper and the colours compared.

If a drop of Condy's Fluid (permanganate of potassium) be placed in the water and it becomes bleached in a short time, it is a sign of the presence of organic matter. A portion of the water may be evaporated and the residue burnt, when if it blackens it indicates the existence of animal organic matter.

If a sample of impure water is put on a gelatine film resting on a plate, organisms will multiply rapidly and are easily discernible under the microscope.

Storage of Water—This is best accomplished, if it can be so arranged, in underground tanks (Ill. 55), as it is thus rendered more palatable by its power of assimilating carbonic acid gas, but care must be taken that there is no possibility of pollution.

Domestic cisterns of lead should be avoided for soft-water storage, owing to the danger of the water carrying away the soluble oxide of lead formed by the action of oxygen. The lime in hard water, however, forms a protective surface on the lead and there is thus less danger in using it. Iron treated with a coating of zinc (known as galvanized iron) should not be used, as most waters will dissolve this coating sooner or later.

Slate and earthenware cisterns should be used wherever possible. Cisterns must be cleaned out regularly, for they become a depositing ground for impurities in the water supply. All cisterns should be covered to prevent their pollution by dust, dirt and possibly by dead mice and birds, and they should always be ventilated. An overflow pipe should be provided with its open end as far as possible from any likely contamination and in such a position that any waste of water may be at once noticed.

Hardness of Water—This may be either temporary or permanent. Temporary hardness is due to the presence of calcic and magnesic carbonates and may be overcome by boiling, which expels the carbonic acid and precipitates the carbonates. Permanent hardness is due to calcic and magnesic sulphates which boiling does not affect. Hard water will not dissolve soap but precipitates it, hence the soap test is now usually employed for determining the hardness of water. Every grain of calcic carbonate or its equivalent in one gallon of water constitutes one degree of hardness.

The effect of hard water on the health is a debated point, but from an economic point of view soft water ensures a considerable saving, and it is said that in Glasgow, when the soft-water supply from Loch Katrine was introduced, a saving of over £30,000 in soap was effected per annum. Hard water is also responsible for the lime deposits formed in boilers, kettles and hot-water pipes commonly known as furring, and is also unpleasant for domestic use. Dyspepsia, gravel and stone in the bladder, and swellings of the glands have also been attributed to its use. The late Sir Douglas Galton suggested that 10 degrees of hardness would satisfy the general requirements of a town supply. Dr.

Clark's process for removing temporary hardness consists in the addition of 1 oz. of quicklime to every 100 gallons, by means of which the bicarbonate of lime is reduced to a carbonate, which is precipitated. At Luton Hoo the hardness of the water is reduced from 18½ degrees to 4 degrees by this process, and 70,000 gallons can be softened per diem.

The Porter-Clark is a modification of this system, the precipitated calcic carbonate being removed by cloth filtration under pressure, thus avoiding the delay of slow subsidence. There are several other systems, including Boby's simplex water softener, which latter we have successfully employed in various instances.

Permanent hardness of water at Penarth is reduced from 18 degrees to 6 degrees by the addition of 22·5 lb. of lime, 5 lb. of soda and 1 lb. of alum to every 10,000 gallons of water.

Distribution—This is effected either on the constant or intermittent system. Every water company should be compelled by Act of Parliament to provide a constant supply, as it is not only more conducive to health, but in the case of outbreaks of fire lack of water is a very serious matter. Even with a constant supply it is wise to have a small supply cistern, as the water is sometimes necessarily cut off for repairs to mains and for other causes.

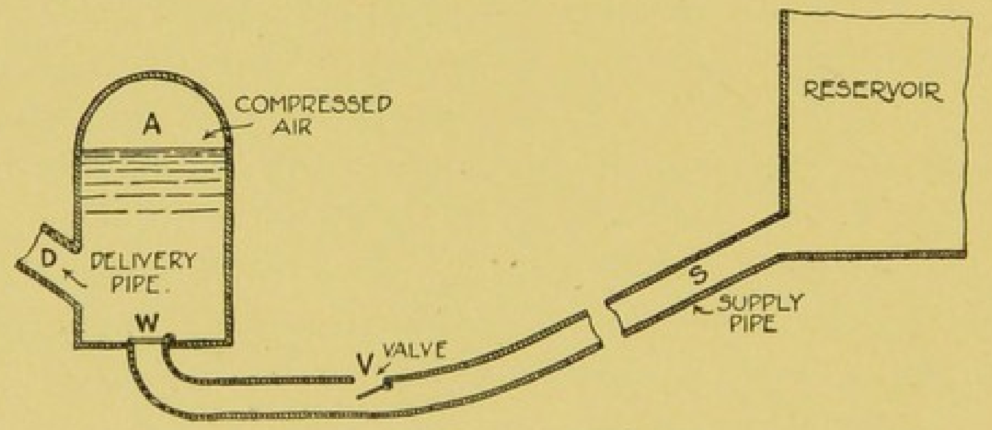
Lead pipes are generally used inside the house and are preferred by the water companies, but, as previously mentioned, the lead is liable to be dissolved if the water is soft, and the pipes are very liable to damage owing to accidental penetration by nails and screws used for the finishings of the house. The best method is to have a lining of glass or tin, but this is somewhat costly.

Water mains should not be less than four feet below the ground level, or they are liable to be affected by heat and frost. The main pipes are usually of iron coated with bitumen, magnetic oxide or some preservative solution as mentioned in chapter VIII., page 127.

Stopcocks should be arranged so that any branch supply may be cut off from the main, and all pipes should be run so as to avoid danger to the supply from frost. If it is found necessary to place them outside the building, they should be covered with asbestos, felt or other non-conducting material.

In country houses it frequently happens that no spring or water supply exists above the level of the house, and, consequently, water has to be raised by mechanical means.

Hydraulic Rams are sometimes employed, their action being as follows:—A supply pipe S, in Ill. 52, is



ILL. 52. HYDRAULIC RAM.

taken from the reservoir to the Air Vessel or ram A. A finely balanced valve is fixed at V whose weight is a little greater than the water pressure from the reservoir, and hence when the water is at rest in the supply pipe the valve V opens downwards and water runs to waste. As the velocity of the water increases the valve V is closed and the momentum opens the valve W, and water is thus forced into the air vessel, in which the air is compressed, and by its reaction the water is forced up the delivery pipe D. The pressure in the supply pipe is thus diminished, and both valves therefore fall and the water escapes at V until this valve is again closed by the impact of the water due to the increased velocity, when more water enters the ram and is raised higher in the delivery pipe. This action is continually repeated while the supply in the reservoir is maintained. It is estimated that about one-eighth of the water is wasted.

The following formula and notes on the hydraulic ram may be of use :—

When Q = quantity of water used in cubic feet per second,

h = head of water in feet (i.e. difference in level of reservoir and ram),

P = effective horse-power ;

Then $Q = \frac{14.7\ P}{h}$

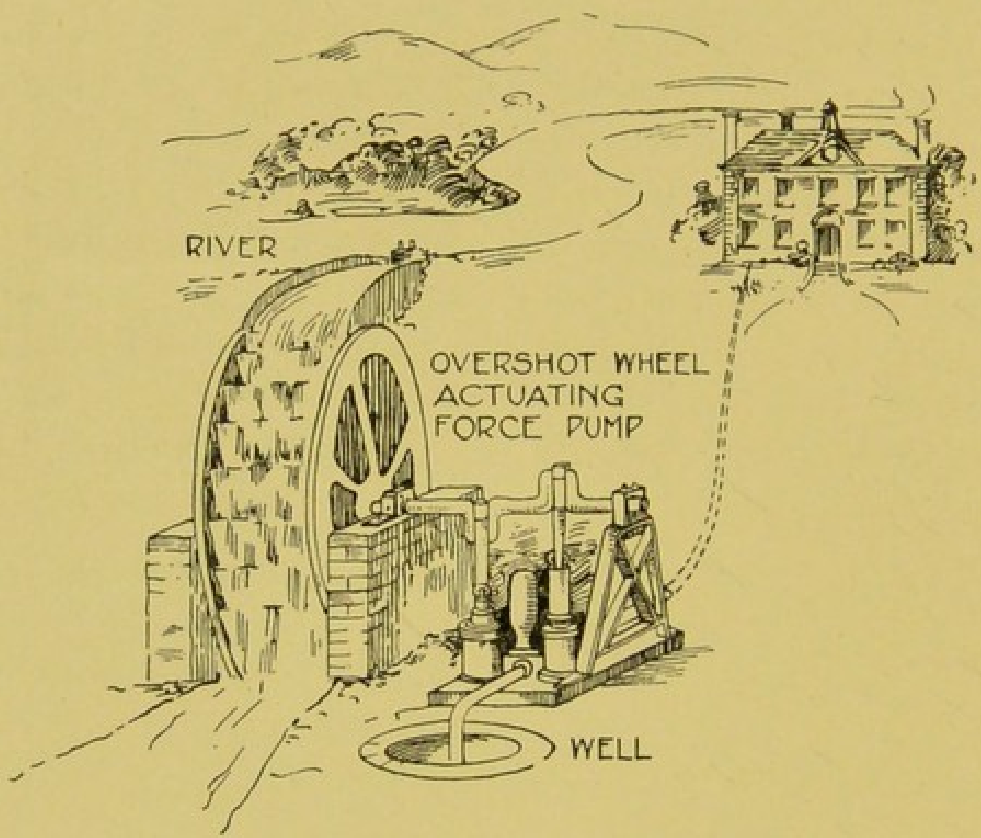
and $P = .068\ Q\ h$.

The length of the supply pipe should not be less than three-quarters of the height to which the water is to be raised.

The diameter of the supply pipe should be equal to $1.45 \sqrt{Q}$, and the diameter of the rising pipe should equal $.75 \sqrt{Q}$.

The contents of the air vessel should be the same as that of the rising tube. One-seventh of the water may be raised to four times the head of the reservoir, or one-fourteenth eight times, or one-twenty-eighth sixteen times, etc.

Water-wheel Driving Pumps, both overshot and undershot, may be used for raising water, and Ill. 53 gives a sketch of the former type.

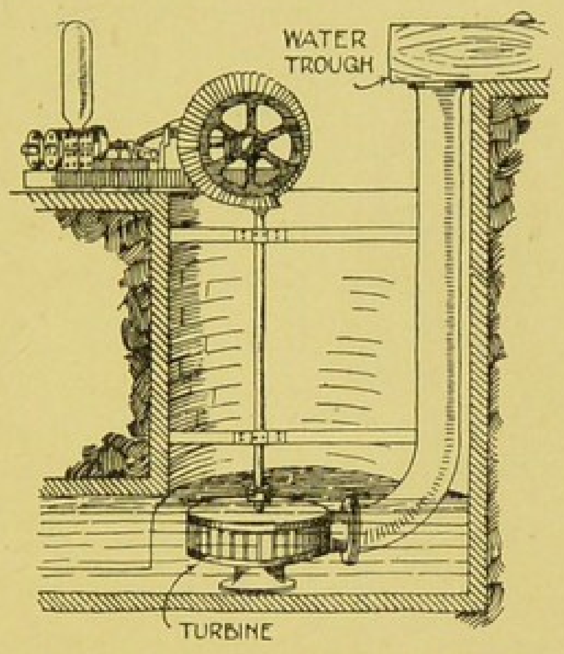


Ill. 53. Water-wheel Pump.

Turbine-driven pumps are also used, as shown in Ill. 54. Arrangements may also be made when fixing for driving electric lighting, laundry and refrigerating machinery from the same turbine or wheel.

When power is being installed for the production of electricity for lighting purposes, it frequently happens that one small motor can economically pump the water up to the house.

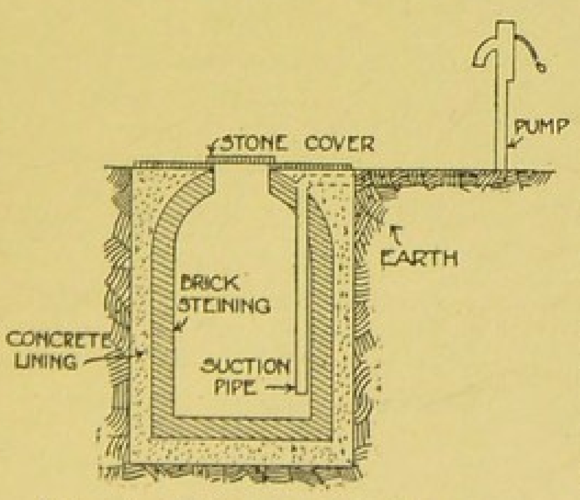
Windmills are sometimes used for pumping water; but if adopted the reservoir should be capable of containing at least one full week's supply. On an average it may be taken that in Great Britain wind blows with a pressure of one pound per square foot for one-third of the twenty-four hours.



ILL. 54. TURBINE-DRIVEN PUMP.

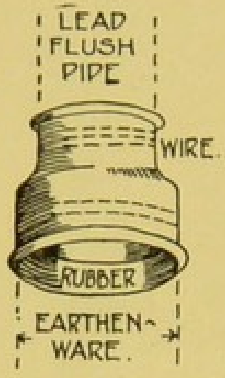
Steam engines require a good deal of attention, and consequently are not much used for pumping small supplies; but the introduction of gas-producing plants on a small scale has recently drawn much attention to this power for pumping in conjunction with the production of electric current for illuminating and heating purposes. We deal with producer-gas plants in chapter xiv., page 198, which is devoted to lighting.

Underground Cisterns—Ill. 55 shows an underground cistern circular in plan, bottle-shaped in section, and built of brickwork with puddled clay backing and covered with a stone top. It is also fitted with a pump, the suction pipe of which should be kept up at least six inches from the bottom of the cistern, so as to prevent sediment being drawn up the pipe. This should be of iron, as a lead pipe is liable to be dissolved, by the action of the water. Water stored in these cisterns is found to



ILL. 55. UNDERGROUND CISTERN.

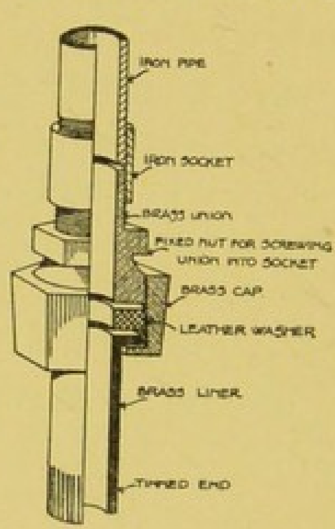
be colder in summer and warmer in winter than that supplied through ordinary town mains. They should be cleansed at least once a year, access being obtained by means of a ladder from the top.



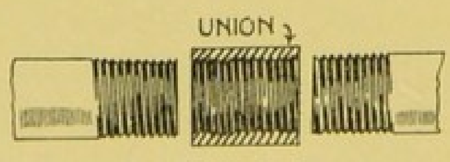
Ill. 56. India-rubber Cone Closet Joint.

Unions and Junctions — Ill. 56 represents an indiarubber closet joint for connecting the end of the flushing pipe with the fitting, which is accomplished by tightly binding the two ends of the rubber cone with copper wire as shown by the dotted lines.

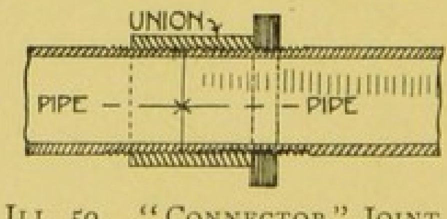
Ill. 57 shows the method of connection between a lead and iron pipe. An ordinary barrel union has one end formed with a male screw for iron pipe (*Note.*—A male screw is one cut on the outside of a pipe, and a female screw is one cut on the inside of another pipe) and the other end fitted with a cap and lining, the latter having a tinned end for connecting to a lead pipe. The lining is attached to the lead pipe by means of a wiped soldered joint as described on page



Ill. 57. Barrel Union, Lead to Iron.



Ill. 58. Barrel Union, Iron to Iron.

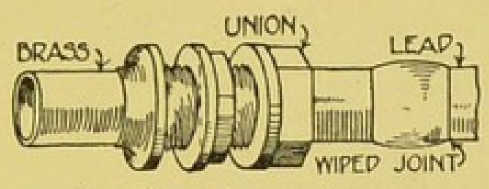


Ill. 59. "Connector" Joint, Iron to Iron.

146; the screwed end is attached to the wrought-iron barrel by means of a socket, as shown.

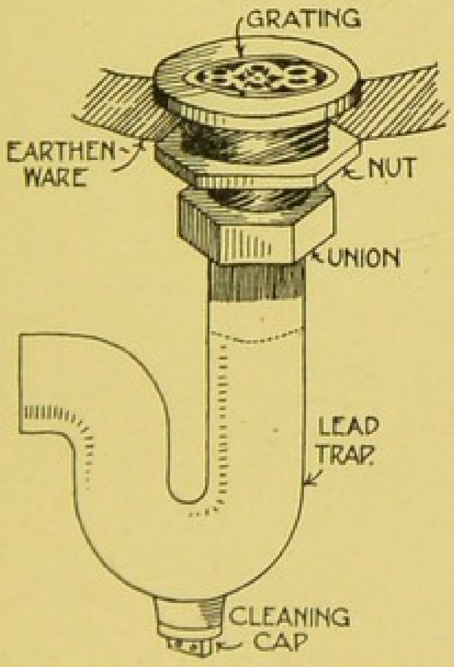
Ill. 58 shows a barrel union for joining two iron pipes.

Ill. 59 shows a connector joint, a type much used in hot-water work. The back nut is screwed on to the end of a long thread, and the socket is then screwed on ; the pipe to be connected is placed in position, and the socket is afterwards screwed over it. The back nut is then screwed tightly to the end of the socket, the joint being made secure with a packing of red lead and hemp.



Ill. 60. Boiler Screw.

Ill. 60 shows a boiler screw with cap and lining, in which it will be seen that the fly nut secures the fitting to the cistern, the cap secures the lining to the boiler screw, and the lead pipe is connected to the lining by means of an ordinary wiped soldered joint. Inside the cap a leather washer is always used, in order to form a perfect joint between the ends of the lining and the boiler screws.

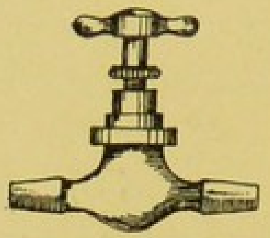


Ill. 61. Waste to Bath.

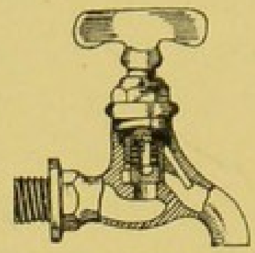
Ill. 61 shows the junction of a waste to a bath, in which it will be seen that this is similar in principle to that last described, the hatched portion representing the thickness of the bath.

Taps—The taps and other fittings allowed by various water companies vary according to the idiosyncrasies of their officials; hence we often find that those which are permissible and even recommended in some districts are prohibited in others.

Ill. 62 shows an ordinary screw-down valve which performs the functions of a stopcock, so as to shut off and regulate the supply.



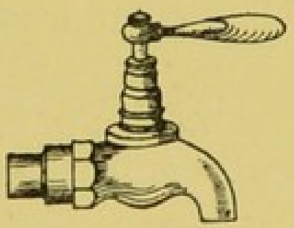
Ill. 62. Stopcock.



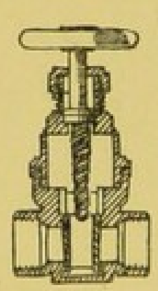
Ill. 63. Kelvin's Tap.

Ill. 63 shows a section of one of Lord Kelvin's patent bib-taps, which are made in no less than twenty-six different sizes.

Ill. 64 shows a quarter-turn bib-valve, which should only be used on a low-pressure system, or the pressure of water would tend to open the valve, while shutting it off suddenly might burst the pipe.



Ill. 64. Quarter-turn Bib-valve.

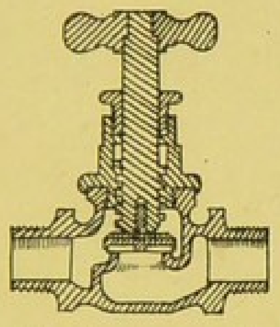


Ill. 65. Clear-way Wheel-valve.

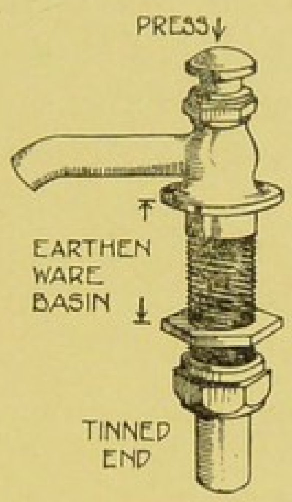
Ill. 65 represents the section of a clear-way wheel-valve, which is useful in connecting fittings where the pressure is low, and it is desirable that when open the valve should not materially check the force of the supply.

Ill. 66 is a section of a quick-turn full-way valve, the full-way being obtained by the extra sectional area of the body of the tap.

Ill. 67 shows a spring valve, which is sometimes used for lavatory basins, where the supply of water is



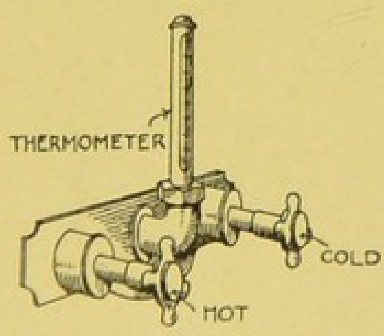
Ill. 66. Full-way Valve.



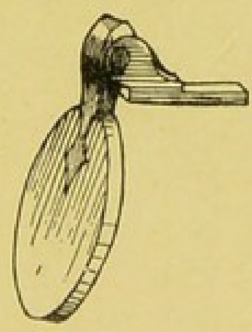
Ill. 67. Spring Valve.

limited and it is desired that no waste shall take place.

Ill. 68 shows a bath fitting with a mixing box and thermometer, an arrangement which is useful for obtaining water at any required heat.



Ill. 68. Bath Fitting.



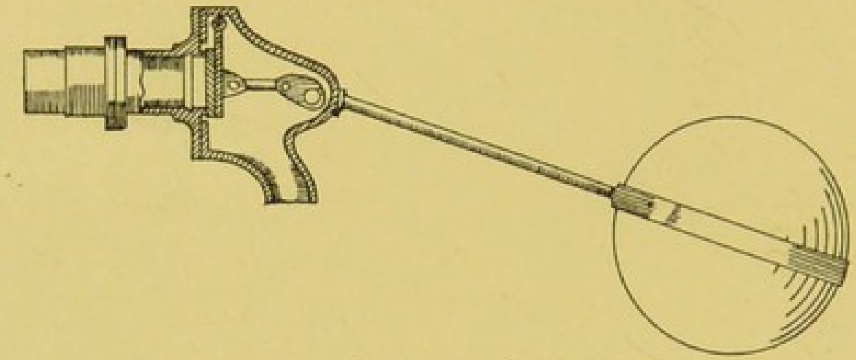
Ill. 69. Flap-valve.

Ill. 69 represents an ordinary flap-valve, which is mostly used for the ends of overflow pipes to prevent the ingress of birds, dirt, etc., and is also useful in preventing cold weather affecting the ball-valve.

Ill. 70 represents a full-way ball-valve, which is to be recommended owing to its simplicity and to the fact that it acts directly and a full supply is obtained.

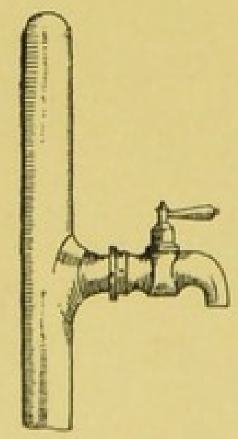
This type is particularly suitable in cases where only a low pressure is obtainable. A pipe should be carried from the inlet to the bottom of the cistern so as to reduce the noise of the inrush of water.

Whenever a Fuller bib-tap or a spring self-closing tap is used, they should always be provided with an

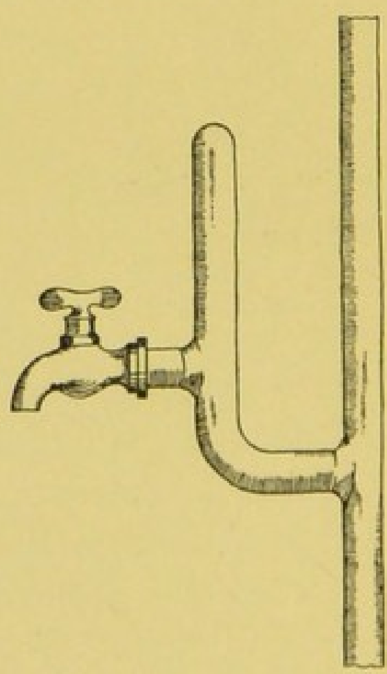


Ill. 70. Full-way Ball-valve.

air chamber, otherwise their sudden closing gives rise to the loud knocking sound which is technically known as water hammer. The explanation of this is that when water issues from a tap the whole body in the pipe is in motion. When a screw-down tap is closed



Ill. 71.
Air Chamber.



Ill. 72. Air Chamber.

the motion of the water is gradually arrested. In the spring self-closing types the sudden arrest of the motion causes the jarring in the pipe unless air chambers are fixed, but when this is done the air in the chamber is compressed and acts as a buffer.

Ill. 71 shows an air chamber when the tap is on an ascending pipe, and Ill. 72 when the tap is on a rising main or on a pipe which also supplies an upper fitting.

Hydrants—These are valves placed upon supply pipes, and are used for watering roads, gardens, and for extinguishing fires. In towns hydrants are usually placed at frequent intervals along the roads. In large country houses it is advisable to carry water mains round the building with hydrants at suitable places, and branches should also be carried round the interior of the building with hydrants on each floor.

Domestic Fire - extinguishers—The old-fashioned glass bottles containing chemicals are not to be commended, but some of the later chemical fire-extinguishers are at once handy and efficient if applied in the early stages of a conflagration. In some fire-extinguishers sulphuric acid mingles with bicarbonate of soda in solution, producing a large quantity of carbonic acid, which forces the water out in a violent stream. The extinguisher is set in motion by the simple process of turning it upside down.

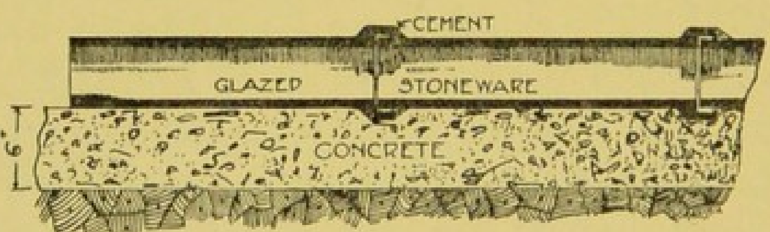
CHAPTER VIII

HOUSE DRAINAGE

Stoneware Drain Pipes (Joints)—Iron Drain Pipes (Corrosion)—Diameter of Drain Pipes—Junctions—Bends—Inspection Chambers—Gully Traps—Grease Traps—Channel Gullies—Surface Drainage—Back-flow Trap.

THE laying and inspection of underground drains is considered in this chapter, and typical drainage plans are described and illustrated in chapter XI.

Stoneware Drain Pipes—Underground drains are usually constructed of glazed stoneware tested pipes, made in two-feet lengths, of cylindrical form, with a socket at one end and a spigot at the other (Ills.



ILL. 73. DRAIN LAID ON CONCRETE BED.

73, 74, and 75), both having ridges and furrows formed on them, so as to give a key for the jointing materials.

The inclination of the drain pipes should be sufficient to carry both the liquid and solid matter away, and it is generally agreed that a rate of 4 ft. 6 in. per second is the best velocity for this purpose, but where a separate system of drainage for sewage and rain-water is constructed, such a high velocity is not necessary, and 2 ft. 6 in. to 3 ft. per second is quite sufficient.

The pipes should be truly laid and securely jointed, and should have a fall of at least 1 in 40 (i.e. 3 in. in 10 ft.) for 4-in. pipes, 1 in 60 for 6-in. pipes, and 1 in 90 for 9-in. pipes. In towns it is not always possible to obtain such a fall, and with 4-in. pipes one often has to be content with 2½ in. or even 2 in. in 10 ft.

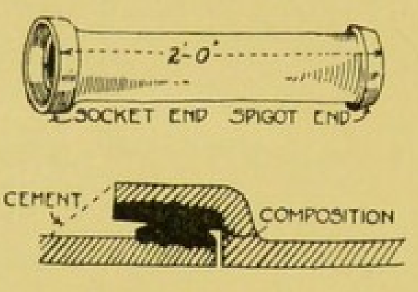
All drains should be laid in as straight a line as possible, thus shortening their length, facilitating inspection and ensuring that the excreta will be carried away quickly.

The pipes should be laid to the required fall on a bed of Portland cement concrete, 6 in. in thickness, as shown in Ill. 73. They are laid in position commencing at the lower end of the drain, the spigot end being placed in the socket of the pipe next below it, care being taken that the bore of adjacent pipes is concentric. The space underneath the pipe should then be packed up carefully with concrete, so that not merely the socket but the whole length of the pipe may be supported, otherwise any weight from above would be liable to cause a fracture to the pipe.

The jointing of drain pipes requires the greatest care, for the drains may be in perfect alignment upon a solid bed of concrete, but the drainage system is bound to be faulty if the joints between the pipes are not absolutely water-tight.

Joints—The best joint is that formed with Portland cement, which is placed round the socket before the spigot is pressed into position. The inside of the pipe should then be carefully cleaned out by means of india-rubber cylinders, in order to clear away any cement which may have passed into the pipes, and a fillet of cement is then formed round the outside of the joint, as shown by the dotted line on Ill. 75.

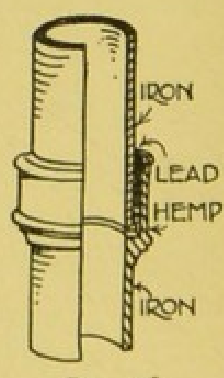
There are various patent methods for making joints. "Stanford's" joint, shown in Ills. 74 and 75, has a composition of coal tar, sulphur and ground pottery formed on the spigot and socket ends of the pipes, which are then greased and fitted one into another. This ball-and-socket principle allows for a certain amount of deflection, and prevents the possibility of obstruction by the cement of the outer joint passing into the drain. Doulton's patent self-adjusting joint is also very useful in relaying drains where the flow of sewage cannot be altogether stopped, such as in large buildings.



ILLS. 74 AND 75.
STANFORD'S JOINT.

Iron Drain Pipes—Iron pipes are preferred by some architects, especially for drainage under houses, one of the advantages being that there are fewer joints; but as the internal surface of glazed stoneware pipes is practically indestructible, their use, if encased all round with six inches of concrete, makes a good system.

Iron pipes are obtained in nine-feet lengths, bends and junctions being made of similar pattern to those for stoneware pipes. The joints are formed with gaskin run in with molten lead and well caulked (Ill. 76). Such pipes are sometimes necessary in deep basements, or in places where, owing to



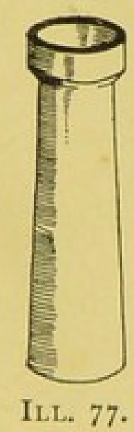
ILL. 76.
CAULKED LEAD JOINT.

the depth of the sewer, the pipes have to be slung to the walls.

Corrosion—Iron pipes should be subjected to some process to retard corrosion. In the Bower-Barff process the pipes are raised to a very high temperature and treated for some twelve hours to the action of super-heated steam, which coats them with a black oxide of iron. Dr. Angus Smith's system consists in heating the pipes to a certain degree, and then they are dipped in a special solution, which is said to preserve them for at least forty years. Iron pipes lined with glass or lead are made, but expense debars them from general use.

Diameter of Drain Pipes—The internal diameter of drain pipes for ordinary dwelling-houses is usually four inches, and as this size with a fall of 1 in 40 can discharge 140 gallons per minute, which is never likely to be exceeded in an ordinary dwelling-house, it is sufficient.

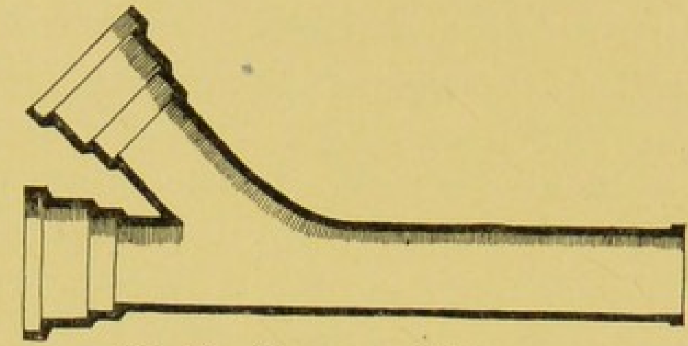
The bore of the pipes should be kept as small as possible having regard to the amount to be discharged, for a pipe discharging nearly full-bore is self-cleansing. The size of the pipes must, however, be increased as they get nearer the sewer and receive branch drains. This difference in the diameter of the pipes may be effected by means of taper pipes as shown in Ill. 77.



Ill. 77. Taper Pipe.

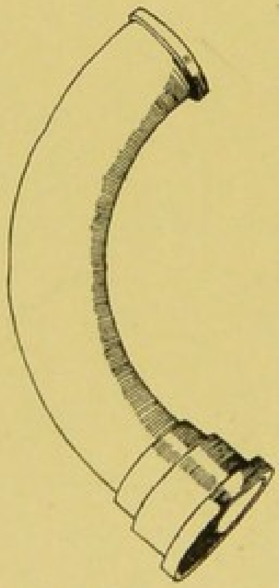
Taper half-pipes in manholes may be used as shown in Ills. 81 and 82.

Junctions are necessary when one line of pipe is to be connected to another, and they may be formed as single or Y-junctions shown in Ill. 78, so that the sewage will enter the main pipe in the direction of the fall, thereby minimizing any chance of back flow.

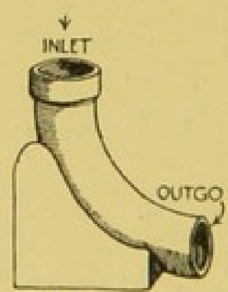


ILL. 78. SINGLE OR Y-JUNCTION.

Bends are necessary where the drain makes any change in direction, and are made of various curvatures to suit special circumstances, a right-angle bend being shown in Ill. 79. The pedestal "bend" shown in Ill. 80 is made in order to take the discharge of the



ILL. 79. RIGHT-ANGLED IRON BEND.



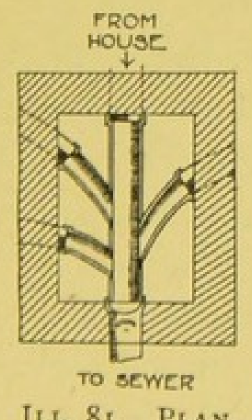
ILL. 80. PEDESTAL BEND.

vertical soil pipe where it meets the ground drainage, and it has a horizontal base fixed to it, so that a direct seating can be obtained on the concrete bed which is laid to receive it.

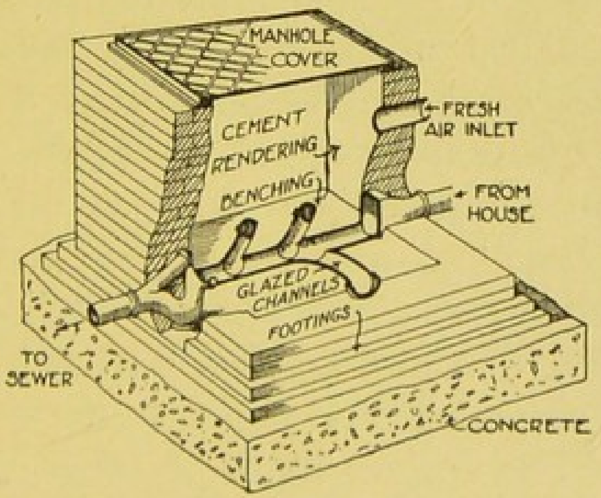
Inspection Chambers—Although a system of drainage may be faultless, yet in practice it is found necessary to have means of access at certain points so that any obstruction can be removed with drain rods. This is all the more necessary, because a water-closet pan is regarded by many servants as the proper receptacle for all kinds of articles, which on passing into the drains cause them to be blocked.

Inspection chambers or manholes as they are commonly called should therefore be formed at certain points, so that the whole drainage system can be thoroughly overhauled if required, and each separate section may be tested at any period at or subsequent to its construction. Where two or more branch pipes join the main drain, as in Ill. 135, an inspection chamber should be provided ; and, in planning the system, care should be taken to bring as many branches as possible into each inspection chamber, and thus save unnecessary expense.

Ills. 81 and 82 show a plan and sectional elevation of an inspection chamber, which should be built in



Ill. 81. Plan.



Ill. 82. Sectional Elevation.

Inspection Chamber.

white glazed bricks laid in cement mortar, a bed of concrete one foot in thickness being formed underneath the whole area of the chamber. The glazed bricks are used so that splashings can be periodically washed off with a hose, but if they are too expensive, stock or Fletton bricks finished with a cement face may be substituted.

The drain is continued through the manhole in channel pipes (i.e. half-pipes), as shown in Ill. 83, or in three-quarter pipes, as shown in Ill. 84, which latter

Ill. 83. Channel Pipe.

Ill. 84. Channel Pipe.

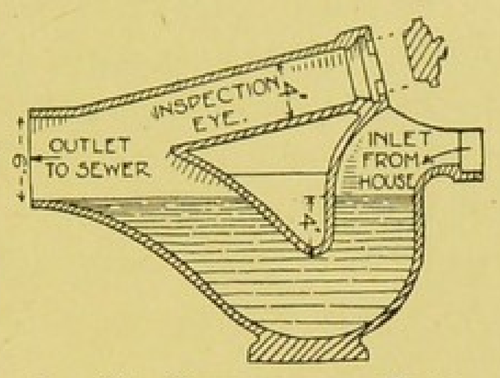
are used for bends to lessen the liability of overflow, as shown in Ill. 82.

The junction between the circular drain pipe and the channel pipe is generally made at the inside face of the manhole wall by means of a channel bend. Ill. 85 shows a pipe sometimes used, the flat portion going through the wall without necessitating much cutting to the brickwork.

Ill. 85. Inspection Chamber-Junction.

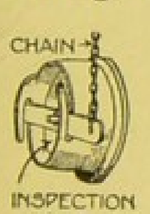
The branch drains enter at various angles (Ill. 81) and discharge into the curved channel pipes in the inspection chamber so as to direct the flow without splashing and with as little friction as possible. The pipes are set in the cement concrete forming the floor, which should be benched up (Ill. 82) in neat Portland cement, so that in case of splashing the sewage is thrown back to the channels.

The various kinds of traps for the disconnection of drains are considered on page 132, but it is necessary to refer here to the interceptor trap, which is placed on the sewer side of the lowest manhole, as shown in Ills. 82 and 86. It should have an inspection eye provided with an air-tight plug (as shown in Ill. 86), which is useful in case of a stoppage between the disconnecting trap and the sewer, as the plug can be removed and drain rods inserted.



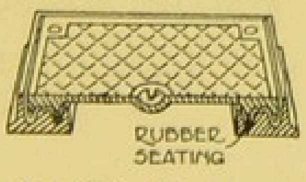
ILL. 86. INTERCEPTOR TRAP.

There is a disadvantage in having a fixed plug, as if stoppages occur in the disconnecting trap this would probably not be detected until the drain, together with the inspection chamber, was charged with sewage, which would necessitate the baling out of the manhole before the plug could be released. This difficulty is now obviated by means of a patent gun-metal cap (Ill. 87) with a lever which releases a plug attached to a chain hooked close to the manhole cover and released as required, allowing the plug to fall out and the drain to clear itself.

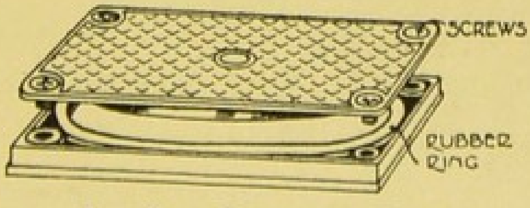


ILL. 87. INTERCEPTOR STOPPER.

Drain rods enable any of the drains that discharge into the manhole to be immediately unstopped, and this is the chief value of manholes, though as mentioned in chapter x., page 155, they are also useful as a means of distributing a current of air through the drains. Their initial cost is saved many times over, for when a stoppage occurs it is not necessary to break up the ground in various places in order to clear the drain.

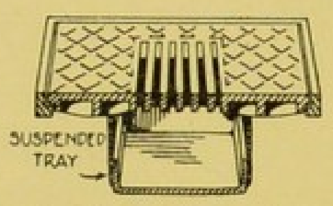


ILL. 88. MANHOLE COVER.

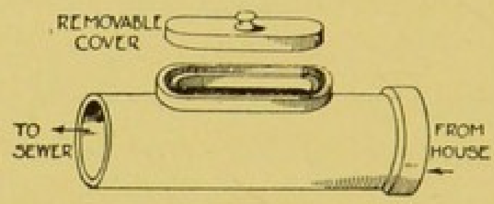


ILL. 89. MANHOLE COVER FOR INTERNAL USE.

Inspection chambers should have air-tight covers (Ill. 88) held down by four gun-metal screws and fitted with india-rubber joints and grooves to be filled with grease, soft-soap and sand. The cover, shown in Ill. 89, is specially designed for fixing inside houses and in positions where it is essential that the cover be absolutely air-tight. In the country an open grid with a wrought-iron dirt box below which prevents anything falling into the manholes may be used, as



Ill. 90. Open Grid Cover.

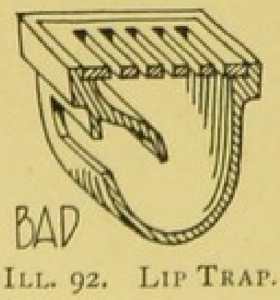


Ill. 91. Inspection Pipe.

shown in Ill. 90, and in this case the grid forms the air inlet to the drains and no inlet pipe is required.

Inspection pipes (Ill. 91) are occasionally used in a long section of drainage, where it is not considered necessary to go to the expense of an inspection chamber.

Gully Traps—Gully traps are required at the feet of rain-water pipes, and waste pipes from baths, lavatories, and sinks, in order to disconnect them from the ground drains, and if the latter are properly ventilated the water seal in the traps effectually accomplishes this disconnection, a current of fresh air being allowed to pass up the vertical pipes and thus keep them thoroughly ventilated.



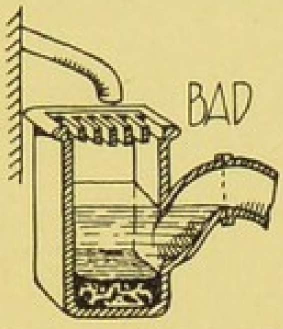
Ill. 92. Lip Trap.

There are various kinds of traps, and we will firstly mention those of a bad form which are still found in many old houses.

The "Lip" trap (Ill. 92) was made

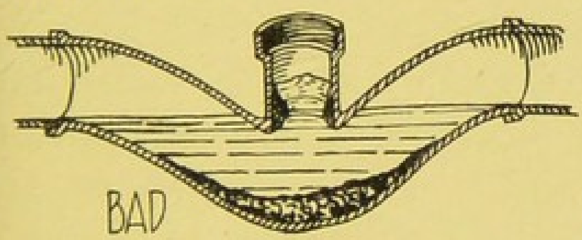
in cast-iron, but was a bad form owing to the many corners for the collection of sewage, and having no socket, it was difficult to connect it properly with drainage pipes.

Ill. 93 shows another bad gully trap, because it is not self-cleansing, as the flat bottom forms a receptacle for the collection of filth, as shown.



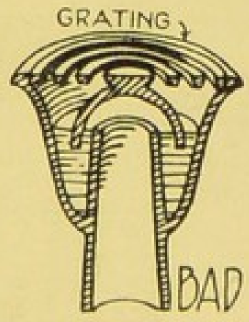
ILL. 93. BAD FORM OF GULLY.

The siphon or U trap (Ill. 94) was an early and frequently used form ; but it is insanitary owing to the quantity of water it contains, so that an ordinary flush from a lavatory or water-closet does not clear out the solids remaining in the bottom of the trap. The introduction of an inspection pipe, as shown in the illustration, only makes matters worse, as the solids are pushed up into it and can only be removed with drain rods from above.



ILL. 94. U TRAP.

The bell trap (Ill. 95) was formerly much used for yards and scullery sinks. It is a bad form, being non-cleansing, besides which if the bell is removed there is direct communication with the drain.

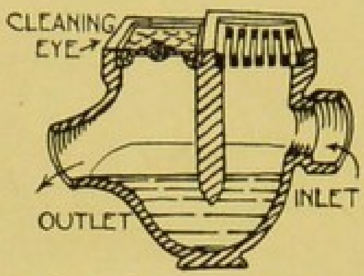


ILL. 95. BELL TRAP.

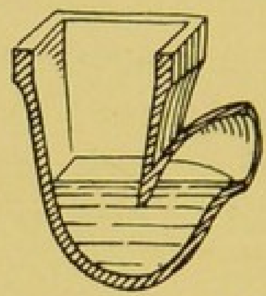
Having dealt with the defects of the older forms of traps, we may now discuss those which are designed to keep their seal and be as far as possible self-cleansing.

Gully traps are now usually made as shown in

Ill. 96, which is made for receiving the discharge from a rain-water pipe (or the waste from baths or lavatories) by means of a back inlet. The rain-water in this case



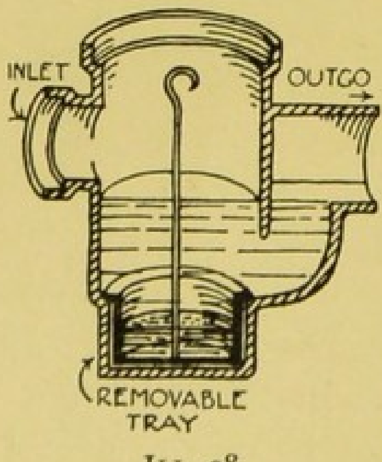
ILL. 96. BACK-INLET GULLY.



ILL. 97. SECTION OF ORDINARY GULLY.

is led into the trap under an iron grating in order to prevent splashing, but some Local Authorities insist that it shall discharge over the gully, as in Ill. 97.

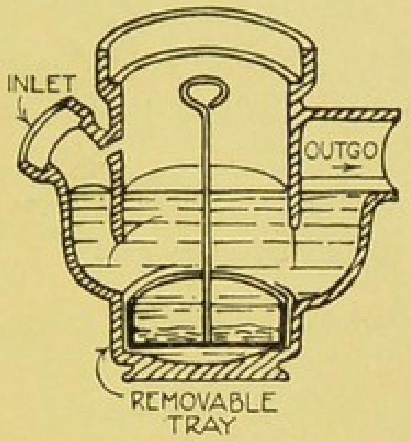
Grease Traps—Grease traps are used to receive the discharge from scullery sinks in order to prevent grease entering the drains. The objection to all grease traps, however, is that if not frequently cleaned out they become little cesspools. Many authorities consider that in ordinary dwelling-houses it is better to have a gully provided with a flushing rim, and with an automatic flushing tank in connection.



ILL. 98.
DEAN'S GREASE TRAP.

In hotels and large mansions some people consider grease traps necessary, as the amount of grease and dirt discharged from scullery sinks is very great and might soon clog up the drains.

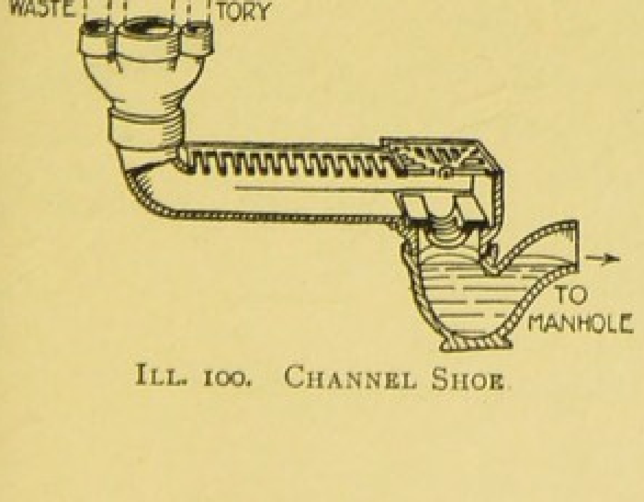
Grease traps should consist of a receptacle large enough to collect the fat from the greasy water which is brought into it by the sink waste. Dean's grease trap (Ill. 98) is one of many patents which have this object in view. The sink waste discharges by means of a back inlet, and owing to the depth of the seal the floating grease is prevented to a large extent from going into the drain. The removable tray which rests on the bottom of the trap is provided with a long handle by means of which it can be raised; the solid matters and congealed grease can then be removed from it.



ILL. 99.
WINSER'S GREASE TRAP.

Ill. 99 shows a grease trap made by Messrs. Winser and Co., in which the greasy water is discharged below the water-line, thus leaving a still wider space for the congealed grease.

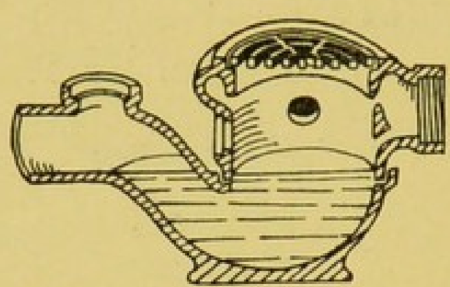
Channel Gullies—The Local Government Board's recommendation that all wastes should discharge over an open channel connected with a trapped gully, as shown in Ill. 100, is, however, probably the most hygienic way of treating sink wastes. Duckett's self-cleansing channel gully consists of an open glazed channel in connection with an ordinary form of gully trap, in which the grease from the sink-water has time to congeal while passing towards the trap. The grease is visible, and if not cleared away frequently gives rise to smells which draw attention to it, whereas the ordinary grease trap ful-



ILL. 100. CHANNEL SHOE

fils that condition which is always insanitary, viz. "out of sight out of mind."

Ill. 100 shows a channel shoe and gully trap, in which the waste water from a bath, rain-water pipe and lavatory is discharged by means of a three-way head into an open shoe and thence to the gully trap. In this case an iron grid is used if the trap is to receive surface water from the yard, in order to prevent débris finding its way into the drain.

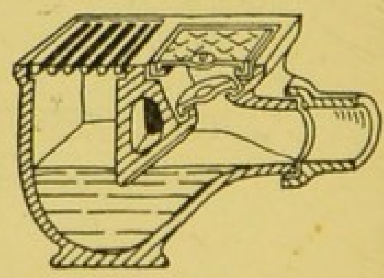


Ill. 101. Flushing Gully.

The flushing gully shown in Ill. 101 is often used for sink wastes, being connected at the back with a flushing tank holding some thirty gallons, which discharges automatically at intervals and helps to keep the drains clean.

Surface Drainage—Yards, areas and other open spaces are drained by having their surfaces sloped towards gully traps, which should, generally speaking, be made to receive as much water as possible from baths and lavatories, so that it may be kept sealed during dry weather. In positions where many leaves fall or much waste paper is blown about, gullies should be protected with wire cages.

Many traps are made with inspection eyes, so that if a stoppage occurs it can easily be removed by means of drain rods. It will be readily seen that to pass a drain rod from above through the curved space forming the trap is somewhat difficult, and Ill. 102 shows an air-tight stopper on the drain side of the

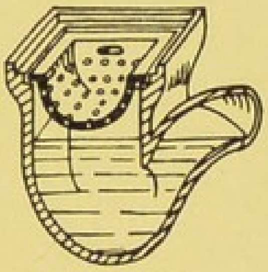


Ill. 102.
Inspection Gully.

trap which can be removed and the drain rods inserted without going through the trap. There is, however, always a danger that this may become unsealed and leave the outlet in direct communication with the drain.

Ill. 98 shows a gully which can be used to prevent sand and grit from entering the drain, and this form is also useful in the basements of large warehouses, so that when the floor is washed down the dirt falls into the removable tray.

Stables should have no gullies inside the building, the drainage being led to outside gullies in open channels, which can be washed down with a hose-pipe.

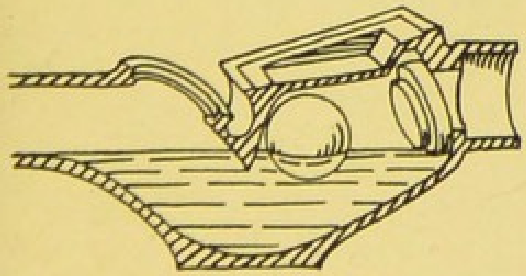


Ill. 103.
Stable Gully.

Ill. 103 shows a stable gully with a perforated bucket designed to intercept particles of straw which may have passed through the top grating, not shown on the illustration.

Stable drainage is dealt with in chapter XX., page 369, and a typical stable drainage plan is described in chapter XI., page 164.

Back-flow Trap—Before passing from this subject, attention should be drawn to the prevention of what is known as back flow, or the return of sewage back to the house drainage, which is liable to occur where the main drain is not of sufficient depth to secure immunity from floods. Ill. 104 shows an intercepting trap in which floats a copper ball. In the event of any back flow this effectively stops up the opening on the house



Ill. 104. Back-flow Trap.

side of the drain. In case of stoppage the iron cover can be removed and the drain rods easily inserted.

The traps dealt with in this chapter are those which occur in the system of house drainage outside the building; those fixed inside the building are described in chapter IX. For typical drainage plans the reader is referred to chapter XI.

CHAPTER IX

SANITARY FITTINGS

General Principles—Water-closets (Pan, Long Hopper, Wash-out, Short Hopper, Wash-down, Valve, Siphonic)—Urinals—Flushing Cisterns—Soil Pipes (Joints between Lead and Earthenware; Lead and Iron Pipes compared)—Baths—Lavatories—Sinks (Scullery, Housemaid's, Butler's)—Expansion Joints.

GENERAL Principles—Sanitary fittings of all kinds should, where possible, be fixed against an external wall, so as to avoid danger from internal soil or waste pipes.

The position of lavatories, bathrooms, and water-closets in relation to the other parts of the house has been dealt with in chapter III., and the necessity for making the walls and floors of non-porous materials is referred to in chapter VI. All apartments should be well lighted and ventilated, for when light is abundant cleanliness is as a rule the result. The casings or wooden enclosures which were formerly considered necessary to conceal closets, baths or lavatory basins are now dispensed with, for they simply harbour dirt and vermin, and answer no useful purpose.

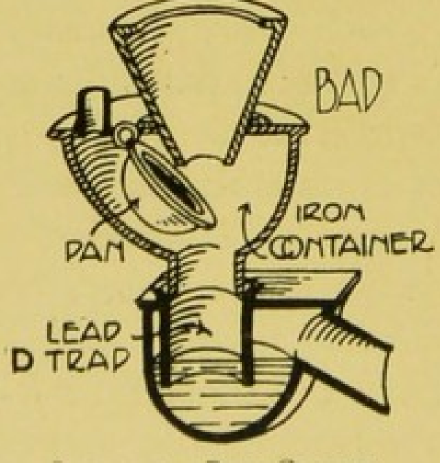
All sanitary fittings—W.C.'s, baths, lavatories—should, where possible, for the sake of economy, be placed over each other on the different floors.

Water-closets—Water-closets are the most important of all sanitary fittings, their efficiency depending on the way the pan and trap fulfil certain sanitary requirements.

The pan must be made of impermeable material such as glazed stoneware, and so formed that it can be thoroughly flushed and retain a sufficient depth of water to prevent fouling. It is found, moreover, that if the excreta be thoroughly covered with water before being discharged into the soil pipe there is less likelihood of the fouling of the drainage system.

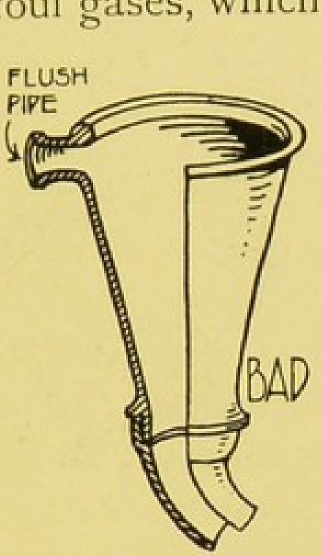
The water-closet trap should be of a simple self-cleansing form, fixed above the floor so as to be easily accessible, and should have a minimum water seal of $1\frac{1}{2}$ in. to 2 in. It should be protected against siphonage by being ventilated at its outgo, as described in chapter x., p. 158. The basin and trap are sometimes made of the same piece of earthenware, but in other cases the trap is made separately of lead or iron. The separate trap, as shown in Ill. 108, allows the pan to be removed in case of damage without opening up communication with the drains.

The insanitary forms of water-closet have been generally discarded, but being still found in old houses are here briefly described, in order to enable the reader to appreciate the advantages of modern types.



Ill. 105. Pan Closet.

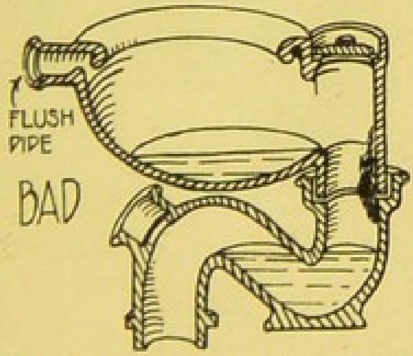
The **Pan** closet (Ill. 105), with iron container and lead D-trap, was undoubtedly a bad type, taking its name from the hinged copper pan which requires a space to swing in, called the "container." When the closet was flushed a large part of the container was not reached by the water, but became more and more foul each time the apparatus was used. A D-trap (the disadvantages of which are described in chap. x., p. 157) was also provided as shown, but this being as a rule unventilated it formed another collecting space for foul gases, which were ready to pour into the house whenever the pan was lowered. Only those who have inspected a pan closet with D-trap will realize its danger and the necessity for the removal of such a form of closet.



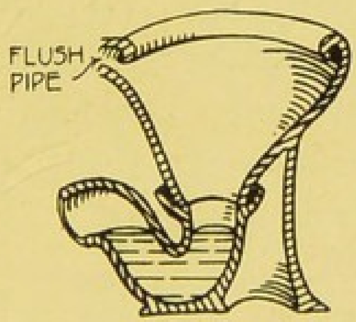
ILL. 106.
LONG-HOPPER CLOSET.

The **Long-hopper** closet (Ill. 106) was another insanitary fitting, the water being introduced by means of a spiral flush which only half cleansed the pan; the latter was continually soiled because the water area at the bottom of the basin was not of sufficient capacity to catch the excreta.

The **Wash-out** closet (Ill. 107) secured the favour of sanitarians some years ago, but must be condemned,



ILL. 107. WASH-OUT CLOSET.



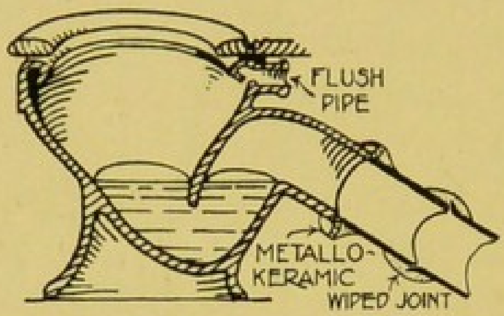
ILL. 108. SHORT-HOPPER CLOSET.

for the water in the basin is too shallow, and the excreta, instead of being forced straight down the trap, was dashed against the outgo, which was in consequence fouled, as marked on the illustration.

Having discussed the foregoing insanitary types, we can now deal with the more modern fittings.

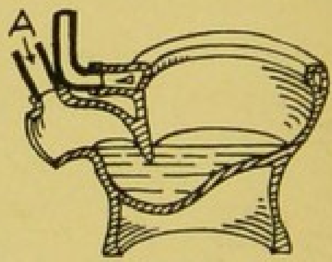
The **Short-hopper** (Ill. 108) is an improvement, but the water area at the bottom being only about 4 in. in diameter, the basin still becomes fouled.

The **Wash-down** (Ill. 109) is a great improvement on the short-hopper and is the simplest and best form of closet for ordinary purposes. It is usually made of a pedestal shape with large flushing rim, and requires no enclosure, but is provided with a lift-up seat, hinged to fall back when used as a urinal. It will be observed that the water area is as large as possible in order to catch and submerge the excreta, which can then flow into the drain without fouling the pan, as mentioned on page 140.



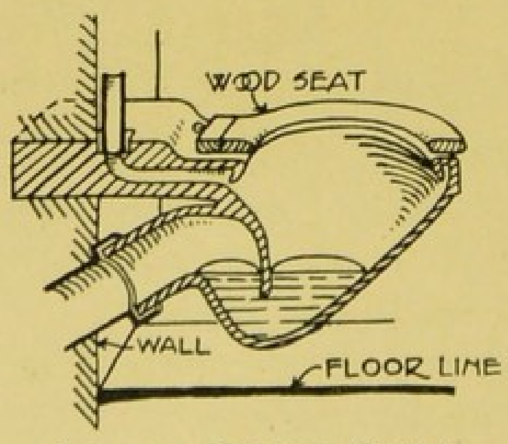
Ill. 109. Wash-down Closet.

Ill. 110 shows the Simplicitas closet with a large water area of $10\frac{1}{2}$ in. by $6\frac{3}{4}$ in., and an anti-siphonage pipe (A) the use of which is dealt with in chapter x., page 158. It is placed not less than 3 in. or more than 12 in. from the highest point of the trap. The illustration shows the flushing pipe, which usually has an internal diameter of $1\frac{1}{2}$ in., and connects the cistern with the flushing rim of the pan.



Ill. 110. Simplicitas Closet.

The Bracket closet (Ill. 111) is an improvement on the ordinary "wash-down," and has been employed in many hospitals. Being

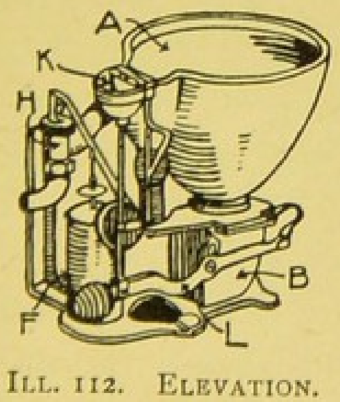


Ill. 111. Bracket Closet.

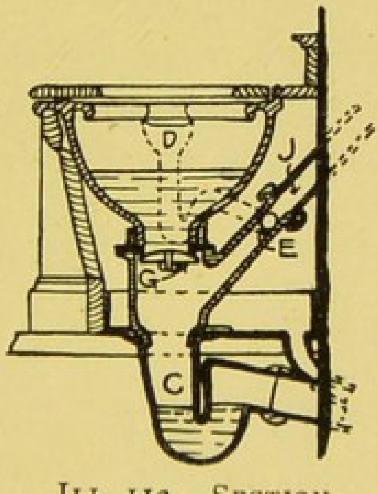
built into the wall and thus supported above the floor, it enables the latter to be properly washed and obviates any accumulation of dirt around the pedestal.

The **Valve** closet (Ills. 112 and 113) is another form of a more complicated nature which is preferred by some, but as a wooden casing is usually considered necessary to conceal the mechanism, it sometimes also hides a good deal of dirt. Another disadvantage is that the supply of water is not regular but dependent on the person using the lever, whereas in the ordinary wash-down closet one pull of the handle empties the contents of the flushing cistern into the basin. The water for flushing this form of closet should be obtained from a special cistern properly disconnected from that which supplies the water service of the house.

Ills. 112 and 113 show the Optimus valve closet, which consists of three parts : the pan (A), the valve-



ILL. 112. ELEVATION.



ILL. 113. SECTION.

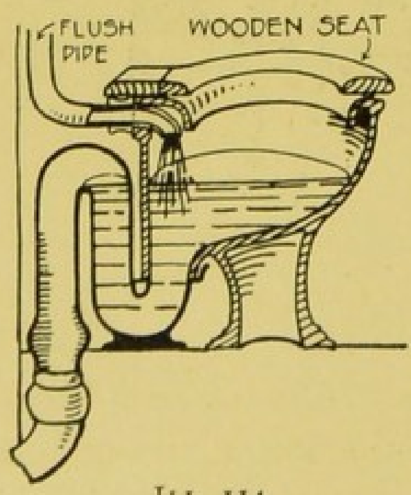
HELLYER'S OPTIMUS VALVE CLOSET.

box (B), and the lead anti-D-trap (C). The advantages claimed for this type are the large amount of water for catching the excreta, the double water-seal giving additional security if the closet remains unused for some time, and the noiseless action in comparison with the "wash-down" closet.

The various parts are lettered on Ills. 112 and 113 as follows :—

A. Earthenware pan with flushing rim.
B. Valve-box of enamelled white iron.
C. Anti-D-trap.
D. Overflow from basin.
E. Connection of overflow pipe (D) with ventilating arm (J) of valve-box.
F. Copper bellows for regulating the quantity of water-flush after the handle is dropped.
G. Flap-valve to keep water in the basin.
H. Brass supply valve admitting water to flushing rim.
J. 2-in. vent pipe to the valve-box, carried to the outer air, and preventing siphonage.
K. The lever for opening and closing the basin valve.
L. Weight for shutting the supply valve.

A good valve closet will, with very little attention, work satisfactorily, but in most cases it is perhaps advisable to install a wash-down closet.



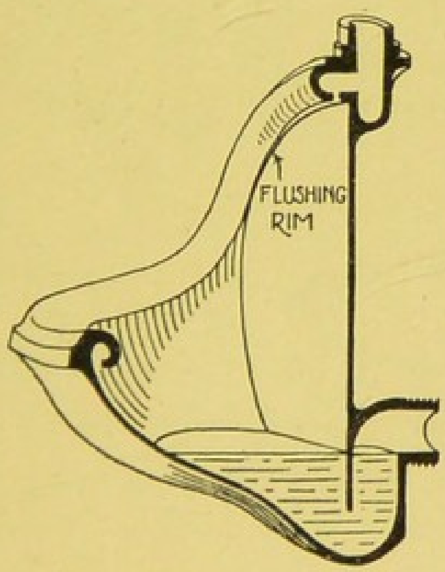
ILL. 114.
SHANK'S SIPHONIC CLOSET.

The **Siphonic** closet has found favour in recent years, and Ill. 114 shows Messrs. Shank's Siphonic closet, in which the emptying of the basin is produced by the direct action of the water from the flush pipe, the contents being completely discharged by the powerful suction, the basin being again filled up with clean water. The pan has a deep water-seal of 8 in., a water surface of $13\frac{1}{2}$ in. by 11 in.; and it is said to require only a two-gallon flush.

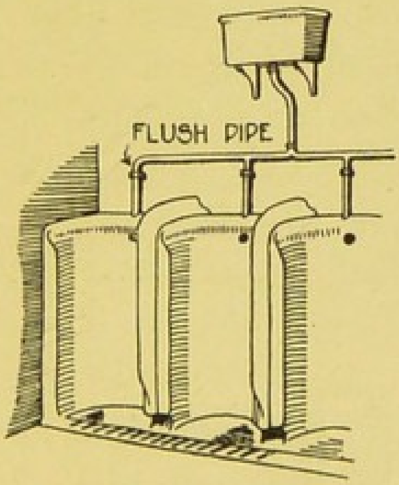
Messrs. Shank's Combination closet (Ill. 115) is siphonic in action, being started by a hand lever instead of a chain, and the flushing cistern is silent in its action, as it is constructed upon the float-valve principle.

Ill. 115. Shank's Silent Combination Closet.

Urinals—Urinals are not necessary in a private house, for a wash-down closet with a hinged seat answers their purpose and thus obviates an extra fitting. They are of various shapes, such as Ill. 116, and are trapped like other sanitary fittings, the waste pipe



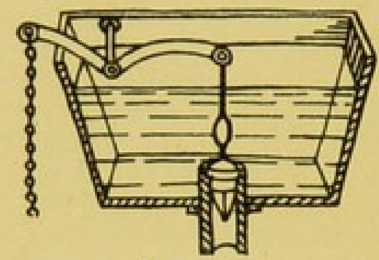
Ill. 116. Urinal Basin.



Ill. 117. Range of Urinals.

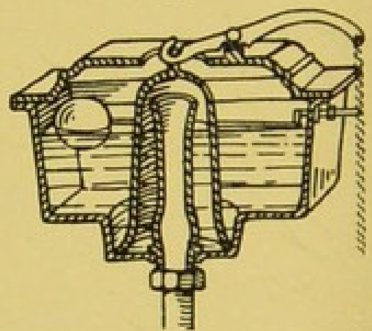
being ventilated in a similar way to a soil pipe. White glazed urinals with semicircular backs, as shown in Ill. 117, are largely used and are made without angles, projections or corners where dirt can accumulate. They should be flushed automatically by means of a cistern fixed over them.

Flushing Cisterns—Flushing Cisterns (or water waste preventers) are used to all ordinary wash-down closets and urinals. The water companies usually limit their capacity to two gallons, but wherever possible three gallons should be provided. The best variety is that which works on the siphonic principle, so that, on the chain being pulled, the contents of the cistern are at once discharged. In the ordinary valve cistern (Ill. 118) the chain must be held until all the contents of the cistern are discharged.



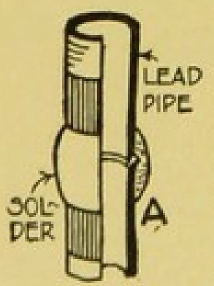
Ill. 118.
Flushing Cistern,
Old Type.

Ill. 119 shows a Levern flushing cistern, in which, when the dome is raised, the water is drawn up above the level of the head of the flush pipe, and starts the siphonage, after which the ball-valve allows the cistern to be refilled to a point just below the top of the flush pipe.



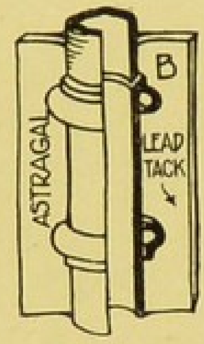
Ill. 119.
Flushing Cistern,
Modern Type.

Soil Pipes—Soil pipes should be made of strong hydraulic drawn lead, weighing eight pounds to the square foot, and should be fixed on the external face of walls with as few bends as possible. Ill. 120 shows the wiped soldered joint used to join lead pipes, in which a socket is formed on the upper end of the lower of the two pipes to be joined, by means of the turning pin, and the spigot on the lower end of the upper pipe is rasped off to a feather edge so as to fit into this socket. The pipes are then covered for a distance of four to nine inches with a mixture



Ill. 120.
Wiped
Soldered
Joint.

of size, lampblack and powdered chalk, called soil or smudge, which is then scraped off the ends of the pipes to be occupied by the solder. Molten solder is then poured around the joint and wiped into shape by means of a greased cloth, the soil preventing the solder adhering beyond the point desired.



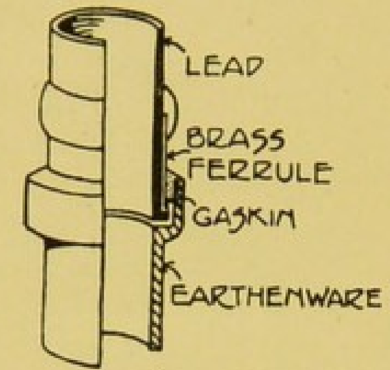
ILL. 121.
ASTRAGAL AND LEAD TACK.

Soil pipes are secured to the walls by tacks (Ill. 121) of eight-pound lead, placed from three to five feet apart, centre to centre, and usually about ten inches deep. These tacks may be made in pairs or singly, and are merely soldered to the back of the soil pipe and secured to the wall by hooks, as shown in Ill. 122. The tacks in the better class of work are more ornamental, and have astragal mouldings, as shown.

ILL. 122.
SECTION OF SOIL PIPE AND LEAD TACK.

The soil pipe should be carried well above all windows for the purpose of ventilation, and to prevent smells entering the rooms, as described in chapter x., page 155. It may be taken up between the rafters, being enclosed in a casing to prevent it being damaged, but this is objected to by some local authorities who require it to be carried up on the external surface of the roof, where it often forms an objectionable disfigurement to the exterior.

The Joints between Lead and Earthenware at the junction of the closet with the soil pipe and at the base of the soil pipe with the drain must be made with great care in order to render them perfectly water-tight. A brass ferrule joint shown in Ill. 123 should therefore be used, in which a socket is formed on the lead pipe by means of a plumber's turning pin, and the end of a brass collar or ferrule fits into this, and a wiped joint is then made between the lead and brass, as described above. The brass ferrule is then jointed to the earthenware by means of a ring of gaskin (hemp), neat cement being run in, and thus making a waterproof and air-tight joint.



ILL. 123.
BRASS FERRULE JOINT.

The old method of forming a red-lead joint between the earthenware and lead pipes is bad, owing to the contraction and expansion of the latter material, which allows of direct communication between the drainage system and the house.

The Metallo-Keramic joint, which is an invention of Messrs. Doulton, is another method in which a short piece of lead pipe is fused by a patent process on to the earthenware pipe of the closet; this can then be connected with the soil pipe by means of an ordinary wiped joint.

Iron soil pipes, when used, should be of special thickness and have caulked lead joints, as shown in Ill. 76, and they should be galvanized or treated with the Bower-Barff or Angus Smith solution to prevent them from rusting, as described in chapter VIII., page 127.

The Comparative Advantages of Iron and Lead for Soil Pipes have been frequently discussed, and opinion is still divided as to their relative merits.

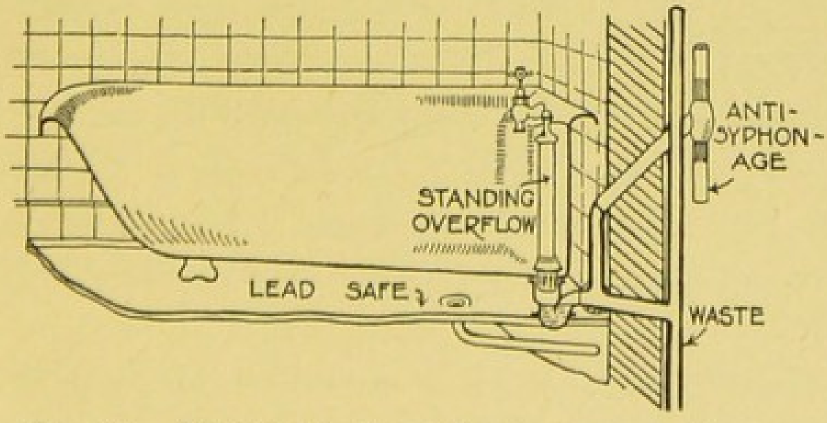
The London County Council require all soil pipes where fixed within buildings to be constructed of lead, whereas in the United States lead soil pipes are prohibited, as iron is considered the better material.

Lead soil pipes are smoother, easily bossed to any shape, do not require painting and give a little in case of settlements; but in order to protect them from damage they should be covered with sheet iron up to about six feet from the ground. Lead soil pipes may be, in our opinion, dangerous when used inside a building, as instances have occurred in which they have been damaged by nails driven through floor boards and casings, and so have admitted foul air into the house.

Where soil and drain ventilation pipes have to be fixed on internal walls, recesses may be formed to receive them, and where they have to be fixed under floors and over ornamental ceilings special precautions should be taken by laying them in lead-lined troughs provided with a lead warning pipe carried to the external air.

Baths—Baths are made of various materials, such as enamelled iron, copper or porcelain, but the wooden enclosures formerly considered necessary should now be discarded (see chap. XVI., p. 226).

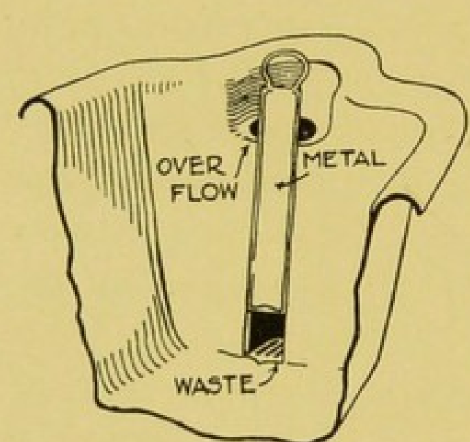
Ill. 124 shows a porcelain enamelled bath, standing



ILL. 124. ENAMELLED IRON BATH WITHOUT CASING.

on four legs, without any casing. It is fitted with $1\frac{1}{2}$-in. lead waste, having $1\frac{1}{2}$-in. anti-D-trap discharging into a 2-in. main waste, which is carried up above the highest fitting as a ventilating pipe. The trap is also ventilated, to obviate siphonage, by means of a 2-in. anti-siphonage pipe, which is carried up and connected to the waste pipe above the highest fitting where such are arranged over one another.

The bath waste is of the standing overflow type, in which the waste is formed of a 2-in. pipe which acts as an overflow on the water reaching to the top.



ILL. 125.
AJAX BATH OVERFLOW.

Ill. 125 shows the Ajax patent shutter and overflow designed by Dr. C. A. James, which can be used either with a bath or lavatory basin, and consists of a metal weir which fits into a slot and is easily removed for cleaning. It is simple and completely visible, so that there can be no foul collection of soapsuds or dirt.

The by-laws of some water companies require the supply pipe to be brought into the bath above the water-line, but as this causes the room to be filled with steam it is better that the hot water should be brought in at the bottom of the bath if possible. The bath, so that it may be quickly filled, should have supply pipes of not less than 1 in. diameter, but of course the size of pipe varies in different circumstances.

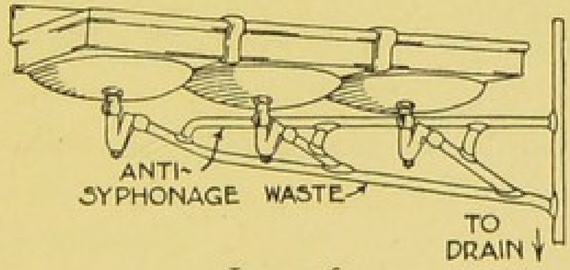
The bath waste pipe is sometimes delivered into a rain-water head, but if this happens to be near a window the effluvium from the dirty water and soap-suds is offensive, and in confined situations, such as areas, it is better to have a waste pipe carried up and ventilated as shown in Ill. 124.

When the floor is of wood a 4-lb. lead safe, as shown in Ill. 124, may be placed under the bath, and sloped so as to throw the water towards a 2-in. overflow leading direct to the open air.

Lavatories—Lavatories are usually made of glazed earthenware and are of various patterns. The tip-up variety has the advantage of emptying the basin quickly, but the receiver in which the dirty water is thrown must be cleaned periodically, as the smell arising from decomposing soapsuds is most unpleasant.

The waste pipe from a single lavatory should be at least $1\frac{1}{4}$ in. diameter, and should be treated in the same manner as with baths, but if the lavatory is on the ground floor, it can discharge direct into a gully trap.

An overflow pipe is a cause of annoyance in consequence of the difficulty of keeping it clean, and this is avoided by using some fitting such as that described for baths on page 150.

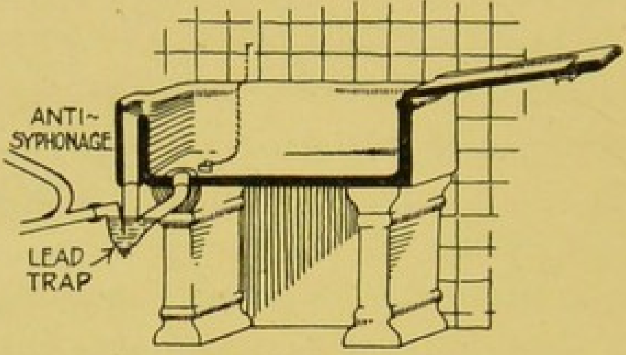


Ill. 126.
Range of Lavatory Basins.

Lavatory basins, when fitted in ranges, must each have a trap which should be ventilated to prevent siphonage, as shown in Ill. 126.

Sinks—Sinks for various purposes are in general use, viz. : (*a*) Scullery Sinks ; (*b*) Housemaid's Sinks ; and (*c*) Butler's Sinks.

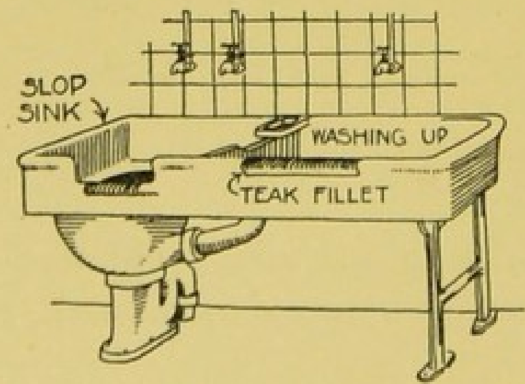
(*a*) **Scullery Sinks** should be made of glazed stoneware so as to be easily cleaned, and may be supported on galvanized iron cantilevers or on stoneware pedestals, as shown in Ill. 127. They are generally about 3 ft. by 2 ft., the height of the top edge being about 2 ft. 6 in. from the floor. The bottom of the



ILL. 127. SCULLERY SINK.

sink should have a good fall towards the outlet, which should be placed adjacent to the outer wall, and should be provided with $3\frac{1}{2}$ in. bell-mouthed cobweb grating to arrest the solid matter. The waste should have an internal diameter of at least 2 in., and should have an anti-D-trap fitted with inspection screw for use in case of stoppage. It should discharge on to an open channel connected with a trapped gully or on a grease trap, so as to be disconnected from the drains, as mentioned in chapter VIII., page 135.

(*b*) **Housemaid's Sinks** are sometimes provided, but the slops from the bedrooms can be emptied down the water-closet in an ordinary house, as sanitary fittings should not be multiplied more than absolutely necessary. The closet basin should have a lift-up seat, or "slop top." We give Ill. 128 to show a Doulton's combined wash-up and

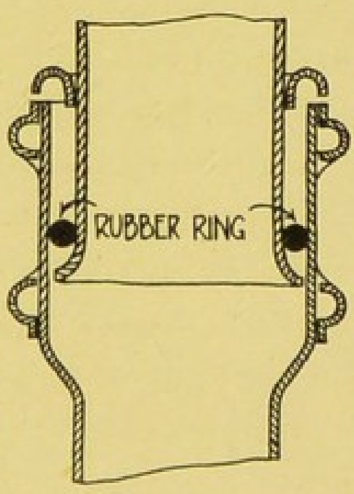


ILL. 128. HOUSEMAID'S SINK.

slop sink, with an earthenware basin and trap to which a flushing tank is frequently provided. The wash-up sink has a hardwood grating to prevent crockery being broken against the earthenware bottom.

(*c*) **Butler's Sinks** should be fitted with a hot and cold water supply, and be about 15 in. deep in order that bottles and decanters may be held underneath the taps. They are, as a rule, lined with lead, which should not be of less than eight pounds to the foot, and if they are to have much hard wear the bottom must be of ten-pound lead. These sinks can also be obtained of glazed earthenware, but with this material breakages are more frequent than if of wood lined with lead. They can also be lined with sheet iron, tin, copper, or with best white metal, which always retains its colour. Some people consider that these are superior to lead, as they withstand the action of hot water, and are not liable to be damaged by the effects of expansion and contraction.

Expansion Joints—Where a lead waste pipe has a large amount of hot water continually passing through it, a "telescope" joint, as shown in Ill. 129, which allows for expansion and contraction of the pipe, is sometimes used. It has a rubber ring round the inside of the upper pipe, which can thus move up and down in the socket of the lower one.



Ill. 129.
Telescope Joint.

CHAPTER X

THE VENTILATION, TRAPPING, AND SIPHONAGE OF DRAINS

General Principles—(Outlet pipes—Inlet pipes—Materials for pipes—Another theory of ventilation)—Traps (Bell, D, S, P, Anti-D)—Siphonage.

GENERAL **Principles**—A drainage system requires to be properly ventilated in order to prevent stagnation of foul air, and siphonage of traps which would result in the admission of sewer gas into the house. By means of ventilating pipes the accumulation of foul gases is prevented, for they are immediately led away to the open air at some point where they cannot be drawn into the house through windows or other openings. In order to produce this current of fresh air throughout the whole system, it should be remembered that air, when heated, expands and rises; and that air in motion is lighter and more rarefied than when at rest.

All drains should be laid to a fall as described in chapter VIII., and the vitiated air therein, owing to chemical decomposition, is warmer than the atmosphere, and hence its specific gravity is less. It has therefore a tendency to rise to the higher end of the drain. If there is an outlet at the higher end, and an inlet for fresh air is provided at the lower end of the system, a current is produced which in ordinary circumstances will be effective in ventilating the drain.

If a ventilating pipe is carried up well above any structure a self-acting exhaust shaft is obtained, because the air at the top end of the pipe is less dense than that at the lower end, and an upward draught is thus automatically produced. For the above reasons a short fresh-air inlet pipe is fixed at the lower extremity of a drain, and a long outlet pipe is fixed at the highest point; one of the latter is also fixed at the head of each branch carrying the drainage from a water-closet.

Outlet pipes should be of the same diameter as the soil pipes to which they are attached, and may have either an open end, fitted with a galvanized wire cage, to keep out dead leaves and to prevent birds building therein, or be provided with an up-draught cowl which is said to increase the upward current of air.

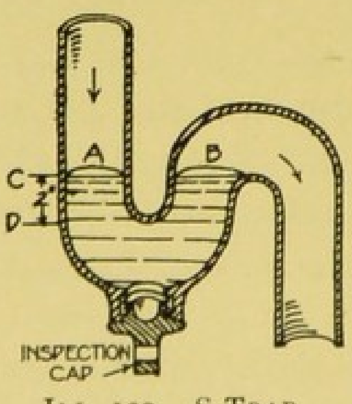
Inlet pipes have openings usually six feet from the ground, and should be kept as far as possible from any door or window openings. They are sometimes fitted with a mica flap-valve so arranged as only to allow air to enter, while any back current from the drains causes the valve to shut. The inlet pipe is taken into the manhole which is nearest the sewer, so that fresh air is admitted to the lower part of the drainage system and finds its way through the pipes to the various outlets. In order to be effective, inlet pipes should have a sectional area approximating to the sum of the various outlets of the main branch drains.

Materials for Pipes—Inlet and outlet pipes should be made of some material which will not rust or decay, otherwise they are liable to become choked. Lead is considered by many to be the best material, as with iron, even when galvanized, rust will sometimes form and collect in the bottom of the pipe, thus blocking it up. We found this state of affairs in the drainage system of a hospital which recently came under our notice. We took more than half a pailful of oxide of iron from the bottom of the outlet pipe, which had thus completely stopped the circulation of the air in the system.

The method of ventilation mentioned is the one in general use, yet it will be understood that when the contents of a water-closet are suddenly discharged down a soil-pipe, there is a downward current of air which reverses this arrangement for ventilation, as it tends to force the foul air in the pipes in the direction of the flow.

It is therefore held by some authorities that both inlet and outlet ventilating pipes should be carried above the roof level, so that they may act intermittently either as inlets or outlets.

Traps—Traps are required in the drainage system to prevent foul air entering the house, and the principles upon which they should be designed may be briefly outlined.



ILL. 130. S-TRAP.

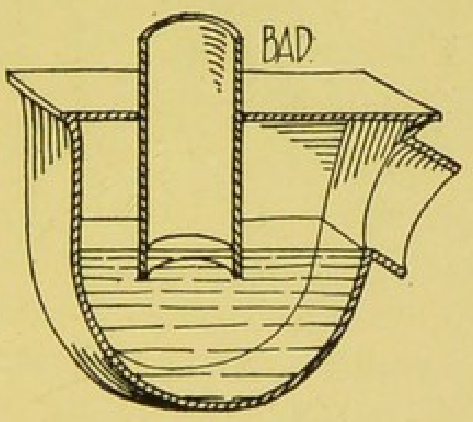
A trap in its simplest state is merely a bend in a pipe which retains water and thus prevents air from passing beyond it. Underground earthenware traps have been already dealt with in chapter VIII.

An **S-trap** is shown in Ill. 130, the space between C and D being the water-seal, which should never be less than 1½ in. in depth. A water-seal alone, however, is not sufficient to prevent the passage of gases, because it is known that water absorbs such gases and passes them through to the other side of the trap. It may also be rendered ineffective by means of evaporation. For the above reasons it is necessary that the water should be changed frequently, and also that the trap itself should be ventilated on the side nearest to the drain, so that noxious gases may escape by the ventilating pipe and not saturate the water in the trap. The ventilating pipe is also required to prevent siphonage, which is dealt with on page 158.

Traps used with the sanitary fittings of a house should be designed with as few angles as possible, so as to render them self-cleansing.

The **Bell-trap** is a bad type which does not fulfil these conditions, as has been pointed out in chapter VIII., page 133.

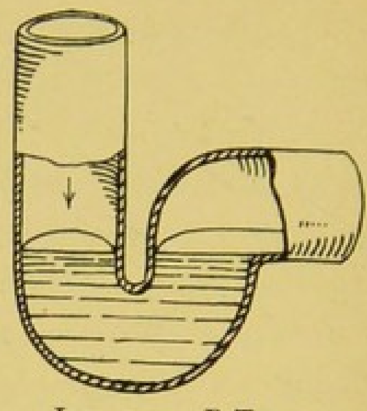
The **D-trap,** shown in Ill. 131, as still occasionally found in old houses, has a dip pipe, which is projected about 1½ in. into the water of the trap, as shown, and if, as is usual, it becomes eaten away the "trap" itself is entirely destroyed. It has, moreover, many corners for the collection of filth, as can be seen on examining one on its removal.



ILL. 131. D-TRAP.

The **S-trap** shown in Ill. 130 is made of 1¼ in. to 4 in. internal diameter of drawn lead, generally 8 lb. to the superficial foot. It is used with a vertical waste pipe. The smaller kinds should be fitted with screw inspection caps at the bottom, as shown in the illustration, so as to be easily cleared out if they become stopped.

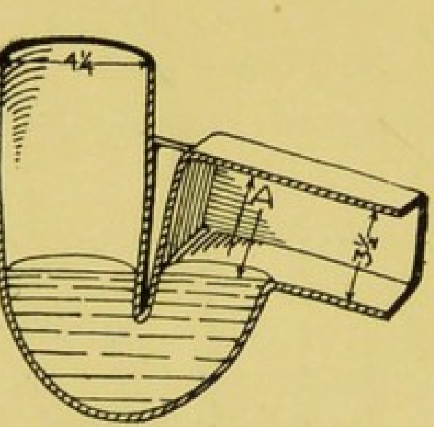
The **P-trap** shown in Ill. 132 is constructed in a similar way to the S-trap, and used where the waste pipe is horizontal for a certain length.



Ill. 132. P-Trap.

These "S" and "P" traps, largely used for the wastes of W.C.'s, baths, sinks and lavatories, are usually circular in section.

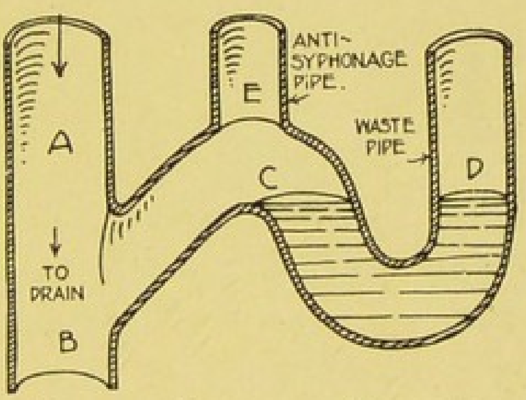
The **anti-D-trap**, shown in Ill. 133, was invented by Mr. Hellyer to check siphonage, i.e. the drawing out of the water in the trap by the momentum of the discharge. He found that siphonage could be checked by contracting the water-holding portion of the trap and making the outgo larger and square in section, thus producing more friction during the discharge. Another advantage claimed for this trap is that the water in rushing through it has a tendency to hit the upper edge of the outlet at A (Ill. 133) and to fall back into the trap instead of being drawn down the waste pipe.



Ill. 133. Anti-D-Trap.

Siphonage—Siphonage, which causes the unsealing of traps, may occur in two ways, which will be best explained by reference to Ill. 134, which shows an ordinary S-trap filled with water. If a discharge of water is sent through the trap which is sufficient to fill the sectional area of the pipe, the trap would either remain empty or a partial vacuum would be formed at its outgo C, and the pressure of the atmosphere at D being greater than at C would cause part or the whole of the water to be forced out of the trap ; or, in other words, the trap would be "siphoned." This siphonage would render the trap useless for preventing the inlet of foul air, and it may be obviated by fixing an anti-siphonage pipe, as shown at E, which causes air to be drawn into the drain on the outlet side of the trap, and also ventilates the space between the trap and down-pipe.

The water-seal of the trap may be, however, interfered with in another way, as when two closets are placed one above the other and discharge into the same down-pipe. If we assume, again, that there is no anti-siphonage pipe E, the air following the discharge from the upper fitting down the pipe A B on Ill. 134, will draw the air in the portion B C along with it, thus lessening the pressure on the water in the trap at C, which causes it to become unsealed by the pressure of the atmosphere at D. These points are easily demonstrated by means of small glass traps connected to glass down-pipes by means of india-rubber rings.



ILL. 134. SIPHONAGE DIAGRAM.

These causes of unsealing, or siphonage, may be prevented by an anti-siphonage pipe E, which, in order to be effective, should be of the same diameter as C, and should be carried up higher than any of the fittings above and connected to the main pipe A B, which in turn must be carried above the roof level.

CHAPTER XI

TYPICAL DRAINAGE PLANS

Terraced Houses drained towards the Front Street—Terraced Houses drained towards the Back—Semi-detached Houses—A Small Country House—A Large Country House—A Town House—A Small Stable.

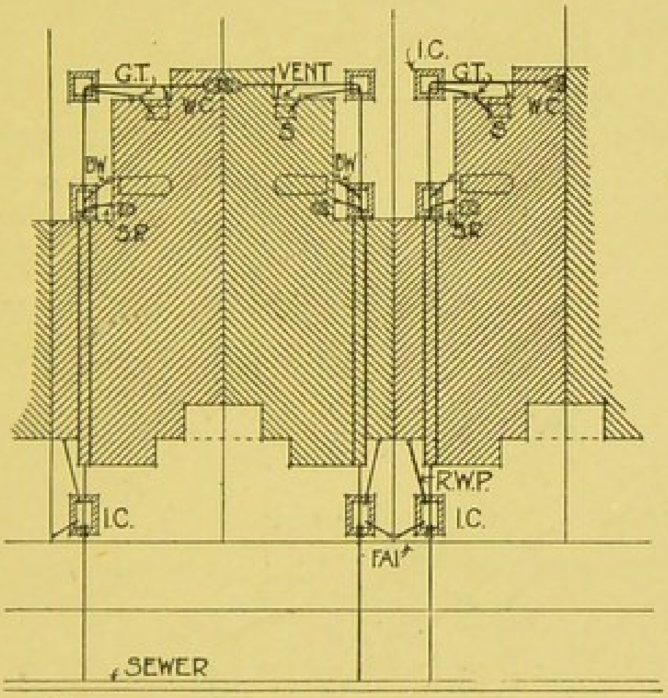
THE reader's special attention is drawn to chapter VIII., which deals with house drainage and describes the method of laying drain pipes. The disconnection of rain-water pipes and bath and lavatory wastes is discussed in chapter VIII., page 132. The ventilation of the drainage systems is described in chapter X.

In addition to this, drainage systems are sometimes cleansed periodically by means of an automatic flushing tank fixed near the highest point of the system. If this is not provided the bath and lavatory wastes should be arranged so as to fulfil this purpose.

A selection of typical drainage plans for different houses is now given, which are lettered as follows :—

B.W. = Bath Wastes.
G. = Gully for rain-water pipes, etc.
I.C. = Inspection Chamber.
S.P. = Soil Pipe.
R.W.P. = Rain-water Pipe.
G.T. = Grease Trap.
F.A.I. = Fresh-air Inlet.
S. = Sink.
W.C. = Water-closet.

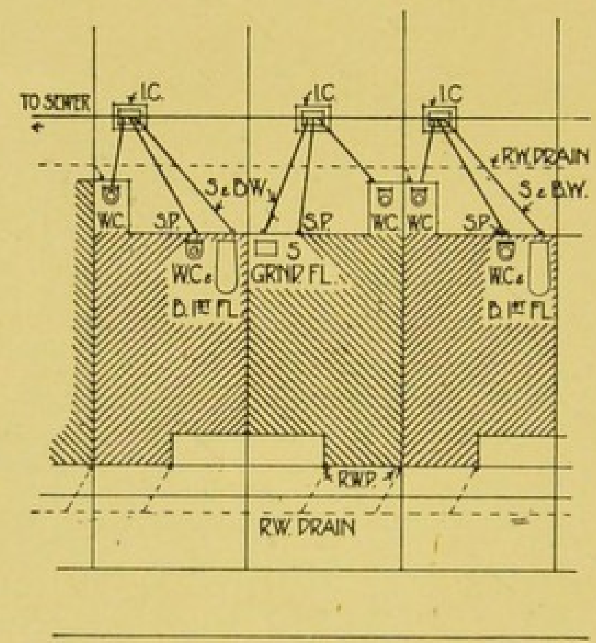
Terraced Houses drained towards the Front Street—Ill. 135 shows a drainage plan of terraced houses drained towards the front street. The drainage in this case empties itself into a sewer in the centre of the road which receives the sewage from houses on both sides of the street. It has already been pointed out in



ILL. 135. TERRACED HOUSES DRAINED TOWARDS THE FRONT.

chapter VIII., that it is not advisable to lay drains beneath the house owing to difficulty of access, and the harm that might be caused by any leakage, but in these cases there is no alternative. The precaution must therefore be taken of surrounding the pipes under the house with concrete, so as to give additional security against the entry of sewer gas into the house. Iron pipes are sometimes used, as referred to in chapter VIII., page 126.

Terraced Houses drained towards the Back—Ill. 136 shows a plan of terraced houses drained towards the back. This arrangement does away with the objectionable practice of carrying drain pipes underneath the house, and the consequent trouble and expense in case of stoppage, as it is sometimes necessary to break up the floor in order to make good any defects. By referring to this diagram, it will be observed that the soil and waste pipes are taken into an inspection chamber (I.C.) at the back of each house, and from

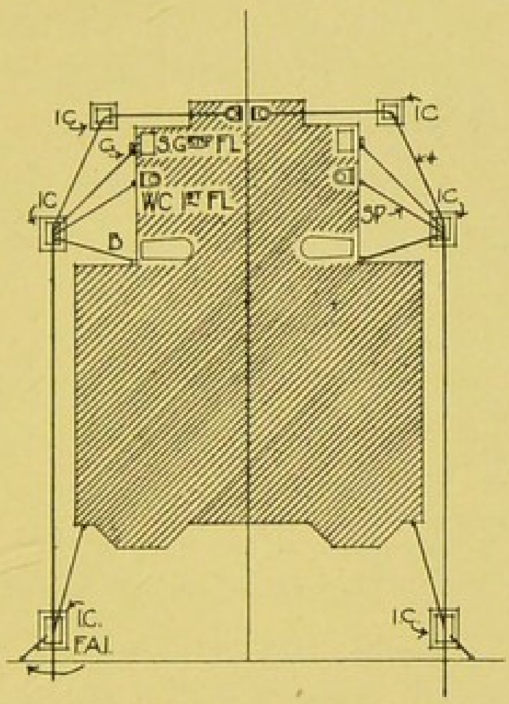


ILL. 136. TERRACED HOUSES DRAINED TOWARDS THE BACK.

thence the pipes have a straight fall to the sewer, at the junction of which a further inspection chamber might be placed. In case of a stoppage, a man would find no difficulty whatever in reaching any part of the drainage system with drain rods, thereby easily and quickly removing the obstruction.

The rain-water in this case is collected and removed to a storage tank—as required by many district councils—by a separate system of drains, as shown.

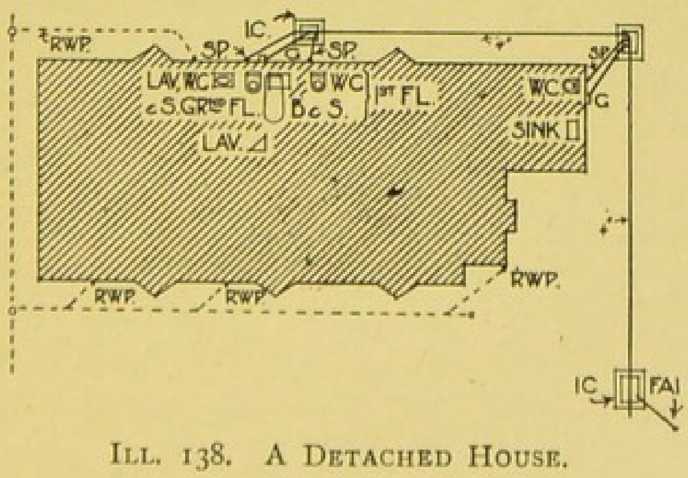
Semi-detached Houses—Ill. 137 shows a drainage plan of semi-detached houses, from which it will be seen that each house is provided with three inspection chambers, which receive the branch drains. The planning follows out the principles already laid down in chapter VIII., page 125, that the drains be laid in straight lines with easy bends, so as to assist the flow of the sewage in



ILL. 137. SEMI-DETACHED HOUSES.

the required direction, and that care be taken that no sharp angles occur which may in any way impede the flow.

A Small Country House—Ill. 138 depicts a drainage system of a small country house in which a right-angle bend

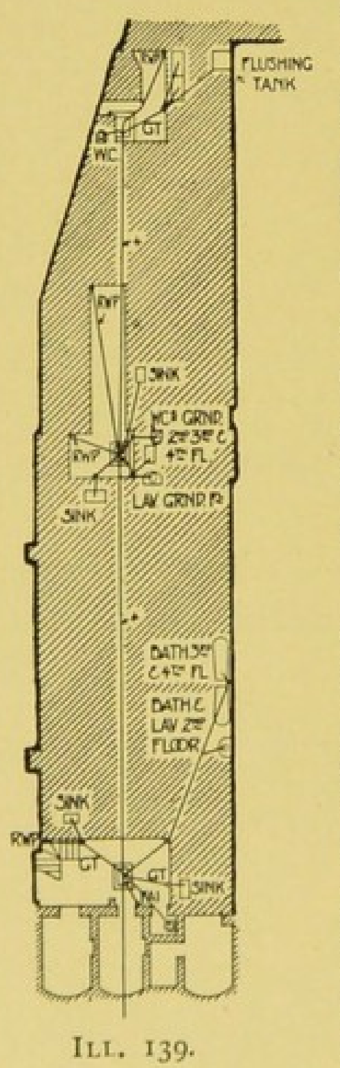


ILL. 138. A DETACHED HOUSE.

in the drain is necessary, a manhole being constructed at this point.

The plan emphasizes the necessity for placing the sanitary arrangements as near each other as possible, and although this is often difficult to arrange, it is a principle that should be aimed at.

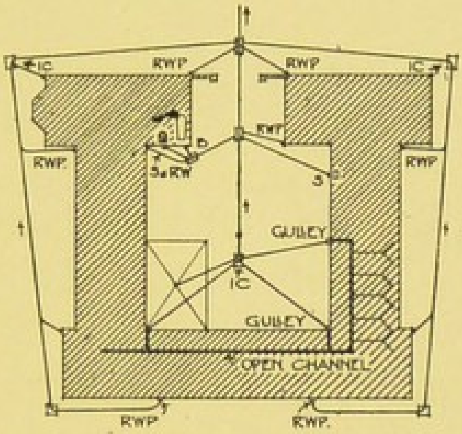
A Large Country House—Ill. 186 shows the drainage scheme of a large country house, which is given in greater detail in *Architectural Hygiene* (3rd edition), page 252, but which sufficiently explains itself. The rain-water is stored in a tank connected to a pump, and can be utilized for domestic purposes. The waste water from the baths is collected into two automatic flushing tanks, one being by the servants' hall at the upper end of the system, and these discharge their contents at regular intervals into the drains in order to cleanse them. The sewage of this house was treated by the Scott-Moncrieff system, as mentioned in chapter XII., page 170.



Ill. 139.
A Town House.

A Town House—Ill. 139 shows the drainage of a town house, in which it is generally necessary to carry the drains for some distance under the building, and in this case 4-in. iron pipes were used and treated with Angus Smith's solution, as described in chapter VIII. The drainage is all carried into manholes, from which access can be obtained to the whole system.

A Small Stable—Ill. 140 shows the drainage for a small stable. The principles governing such a scheme are set out in chapter XX., page 369. The stable floor has a fall towards an open channel six inches in diameter, which is carried the whole length of the stable, the channel itself having a fall towards the stable gullies (Ill. 103), which are placed outside the building at the end of the channel pipes, and are provided with a grid so as to intercept straw and other refuse that would block the drain.



ILL. 140. A SMALL STABLE.

The central washing place for carriages has a floor inclined towards a gully in the centre. The waste water from the yard and the stable drainage are brought by the various branch pipes into inspection chambers and conveyed from thence to the sewer.

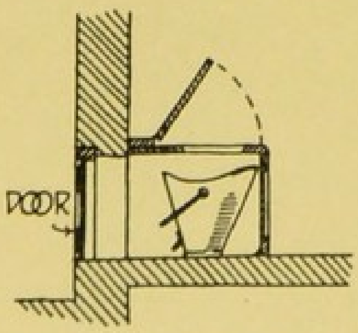
CHAPTER XII

THE COLLECTION AND DISPOSAL OF SEWAGE AND REFUSE

The Collection of Sewage (The Conservancy System; the Water-carried System)—The Disposal of Sewage (Cesspools; Irrigation; Discharge into the Sea; Discharge into Rivers)—The Treatment of Sewage (Scott-Moncrieff System; Dibdin's or Sutton System; Septic Tank System; Colonel Ducat's System; Oxygen Sewage Purification)—The Collection and Disposal of Refuse; Refuse Destructors.

THE Collection of Sewage: **The Conservancy System**—The conservancy system consists in the use of earth-closets, the earliest form of which was a seat placed over the midden or shallow pit lined with rough brick or stone, but this form is very insanitary and is not now much in use. In modern forms the receptacles for the excreta are either fixed or movable.

Fixed receptacles should be easy of access and care should be taken that they are perfectly water-tight and have a smooth impervious surface with no angles for the collection of excreta.

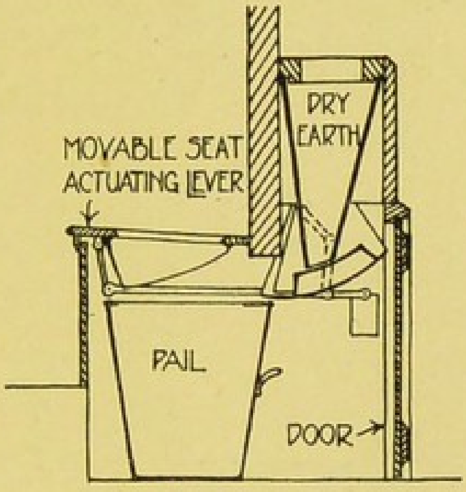


ILL. 141. PAIL CLOSET.

Movable receptacles consist of galvanized iron pails, which should be emptied early every morning and properly cleaned out and disinfected. Ill. 141 shows a good form of earth-closet with movable receptacle, or pail, behind which is the small door, outside the building, through which it is removed.

Ill. 142 shows Moule's closet in which, by means of a lever operated by the seat, dry earth is shot into the receptacle every time the closet is used.

In closets of this kind dry earth may be used as a deodorant, and if of a loamy nature it has the effect of turning the excreta into a kind of vegetable mould. In cases where there is a saw-mill in the neighbourhood, sawdust may be used, as it is found to be quite as good a deodorant as dry earth.



Ill. 142.
Moule's Earth-closet.

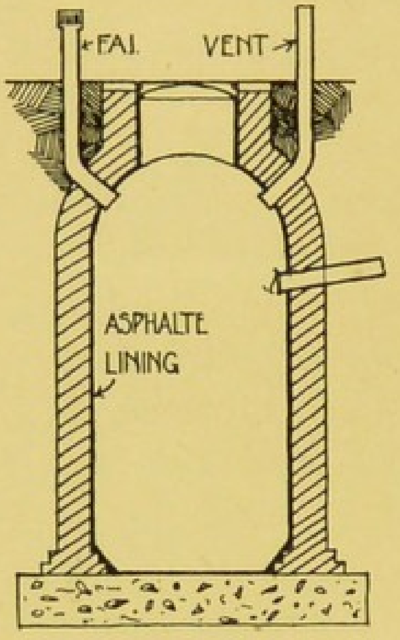
There is no doubt that where country houses are remote from sewers, and there are no means of treating sewage, earth-closets may often be advantageously used, but the process of removing pails from the upper floors is an objectionable feature.

The Water-carried System—The water-carried system consists in removing the sewage through drain pipes, the details of which have been dealt with in the preceding chapters.

The Disposal of Sewage—This is a matter of vital interest, and of recent years much thought has been given to it.

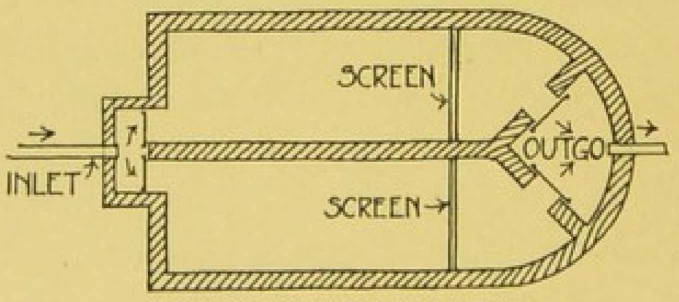
Cesspools—Cesspools are sometimes made for the collection of sewage in country districts where there is no main sewer, and these are sometimes constructed of porous materials so that the liquids soak away, leaving behind the solid matter, which is cleared out at long intervals.

This is a dangerous method, and cesspools should be constructed of brick or stonework in cement, and should be rendered with an impervious material. They should be domed over at the top and fitted with an air-tight manhole cover and properly ventilated, as shown in Ill. 143, the sewage being removed about once a week by means of an air-tight iron cart. If it is possible some other means of dealing with sewage should be adopted.



Ill. 143. Cesspool.

Irrigation—For country houses two small settling tanks, as in Ill. 144, can be used alternately, so that one may be cleaned out while the other is in operation. The sewage in passing through the tank deposits a certain amount of the solid particles and the screen, as shown, further assists to arrest them. A cake of alumino-ferric is also sometimes used for the purpose



Ill. 144. Settling Tank.

of precipitating the solid particles to the bottom of the tank. From the outgo the effluent, which must be discharged intermittently over various portions of the ground, is conveyed along an open glazed pipe to a small irrigation field, and branches are taken over the ground in different directions.

The value of the disposal of sewage by irrigation was formerly much overrated and erroneous figures and statements were put before the public, but this was chiefly due to the fallacious supposition that the full chemical value of sewage could be utilized by the ground on which it was placed. Sandy soils are usually well adapted for the purpose, but clay soils are entirely unsuited for sewage irrigation, although they have in some cases been rendered more suitable by the ploughing in of ashes and other materials.

Great care must be taken that the subsoil drains are put at the right levels to ensure that the effluent from sewage farms shall not be foul. The ground is usually prepared on the ridge-and-furrow system, and channels are formed in the ridges so that the sewage may flow over them into the furrows in a uniform stream.

Italian rye grass is considered one of the best crops to raise on a sewage farm, though many other crops are produced in various localities.

Many towns in England dispose of their sewage on this principle, notably Norwich and Reading. Berlin, which has a population of over one million and a half, has thirty million gallons of sewage treated daily on sewage farms which have an area of nearly twenty thousand acres.

Discharge into the Sea—The Local Government Board permit of sewage being discharged into the sea beyond low-water level; but this should not be done unless there is a well-defined current that will carry it away from the shore without any chance of its being washed back.

Discharge into Rivers—The Public Health Act (1875) and the Rivers Pollution Act (1876) were drafted for the purpose of preventing the fouling of rivers by the discharge of crude sewage and trade effluents. The Local Government Act of 1888, which empowers the County Councils to enforce the Act of 1876 and gives powers to the Local Government Board to form and invest Committees with powers under the Act, has done something to prevent our rivers from becoming open sewers.

The Treatment of Sewage—The biological treatment of sewage for purification dates from 1891, and is due to the practical efforts of Mr. Scott-Moncrieff.

Nature has, as a matter of fact, always decomposed the organic matter which is received into the surface of the ground by means of organisms, but it is only in recent years that we have been enabled to make use of the life processes of micro-organisms which were revealed to us by Warrington. Sewage contains highly putrefactive organic matter, and the object of the various purification schemes is to remove or to bring into solution the solid portions of such matter and to effect such a change in this solution as will render it non-putrefactive.

The process is divided into two stages, viz. the liquefying of the organic matter, and the nitrifying or mineralization of the resulting liquids.

Two classes of organisms are engaged in the first process, viz. the *anaerobic*, which exist without oxygen, and the *aerobic* to whom oxygen is essential, but the *aerobic* alone are capable of performing the second process.

The "Scott-Moncrieff" System—This was the first in which the sequence of the two processes was recognized. The first is carried on in an open tank which is filled with large stones and should be capable of containing one day's sewage. This enters at the bottom and passes upwards and onwards continually. The liquefying organisms form dense colonies in the nidus formed by the stones, and increase in proportion to the work required, and an effluent without solids in suspension is produced for the second process.

This latter is carried out by a series of trays, one above the other, having air spaces between them. The series are in duplicate, and the effluent from the first process is delivered alternately over the surface of the upper trays by means of a tipping trough. The liquid is thus conveyed downwards from tray to tray as a heavy dropping liquid, and the organisms of nitrification thus have to deal with it in a most favourable form until it finally passes away to an outfall. The system appears to be one of the most efficient yet in use, as it occupies little space and attention. It has been installed in the drainage system of the country house shown in Ill. 186.

The "Dibdin" or "Sutton" System has a preliminary process of chemical precipitation, the aëration of the resulting effluent being obtained by intermittent filtration. Each filter bed is filled up and allowed to remain for an hour or so to complete the nitrification, the filtrate then being drawn off and the bed allowed to remain empty for over an hour before re-use.

The "Septic Tank" System was devised by the City Surveyor for Exeter, and the first stage consists of a closed chamber through which the sewage passes slowly to allow of the efficient action of the organisms of liquefaction, the second being brought about by a series of intermittent filters as in the Dibdin system.

"Colonel Ducat's" System aims at combining the two stages of liquefaction and nitrification in one operation. A chamber eight feet deep is constructed, having its walls composed of agricultural drain pipes, all built in as headers, sloping down towards the interior of the chamber, the bottom of which is formed in cement. The lowest course of the walls is built with header bricks which have spaces between them on plan so as to permit the liquid to fall into a channel which runs all round the outside of the tank.

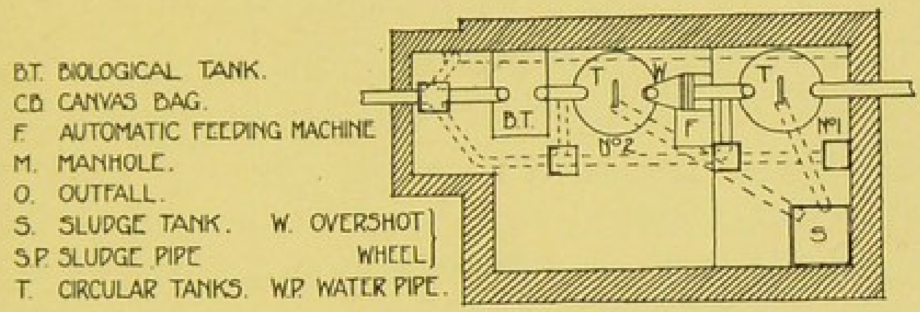
This latter is filled with layers of coke, the pieces decreasing in size from the top to the bottom, each layer being eighteen inches deep and separated from those above and below by an aërated layer of big stones.

The Oxygen Sewage Purification System, first introduced by Mr. Kaye-Parry, M.A., B.E., and Professor Adeney, may be briefly described as follows :—

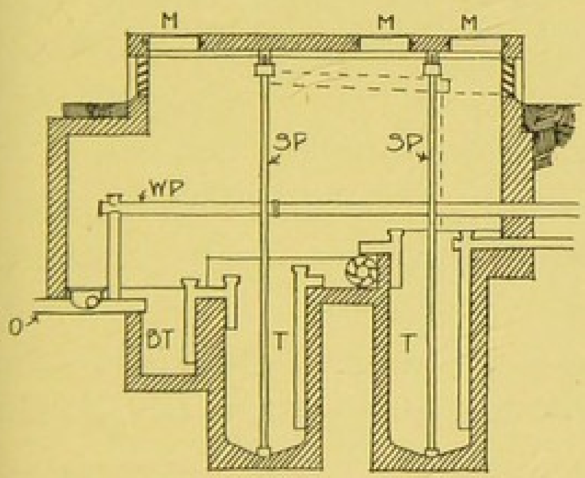
The sewage after mechanical subsidence is treated by powerful oxidizing agents such as Oxynite. This is one of the best deodorizing precipitants known, and also has the property of preventing fermentation of the organic matters contained in the sludge and of converting the latter into the *humus* of ordinary soil. The sludge therefore becomes a valuable manure and may be stored without offensive smell. The effluent is then treated with nitrate of soda which really assumes the place of the ordinary filter bed, and is solely used as a means of supplying oxygen to all parts of the sewage during purification by organisms.

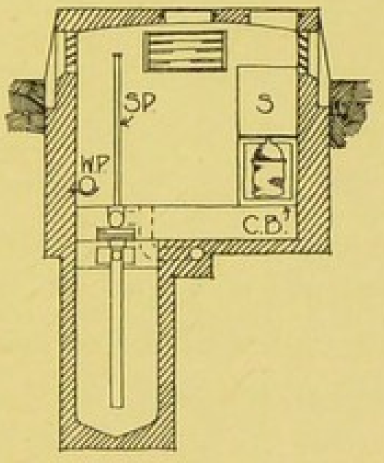
The system is one which is equally applicable to towns, barracks, factories, hospitals and private houses, for no large space is required, and no fuel for machinery, the only mechanism being a water-wheel, which is worked by the flow of the sewage itself.

Ills. 145, 146, 147 show this process as now in operation at Blarney Castle, where the installation was erected by Mr. Kaye-Parry, and it is by his courtesy that the drawings are published.



ILL. 145. PLAN.





ILL. 146. LONGITUDINAL SECTION. ILL. 147. TRANSVERSE SECTION.
KAYE-PARRY'S SYSTEM.

The crude sewage passes into the bottom of a deep circular tank No. 1 by means of a cast-iron pipe, and the liquid rises again to the surface. It passes out by a T-pipe connection, and before it enters tank No. 2 (Ill. 145) it passes over a small overshot wheel W, which drives a patent automatic feeding machine by which a regulated quantity of oxynite can be added to the liquid. The mixture then passes into tank No. 2, which is similar in construction to tank No. 1.

The solids which are precipitated by the oxynite are retained in the second tank, the first tank merely intercepting the heavier solids which are thrown down by sedimentation. The clarified liquid, after leaving tank No. 2, passes into a small rectangular biological tank, and a little nitrate of soda is added every day. The liquid is conducted to a point near the bottom of this tank by a cast-iron pipe (see Ill. 146).

The bacterial action takes place in the tank and the purified liquid passes out through the outfall pipe O direct to the river.

The sludge collected in the two tanks is pumped up by ordinary chain pumps, and is conducted by an open trough into a sludge tank S about two feet square, from which it is drawn off by a sludge cock connected with a semi-spherical outlet.

An ordinary canvas bag is attached to the mouth of the outlet C B and the sewage falls into this bag, the liquid being drained back into tank No. 1, after which the sludge can be carried away.

The Collection and Disposal of Refuse—The refuse from houses is now removed much more frequently than formerly, a daily collection having been established in many urban districts. The refuse is placed in galvanized iron buckets which are emptied into the removal van, and the buckets are disinfected and returned to the occupier.

The old-fashioned brick dustbin which was emptied once every week or fortnight is not to be commended, but in some instances it is unavoidable, and then the floor and sides of the bin should always be of impervious materials.

It should also be protected from the effects of sun and rain and should be as far as possible from the house and from any source of water supply. It is important that as far as practicable everything, especially garbage and vegetable matter, should be burnt before being put in the dustbin, and special kitcheners are now manufactured which fulfil this purpose by means of a firebox under the grate.

The Disposal of Refuse has of late occupied an important place in the deliberations of local authorities, and refuse destructors have multiplied exceedingly within the last few years. Some local authorities sell refuse to brickmakers, who use it in their kilns for firing, but this, however, causes an almost intolerable nuisance to the adjoining owners. Other authorities endeavour to utilize the heat from the combustion of the refuse to generate steam for driving dynamos, but the low calorific value of refuse as fuel renders the admixture of coal necessary, and in most cases it is probably more economical to use coal alone.

Refuse Destructors—The occupier of a country mansion is well advised to have a small refuse destructor which can also be used for destroying garden rubbish and weeds, which should always be burnt at once in order to avoid—that bugbear of a good gardener—the rubbish heap, which breeds myriads of insects and pests to destroy his handiwork.

CHAPTER XIII

HEATING

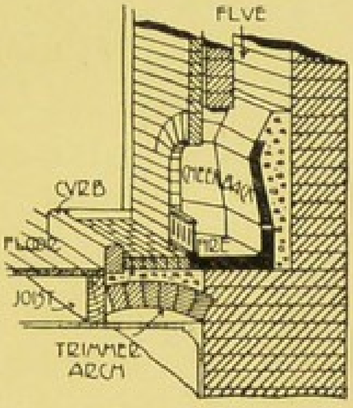
General Principles—Open Grates—Gas Fires—Gas Radiators—Closed Stoves—Hot-water Heating (Low-pressure System; Radiators; High-pressure System)—Steam Heating—Electric Heating—Hot-water Domestic Supply (The Tank and Cylinder Systems)—Kitchen Ranges—Gas and Oil Geysers.

GENERAL **Principles**—All heating arrangements must be considered together with the scheme of ventilation to be adopted (see chap. xv.). Heat is termed radiant when conveyed in a straight line from a heated surface, and its intensity (like light) is in inverse ratio to the square of the distance. It is called convexed when the air around heated surfaces becomes warmed, and rises while the surrounding cold air takes its place; an operation which is continually repeated till all the air is warmed.

Open Grates—The most cheerful and pleasant method of heating an ordinary room is by means of an open grate, and if the flue is properly constructed, as mentioned in chapter IV., page 71, and chapter V., page 81, it should draw well, and at the same time help to ventilate the room.

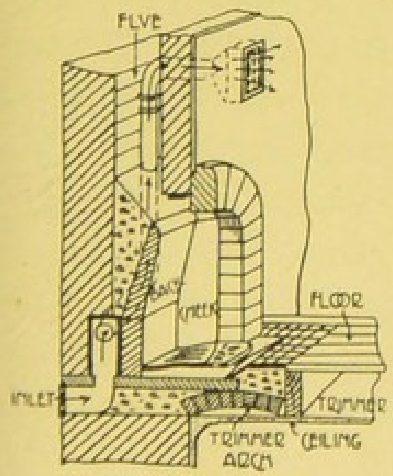
Slow-combustion stoves of the Pridgin-Teale model are a vast improvement upon the old-fashioned kinds, in which about five-sixths of the heat went up the flue. The basis of his improvements, which has been followed by others, was the use of firebrick sides and back and the employment of small front and bottom iron bars ; these are necessary to keep the coal in position, but, being small in cross section, do not hinder combustion. In selecting a stove the advisability of having as little metal as possible adjacent to the fire should always be borne in mind.

The **Devon** fire, Ill. 148, is a sectional elevation showing the firebrick sides and back, the latter being inclined forward, so as to increase the intensity and more widely diffuse the heat which is thrown forward into the room to a greater extent than with the old grates. This illustration also shows the trimmer arch formed in the floor in front of the chimney opening, in order to support the hearth and protect the floor joists from the heat.



Ill. 148.
The Devon Fire.

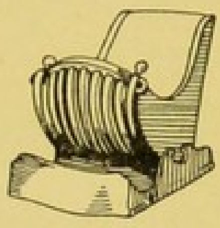
The **Bond** fire, Ill. 149, shows the movable ashpan which regulates the draught, so that more perfect combustion can be obtained and the removal of the ashes facilitated. This illustration also indicates how a supply of fresh-warmed air can be obtained by means of an inlet flue, fed by the external air, which is heated by the fire.



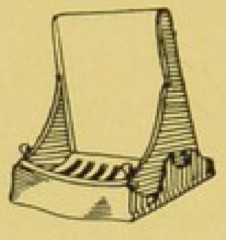
Ill. 149. The Bond Fire.

The **Well** fire has the coals placed upon a back perforated hearth, underneath which is a small chamber lined with fireclay, in which air is heated to a high temperature before passing through the fire, thus ensuring more perfect combustion. Air is often supplied to the fire by ducts contained in the depth of the front hearth.

The **Tilt fire**, Ills. 150 and 151, is easily ignited when tilted up to the position shown in Ill. 150, after which it should be lowered to the position shown in Ill. 151, where it will then burn for some



Ill. 150.

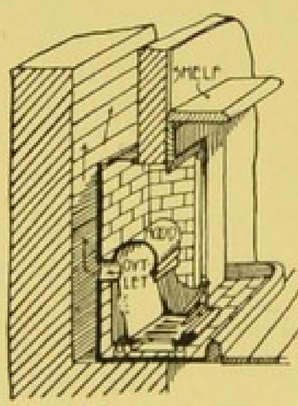


Ill. 151.

The Tilt Fire.

hours without attention. We have cured some rather bad smoky chimneys by its use, and it has the additional advantage that in appearance it resembles an open dog-grate, and can be removed bodily in the summer and its place taken by flowers or shrubs.

The **Nautilus** stove is of the dog-grate type, as shown in Ill. 152, but lacks some of its disadvantages. It is free standing, and heat is thus radiated, not only from the front, but also from the sides, back and top. Extra heating surface is provided by the volute-shaped hood through which the heated gases from the fire have to pass in order to reach the flue at the back, the opening into which is much smaller than with ordinary stoves. Another feature is the wheels with which the grate is provided, so that it may be removed in the summer time. It is sometimes economical and convenient to arrange for heating two or three small radiators from an ordinary fireplace, and this has been successfully accomplished with the above-mentioned stove in conjunction with a suitable boiler and pipes.



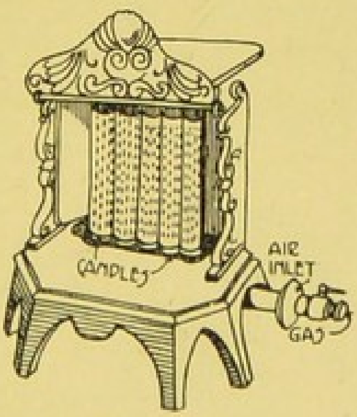
Ill. 152.
The Nautilus Fire.

Various forms of stoves are made by the leading manufacturers, which are improvements on old patterns. Some people, however, prefer to have the fire direct upon the ordinary hearth without using any grate at all, but we have not found this method very economical or serviceable for giving heat.

Gas Fires—Gas fires are now used somewhat extensively, especially in bed and other rooms where heat is not required continuously. Sometimes the heat is radiated by means of asbestos balls placed over Bunsen burners, which render them incandescent. A flue should always be provided to carry off the unhealthy products of combustion.

Gas kitcheners are used extensively for cooking purposes, owing to their cleanliness and the facility with which they can be brought into use.

Gas Radiators—Gas radiators of various types are used, being similar in appearance to Ill. 159, but the Independent circulating hot-water or steam-gas Radiators, although suitable for halls and passages, are not desirable for sitting-rooms, as they vitiate the air to some extent. The radiators are fitted with a special circulating boiler connected with flow and return tubes, and can be placed in any position, as they only require connecting to the gas supply. They give off a large amount of heat within a few minutes of lighting.

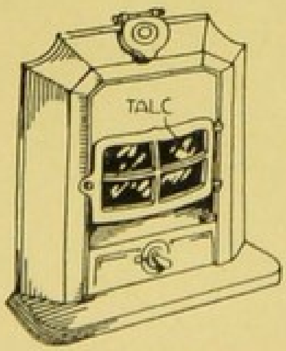


ILL. 153.
WELSBACH KERN RADIATOR.

Ill. 153 shows a radiator with a Welsbach Kern burner formed of five specially prepared perforated fireclay candles, which marks a distinct advance in efficiency and economy. This fire is sufficient to heat a room about twelve feet square, while a radiator with ten tubes suffices for a room about eighteen feet square. In the latter there is a tap at each side of the radiator which controls five of the tubes, and consequently either five or ten tubes can be used as required. Five tubes will consume about ten feet of gas per hour, so that in some country places where gas costs as much as four to five shillings per thousand the radiator will only cost about one halfpenny per hour.

Closed Stoves—Closed stoves are of many kinds, and are certainly economical, but some people contend that they are liable to render the air over-dry and cause discomfort. It is suggested that they are apt to char the organic matter in the air and to generate carbonic oxide, which is, of course, injurious to health, and they do not help to ventilate the room in the same way as the ordinary open grate.

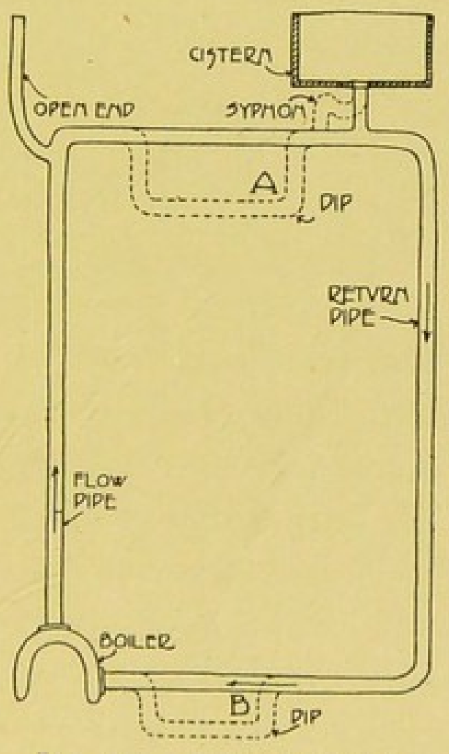
Personally we are inclined to agree with Dr. Glover Lyon that air can scarcely be rendered over-dry; and that the unpleasantness is due to the action of the superheated iron producing some chemical change in the atmosphere.



ILL. 154.
ANTHRACITE STOVE.

Ill. 154 shows a closed stove which presents a somewhat cheerful appearance, owing to the doors being fitted with mica panels. The dampers are so arranged that when the stove is burning slowly the expense for fuel is reduced to a minimum, while by altering the regulator the heating may in five minutes be increased to its full power. It has been specially constructed to utilize smokeless anthracite coal to the best advantage and can be placed in front of any existing grate, or if the latter be removed it can be provided with a perforated ventilating front. It is contended that if anthracite costs thirty-five shillings per ton, a twenty-five-inch stove of this type will only cost about twopence for twelve hours' consumption.[1]

Hot-water Heating—Heating by hot water is effected either by the low- or high-pressure systems, in both of which the circulation is due to the difference in weight of two columns of water connected together in one continuous circuit. When one column is heated the water expands and rises, being forced upward by the heavier column pressing against its base.

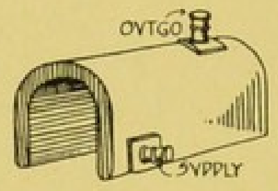


Ill. 155. Low-pressure Hot-water System.

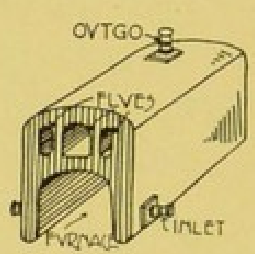
Low-pressure System—This has many advantages, chiefly because there is little risk of fire and an even temperature is more easily maintained. Ill. 155 shows a system on this principle, the flow-pipe rising, as shown, direct from the boiler to the highest level of the circulation, and the vertical fall of the return pipe being designed at the end of the circulation in order to obtain as the motive power the highest vertical column of the coldest water. Dips as dotted at A and B tend to reverse the circulation. The column of water in the latter, farthest from the boiler, is cooler and heavier than that which is nearer.

[1] See *Architectural Hygiene*, p. 163.

Means of escape for air and steam are essential, and a small pipe should be carried up well above the highest water level and be provided with an open end as shown. A recognized calculation on this subject is that one superficial foot of direct heating surface of the boiler will heat fifty feet of four-inch pipes; but it is found best to allow an excess of at least twenty-five per cent of heating surface, in order to allow for improperly swept flues and indifferent stoking. The



ILL. 156. A SADDLE BOILER.



ILL. 157. A CHAMBERED BOILER.

ordinary saddle boiler shown in Ill. 156 is much used, but chambered saddle boilers, as shown in Ill. 157, have a greater heating surface, and are more suitable for larger systems.

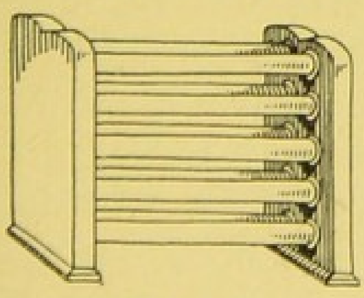
Boiler chimneys should not be less than nine inches square in area for every hundred feet of radiating surface.

The hot-water heating pipes are often of cast-iron, three or four inches in diameter, and the joints should be properly caulked with lead and spun-yarn, those near the boiler being provided with sliding expansion joints to prevent leakage. The pipes should be painted to prevent oxidation, and fitted with valves so arranged that any part of the system may be shut off at will. Heating pipes should always be placed above ground level, and should not be cased, so that they may be easily examined and cleaned periodically. They should never be laid in trenches and covered with gratings, as the former become receptacles for dirt.

The following table calculated by Hood gives the length of pipe required for every 1000 cubic feet of space in different cases, and if the apartments are thoroughly ventilated twenty-five to fifty per cent must be added.

Nature of Building.	Temperature Required.	Length of Pipe. 4 in.	3 in.	2 in.
		ft.	ft.	ft.
Dwelling-rooms . .	65	12	16	24
" " . .	70	14	19	28
Drying - rooms for linen, etc. . .	120[1]	150–180	200–240	300–360
Greenhouses and conservatories . .	55[2]	35	47	70
Graperies and stove-houses . . .	65–70[2]	45	60	90
Pineries, hothouses, cucumber pits .	80	55	74	110

A cistern regulated by a ball-valve should be fixed above the highest water level, as shown in Ill. 155, to supply the loss of water due to evaporation.



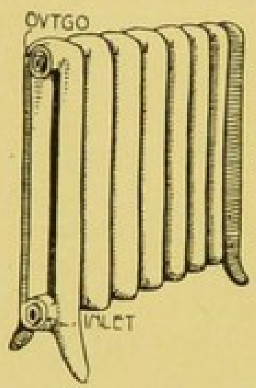
Ill. 158.
A Hot-water Coil.

Radiators—Coils and radiators in connection with the flow and return pipes are placed in suitable positions in order to obtain a larger amount of heating surface. A simple form of double coil is shown in Ill. 158, which is sometimes screened by a perforated iron case, but this is objectionable, as it facilitates the

[1] This is the temperature when empty; when filled with wet linen about 80 degrees. [2] In coldest weather.

collection of dirt. Radiators, as shown in Ill. 159, have lately been much simplified and improved in design, and are therefore to be preferred to coils.

In houses which have a sitting-hall of sufficient size it is often desirable that the hall fire should be the means of heating not only the sitting-hall and passages, but also some of the other rooms. Ill. 195 shows a fireplace where a system was arranged by which the fire not only heated the hall but also a boiler which served three radiators situated in the entrance hall, loggia and staircase. This seems to us an economical and successful method, for, as a rule, a boiler in any heating scheme is situated in a specially constructed basement, and a good deal of the heat from the furnace itself is thus wasted.



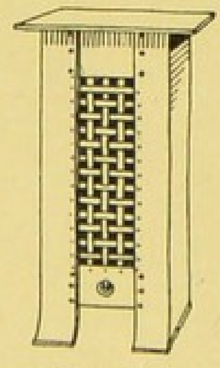
Ill. 159.
A Hot-water Radiator.

High-pressure System—This system has a continuous circuit of wrought-iron welded tubing, generally about $\frac{7}{8}$ in. diameter, about one-tenth of the total length of piping being formed into a coil and placed in a furnace in which the temperature can be raised to about 380 degrees Fahr. A pipe is placed at the top of the flow in order to provide room for the expansion of the heated water. The whole apparatus being sealed, the water becomes rapidly heated and cools quickly, and it is therefore considered that this system is more economical for rooms that are not frequently used. A disagreeable smell is sometimes noticed from this system owing to the high temperature, for the same reason as mentioned when discussing closed stoves.

Steam Heating—Heating by steam is not used to the same extent as hot water, as it is somewhat difficult to control, but where waste steam is available it is convenient and economical. Steam coils are fixed in the same way as those for hot water, but they are smaller *pro rata* than the latter owing to their high temperature. The utilization of exhaust or low-pressure steam as a means of heating has been extensively adopted in the United States, as mentioned in *Architectural Hygiene*, but its use in this country has mostly been confined to the working of low-pressure hot-water apparatus.

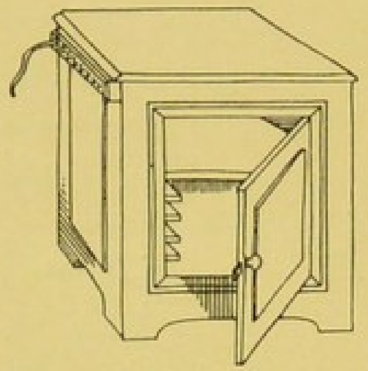
Electric Heating—The cheerful appearance of an open fire would probably prevent an extended use of electricity for heating even if the cost were of no consideration. This form of heating is successful in certain cases, and especially in town houses, because the heat can be turned on at once, and it is a clean and wholesome way of providing warmth.

Ill. 160 shows the **Prometheus** electric radiator, which simply requires attaching to a wall plug connected with an electric current, when it will immediately commence to radiate heat. This radiator consists primarily of resistances composed of metallic films deposited on insulating bases composed of thin mica sheets, and the film is protected from mechanical injury by enclosure in a metal case from which it is efficiently insulated. Electrical continuity is established by means of flat metal terminals in close contact with the two ends of the film. The apparatus, unlike wire-coil systems, is practically free from self-induction and consequently absorbs the same power at any definite voltage, whether used on con-



ILL. 160. PROMETHEUS ELECTRIC RADIATOR.

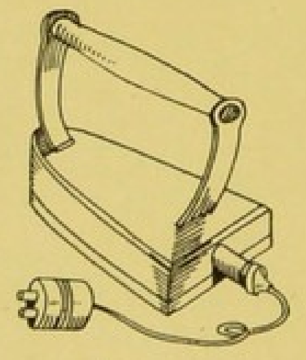
tinuous or alternating currents, and is independent of the frequency of the latter.



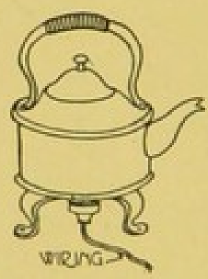
Ill. 161. Electric Cooking Stove.

Ill. 161 shows an electric cooking stove, which is cleanly in operation and takes up little room. Ill. 162 illustrates an electric flat-iron and Ill. 163 shows an electric kettle, both of which are much used nowadays; as also are hot plates, which are useful where electric current is available.

The cost is the great drawback to cooking by electricity, but the time must come when this will be reduced, although at one penny per unit it is not very much more expensive than ordinary



Ill. 162.
Electric Flat-Iron.

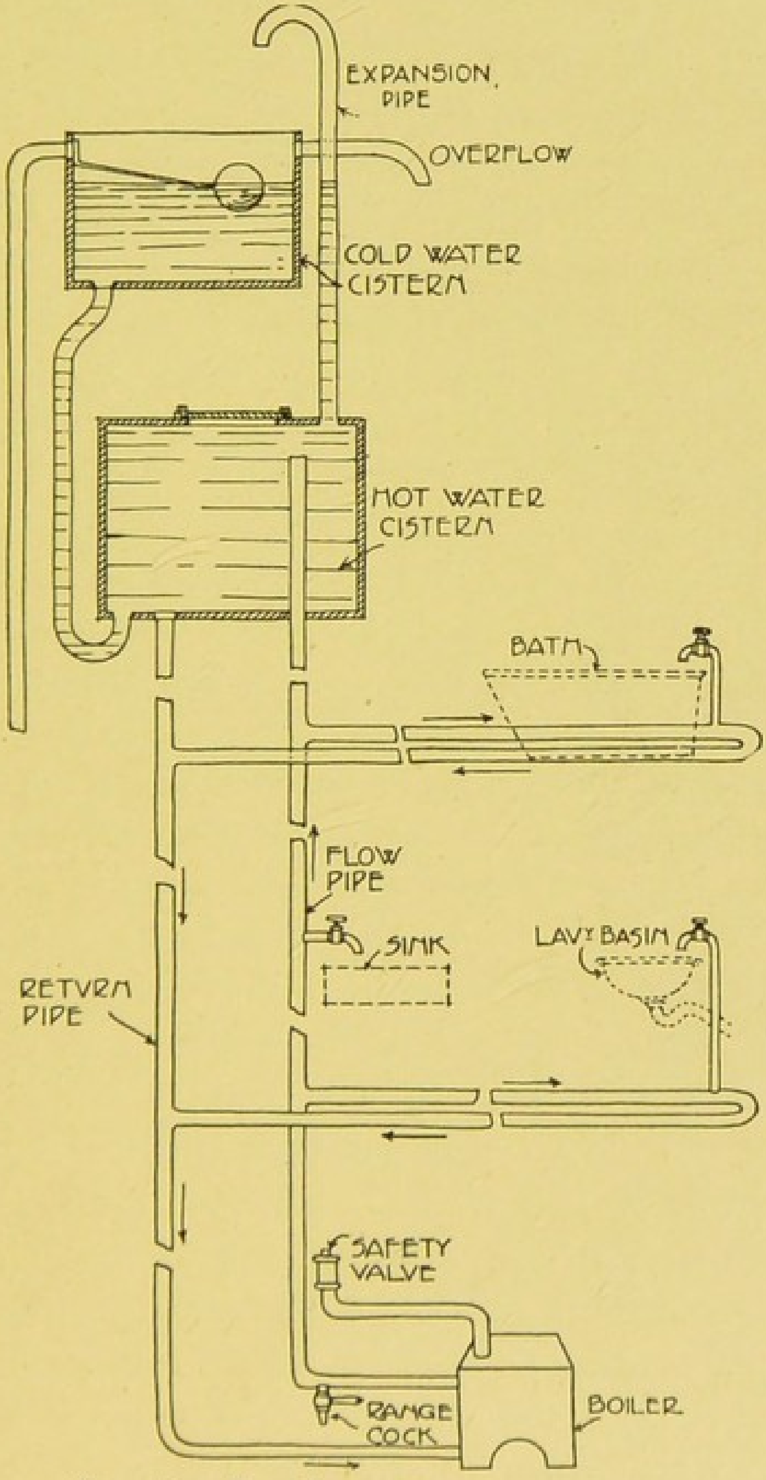


Ill. 163.
Electric Kettle.

coal. Electric radiators are portable and convenient for airing the rooms, and if plugs are provided they can be moved about at will.

Hot-water Domestic Supply—The principles involved in the supply of hot water are the same as those for heating domestic buildings. The pipes of the hot-water supply should be of wrought galvanized iron, not less than one inch in diameter, as lead pipes are apt to sag and thus impede the circulation.

(Chapter VII. has already dealt with the cold-water supply of the house and fittings.)

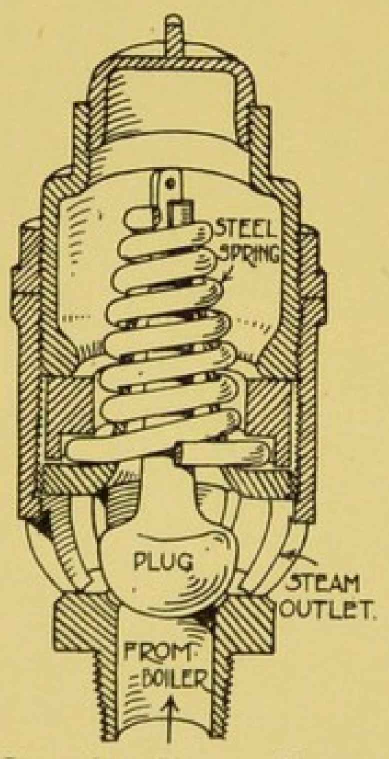


Ill. 164. The Tank Hot-water System.

There are two systems in general use, viz. the Tank System and the Cylinder System.

The Tank System—This system is shown in Ill. 164. The boiler is heated by the kitchen fire, and may be of either the saddle variety, as before shown (Ill. 156), or of the tubular type. But in large houses an independent boiler and furnace should be used, if a constant supply of hot water is required.

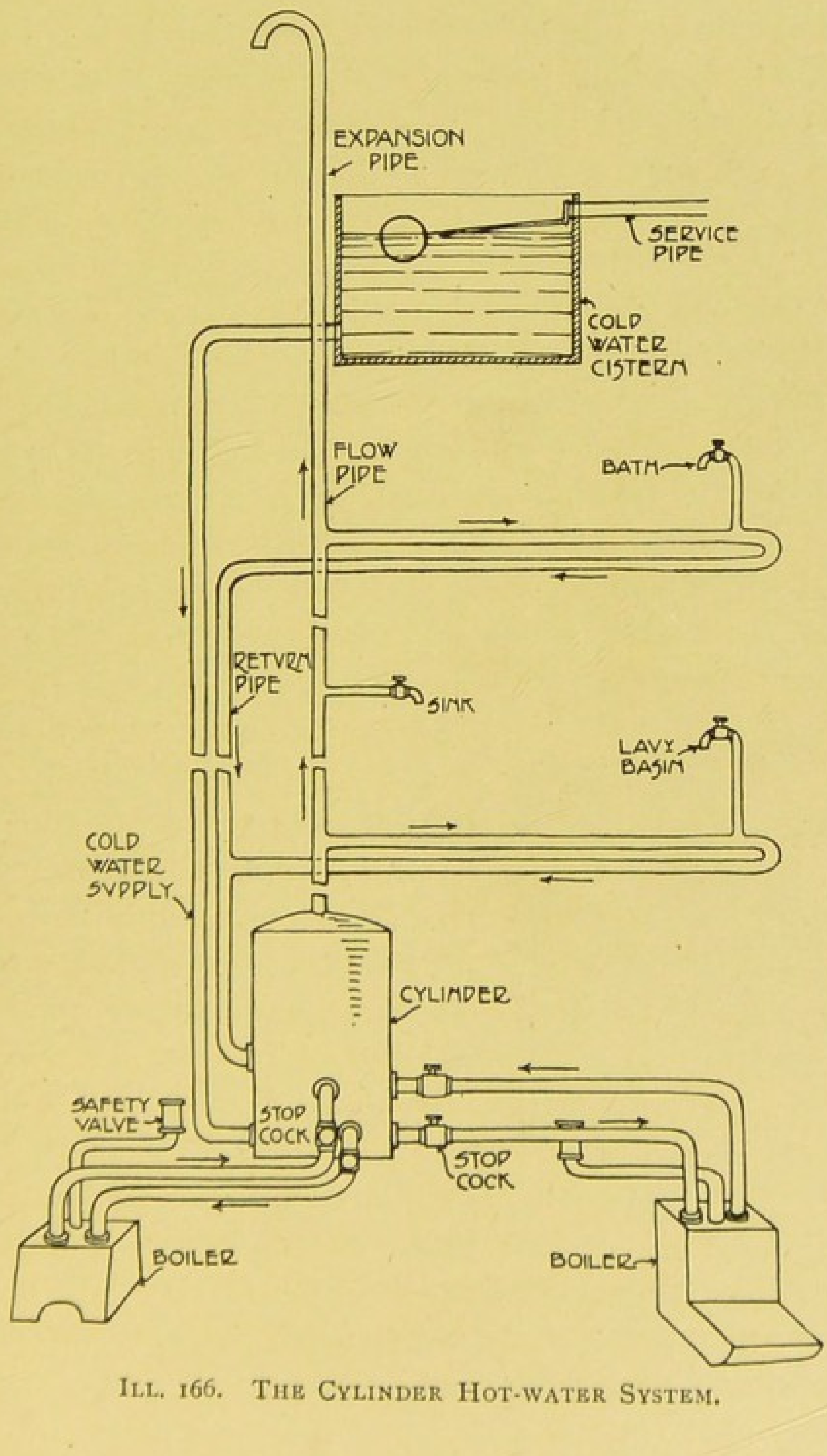
Boilers should have a safety valve, as shown in Ill. 164, attached to a pipe that is not in connection with the circulation. There are several kinds of safety valves, and Ill. 165 shows Turnbull's patent spring safety valve in which the plug is attached to a strong spring at the top, the other end is fixed so that when the valve is open the spring is in tension, and when the extra pressure of steam is reduced the spring forces back the plug into position. Safety valves are useless unless of good manufacture, and they should be so fixed that they can be conveniently inspected at regular intervals.



Ill. 165. Safety Valve.

In Ill. 164 it will be seen that the flow pipe is connected to the top of the boiler and the return pipe to the bottom. All branch pipes supplying hot water to the various fittings should be connected to both of the above pipes, and should enter the return pipe at a lower level than the flow pipe. Where, however, a fitting is quite close to the flow pipe this is not so necessary, as the amount of cold water to be drawn out of the branch pipe, which does not form part of the main circulation, is small.

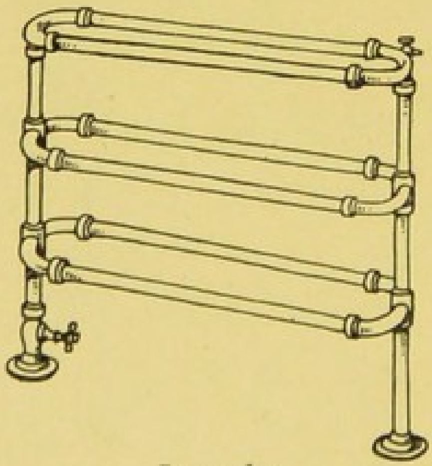
An expansion pipe for steam and air should be connected to the top of the hot-water cistern and carried above the level of the cold-water cistern.



ILL. 166. THE CYLINDER HOT-WATER SYSTEM.

The cold-water cistern, which is controlled by a ball valve, supplies the hot-water cistern with water, and the hot-water cistern is placed above the highest fitting for which hot water is required.

The Cylinder System—This system is shown in Ill. 166 and is now generally held to possess important advantages over the Tank System because it operates more quickly, a temporary failure of the cold-water supply does not stop the circulation, more hot water can be withdrawn before its temperature is lowered, and the risk of incrustation is less owing to the shorter circulation of the pipes between the boiler and the cylinder. The principal difference lies in the fact that the reserve of hot water (i.e. the cylinder) is at the base of the flow pipe instead of at the top, as in the Tank System (Ill. 164). A coil heated by steam is sometimes enclosed in a cylinder to heat the water, but it is not advantageous to use this method if steam has to be generated especially for this purpose.



Ill. 167.
Combined Radiator and Towel-drier.

Ill. 167 shows a combined radiator and towel-drier connected to the hot-water supply and generally placed in bathrooms. Coils of hot-water pipes are also frequently used to warm linen rooms or cupboards.

When either system is used it is advisable to place the hot-water cistern or cylinder in a linen closet in order that it may air the linen and clothes. It has, however, the disadvantage of becoming dirty soon, so that it is impossible to leave the things therein for long.

Kitchen Ranges—The boiler in both the tank and the cylinder hot water systems is usually set in the kitchen range, so that this performs the double duty of cooking and heating the water. Where, however, much hot water is required or many baths are used successively, it is advisable to have an additional separate and independent boiler as shown in Ill. 166, page 189; another advantage is that in the summer hot baths can thus be supplied without lighting the kitchen fire. There are many kinds of kitcheners on the market, and many boilers of various shapes. In selecting these fittings care should be taken that the boiler has a sufficient heating surface for the work that it has to do and that the flues to the same can be easily cleaned. It should also be ascertained that the thickness of the metal to the top plate of the kitchener is not less than three quarters of an inch.

Gas and Oil Geysers—These are much used nowadays, and if ventilated to the open air and fitted with a dual tap controlling both the water and gas they may be used with safety. Geysers, indeed, are a great boon to those who cannot rely upon the kitchen fire being lit sufficiently early to get the water heated for their morning bath, and are useful for the reason that any number of hot baths can be obtained independently of the ordinary hot-water supply.

CHAPTER XIV

LIGHTING

Natural Lighting : Size of Windows, Glazing, Reflectors, Luxfer Prisms—Artificial Lighting : Candles and Lamps, Gas, Acetylene, Air Gas, Electric Light, Accumulators, Transformers, Switches, Fuses, Wiring—Fittings : Lamps, Tantalum Lamps and Osram Lamps compared, Electric Arc Lamps, Cost of Electric Installation, Cost of Gas and Electricity.

NATURAL **Lighting**—If healthy conditions are to be maintained in the home, the necessity for sufficient light cannot be too strongly emphasized.

The position of openings for the admission of light was studied by the Romans. In the Pantheon at Rome they demonstrated that light has a greater illuminating value when admitted through a horizontal aperture in the ceiling than when admitted through vertical openings in the wall. The diameter of the eye of the Pantheon dome is only 27 feet, and yet the building is comfortably and sufficiently lighted, though each superficial foot of lighting area has to light nearly 3400 cubic feet of the interior.

Apartments lit by means of ordinary windows should, if possible, have an odd number to obviate a central pier which is apt to cast a shadow, and thus give a gloomy effect to a room.

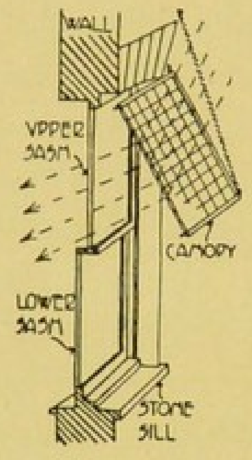
Size of Windows—The size of windows is regulated by the climate, and the laws laid down by Vitruvius, Palladio and Scammozzi, for the sunny climate and bright atmosphere of Italy, are scarcely applicable to England.

Sir William Chambers recommended that the depth and height of the rooms on the principal floors should be added together, and one-eighth part thereof should be taken for the width of the windows. Robert Morris recommended that the superficial area of the lighting surface in feet should equal the square root of the cubical contents of the room. Gwilt was of opinion that one square foot of lighting centrally placed in one vertical wall of a square room is sufficient for every 100 cubic feet. This calculation is based on the supposition that the building is free from obstruction by high objects in the vicinity.

The model By-Laws of the Local Government Board require that the area of the windows be at least one-tenth of the floor area of the room, and this requirement is also incorporated in the London Building Acts of 1894–1909. It is well to remember that by keeping the window frames flush with the external face of the wall, as mentioned in chapter IV., page 63, a larger angle of light is admitted, as shown in Ill. 22. The architectural treatment of windows has been considered in chapter III., page 47, chapter IV., page 61, and chapter VI., page 98.

Glazing—The glazing of windows is effected by means of plate or sheet glass, the former of which affords less resistance to the admission of light and is not so easily penetrated by sound. Cathedral tinted or roughened glass, which may be obtained in many varieties, may be used in lavatories, bathrooms, etc., where it is intended to act as a screen.

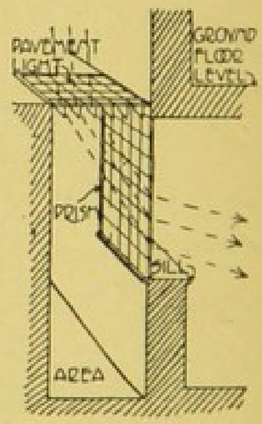
Reflectors—External reflectors are sometimes necessary for windows facing narrow thoroughfares and for lighting basement apartments, as they help to throw the light into the back portion of the rooms.



ILL. 168.
LUXFER PRISMS.

Lüxfer Prisms are designed upon the laws of refraction, being usually fixed to the upper half of the window nearly flush with the outer surface of the wall, as shown in Ill. 168. Basements in town houses may be lighted by pavement lenses, which throw the light down on to a luxfer canopy, the latter in turn refracting the light in a horizontal direction to the rear of the apartment, as shown in Ill. 169.

The facing of obstructing walls with white glazed tiles, or even painting them white, does something to assist the reflection of natural light into such rooms.

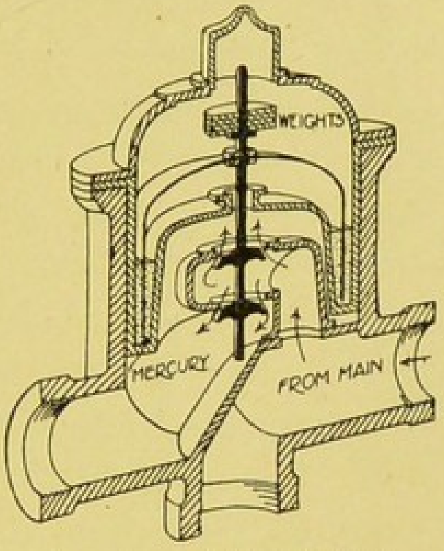


ILL. 169.
LUXFER PRISMS.

Artificial Lighting—Candles and Lamps are still largely used for the lighting of private houses, especially those situated in the country, even when other methods of lighting are available, but to minimize danger from fire great care should be exercised.

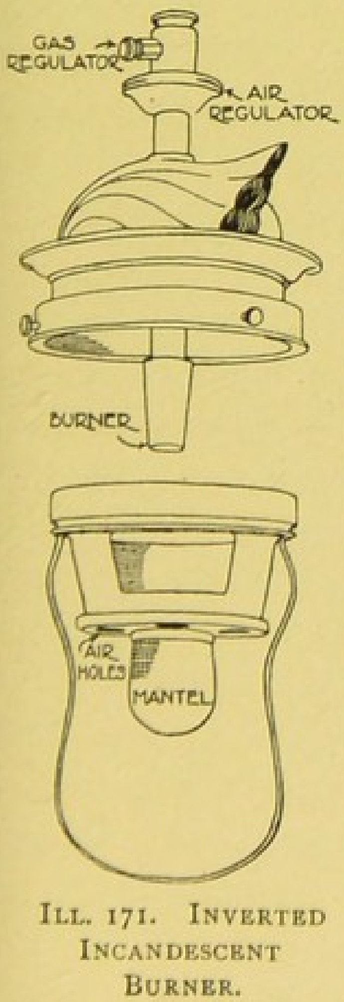
Gas was first used for illuminating purposes at the end of the eighteenth century, but since then its manufacture has been much improved, although it has been stated that one gas burner will consume as much oxygen and give out as much carbonic acid as six men. Gas is supplied at varying pressures, and hence it is advisable to have a Governor fixed near the meter in order to maintain an equal pressure. Ill. 170 is a section taken through a Stott Governor, in which the opening from the main varies in size according to the amount of pressure.

The practice of turning off the gas at the meter every night is not to be commended because the taps to some of the fittings may be left open; and when the gas is turned on the next day it escapes, and an accident is probable.



ILL. 170. A STOTT GAS GOVERNOR.

There were two forms of old-fashioned gas-burners known as the Fish-tail and the Bat-wing, but these are now seldom used, owing to the introduction of the Welsbach incandescent mantle which created a revolution in lighting. These mantles are somewhat fragile, but their manufacture has been improved in recent years.



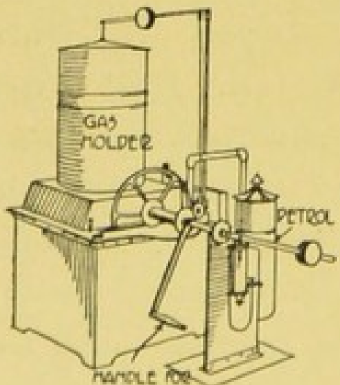
ILL. 171. INVERTED INCANDESCENT BURNER.

Inverted incandescent burners have been introduced in which the mantles are attached by means of small projections around the rim. The **Bland** burner (Ill. 171) has been used with satisfactory results and the patent mantle carrier is an advance upon others. All users of incandescent gas know the bother that ensues with by-passes; but in some of the later fittings this has been to some extent overcome.

The Pneumatic Distance Gas Lighter does away with one of the inconveniences of gas lighting, as it operates the by-pass of the burner upon a similar principle to that which obtains in the Bowden Brake, so familiar to cyclists. The light can be turned on by pressing or pulling a button situated in some convenient position in the room; with this fitting gas lighting possesses one of the advantages of electric light.

Acetylene gas is made by adding water to calcium carbide, and is now being used to some extent in the country, especially where electric current is not available, as the generating plant required is somewhat simple; but the clogging of the burners and the disagreeable smell are two great disadvantages which are difficult to overcome. The illuminating property of acetylene is much greater than coal-gas and its combustion does not evolve carbonic acid. The plant for 100 lights costs between £60 and £100.

Air gas is manufactured by the admixture of air with the vapour of a combustible liquid, but the great disadvantage hitherto was that hot-air engines have been used in its manufacture and, on the temperature of the vapour becoming lowered, liquefaction occurred with the consequent danger and inconvenience of the stoppage of the system.



ILL. 172.
DE LAITTE SYSTEM.

The De Laitte system (shown in Ill. 172) claims to obviate this nuisance, as, by means of a revolving drum, the air is sucked into the carburettor, into which petrol is measured in such a way that a fixed quantity of air and spirit is evaporated.

The comparative cost of a 40 candle-power lamp per hour is worked out by the De Laitte Company as follows :—

Electric light @ 4d. per unit	$\frac{13}{20}$d.
Acetylene (calcium carbide) @ 2d. per lb. .	$\frac{1}{2}$d.
Paraffin @ 7d. per gallon	$\frac{1}{4}$d.
Coal-gas @ 3s. per 1000 feet	$\frac{1}{5}$d.
De Laitte Light, petrol @ 1s. 4d. per gallon .	$\frac{1}{14}$d.

The Aerogen Gas Generator actuated by clockwork, and the Michelite non-explosive air-gas in which the motive force consists of water from an ordinary tap, are other systems.

The makers of the Michelite system give the following comparative table of cost for maintaining 100 candle-power for ten hours or its equivalent, assuming coal-gas at 3s. per 1000 feet and electricity at 3½d. per unit :—

	s.	*d.*
Acetylene	1	3
Electric incandescent	1	2
Coal-gas	1	0
Incandescent gas	0	2½
"Michelite" air-gas	0	1½–1¾

Electric Light possesses many advantages over other illuminants, for it is easily switched on and off, and can be used in positions where it would not be safe to have gas, while it does not consume the oxygen, foul the air or deteriorate decorations.

The definitions of the following terms may be found of use :—

An Ampère is the unit of quantity, a Volt is the unit of pressure, a Watt is an ampère multiplied by a volt, an Ohm is the unit of electrical resistance and a Megohm is a million ohms.

An electrical horse-power (E.H.P.) is equal to

746 watts—thus a current of 7·46 ampères at 100 volts pressure is equal to one E.H.P. A Board of Trade unit is the standard measure of output, and this consists of 1000 watt-hours, and thus 10 ampères of current at 100 volts pressure for one hour is equal to one Board of Trade unit.

Current, when obtained from a public supply station, is usually more economical than when produced by a private installation.

Electricity is produced by means of a dynamo, in which coils of copper wire pass rapidly before the poles of powerful electric magnets. These coils of copper are wound on an iron core, which is called an armature, and the current thus generated in the coils is led to a commutator, from which it is collected by brushes and conducted away to the switch-boards, and from thence to the supply mains. Electricity for public supply is often generated at a very high pressure, so that the size of the copper cables may be kept as small as possible; but if the pressure is lowered for the same total energy, of course a larger cable is required.

Dynamos are usually driven by steam engines when a large supply is required, but gas and oil engines are used for small installations, especially for country houses, where they are satisfactory and efficient, those oil engines with the top feed being preferable, as the pump feed seems to be liable to fail occasionally from choking.

A Suction Gas Producer Plant, in combination with a gas engine, is a very economical method, and consists of a generator, a scrubber for cleaning and cooling the gas, and an expansion chamber.

The generator is a cast-iron ash-box containing a firegrate and bars, above which is the generator casing, lined with firebrick, and a vapour chamber, which is partially filled with water, heated by the hot gases coming from the fuel in the generator. Immediately over the vapour chamber is the fuel chamber and charging hopper, through which the fuel is supplied to the generator.

The scrubber is made of steel plates, and is filled with coke, over which water is automatically sprinkled, and this serves to clean and cool the gas after leaving the generator on its way to the engine.

After the machine has been started, the suction *pull* from the engine draws a mixture of air and steam from the vapour chamber through the incandescent fuel in the generator, where it is decomposed into a composition generally known as *producer gas.*

Welsh anthracite coal is employed as fuel on account of its freedom from tarry matter, but other fuels may be used if proper provision is made for cleaning the gas. A 10 h.p. gas engine can be worked in conjunction with the gas plant at a cost of one-tenth of a penny per brake horse-power per hour or about one-fifth the cost of using ordinary gas.

Turbines, as shown in Ill. 54, consisting of a wheel which is made to revolve by the water impinging against vanes fitted to its circumference, may be used where water-power can be obtained. Where the water-power is small, storage batteries should be used, so that the dynamo can be worked continuously, and when lighting is required both dynamo and batteries can supply the current.

Accumulators—Storage batteries or accumulators consist of a number of cells containing sulphuric acid, water and lead plates. When the current is turned on a chemical change takes place until the battery is charged, and this will be indicated by bubbles of hydrogen freely rising in the electrolyte. When the battery is discharging on to the mains the chemical action is reversed and the current is given off. Batteries should be placed on racks and should be separated from the engine-room, as the gases they give off corrode the machinery; they should also be used regularly, as they deteriorate if not worked.

The current is conducted by copper wires, one of which (the positive) conveys the outward current, and the other (the negative) conveys the returning current to the source of supply. These wires must be insulated for the whole of their distance by covering them with an insulating coating, such as vulcanized rubber, after which they are fixed in the building as described below.

Transformers—High-pressure current exceeding 250 volts being dangerous must, however, not be delivered for domestic supply, and a transformer is therefore used which converts a small current at high pressure into a larger current at low pressure. Thus 40 ampères at 2000 volts can be transformed into 800 ampères at 100 volts, both being equal to 80,000 watts. The transformers are usually placed in sub-stations, cellars or other suitable positions for the distribution of electricity at low pressure to the house mains.

Switches—A double-pole switch should be used at the point where the wires enter the house, as this will allow the negative and positive conductors to be cut off from the main. Any number of switches may be used in an installation, so that the light may be turned on and off as may be most convenient, and switches may also be placed on the fittings themselves. A switch should always be placed conveniently just inside or outside a room, so that the light may be turned on or off with convenience.

A **Fuse** consists of a piece of lead or tin wire proportioned so that if the current is greater than the circuit should carry, this wire will melt and stop the supply. A double-pole fuse should be placed by the switch at the point of entry to the house and on every branch service throughout the building.

Wiring—The wires may be fixed by many methods, viz. wooden casing, concentric wiring, steel-armoured and insulating conduits, etc. ; the regulations of various insurance companies differ on this subject.

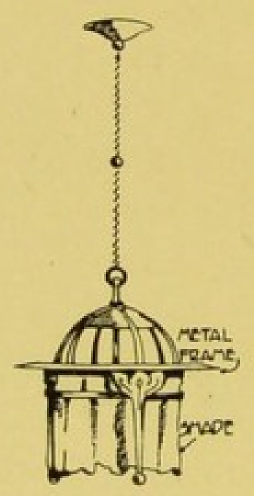
Wooden casing is the most usual method adopted for enclosing the wires ; it is either run along the external face of the plaster or is buried in it, but the latter is objectionable as it is difficult to get at the wires and damage is caused to plaster owing to the shrinkage of the wood. Wood casing should always be varnished, to prevent dampness destroying the efficiency of the installation.

A system much used on the Continent consists of insulated conductors, which are run side by side upon porcelain knobs on the surface of the wall.

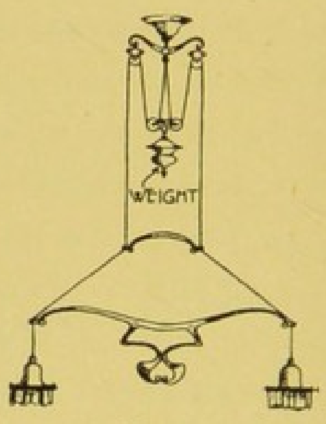
Concentric wiring consists of insulating the positive copper wire with rubber or other material and winding the negative wire concentrically round such insulation, the whole being enveloped in lead. An extra sheathing of steel wires may be used outside the lead envelope and the negative conductor must be run to earth.

Steel-armoured insulating conduits are preferred by many authorities. Iron piping has been extensively used, but there is much to be said against it, owing to the occurrence of short circuits, the liability of condensation and the abrasion of the insulating material from the wires, caused by the jagged nature of the jointing.

Tinned brass tubes are found in practice to be more or less free from condensation. The Kalkos is one of various forms of tubing which has been in vogue during recent years, the idea being to provide a



ILL. 173.
ELECTRIC LIGHT PENDANT.

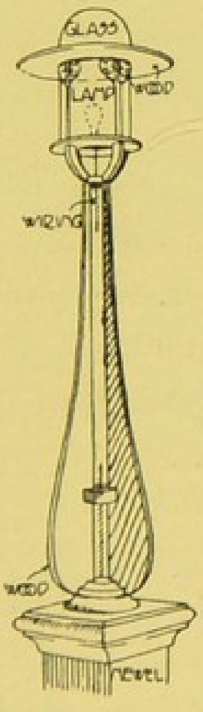


ILL. 174. ELECTRIC LIGHT BALANCE PENDANT.

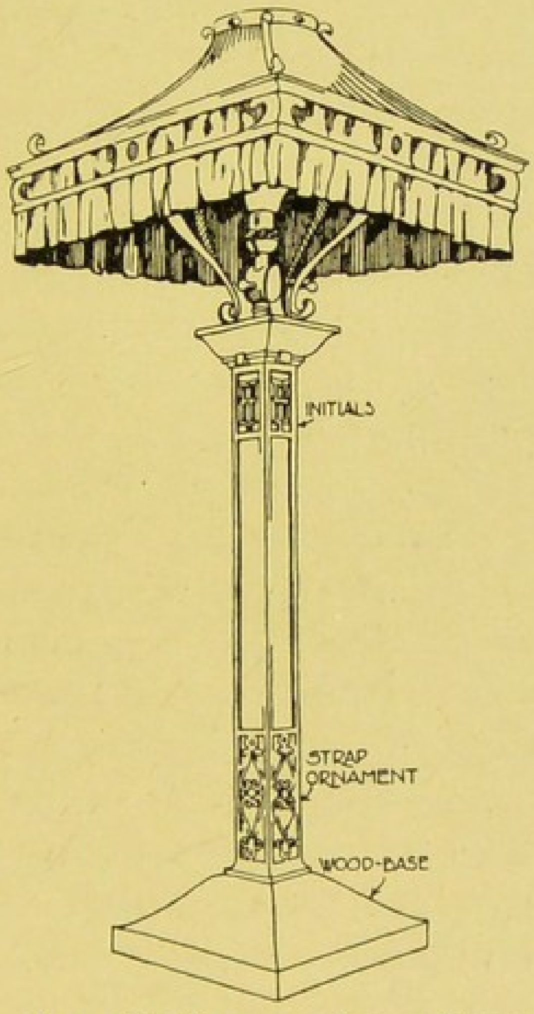
water-tight casing that rapidly follows sudden changes of atmospheric temperature, so as to prevent the collection of moisture in the tubing, caused by condensation. The Kuhlos and Stannos methods of wiring have also recently been introduced; the latter has been used with success and appears to combine efficiency with durability.

The method consists of single or stranded tinned copper wires covered with pure insulated and vulcanized india-rubber, which is taped and then lapped around closely with a sheet of tinned copper, the whole being rendered homogeneous by a special process.

The result is that a light flexible conduit is obtained in which the wires are mechanically protected and can be rapidly and easily fixed alongside picture-rails, architraves, skirtings or other fixtures without being unduly noticeable.



Ill. 175. Electric Light Newel Standard.



Ill. 176. Electric Light Table Lamp.

Fittings—An endless variety of fittings for the incandescent electric light are now made from the simple flexible pendant (Ill. 173) to the most costly and elaborate forms. The adjustable flexible pendant (Ill. 174) is a convenient form, and is useful in bed and dressing rooms. More elaborate fittings are shown in Ills. 175 and 176, the former being fixed to the newel of a stair and the latter forming a centre light for a dining-table.

Sitting and reception rooms should have a number of wall plugs, as they allow of lamps being moved to different positions in the room and are useful in decorative lighting for receptions, also for portable electric radiators.

Lavatories and water-closets may be lighted so that the lamps are automatically switched on and off by opening and shutting the doors, but the advantage of this is doubtful.

Special water-tight fittings are sometimes used in stables, as the stable fumes corrode the metal parts of the lamp holders.

Lamps—An ordinary incandescent carbon filament lamp will last about a thousand hours and use about $3\frac{1}{2}$ to 4 watts per candle-power; but many lamps of higher efficiency are now made, and since the introduction of metal filament lamps the whole question of economy in electric lighting has been revolutionized.

Tantalum lamps have a metal filament and undoubtedly effect a great saving in current, while giving an increased candle-power. These lamps were not made for higher voltages than 130, but recently high-pressure ones have been introduced, thus obviating the necessity to use them in series.

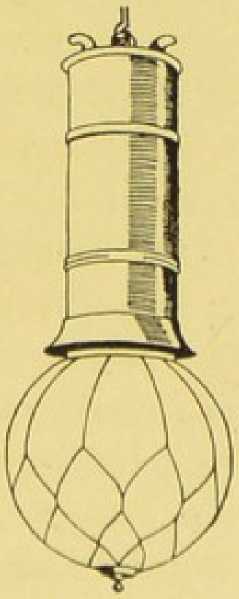
Osram lamps are similar but more efficient; their efficiency is $1\frac{1}{4}$ watts per candle-power, thus saving nearly 70 per cent over carbon filament lamps. They can only be used in a downward position, as the long filament easily breaks if inclined at an angle.

Metallic Filament Lamps Compared—Messrs. Siemens seem to be the only firm who can handle the refractory metal used in the Tantalum lamp, while there are many lamps of the Osram type on the market at the present time. The present prices for Tantalum and Osram lamps for high voltages are 3s. 6d. and 4s. 3d. each, the efficiency of the two lamps being 1·7 and 1·2 watts per candle-power respectively.

We are constantly testing lamps for clients, and at the present moment are rather inclined to favour the Tantalum lamp, as, though not quite so efficient as the Osram type, it is cheaper and appears to be less fragile. But such frequent improvements are taking place that one has constantly to modify one's opinion upon testing the different lamps as they are placed upon the market.

We have recently placed a contract with Messrs. Locke and Soare, of New Cavendish Street, for an Osram type of lamp at 3s. 3d., and they guarantee to replace every lamp that becomes defective within three months of its installation.

A transformer such as has been already described on page 200 can be fitted to an installation for the purpose of reducing the pressure of the current supplied by the company to meet the lower voltage of the earlier types of metal-filament lamps, which are cheaper than those for the high voltage. There are also many forms of the mercury vapour lamps which give a soft bluish-green light with very high efficiency.



ILL. 177.
ARC LAMP.

Arc Lamps—The arc lamp (Ill. 177) is useful for external lighting such as entrance drives, stables and yards. The illumination is caused by the current leaping the space between two carbons which automatically approach each other as they are consumed, and these have to be renewed about every hundred hours. The lamps are made from five hundred candle-power upwards, and their illuminating power is greater, for the amount of current consumed, than the incandescent lamp.

Cost of Electric Installation—The cost of running the wires, as described previously, must of course depend upon the circumstances of each case, but for anything over fifty lights the prices for wiring from the company's main, to cover everything except the fittings, will vary from about 10s. to 30s. per light.

The cost of an independent installation and plant such as may be required in a country house also varies considerably from £2 to £5 per light. When from two to three hundred lamps are required, the cost of supply ought not to exceed £100 per annum if the dynamo is worked by a steam or oil engine, for the entire cost of the necessary attendant should not be included with that of the engine, as the latter should not occupy more than half of his time.

Cost of Gas and Electricity—The cost of electricity at 6d. per unit is roughly calculated to be equivalent to gas at slightly over 4s. per 1000 ft., assuming 4 watts per candle-power. A rough calculation is that a 16-c.p. carbon lamp consumes 1 unit in 16 hours, and 30 8-c.p. lamps will absorb the same energy in 1 hour or 1 8-c.p. in 30 hours.

Electric light is more economical than gas owing to the facility of switching it on and off, and to the fact that books, pictures, curtains, and internal decorations are better preserved; besides which the purer atmosphere maintained is beneficial to health.

In addition to the fixed price per unit, there is a method of payment called The Maximum Demand

Indicator System or the Brighton method. A small indicator fixed near the meter shows the amount of energy consumed at any one time, and such amount multiplied by 182 hours (in the case of the borough of Hampstead) is charged at 6d. per unit, and thereafter units are charged at $1\frac{1}{2}$d. This borough gives consumers the option of adopting the above, and only charges $1\frac{1}{2}$d. per unit for the two summer quarters. The alternative method is a *flat* rate of 4d. per unit; this means that all current consumed is chargeable at such price.

Most of the London companies supply electricity for heating and power purposes at about 1d. per unit.

CHAPTER XV

VENTILATION

General Principles—Composition of Air—Quantity of Air Required (Inlets—Outlets)—Natural Ventilation—Mechanical Ventilation (Plenum, Vacuum, Glover-Lyon)—The Ventilation of a Dwelling-house (Hall and Stairs, Kitchens, Bedrooms, Billiard-rooms).

GENERAL **Principles**—Everybody knows that a supply of fresh air is essential for all human beings; we need not, therefore, discuss the necessity for ventilation. Lack of fresh air produces nausea, headaches, sleepiness and loss of appetite; and most of these conditions are realized after having been in a badly ventilated apartment for some time.

Pure heated air is not objectionable in itself, although people are in the habit of referring to a room as being too hot, whereas it is as a rule badly ventilated, the excess of carbonic acid rendering the air impure.

A general explanation of the movement of air will enable the reader to understand the necessary requirements of any ventilation scheme. The wind and the difference in temperature between the external and internal air are the forces which govern the velocity with which air moves in a building. The wind is a strong factor, but, as it acts principally in cold weather and is moreover such an uncertain agent, it is not practicable to make any ventilation scheme dependent upon it.

Natural principles of great importance are that the specific gravity of cold air is greater than that of hot air of equal purity, and that air when heated expands and rises.

Air expands $\frac{1}{500}$ of its bulk for every degree Fahrenheit to which it is heated, so that if the air in a room be heated to 50 degrees above the external air it will increase one-tenth in bulk, and therefore be lighter in proportion.

Composition of Air—Air consists mainly of oxygen and nitrogen in varying proportions, and in addition there are small proportions of ozone, argon, etc. According to Dr. Angus Smith, the purest sea or mountain air contains as much as 20·999 volumes per cent of oxygen, but the worst air found in a mine contained only 18·27 per cent.

Ozone, which is beneficial to the health, is a condensed form of oxygen principally found near the sea and open country and is rapidly destroyed by smoke and other impurities.

Carbonic Acid (CO_2) is generally taken as the gauge of impurity in air. It emanates from underground sources in the form of gas, and is increased by combustion and fog, but is diminished by vegetation, rain and high winds.

Carbonic Oxide (CO) is another impurity caused by the imperfect combustion of carbon and sulphuretted hydrogen, and is found in sewers and near excavations and marshes.

Marsh Gas is found in the atmosphere adjacent to marshes and also in coal mines, where the proportion may be sufficient to destroy life by the exclusion of oxygen.

Ammonia Compounds, derived principally from putrefaction and animal exhalations, are injurious owing to the impurities which accompany them.

Suspended matter in the air, such as dust formed of mineral particles, or organic matter of animal or vegetable origin, form some of the principal impurities found in town air.

The action of breathing also helps to render the air impure, for it abstracts oxygen and increases carbonic acid, besides which the skin itself gives off impure exhalations.

Coal gas causes much impurity in the air, for its products of combustion are carbonic acid, carbonic oxide, ammonia, and sulphur compounds; and it is estimated that each cubic foot of gas burnt per hour vitiates as much air as one human being by respiration. An oil lamp affects even more the purity of the air in proportion to the amount of light obtained.

Quantity of Air Required—Respirated air is found to contain about 4·5 per cent of carbonic acid, and is thus deprived of that amount of oxygen. An average adult gives off about six cubic feet of carbonic acid per hour, and as 1000 cubic feet of air under average circumstances contain ·4 cubic feet of carbonic acid, an addition of ·2 cubic feet will reach the limit of the standard of purity, which is ·6 as laid down by the late Sir Douglas Galton. An adult will therefore render 3000 cubic feet of air impure in one hour, because he will add ·2 cubic feet to each thousand. It follows that a system of ventilation is required which shall give each person at least 3000 cubic feet of fresh air per hour; a standard, however, which, in practice, seems to be seldom adhered to. It is asserted that no room can be considered even tolerably ventilated unless at least 1000 cubic feet of air per occupant are renewed every hour; consequently a room 20 ft. by 15 ft. by 10 ft. high, which contains 3000 cubic feet and is occupied by three people, requires the air to be changed every hour, but if occupied by fifteen people the air would require to be changed five times an hour.

Rooms are rarely so well built that air cannot enter freely from the loosely-fitted doors and windows of ordinary houses. The air thus accidentally admitted helps to ventilate the room even in the absence of any definite system.

In order to avoid draughts it is usually assumed in a country like England that the air of a compartment should not be changed more often than three times an hour, unless the incoming air is warmed.

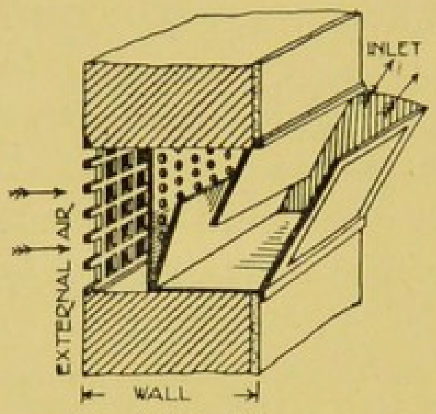
The supply of fresh air should not move with a greater velocity than two or three feet per second, otherwise draughts are felt. Consequently inlets and outlets should be designed in such a way that the movement of the air does not exceed this rate.

The following table from Hood gives the quantity of air which should be provided *per person per hour* for a room occupied to its maximum capacity, but other authorities differ considerably from him :—

	Cubic Feet per Person per Hour.
Ordinary living-room	1200
Sleeping-apartments	900
Ballrooms	2100—2400
Dining-halls	1200—1500

We refrain from giving formulæ here, but examples for different buildings are fully worked out in *Architectural Hygiene* (3rd Edition).

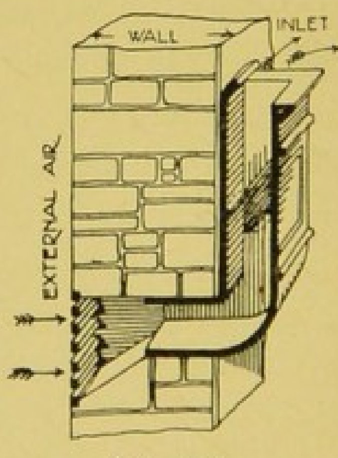
Inlets—Authorities differ as to whether the inlets in an ordinary room should be at the top or bottom of the wall, but the best position, in our opinion, is about six feet from the floor level, on the same side of the room as the fireplace (see p. 177). They should be short and accessible, otherwise they collect dirt and vermin, and should be placed so as to diffuse the air in such a way that all parts of the room may be air-cleansed.



Ill. 178.
Sheringham Ventilator.

A Sheringham inlet ventilator (Ill. 178) is provided with flaps falling inwards and with cheeks so that the air entering is given an upward cant and is then diffused.

A Tobin tube inlet (Ill. 179) is a short upright shaft formed of $1\frac{1}{4}$-inch boarding, lined with zinc or made entirely of metal, as shown in the illustration. It should be provided with a butterfly valve to regulate the amount of air admitted, and the top may be covered with perforated zinc.



Ill. 179.
Tobin Tube.

If a ventilation scheme is to be effective, air must be warmed before entering the building for at least six months in the year, otherwise in cold weather people will close the inlets because of the draught brought about by the introduction of the cold air. This warming may be effected by means of radiators (see Ill. 159) which are fixed against the wall, generally under the window sill. They may with advantage be placed in the thickness of the wall itself, with inlets into the room.

It has been laid down that the inlets should have a sectional area of twenty-four square inches for each person, so that one square foot (i.e. 144 square inches) is required for six persons, and six air-bricks of the effective area of twenty-four square inches each would be sufficient. Such an allowance is seldom obtained in practice. Ordinary rooms provided with a good fireplace, according to Hood, may have inlets of the following area taking into account the size of the room, the number of occupants and gas burners :—

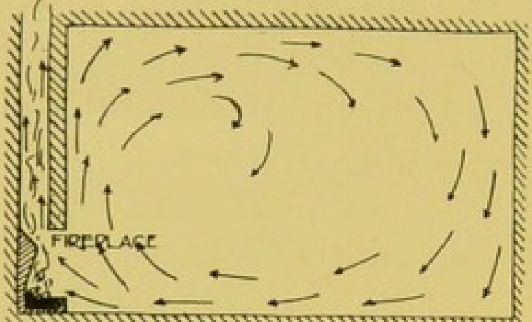
Size of Room.	Number of Occupants.	Number of Gas Burners.	Net Size of Ventilator.
ft. ft.			in. in.
10 by 10	2 or 3	2	9 by 3
16 „ 12	3 „ 4	3	9 „ 6
20 „ 16	4 „ 5	4	9 „ 9

Where sash windows are used they should be provided with a deep bead at the back of the sill (as shown in Ill. 22), as this allows the lower sash to be slightly raised so that air can be admitted between the meeting rails in a vertical direction, as shown by the arrow on the illustration.

Outlets—The position of the outlet depends upon the inlet, but generally speaking they should be as far as possible apart. The natural outlet in an ordinary room is the fireplace, where there is always an up-current drawing the air out of the lower part of the room at a computed velocity of from four to five feet per second.

This factor in domestic ventilation gives a natural outlet in every room, and induces many authorities to suggest downward ventilation, in which the foul air is drawn out through the fireplace opening in preference to having a special outlet in the upper part of the room.

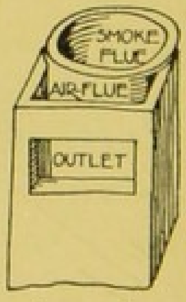
The air in a room with closed doors and windows is in such cases drawn along the floor towards the fire, a part helping the process of combustion and going up the chimney, and a part in consequence of its warmth and impetus flowing towards the ceiling, as shown in Ill. 180. This latter cools in traversing the ceiling, descends, and is again carried towards the fireplace. A good place to introduce air is in the chimney breast wall above the mantelpiece, as shown in Ill. 149, as this results in slightly warming the air when the fire is alight.



ILL. 180. AIR CURRENTS IN ROOM.

The amount of air that an open fire requires is considerable, and where no special supply is provided cold air is drawn in to supply this need through cracks of doors and windows to such an extent that draughts are frequently the result, although the modern slow combustion fireplace obviates this nuisance to a large extent.

If it is desired to extract air from the upper part of the room it is better to have a separate foul-air flue, which costs little when constructed in a new building. Ventilating flue pipes (as shown in Ill. 181) are sometimes used in conjunction with smoke-flue pipes, and being warmed by the smoke flue cause an upward current in the air flue.



ILL. 181. DOULTON'S VENTILATING FLUE.

Natural Ventilation—Natural ventilation is generally in use for ordinary houses, and consists in the removal of foul and the admittance of fresh air by natural means, such as by doors, windows and fire-places.

Nature assists in ventilation, as explained on page 209, because air, when heated, expands and rises, and heated air given off by the body can be removed from the apartment by flues if fresh air is admitted to take its place. Thus if air is introduced at the lower part of the room and an extract flue for heated air formed in the upper part, a natural means of ventilation is provided, but, as a matter of fact, this process may be reversed in ordinary rooms, as the fireplace opening forms the outlet, as before mentioned and shown in Ill. 180.

Mechanical Ventilation—Mechanical ventilation is dependent on means of propulsion and extraction by mechanism, and is either of the *plenum* or *vacuum* systems.

Plenum System—The plenum system is effected by propulsion of fresh air into the apartment by means of fans or air pumps, and the foul air is thus forced out.

We think that the death-blow to this system has been the general condemnation of the ventilation of the Central Criminal Courts.

Vacuum System—The vacuum system consists in producing strong up-currents in special extract shafts either by means of gas jets, hot-water pipes, steam coils or fans, which cause the foul air to be drawn out of the room and fresh air enters to take its place.

The great difficulty in the application of mechanical ventilation is the cost and the liability of the system to get out of order, but, on the other hand, it possesses the great advantage of constancy under change of atmosphere, and is completely under control as to the supply and quality of fresh air required.

Glover-Lyon System—Dr. Thomas Glover-Lyon, M.A., M.D., is responsible for a good system of draughtless ventilation, and when electricity can be obtained at a reasonable cost we have no hesitation, from our own practical experience, in thoroughly recommending its adoption for billiard and smoking rooms and all apartments which are difficult to supply with fresh air in the ordinary way.

Air heated to the required temperature is forced, by electric fans, into the room through a large number of specially graduated apertures, and is extracted in a corresponding manner. The result is a slow sweep of air throughout the apartment without any draught; the even manner in which the air is sprayed, as it were, into the room gives more efficiency than by any other method with which we are acquainted. The system does away with the costly installation of basement boilers and hot-water pipes, and can be applied separately to any apartment, the flow of air being increased or decreased at will.

The Glover-Lyon system, moreover, is not interfered with by the ordinary fire, which may still be used to give a cheerful appearance. The system is not disorganized by the opening and shutting of windows as in other systems.

The Ventilation of a Dwelling-house—The scheme of ventilation employed depends upon the amount that can be expended, and indeed in many houses no special provision is made, but it is well to indicate a few general rules which should be adhered to.

Hall and Stairs—The hall and staircase must be properly warmed and ventilated, if draughts are to be avoided;

and the best way to effect this is by means of hot-water or electric radiators placed in front of inlets, so that the incoming air may be warmed; this tends to keep the hall and staircase at a proper temperature. Warmed air being thus introduced into this part of the house, fanlights can be arranged above the doors of the various rooms, and a continual stream of warmed fresh air is thus supplied to the sitting-rooms and bedrooms instead of the cold draughts which otherwise occur.

The hall and staircase should have a ventilating lantern light in the upper part of the house heated if possible with hot-water pipes to create an up-current and prevent a down-draught.

Kitchens, etc.—The kitchen offices, cellars, lavatories, and W.C.'s should be disconnected by means of cross ventilation as much as possible from the other portions of the house. The lavatories and water-closets should in an ideal house be placed in a separate annexe with cross ventilation lobbies as is usual in hospitals, but in practice this may be effected by placing the lavatory and W.C. with a disconnecting lobby between, as mentioned in chapter III., page 51.

The water-closet itself should have louvres, or a grating in the lower part of the door connecting it with the lavatory, so that a current of air is continually passing through the former to the W.C. window, which should always be kept open.

Cellars should also be cut off from the living portion in order that the cold air and dust from coal cellars and underground passages may not be drawn up by the warmed air into the house.

Bedrooms—Bedrooms can be kept reasonably warm in winter by means of radiators in the hall passages and staircase, and in exposed situations they may be placed in the rooms themselves. All such rooms should, of course, have a fireplace, and the inlet to the flue should be kept open, so that a current of air may always be travelling up the chimney. The old form of grate with a register which can be shut down should be avoided, for some people close it and leave the bedroom without any ventilation, causing such an apartment to be a fruitful source of headaches in the morning.

People who desire to be healthy have their windows open at least an inch or so all the year round, and in addition a ventilating grating over the door should be provided, so that the warm fresh air which has been admitted to the hall can pass through the bedroom to the fireplace as before mentioned.

Billiard-rooms—A billiard-room is often difficult to ventilate because of the large glass lantern necessary for lighting the table, the amount of smoking indulged in and the quantity of gas consumed, and the first thing which should be done, wherever possible, is to install electricity. Fresh air should, of course, be heated by hot-water or electric radiators, and a down-draught from the cold air around the lantern may be prevented by a lay-light (i.e. a horizontal glass ceiling) placed below it, and the space between the two lights may be warmed by hot-water pipes so as to cause an up-current, the vitiated air being drawn out through the roof by an extract ventilator. If hot-water heating is not desired a ventilating grate may be used, the lay-light made air-tight, several inlet ventilators placed in the walls and the extract obtained by a special foul-air flue in the chimney breast, with possibly some mechanical arrangement to accelerate the current.

If electric current can be obtained at a reasonable price, the Glover-Lyon system before described should most certainly be employed.

CHAPTER XVI

THE DECORATION AND FURNISHING OF THE HOUSE

General Principles—The Hall and Staircase—The Dining-room—The Drawing-room—The Library or Study—The Breakfast or Morning-room—Bathrooms and W.C.'s—Bedrooms—The Kitchen and Scullery—Pantry.

GENERAL **Principles**—The keynote of all decoration and furnishing should be simplicity, but at the same time we must not be led away into the affectation of simplicity seen in so much modern work.

Tradition in art should be adhered to, but antiquity should not be worshipped for its own sake, as it is certain that some designs were equally as bad in the past as in the present day, but owing to defects in conception and construction a considerable amount of such work has disappeared.

If a well-designed piece of furniture has been mellowed by time, it has an additional attraction which makes it more beautiful and causes it to appeal to a wider class than that of the technical critic who studies merely the actual design and construction irrespective of its antiquity. We should study the art of the past, not for the purpose of slavishly copying it, but rather for gathering inspiration which will enable us to conceive something that may in its turn be worthy to hand down to future generations.

There is much to be learned in decoration and furnishing from the Japanese, whose marvellous and intuitive skill is evinced, not only in their articles of *virtu*, but also in the decorative treatment of their homes. One is perhaps most impressed when visiting a Japanese home by the extraordinary paucity (as an American friend expressed it) of their decorations, for a *godown*, or warehouse, is attached to all houses of any size, and in this are stored practically the whole of the goods belonging to the owner of the house. One ornament only is displayed prominently on a stool in each room, so that every one can examine it at leisure, and, when the owner is satiated with it, it goes back to the *godown* and another takes its place. Each work of art is thus unhampered by the distraction of adjoining works and receives in its turn due criticism and appreciation.

The ostentatious gimcrackery of much modern furniture is strongly to be condemned, although there are signs of a return to good traditional forms and satisfactory constructive outlines, as referred to in chapter I., pages 28 and 35.

Antimacassars and all such dirt collectors should be avoided, as they are injurious to health, and curtains should not be hung in flounces, which make them a ready receptacle for dust, but should fall loosely from light metal rods and be easily removable for cleaning.

The chief ideas which should govern the furnishing and decoration of the principal rooms in an Englishman's house we deal with somewhat cursorily, for tastes differ and many have ideas of their own, but for those in doubt the general principles laid down will, we hope, be of some use.

The house, it should be remembered, is built for a dwelling, not for the reception of visitors ; and no room should be considered too well furnished for daily use.

The various apartments in a house are now briefly referred to with suggestions which may be helpful in giving some idea as to the general decorative treatment required for each room.

Chapter III. has already dealt with the aspect and chapter VI. with the treatment of the floors, walls, doors, windows, fireplaces and ceilings.

The Hall and Staircase—The hall should have a cheerful and inviting appearance to the visitor and should leave the parting guest full of pleasant recollections.

The floor may be of polished wood blocks or parquet flooring with a rug or two in the centre, or if not considered too cold in appearance it may be of mosaic treated in a warm colour with a plain key-pattern border.

The walls may be hung with a washable leather paper, panelled as seen in Ill. 229, or painted. A deep frieze may be provided, treated in a lighter key, with a picture-rail or moulding in line with the top of the doors and so formed as to hold any pieces of old china which may have been collected. A combined picture-rail and china-rest is indicated in Ills. 196, 205, 236, 237, 238, 239, 245, 292 and 313. The pictures may consist of prints or engravings, either of which are perhaps better than oil paintings in a small hall. They should be few in number but good of their kind.

The staircase may have a dado of some material perhaps of darker colour than the walls and well varnished, so that it can be easily washed. The fireplace is an important feature in the hall, and much will depend upon its treatment, which should be simple and substantial. A semicircular arch of bull-nosed, salt-glazed bricks makes a very good opening, and when filled in with a dog-grate of modern type is especially adapted to give a cosy appearance.

The ceiling can be treated with ribs in geometrical patterns, or the beams of the floor over may be left visible, as shown in Ills. 229 and 312.

The chairs should be strong yet comfortable, and an oak chest or two to contain books or papers is useful.

The cheap varieties of stained glass which have been used of late years *ad nauseam* in the hall of speculative builders' houses should be avoided, and glass, either plain, ribbed or frosted, set in wide lead cames, may be used for the windows, unless good stained glass can be afforded.

The Dining-room — This should have a warm yet subdued treatment in order to give it a quiet and cosy appearance. The walls should be divided only into two, as it is seldom possible in small houses to have a dado as well as a frieze. The lower part may have a dado of wainscot oak, as in Ills. 245, 292, or of stamped leather, and a moulded dado-rail may be formed to act as a chair-back and prevent the chairs rubbing against the wall surface. Pompeian red is a good colour for the dining-room, but a subdued grey-green is preferred by many as a better background for pictures. There should always be a moulded picture-rail from which the pictures can be hung by means of hooks (Ill. 313), for nothing looks more unfurnished and untidy than nails knocked into walls at different heights to support them.

Pictures, moreover, can be easily taken down and cleaned and rehung if there is a picture-rail on the same level with, or not much higher than, the top of the door architraves. The picture-rail may be combined with the cornice where there is no frieze or in cases where a dado is provided, and the panel moulding may be utilized for this purpose where panelled walls are used.

The woodwork may be painted and varnished with a floor border in a darker colour, and a Turkey carpet covering the centre of the room has a pleasant effect. The table and chairs should be simple and harmonize with the style of the room, as in Ills. 273, 308, 317, 319, 327 and 328. In furnishing the dining-room care should be taken not to have the table too large, and thus leave only a narrow passage round the room and a cramped space by the fireplace, which will make waiting at table a difficult operation.

The ceiling can either be plain or treated in ribs of a geometrical pattern, or with the beams showing, as in Ills. 230 and 307.

The Drawing-room—This room, which also usually serves as a music-room, should usually be treated in a lighter key than the dining-room, and the walls may be divided into two by a deep frieze, possibly treated with figure-work of a lighter colour; but in larger rooms the walls may have a triple division, as shown in Ill. 194.

The moulded picture-rail at the bottom of the frieze should be grooved, as already described, to carry china. The rest of the wall may be treated in a gold, a peacock-blue or grey-green colour extending to the skirting, or may be panelled as in Ills. 190, 200 and 288.

A chair-rail and dado may be dispensed with because the chairs in this room are usually arranged about the room in twos and threes for conversational purposes, and cabinets, small tables and bookcases may be placed against the walls.

Water-colour drawings are especially suitable, for they go well with the lighter treatment of this room. The woodwork should harmonize with the walls and ceilings, and may either be painted a cream-white with a finishing coat of eggshell enamel or, if it can be afforded, polished mahogany doors surrounded by architraves painted white are effective.

Ceilings are as a rule best finished in white with moulded cornice and decorative bands, as in Ill. 236.

Drawing-room furniture often consists of a collection of chairs and bric-à-brac of all styles brought together in a happy-go-lucky fashion, without any attempt at a homogeneous idea; but this suggestion of a furniture dealer's shop should be avoided.

Easy-chairs should not be much more than a foot in height, and may be upholstered in a simple texture in harmony with the general scheme of decoration. The primary object for which a chair is made should not be forgotten, and gimcrack constructions which, under the name of "Art," are foisted on the unwary customer only to give way under a person of more than usual weight should be avoided.

The Library or Study—The library should be treated in a manner somewhat similar to the dining-room and should have a subdued and cosy appearance. The tops of the bookcases, which should have glass fronts to prevent dust settling on the books, should not be more than five or six feet from the ground, so that books may be easily reached, the top being used for casts or statuettes, etc. The library window sills may start from the top of these bookcases so as to exclude the outer world, and give the room the secluded character which conduces to study. One window, however, should be low enough to enable one to see out when seated, as this gives the room a cheerful appearance.

The Breakfast or Morning-room—Such should, of course, be sunny and cheerful in character, and a light-coloured paper or distemper is suitable for the walls. The floor boards may be stained round the borders and a bright central carpet used. A moulded picture-rail and deep frieze are appropriate, and the latter treated in figure subjects on a light ground looks well.

The billiard-room has already been referred to in chapter III., page 50, and it is sufficient to say that in regard to decoration and furnishing the green cloth must be primarily considered.

Bathrooms and W.C.'s—Bathroom and W.C. floors and walls should be formed of impervious materials, as mentioned in chapter VI., pages 91 and 94.

Tiles make a clean, suitable and lasting wall surface, as they can be washed down from time to time, but if tiles cannot be afforded, Emdeca (enamelled zinc) may be used, but great care must be taken with the jointing. Plain white enamelled walls are also suitable.

Casings to pipes should be avoided, as they are receptacles for dust and filth.

The bath, hand-basin and W.C. should for the same reason have no enclosure, as already mentioned in chapter IX., page 139. Many people would scarcely credit the filth and disease germs which are to be seen on removing the old bath and W.C. enclosures in some houses.

Bedrooms—The bedrooms should have the fitments designed by the architect, and they should form part of the room, as this will economize space and give it a finished appearance. Although it means additional preliminary expense, this will, however, be saved in subsequent expenditure on wardrobes and other furniture.

The floors should be treated as described in chapter VI., page 93. A bedroom floor may be stained a warm colour, and light hand rugs may be placed at the bedside before the looking-glass and washhand stand. Fitted carpets are a great mistake, for besides harbouring a great deal of dirt, extra domestic labour is required in sweeping them.

The walls may be finished in distemper of suitable tint, which, of course, should vary with the aspect of the room, as it goes without saying that a room facing south may be treated with a cooler tint than one facing north.

The ceiling may be left plain white, or one may get a severe shock on waking from some intricate geometric stencil-work, such as one often sees in Italian hotels.

Kitchen and Scullery—The kitchen and scullery should be floored with non-absorptive materials, as mentioned in chapter VI., page 92.

The walls should be tiled or painted in serviceable colours of a light tint, with a darker dado about four feet six inches high, so that they may be cleaned down with a damp cloth. The woodwork should be painted a dark stone colour, well varnished, so that it can be occasionally washed.

The kitchens should, in addition to the dresser, have cupboards for brooms, etc., so that all utensils may be kept in their proper place.

Pantry—The pantry should be treated in a similar way to the other offices, and should be provided with cupboards.

The sink may be of wood, lined with lead, or glazed stoneware, as mentioned in chapter IX., page 153.

CHAPTER XVII

THE ADAPTATION OF EXISTING HOUSES TO MODERN REQUIREMENTS

General Remarks—A House in Guernsey—A House in Hampshire —A Town House—Small Country House.

GENERAL Remarks—The adaptation and alteration of existing houses, in order to bring them into line with modern requirements or to suit the special idiosyncrasies of the purchaser, is perhaps the most interesting of all the work that comes to the hand of the architect.

Many people like to buy an old country house or cottage and alter it to meet their individual taste, a great advantage in this procedure being that an old and well-matured garden is usually secured.

The majority of such old places, however, are extremely damp, owing to their construction, and nothing short of underpinning and the insertion of an impervious damp course can render them inhabitable. The necessary alterations remind one of the old biblical saying as to the putting of new wine into old bottles, as the building operations are liable to shake the fabric, and the result is often more expensive than the building of a new house. The repairs to an old structure form also a heavy recurring expense, and plumbers and builders are a nightmare to many owners of delightfully picturesque properties, giving point to the Spanish proverb, that "if one has a very bitter enemy the best way to revenge oneself is to give him an old house."

It frequently happens, moreover, that the alterations involve a complete gutting of the interior, although sometimes a judicious rearrangement of the various parts will completely transform the house at a trifling expense. The first point usually to be considered in the remodelling of the interior is the formation of a good square entrance-hall with fireplace and a recessed bay window with seats.

The adaptation of some old houses may best be illustrated by actual examples; although, bearing general principles in mind, it is not wise to multiply examples, as each house must be altered in accordance with its own particular construction and the accommodation required by the owner.

A House in Guernsey—The alterations and additions to a house in Guernsey are shown in Ills. 182, 183, 184 and 185.

The house was an uninteresting example of the Early Victorian period, but for family and sentimental reasons its character was interfered with as little as possible.

The plans indicate the new walls in black, the undisturbed walls being hatched.

The alterations on the Ground Floor (Ill. 182) consisted principally in the formation of a large columned Inner Hall with fireplace giving on to a covered piazza to the south, as shown in Ill. 185. A new Billiard-room, Lavatory, Servants' Stairs, enlarged Dining-room, new Kitchen and Offices were also added. In order to protect the Scullery, Servants' Hall and Yard from the southern sun and to form a connection in wet weather, a covered way was formed between the Conservatory and Billiard-room.

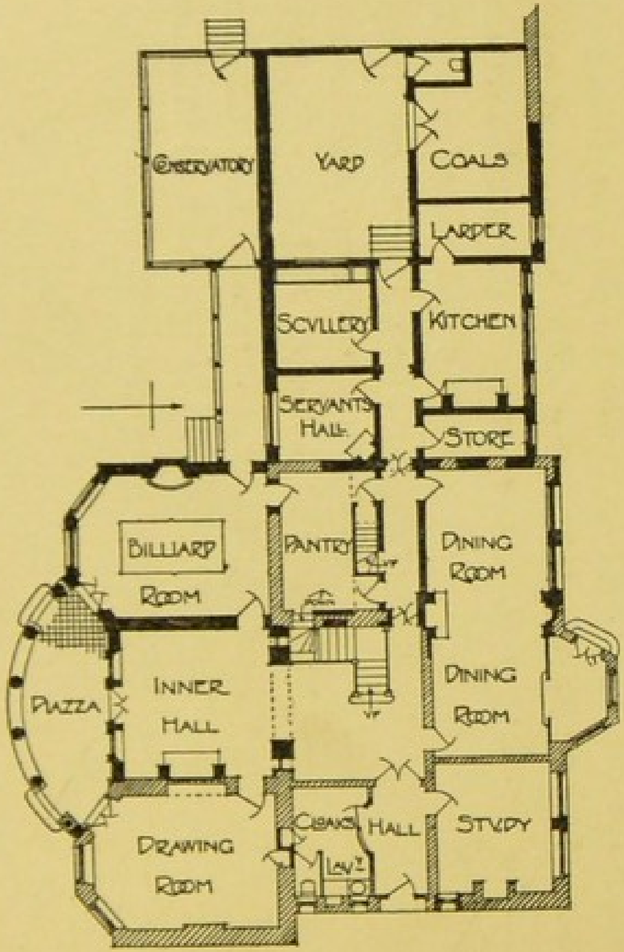
The First Floor (Ill. 183) was provided with two Bathrooms and with additional Bedrooms, Dressing-rooms and a Passage-way on to the Balcony over the piazza.

The Second-floor Bedrooms were rearranged, as shown on Ill. 184, and in order to protect those Bedrooms facing south from the sun, which, at certain seasons of the year, had rendered them almost uninhabitable, open belvederes were constructed, as shown in Ill. 185. These also formed cool balconies intended to be used for sleeping during the hot summer months.

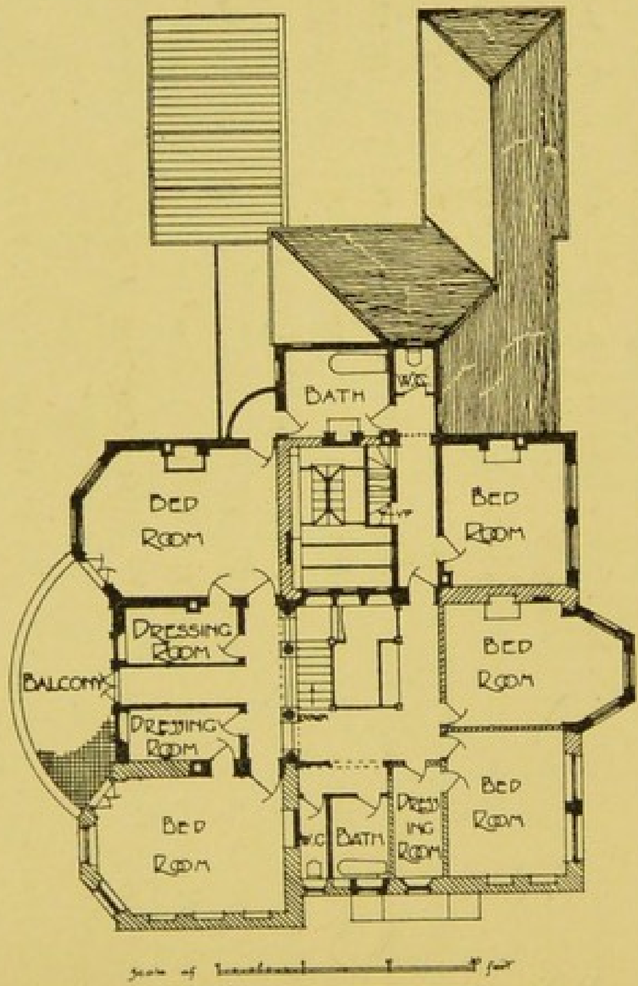
The general view of the exterior (Ill. 185) indicates that an attempt was made to retain the character of the house, the new portion being finished in stucco, so as to be in harmony with the older work.

A HOUSE IN GUERNSEY

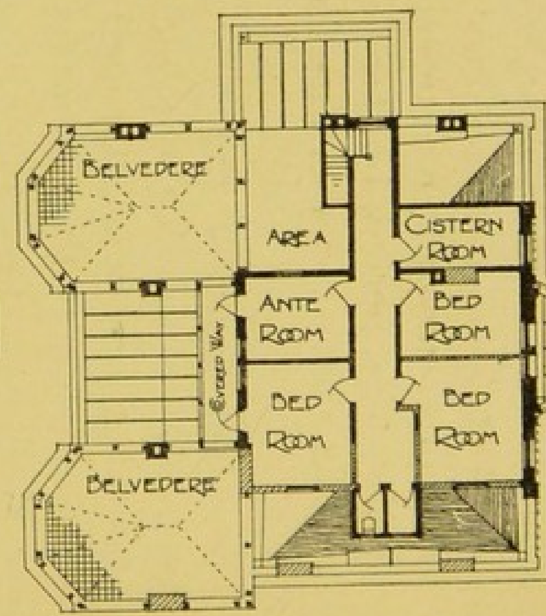
Black walls indicate new work.
Hatched walls indicate old work.



ILL. 182. GROUND-FLOOR PLAN.



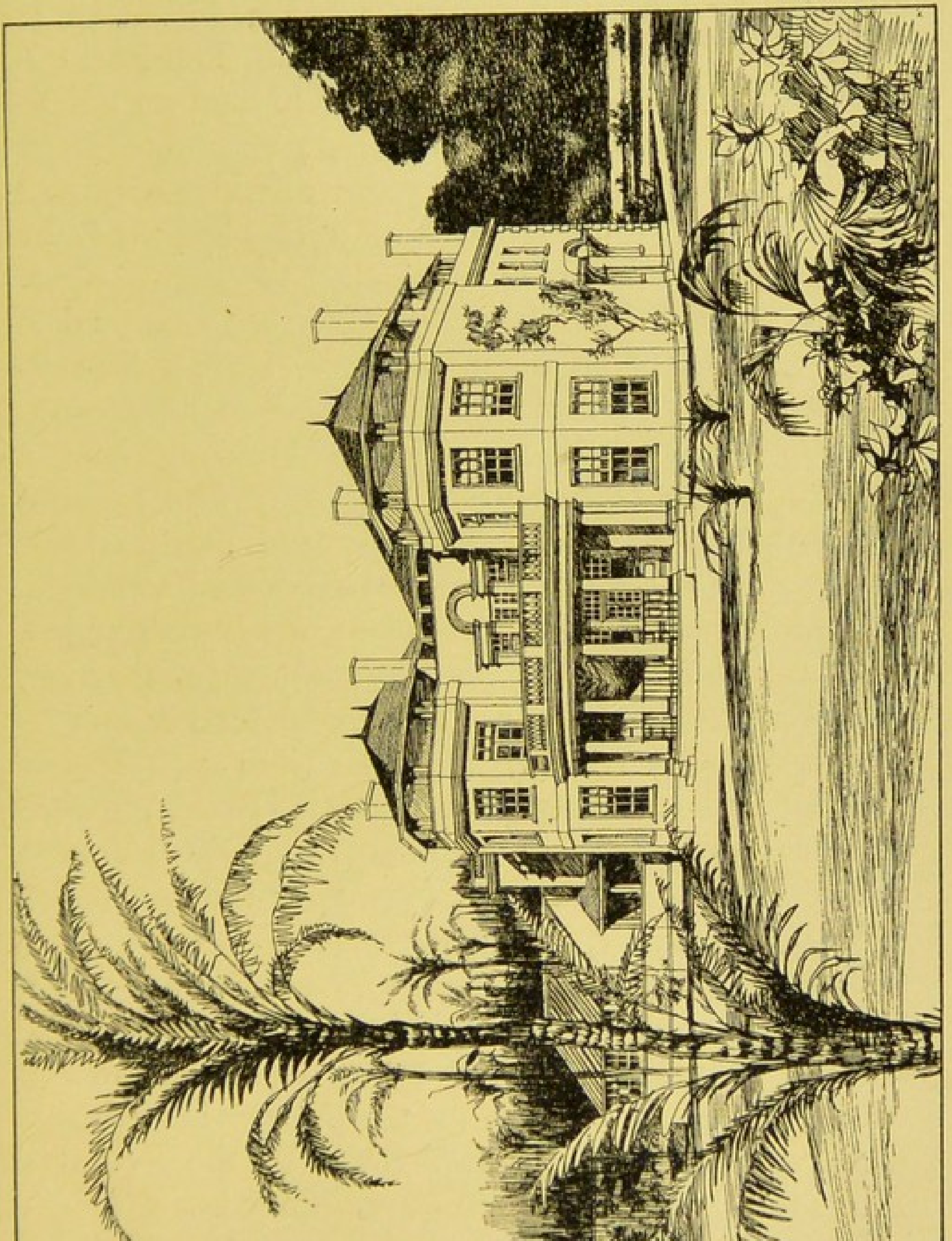
ILL. 183. FIRST-FLOOR PLAN.



ILL. 184. SECOND-FLOOR PLAN.

BANISTER FLETCHER AND SONS, FF.R.I.B.A., *Architects.*

A HOUSE IN GUERNSEY



ILL. 185. THE FRONT.

BANISTER FLETCHER AND SONS, FF.R.I.B.A., *Architects.*

A Country House in Hampshire—Abbess Grange, an old country house in Hampshire, was altered and enlarged to suit modern requirements, as shown in Ills. 186, 187, 188, 189, 190, and 191. The house is picturesquely situated on a plateau formed on a hill-side, as shown in Ill. 191.

The plan (Ill. 186) shows the alterations carried out, the new walls being shown in black and the undisturbed walls being hatched.

The Ground-floor alterations (Ill. 186) consisted in the formation of an outer Staircase Hall, a Sitting-hall with large fireplace, a Morning-room, a Conservatory in connection with the Drawing-room, a bay window to Dining-room, a Library with columns supporting the ceiling where the old partition was removed, and a Billiard-room with domed top light. The kitchen and offices were also entirely rearranged, and although they are on the south side, they are sheltered from the sun, as they are under the shadow of the cliff. A *porte cochère* to ensure shelter while entering and departing was constructed to the principal entrance, and is shown on Ill. 191. A small portion of the eastern cliff was excavated for the purpose of providing room for coals, stores, etc.

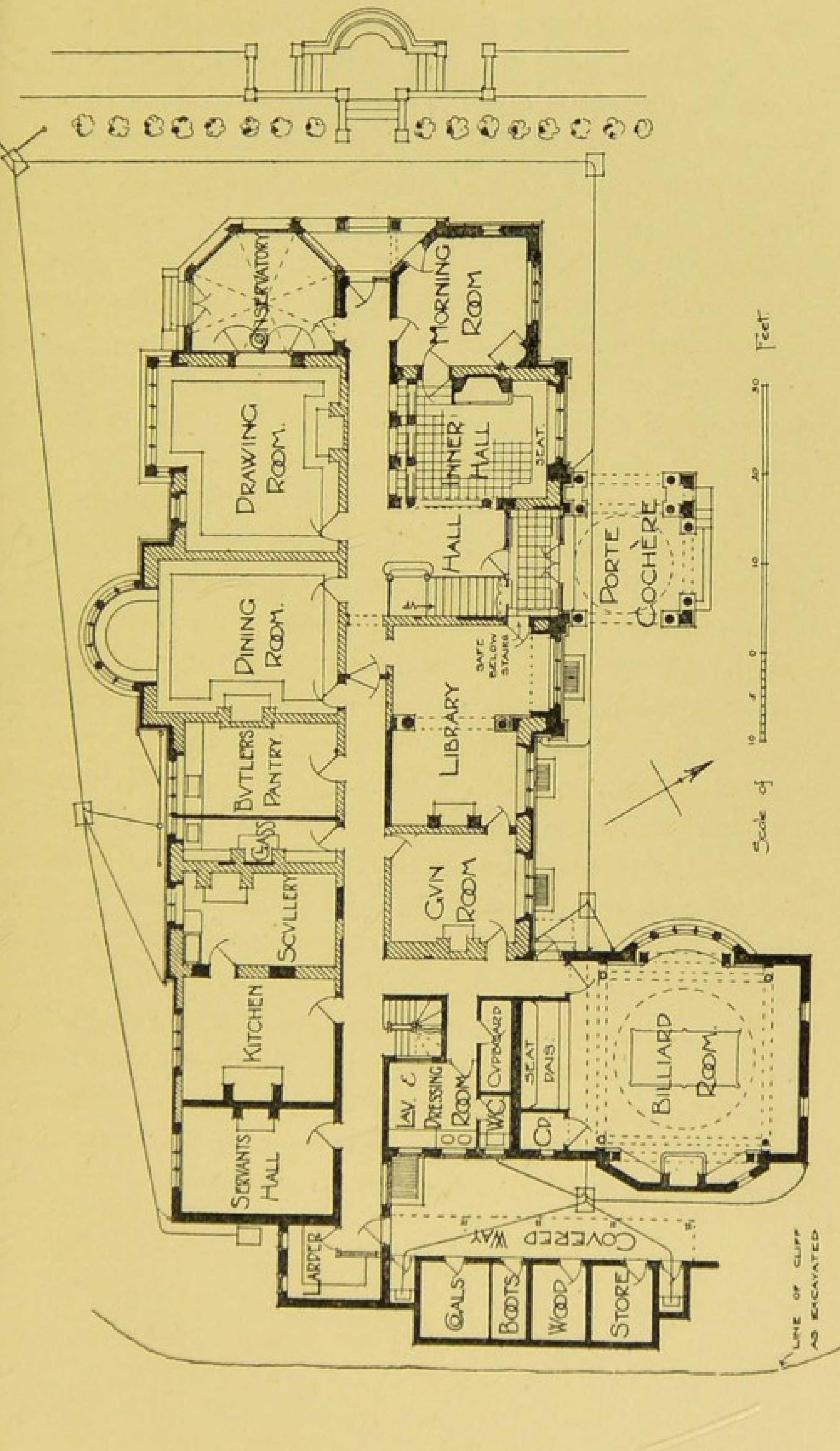
The First Floor was rearranged and extended, four bathrooms being provided, one for the owner in connection with his bedroom suite, one in connection with the nursery, and two for the use of visitors.

The Second Floor was reached by the Servants' Stairs only, and has also been rearranged.

The interior of the house was entirely remodelled and redecorated, as may be seen from the following views:—

The Staircase Hall (Ill. 187) shows the new oak

A COUNTRY HOUSE IN HAMPSHIRE



ILL. 186. GROUND-FLOOR PLAN.

BANISTER FLETCHER AND SONS, FF.R.I.B.A., *Architects.*

staircase leading to the first floor, the panelled hall and passage, and the new doorway to the Dining-room on the right.

The Sitting-hall (Ill. 188) shows the new oak fire-place with Ionic pilasters, the marble architrave, club fender, dog-grate, panelled walls and ornamental ceiling.

The Library (Ill. 189) shows the oak panelling carried round the lower part of the walls, the chimneypiece with Portland stone architrave and the tiled sides to the new Teale Grate. The ceiling is ribbed with plaster in a geometrical pattern.

The Drawing-room (Ill. 190) was treated in a lighter key, the walls having cream-enamelled panelling with double projections for photographs or prints, above which is a patterned frieze and ornamental ceiling in low relief. Character is given to the fire-place by including the whole of the chimney breast in its design. The grate is of polished steel with wide splays of old green tiles enclosed in an architrave of green Connemara marble. The mantel itself is of pine enamelled white with small columns and recesses for ornaments. The lock handles, finger plates, electric and other fittings throughout the house were specially designed.

The external treatment was governed by the existing type of windows and chimneys. Local stone was employed, and a simple mullioned treatment adopted, the idea dominating the scheme being the reposeful character of the manor-house of mediæval times.

A COUNTRY HOUSE IN HAMPSHIRE

ILL. 187. THE STAIRCASE HALL.

ILL. 188. THE SITTING-HALL, SHOWING FIREPLACE.

BANISTER FLETCHER AND SONS, FF.R.I.B.A., *Architects.*

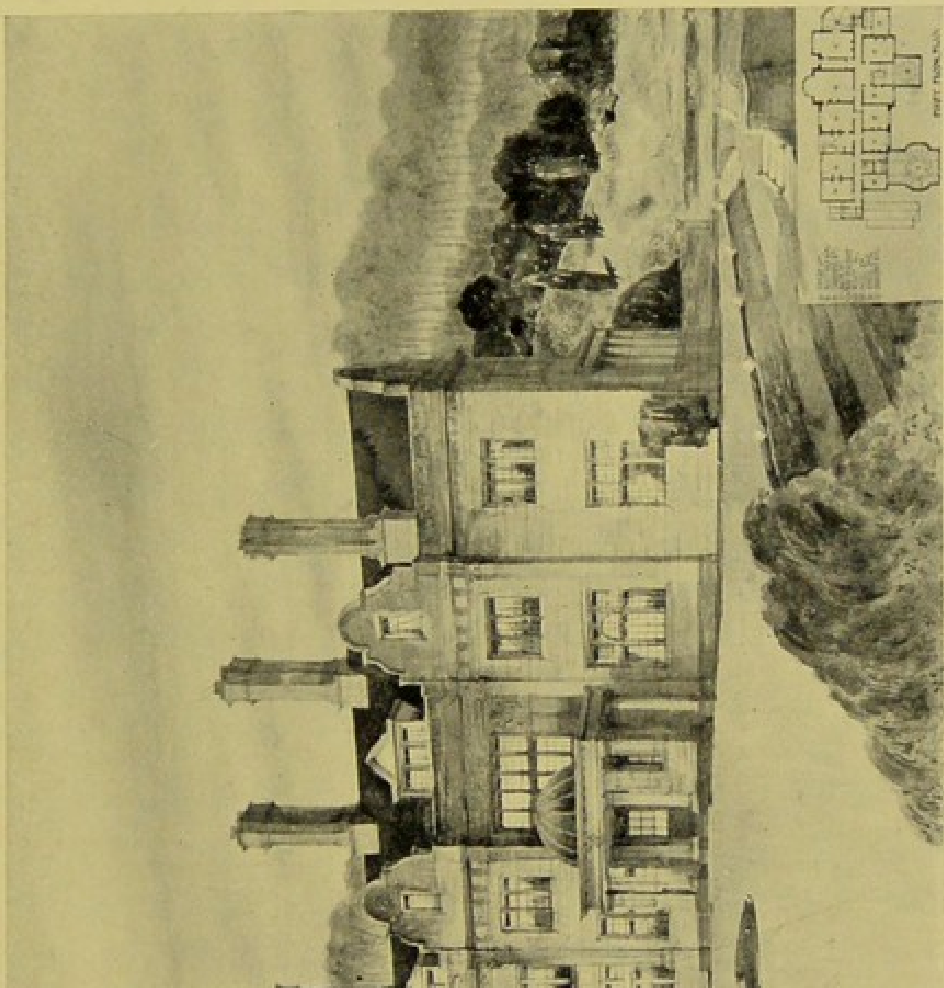
A COUNTRY HOUSE IN HAMPSHIRE

Ill. 189. The Library.

Ill. 190. The Drawing-room.

Banister Fletcher and Sons, ff.r.i.b.a., *Architects.*

A COUNTRY HOUSE IN HAMPSHIRE



ILL. 191. THE ENTRANCE FRONT.

BANISTER FLETCHER AND SONS, FF.R.I.B.A., *Architects.*

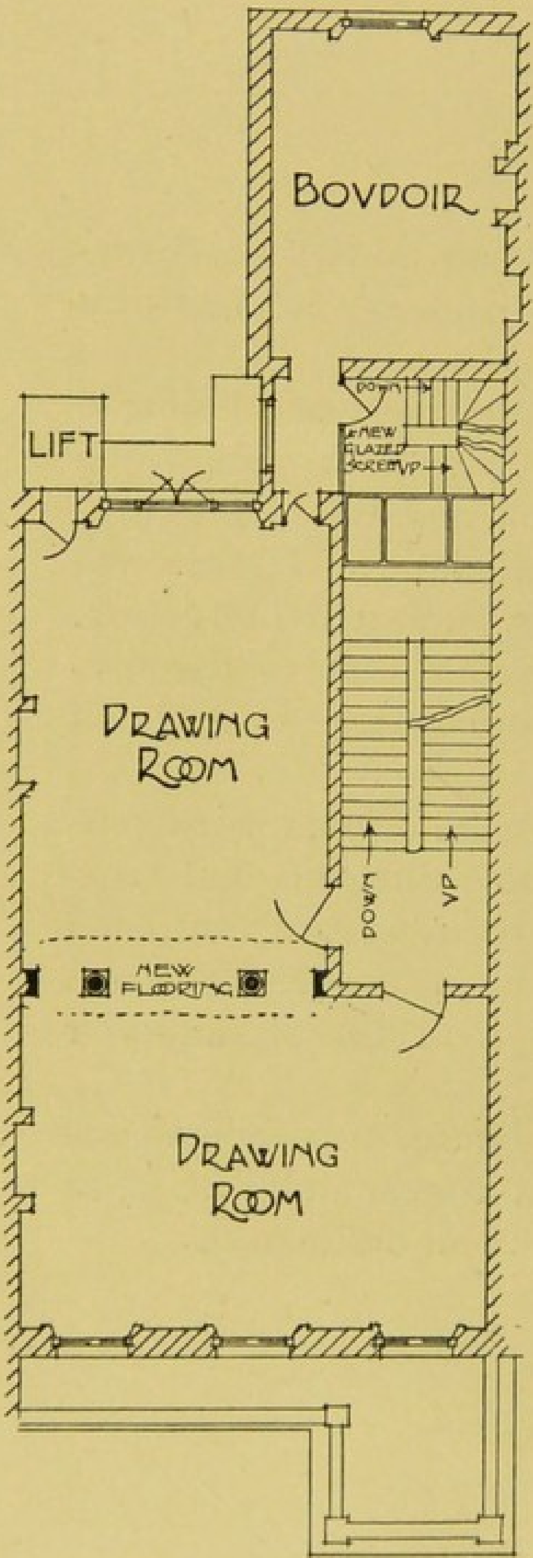
A Town House—The adaptation of No. 44, Grosvenor Place, for the Brazilian Embassy is shown by Ills. 192 and 193.

The First Floor (Ill. 192) demonstrates how the front and back drawing-rooms were thrown into one by the removal of the partition and the insertion of Ionic columns to carry the wall above. The general appearance of this alteration is indicated in Ill. 194, which also shows the new overmantel to the fireplace with its frame surrounding the central oil painting.

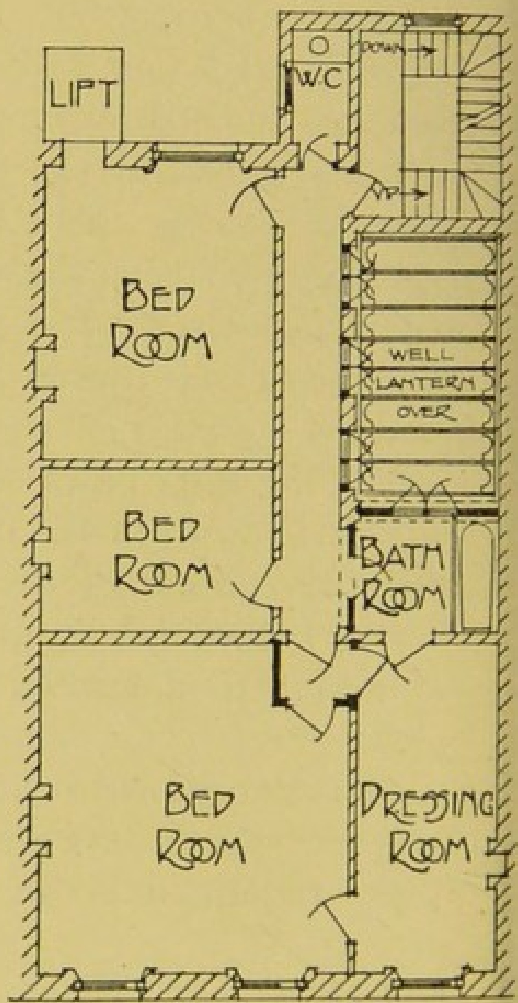
The Second, Third and Fourth Floors were provided, as shown in Ill. 193, with bathrooms and lavatories formed out of the wide corridor, and ventilated into an area which lighted the main staircase; this was covered with a curved skylight at the second-floor level.

The alterations to London houses usually embrace the provision of lavatories, bathrooms and W.C.'s, as these are lamentably deficient in all old houses.

A TOWN HOUSE



ILL. 192. FIRST-FLOOR PLAN.

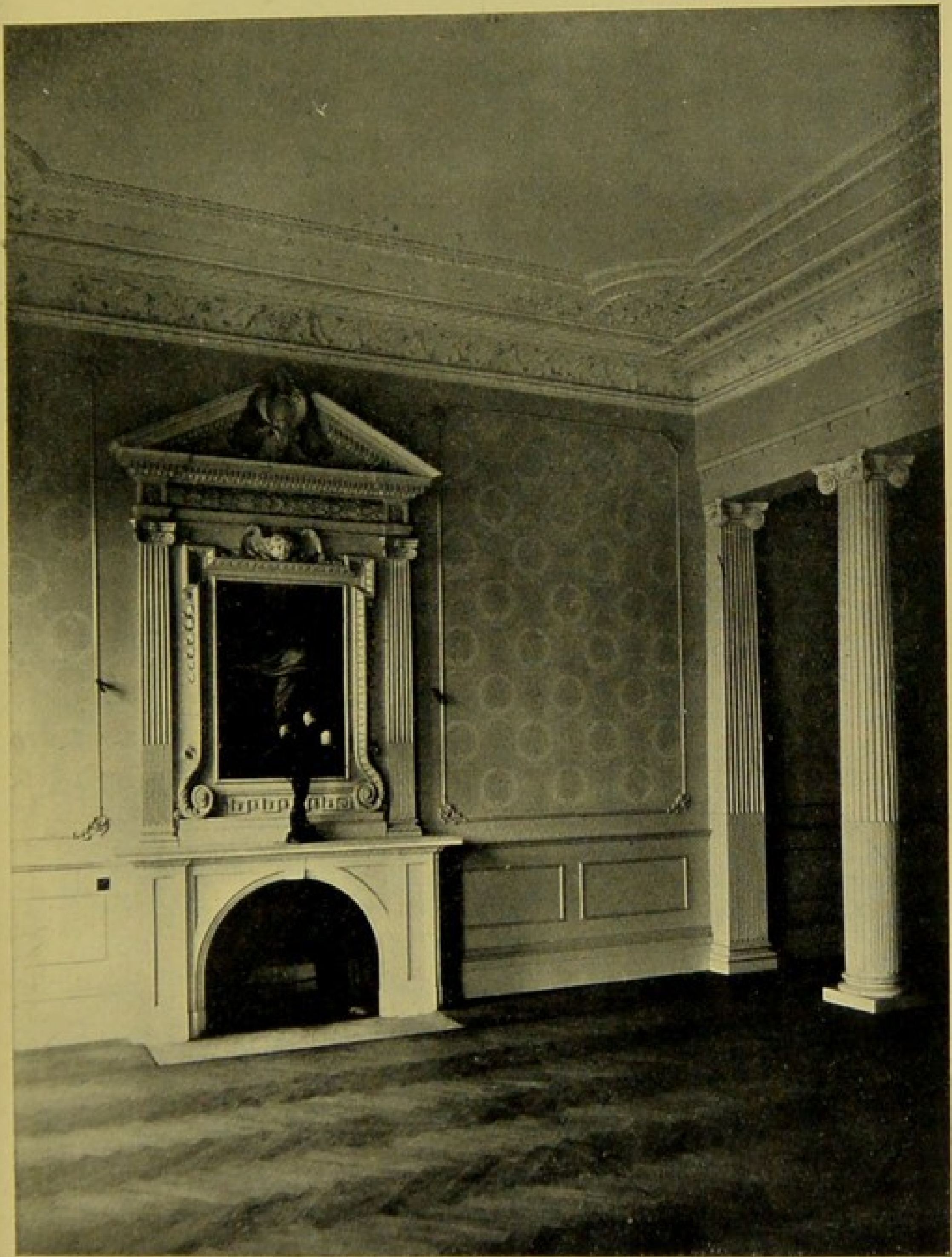


ILL. 193. SECOND-FLOOR PLAN.

SCALE OF 10 5 0 10 20 FEET

BANISTER FLETCHER AND SONS, FF.R.I.B.A., *Architects.*

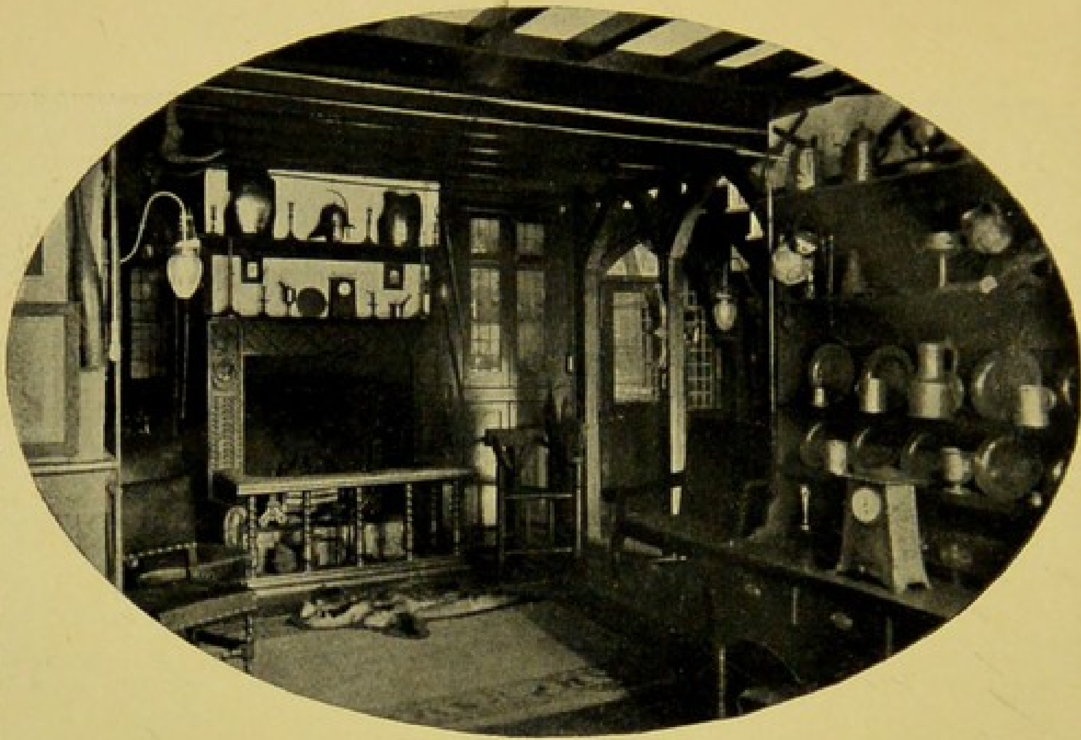
A TOWN HOUSE



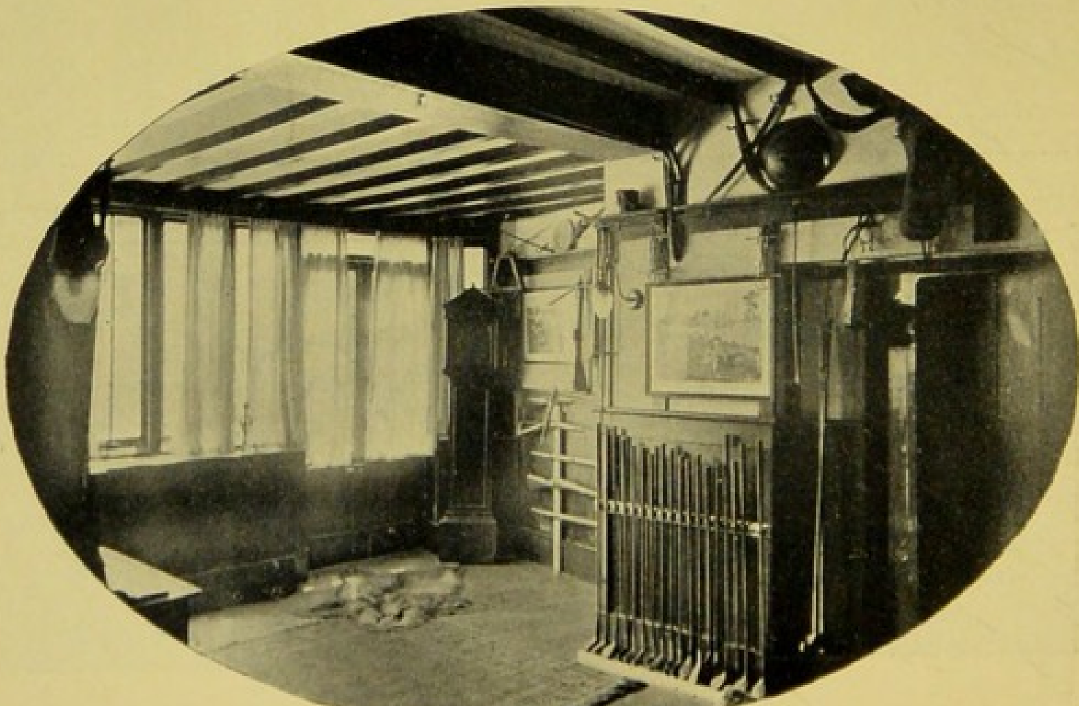
ILL. 194. THE DRAWING-ROOM.

BANISTER FLETCHER AND SONS, FF.R.I.B.A., *Architects.*

A SMALL COUNTRY HOUSE



Ill. 195. Sitting-hall, showing Fireplace.



Ill. 196. Sitting-hall, showing Bay Window.

Banister Fletcher and Sons, ff.r.i.b.a., *Architects.*

A Small Country House—The Lawn, Pinner, a small country house, was altered, as shown in Ills. 195 and 196, by the conversion of the scullery into a sitting-hall, by the removal of certain walls and the erection of an irregular-shaped bay. Bay windows were added to other rooms, more light was obtained by the removal of an antiquated lavatory, and a feature was made of a lounge on the mezzanine thrown out to the south front. A small servants' wing was formed to the north-west of the plan.

CHAPTER XVIII

MODERN ENGLISH HOMES

A Seaside Home in Thanet, designed by Arthur T. Bolton, F.R.I.B.A.

(Ills. 197, 198, 199, 200, and 201.)

THIS house is built as a family home by the sea, and its plan and construction are to be understood from that point of view.

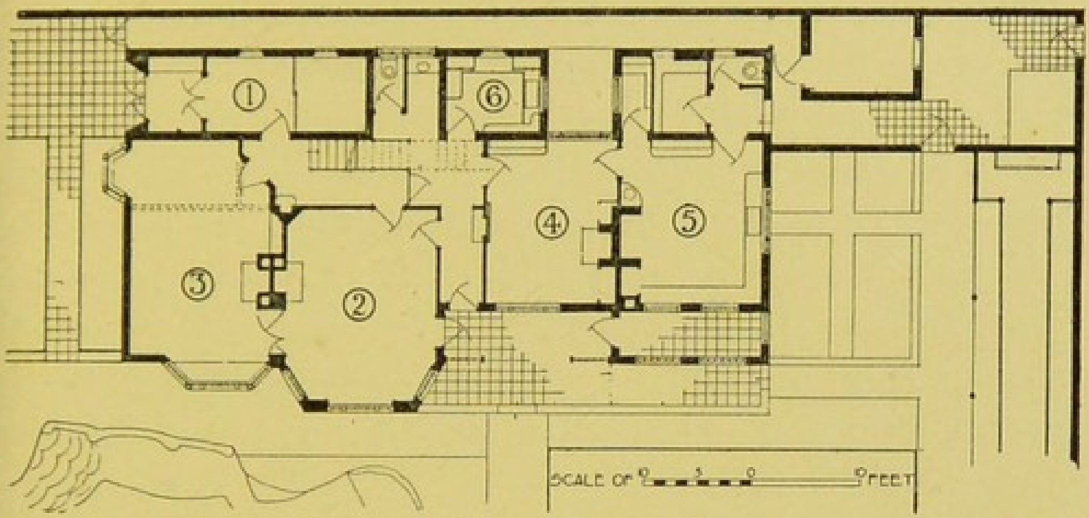
The oblong shape of the plan affords the maximum of sunlight and a wide unobstructed view over the sea, as will be seen in Ill. 201, which is a view of the house taken from the sands at low tide.

The house stands on a quarter-acre plot on the edge of a chalk pit which forms a sunk valley garden sheltered from the prevailing winds.

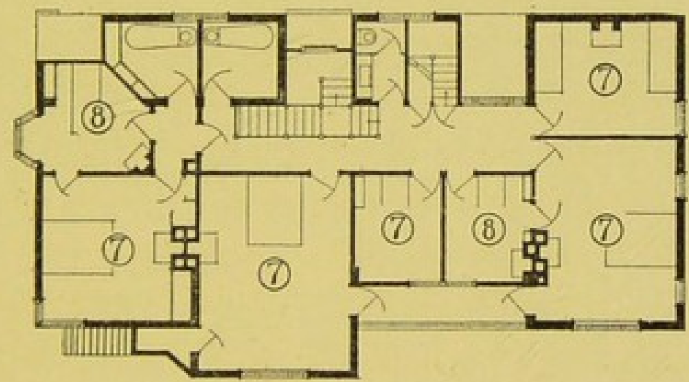
The ground-floor plan (Ill. 197) shows that the place of the usual third reception-room is taken by the recessed veranda and the terrace, where meals can be enjoyed in the open air. The dining and drawing rooms are connected by a folding partition in view of children's parties, and various minor arrangements of the plan are provided from the same point of view, as, for instance, the storage of cycles, etc., at the front rather than at the rear of the house.

The kitchen arrangements are unusually ample and allow of some degree of comfort for the domestics, the outer kitchen (No. 5) being practically a servants' hall.

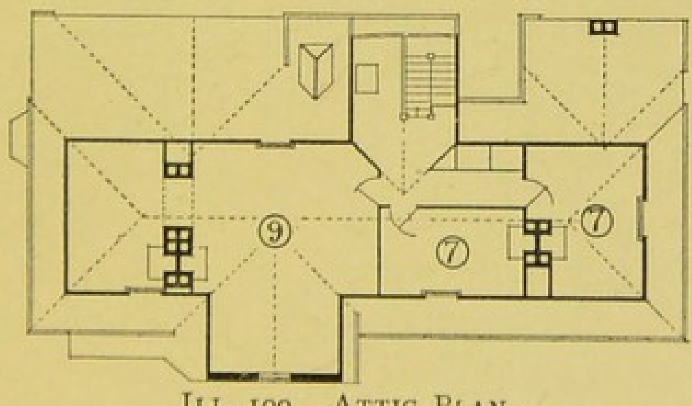
A SEASIDE HOME IN THANET



ILL. 197. GROUND-FLOOR PLAN.



ILL. 198. FIRST-FLOOR PLAN.



ILL. 199. ATTIC PLAN.

REFERENCE.

1. Outer Hall.
2. Dining-room.
3. Drawing-room.
4. Kitchen.
5. Outer Kitchen.
6. Pantry.
7. Bedrooms.
8. Dressing-room.
9. Children's Playroom.

ARTHUR T. BOLTON, F.R.I.B.A., *Architect.*

The bedroom-floor plan (Ill. 198) provides a complete suite (bedroom, dressing and bath room) for guests or for isolation in case of illness. The nursery has a central position, and the covered balcony can be used by young children for play or sleeping in the open, while also giving access to the mother's room.

The attic has a large playroom or children's paradise, formed in the roof with a lining of fireproof slabs. The arching over the flue forms a natural proscenium for charades and other games. Floors and partitions throughout are specially packed to deaden the noise of the children. The bathroom and lavatories have tiled walls and first-class sanitary fittings, and there is a liberal provision of cupboards and other fittings throughout the house.

The house is built of Kentish stock brick with granite and cement rough cast and has a red-tile roof (Ill. 201). It is strongly constructed to resist the wind and weather conditions, which are severe. The garden is enclosed by a rough rag rubble wall.

The total cost may be taken as £1500 inclusive for a similar house in any ordinary locality.

A SEASIDE HOME IN THANET

ILL. 200. THE DRAWING-ROOM.

ILL. 201. SEA FRONT.

ARTHUR T. BOLTON, F.R.I.B.A., *Architect.*

Bengeo House, Hertford, designed by Walter Cave, F.R.I.B.A.

(Ills. 202, 203, 204, 205, 206, 207, and 208.)

This house was designed to take the place of one which had been burnt to the ground. It was absolutely necessary to keep the cost to £4000, and in the end the owner entered into occupation with the house completed in every respect for £3990. The accommodation required was as follows :—Hall, library, dining-room, drawing-room, with the usual servants' offices, servants' hall, thirteen bedrooms for the family, four servants' rooms, three bathrooms and five W.C.'s, etc.

It was evident that there would have to be great economy exercised in the planning so as to provide the necessary rooms within the cost.

The arrangement adopted began with a hall from which all the principal ground-floor rooms opened and one central passage through the offices to the back door.

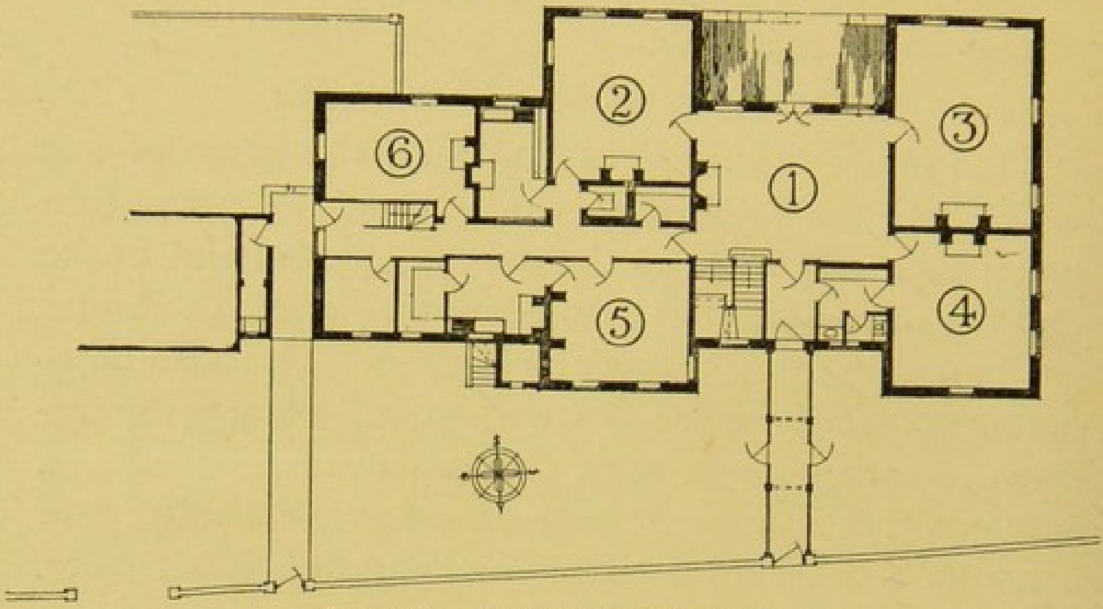
The same central passage is used on the two floors above, and is lit by the windows of the back and front staircases.

The pitch of the roof adopted was 52 degrees, which being fairly steep gives good rooms in the attics with ashlaring 5 ft. high.

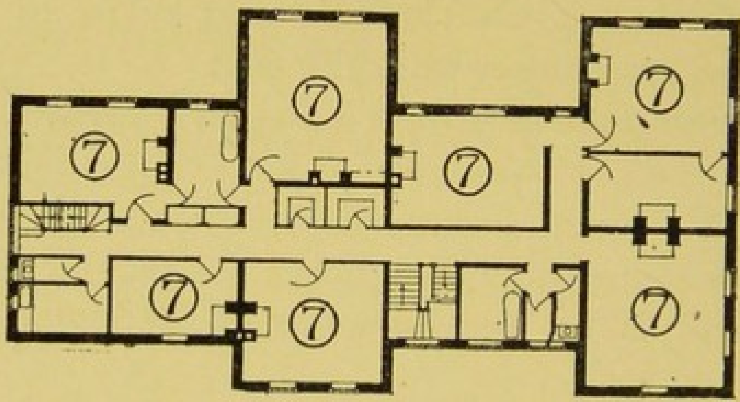
The walls were built with a mottled purple Luton brick with red-brick arches and string course, and a fine lot of old roof tiles were fortunately obtained in the neighbourhood.

The hall and three best rooms on the ground floor have oak floors and birch doors stained dark brown, the other woodwork being left white. All the servants' department and most of the woodwork elsewhere throughout the house are of yellow deal stained a dark brown and dull polished.

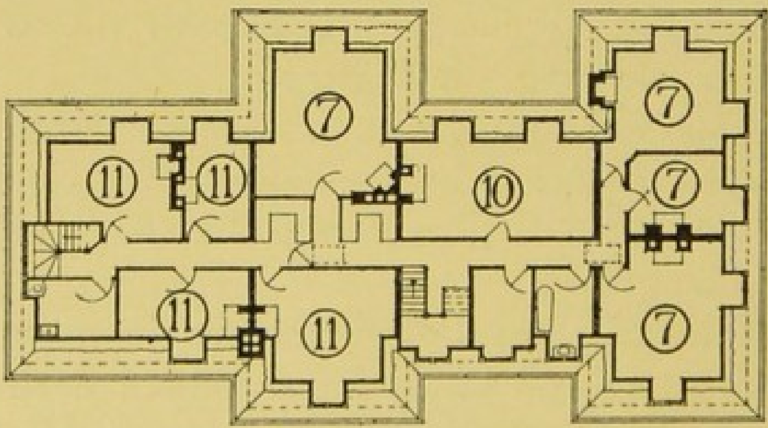
BENGEO HOUSE, HERTFORD



ILL. 202. GROUND-FLOOR PLAN.



ILL. 203. FIRST-FLOOR PLAN.



ILL. 204. ATTIC PLAN.

SCALE OF 10 5 0 10 20 30 FEET.

REFERENCE.

1. Hall.
2. Dining-room.
3. Drawing-room.
4. Library.
5. Kitchen.
6. Servants' Hall.
7. Bedrooms.
10. Nursery.
11. Maids' Rooms.

WALTER CAVE, F.R.I.B.A., *Architect.*

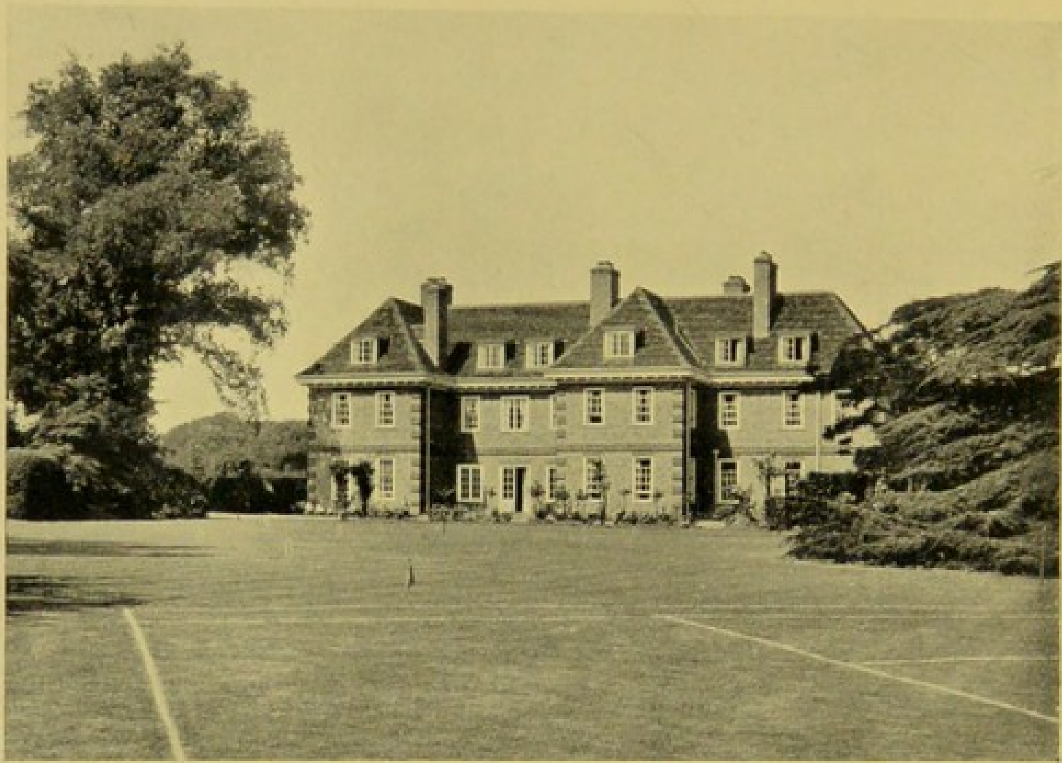
BENGEO HOUSE, HERTFORD

ILL. 205. THE HALL.

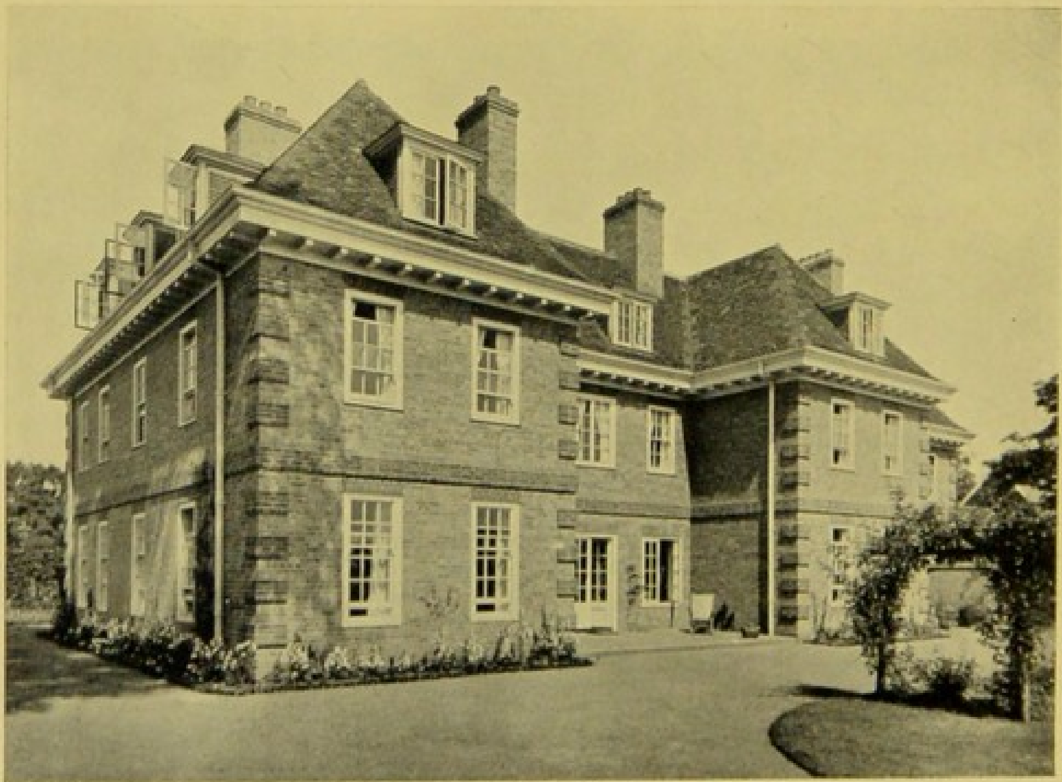
ILL. 206. THE DRAWING-ROOM.

WALTER CAVE, F.R.I.B.A., *Architect.*

BENGEO HOUSE, HERTFORD



ILL. 207. SOUTH ELEVATION.



ILL. 208. SOUTH-WEST ELEVATION.

WALTER CAVE, F.R.I.B.A., *Architect.*

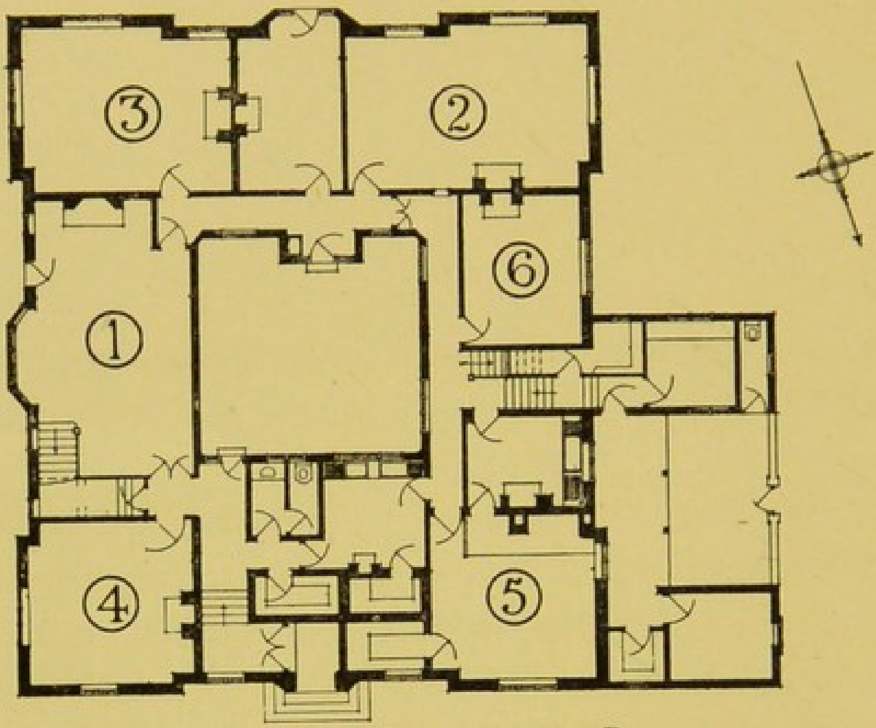
Sherwood, Newton St. Cyres, Devon, designed by Walter Cave, F.R.I.B.A.

(Ills. 209 and 210.)

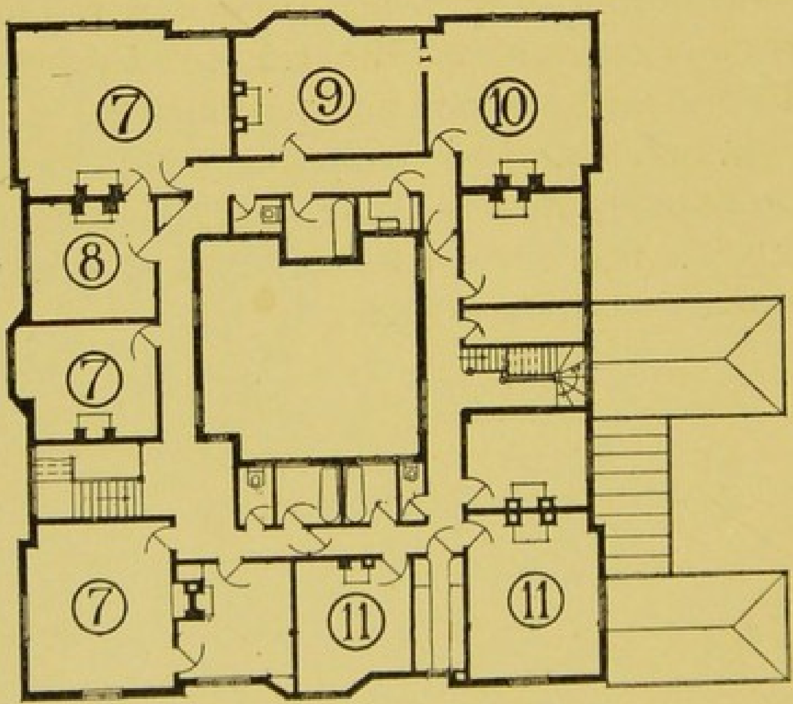
This house is situated on a somewhat inaccessible hillside at some distance from a village and the main road, and in consequence it was essential to plan the house with a view to economy in working, as the service difficulty was sure to be great. The plan adopted was the hollow square, which gives the minimum of passages and easy and quick access to all rooms. The central courtyard is used for lighting the passages, bathroom and the less important servants' offices. Free ventilation into this court from the passage is an important point in the somewhat exposed situation.

The cost was about £4200.

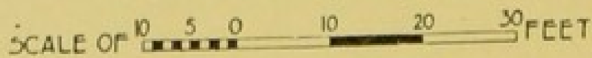
SHERWOOD, NEWTON ST. CYRES, DEVON



ILL. 209. GROUND-FLOOR PLAN.



ILL. 210. FIRST-FLOOR PLAN.



REFERENCE.

1. Hall.
2. Dining-room.
3. Drawing-room.
4. Library.
5. Kitchen.
6. Servants' Hall.
7. Bedroom.
8. Dressing-room.
9. Day Nursery.
10. Night Nursery.
11. Maids' Room.

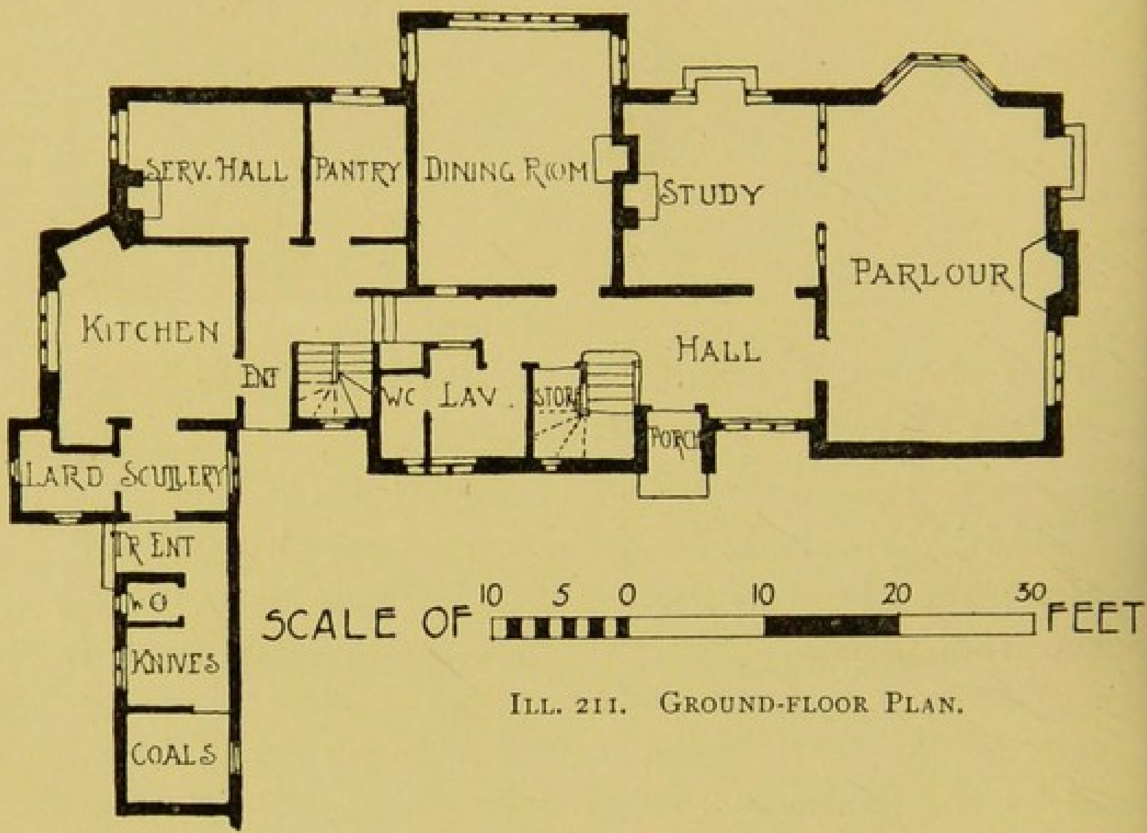
WALTER CAVE, F.R.I.B.A., *Architect.*

Maes Heulyn, Trefnant, North Wales, designed by E. Guy Dawber, F.R.I.B.A.

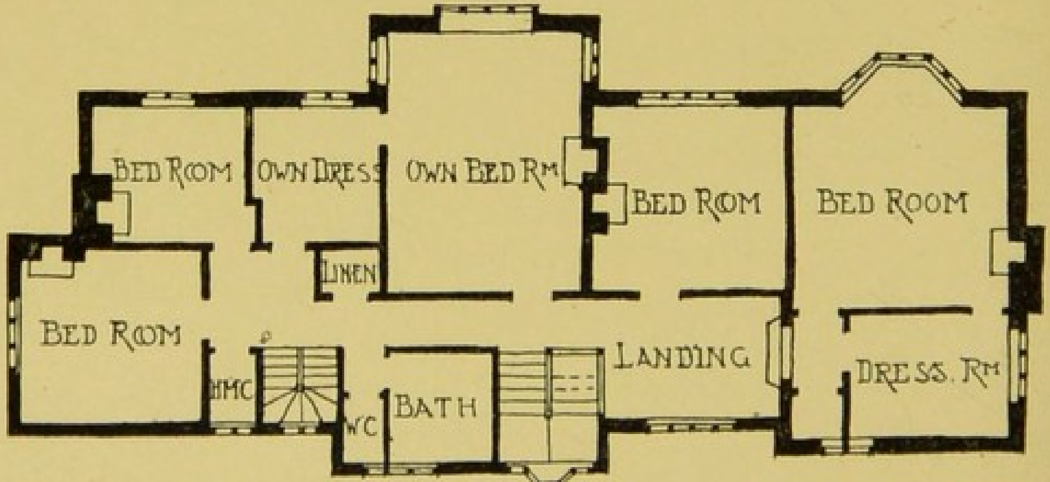
(Ills. 211, 213, 214, 215, and 216.)

This house is built of brick and rough cast, with stone dressings to the external doors and gables, the roof being of grey-green slates graduated in size from the eaves to the ridge. The rooms are finished in white deal, enamelled, with oak floors and hand-modelled plaster ceilings.

MAES HEULYN, TREFNANT, NORTH WALES



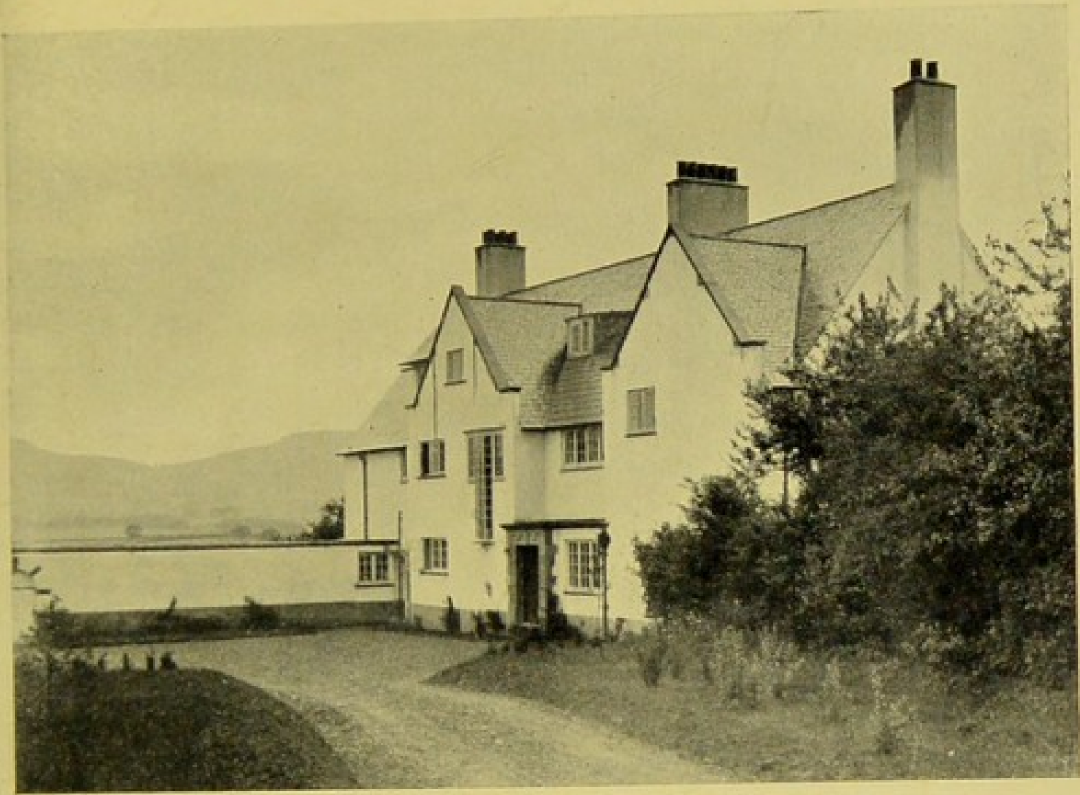
ILL. 211. GROUND-FLOOR PLAN.



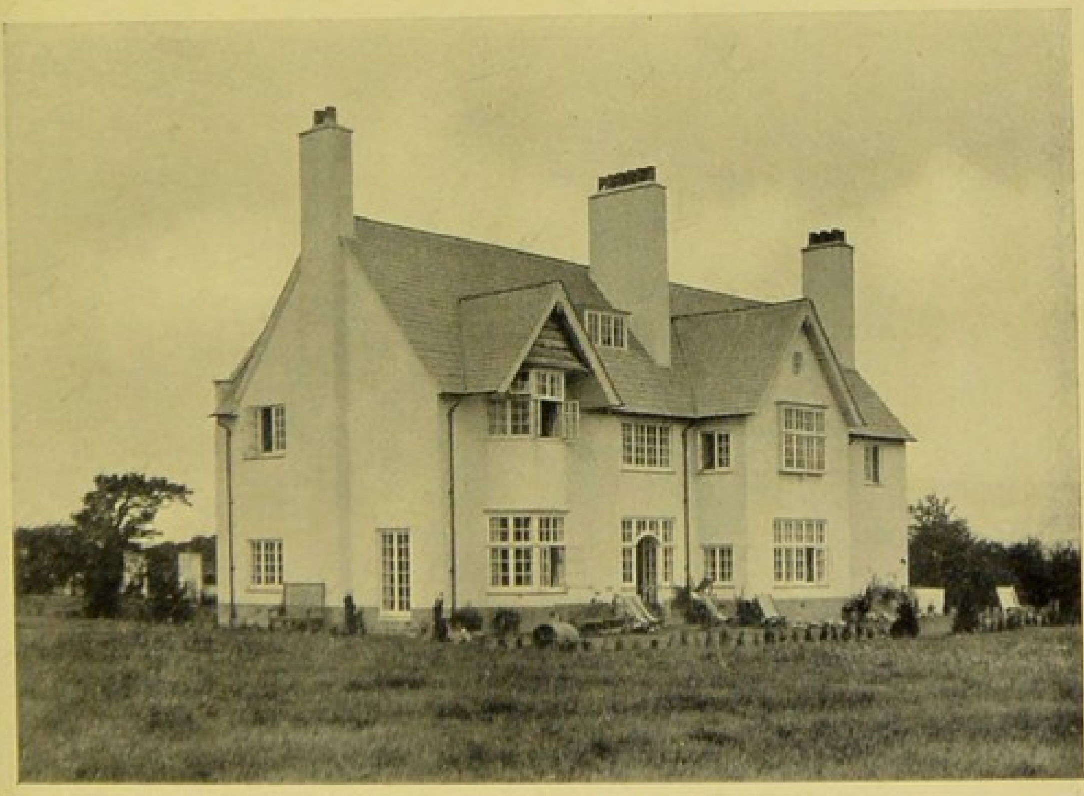
ILL. 212. FIRST-FLOOR PLAN.

E. GUY DAWBER, F.R.I.B.A., *Architect*

MAES HEULYN, TREFNANT, NORTH WALES



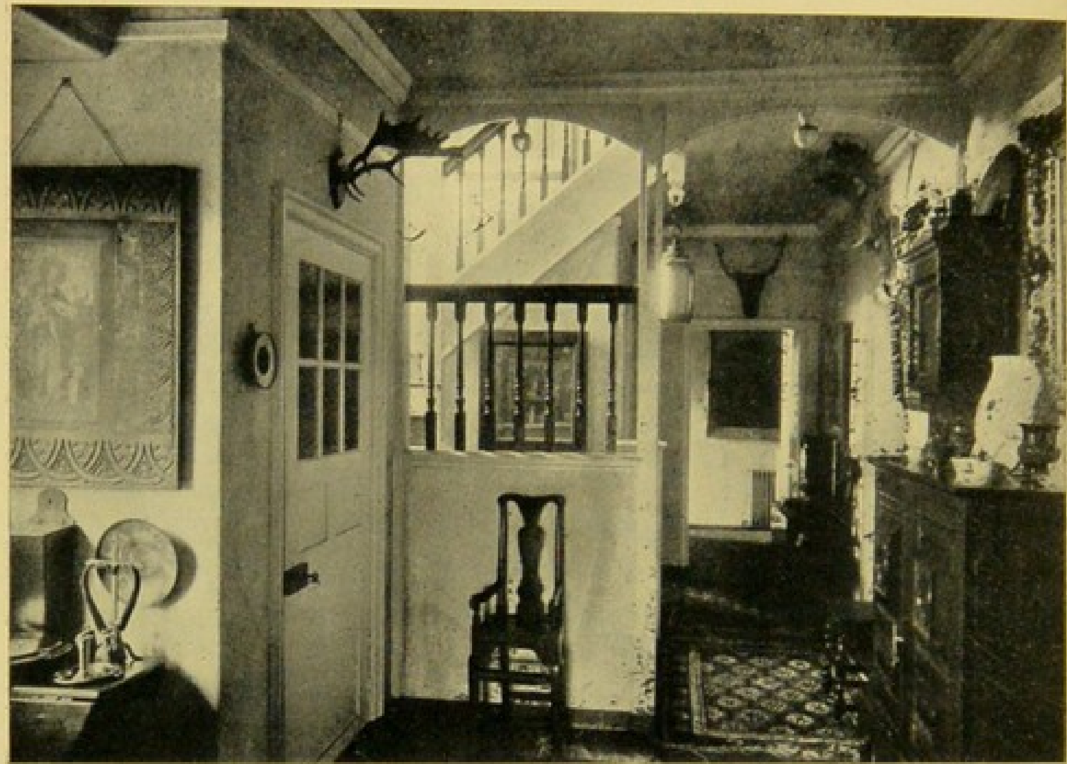
ILL. 213. THE ENTRANCE FORECOURT.



ILL. 214. THE GARDEN FRONT.

E. GUY DAWBER, F.R.I.B.A., *Architect.*

MAES HEULYN, TREFNANT, NORTH WALES



ILL. 215. THE HALL AND STAIRCASE.

ILL. 216. THE DRAWING-ROOM.

E. GUY DAWBER, F.R.I.B.A., *Architect.*

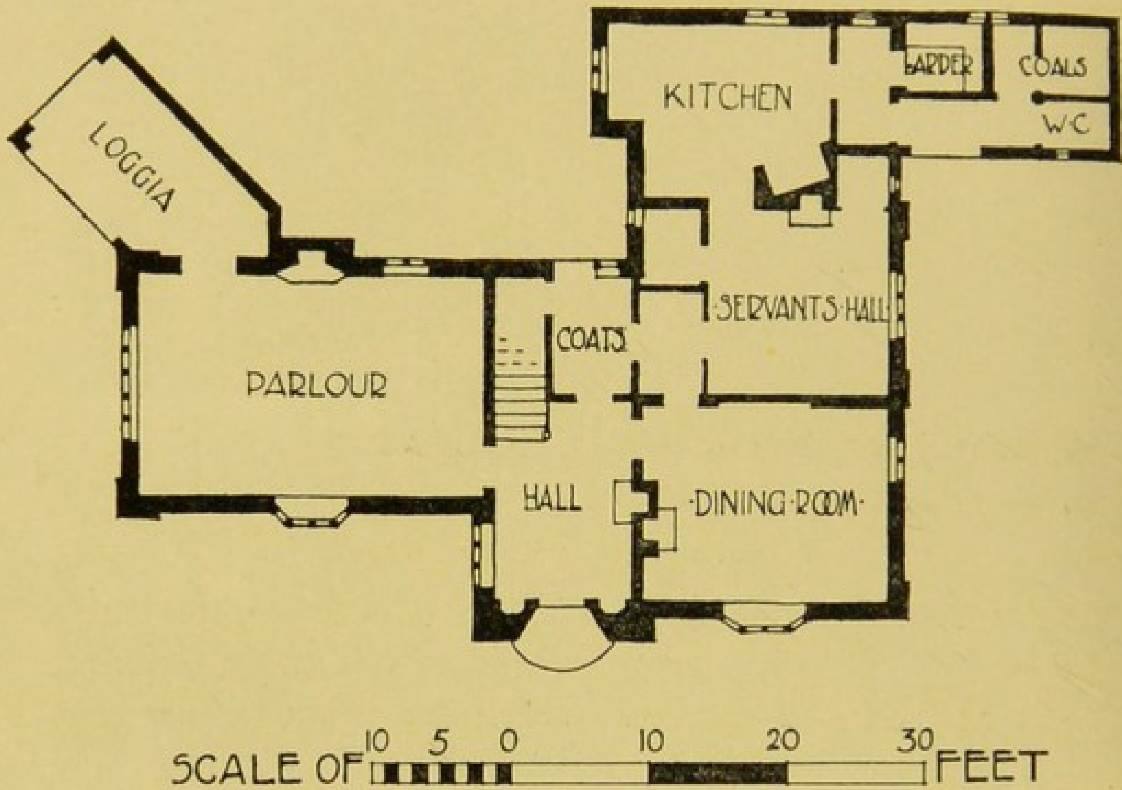
Wynnes Parc, North Wales, designed by E. Guy Dawber, F.R.I.B.A.

(Ills. 217, 218, 219, and 220.)

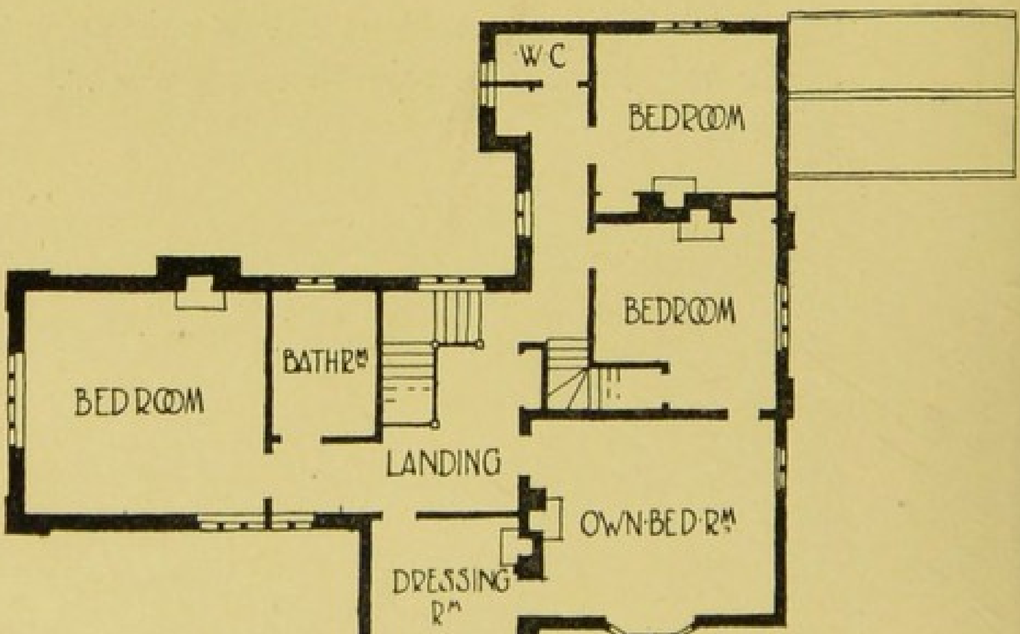
Wynnes Parc is in the Vale of Clwyd, and the house had the advantage of being built in an existing orchard and old garden which by a small amount of alteration has been worked in to suit the new house.

Stone - flagged paths and formal beds make a pleasant feature when seen from the windows of the house or the loggia which adjoins the parlour.

WYNNES PARC, NORTH WALES



ILL. 217. GROUND-FLOOR PLAN.



ILL. 218. FIRST-FLOOR PLAN.

E. GUY DAWBER, F.R.I.B.A., *Architect.*

WYNNES PARC, NORTH WALES

Ill. 219. The Parlour.

Ill. 220. The Entrance Forecourt.

E. Guy Dawber, F.R.I.B.A., *Architect.*

Seldown, Potters Bar, designed by Banister Fletcher and Sons, FF.R.I.B.A.

(Ills. 221, 222, 223, 224, and 225.)

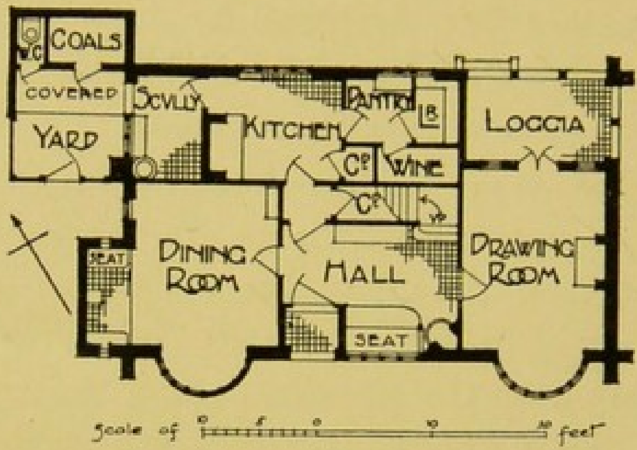
This house was the first to be erected on the Potters Bar estate, which is being developed in order to provide detached houses of an economical description within easy access of Town. The accommodation on the ground floor consists of dining-room with ingle-nook, sitting-hall with fireplace, large drawing-room with tiled loggia, kitchen and usual offices. The first floor contains five bed-rooms, a dressing-room, bathroom and lavatory, and the attic floor has two bedrooms and linen cupboards.

The ground-floor rooms are panelled to a height of seven feet with Oregon pine. The floors to drawing-room and dining-room are of pitchpine wood block, and the hall has 4-in. square red tiles.

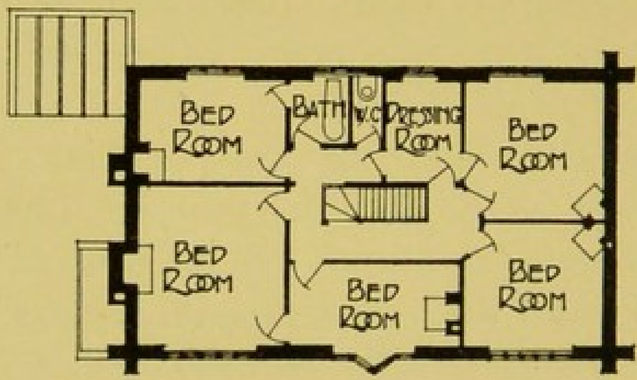
The house is solidly constructed with 14-in. external walls, and effect has been sought for by the simple distribution of the parts. The exterior is rough cast, and the roof is covered with grey-green Lancashire slates laid in diminishing courses. The house was detailed throughout by the architects, who also designed much of the simple furniture which it contains. The cost was £1160.

The garden is laid out in accordance with the architects' plans.

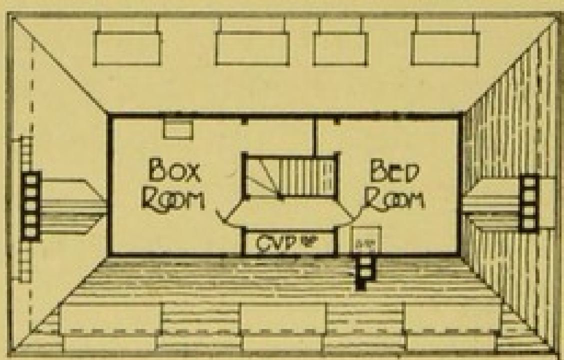
SELDOWN, POTTERS BAR



ILL. 221. GROUND-FLOOR PLAN.



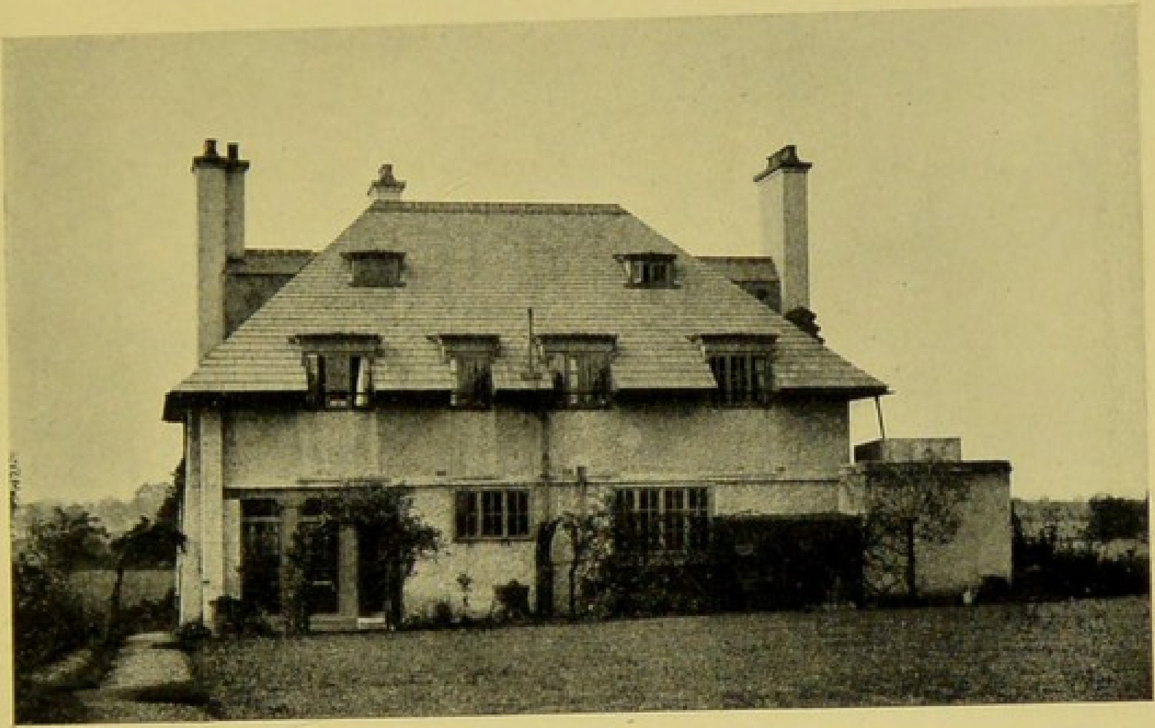
ILL. 222. FIRST-FLOOR PLAN.



ILL. 223. ATTIC PLAN.

BANISTER FLETCHER AND SONS, FF.R.I.B.A., *Architects.*

SELDOWN, POTTERS BAR



ILL. 224. THE GARDEN FRONT.

ILL. 225. THE ENTRANCE FRONT.

BANISTER FLETCHER AND SONS, FF.R.I.B.A., *Architects.*

Homeleigh, Potters Bar, designed by Banister Fletcher and Sons, FF.R.I.B.A.

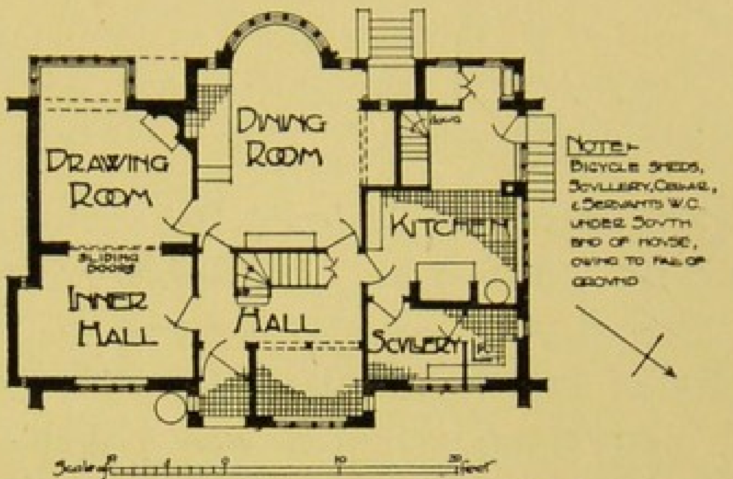
(Ills. 226, 227, 228, 229, 230, 231, 232, and 238.)

The site of this house sloped considerably from the road, and consequently it was possible to get storage for bicycles and other accommodation under the drawing-room, as shown on Ill. 231. The square sitting-hall practically adds another reception-room to the house, which is erected with 14-in. walls treated with rough cast and roofed with red tiles.

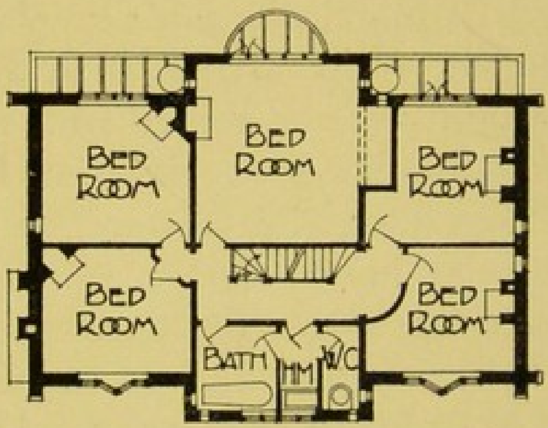
Ills. 229 and 230 show the interior, in which the joists to the floors are visible throughout, there being no plaster ceilings in the house. Two thicknesses of boarding were used on the surface of the joists, and a layer of non-conducting material was placed between them in order to prevent sound passing from one floor to another, as will be easily understood by reference to Ill. 31.

The cost of this house was £1300.

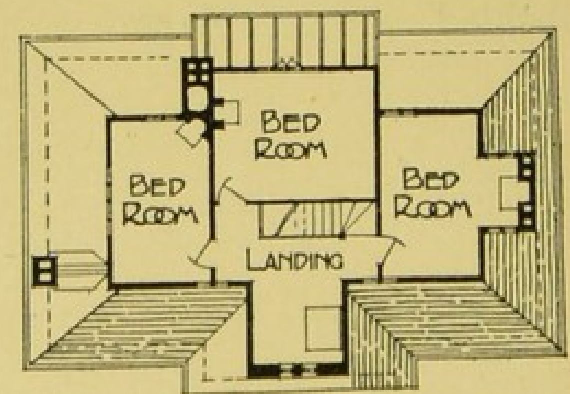
HOMELEIGH, POTTERS BAR



Ill. 226. Ground-floor Plan.



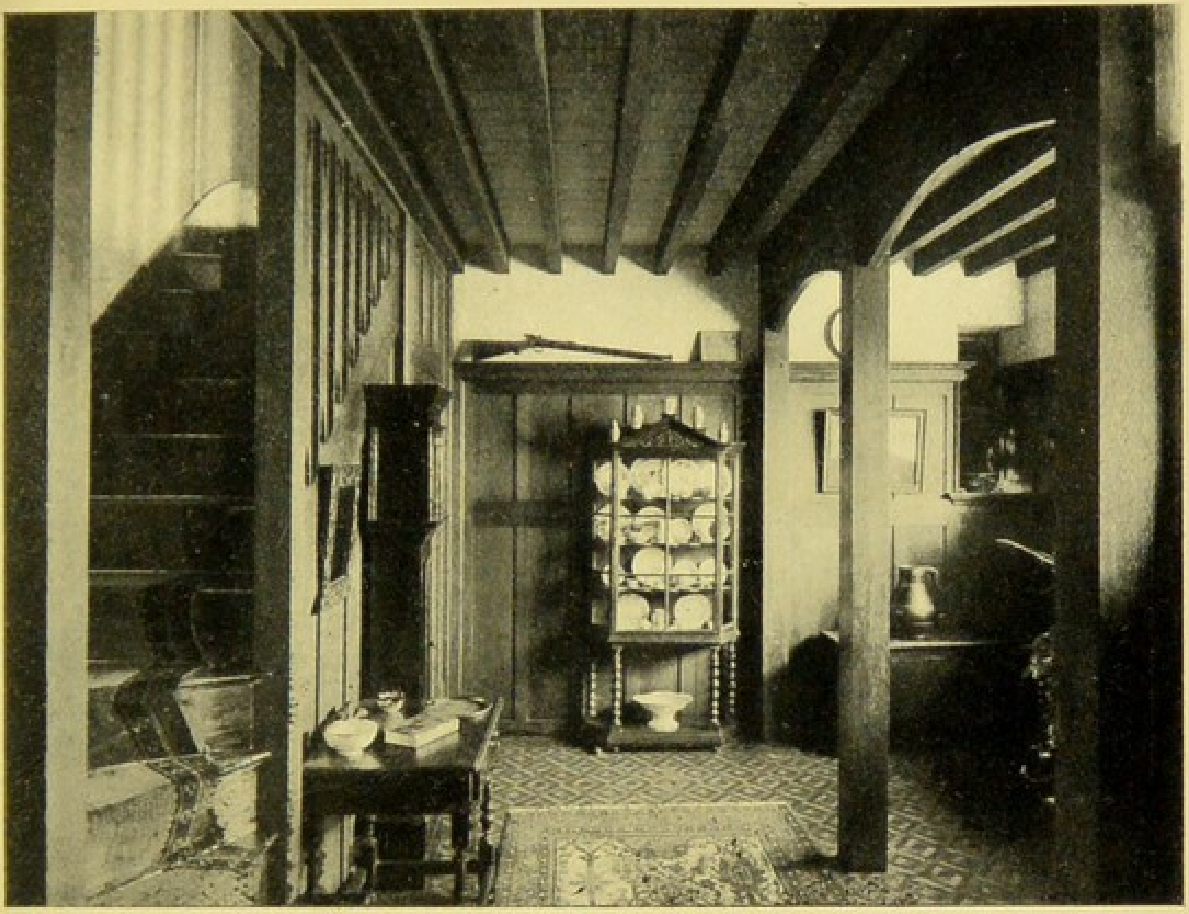
Ill. 227. First-floor Plan.



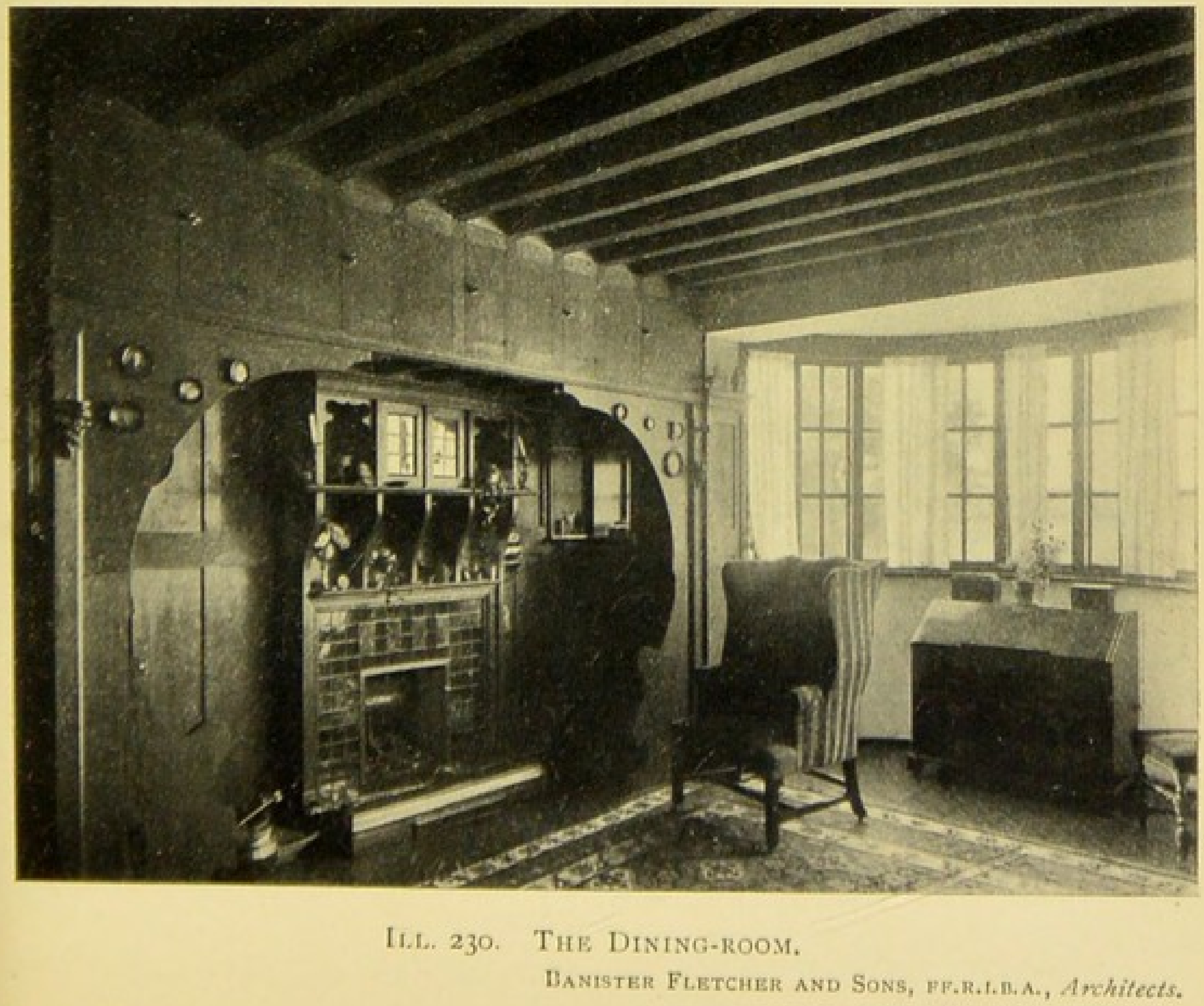
Ill. 228. Attic Plan.

Banister Fletcher and Sons, ff.r.i.b.a., *Architects.*

HOMELEIGH, POTTERS BAR



ILL. 229. THE SITTING-HALL.

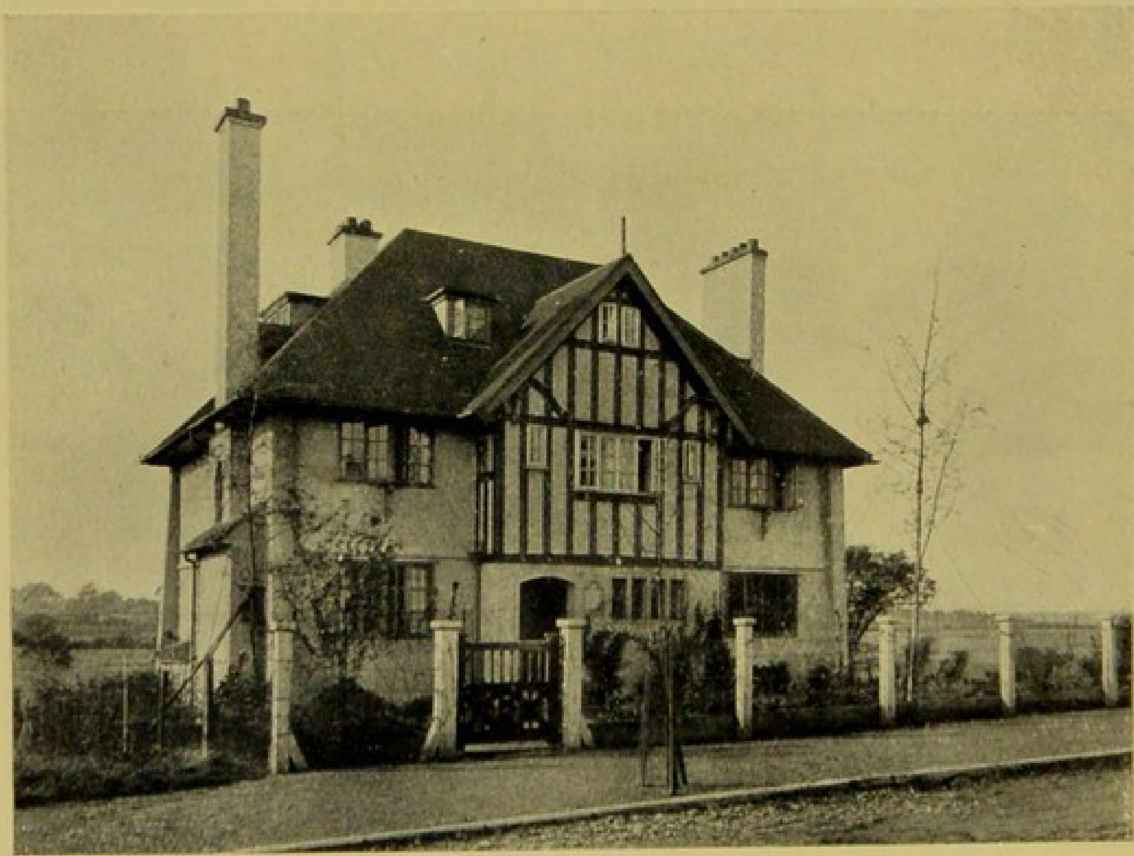


ILL. 230. THE DINING-ROOM.

BANISTER FLETCHER AND SONS, FF.R.I.B.A., *Architects.*

HOMELEIGH, POTTERS BAR

ILL. 231. THE GARDEN FRONT.



ILL. 232. THE ENTRANCE FRONT.

BANISTER FLETCHER AND SONS, FF.R.I.B.A., *Architects.*

The Three Gables, Potters Bar, designed by Banister Fletcher and Sons, FF.R.I.B.A.

(Ills. 233, 234, 235, 236, 237, 239, 240, and 241.)

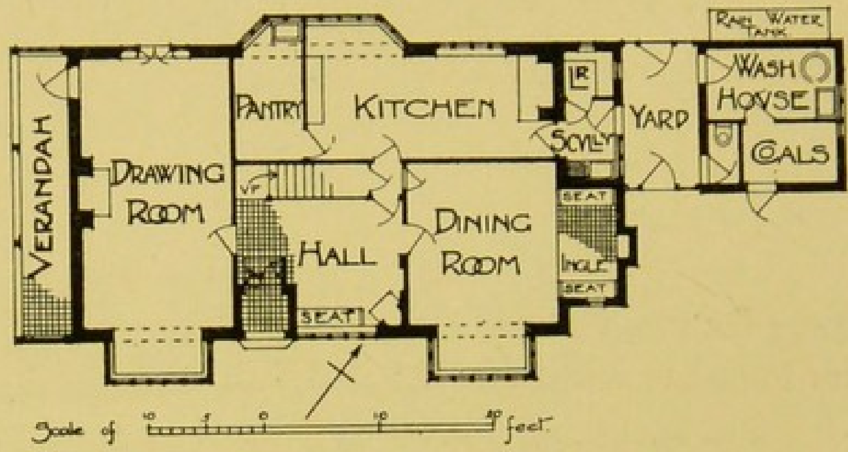
This house was erected for Mr. F. J. Philps, who is one of the Directors of the Potters Bar Estates Company.

The plan has a square central sitting-hall (a view of which is shown in Ill. 239), dining-room with ingle-nook and large drawing-room connected to the veranda; much of the simple furniture has been designed by the architects.

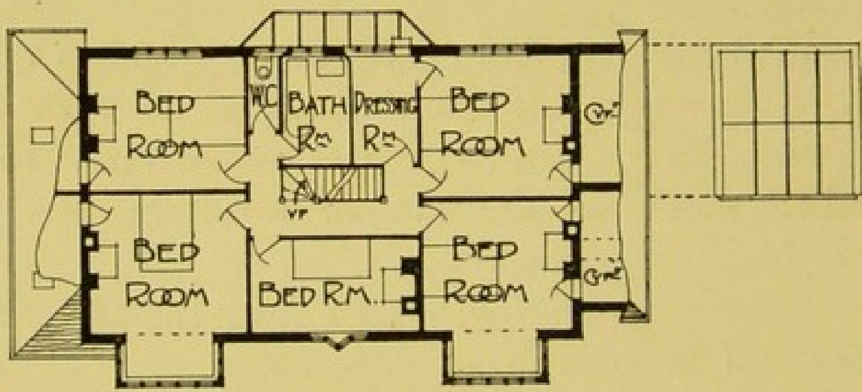
The exterior has rough cast and tile-hung walls and the roof is covered with red titles.

The cost of this house was £1585, including entrance gates and drive.

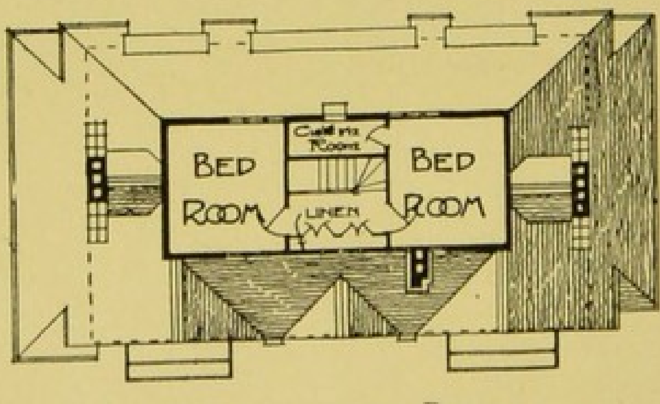
THE THREE GABLES, POTTERS BAR



ILL. 233. GROUND-FLOOR PLAN.



ILL. 234. FIRST-FLOOR PLAN.

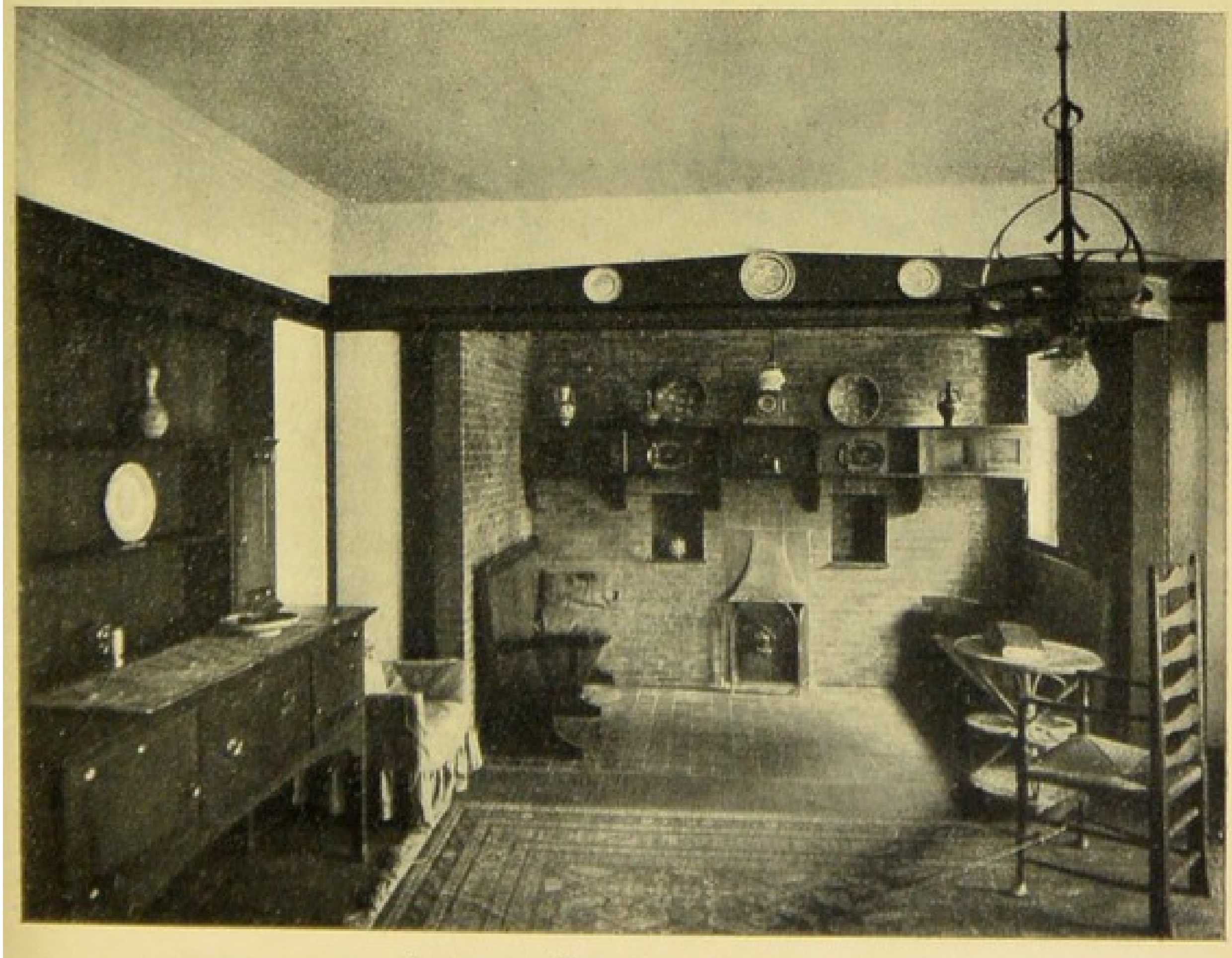


ILL. 235. ATTIC PLAN.

BANISTER FLETCHER AND SONS, FF.R.I.B.A., *Architects.*

THE THREE GABLES, POTTERS BAR

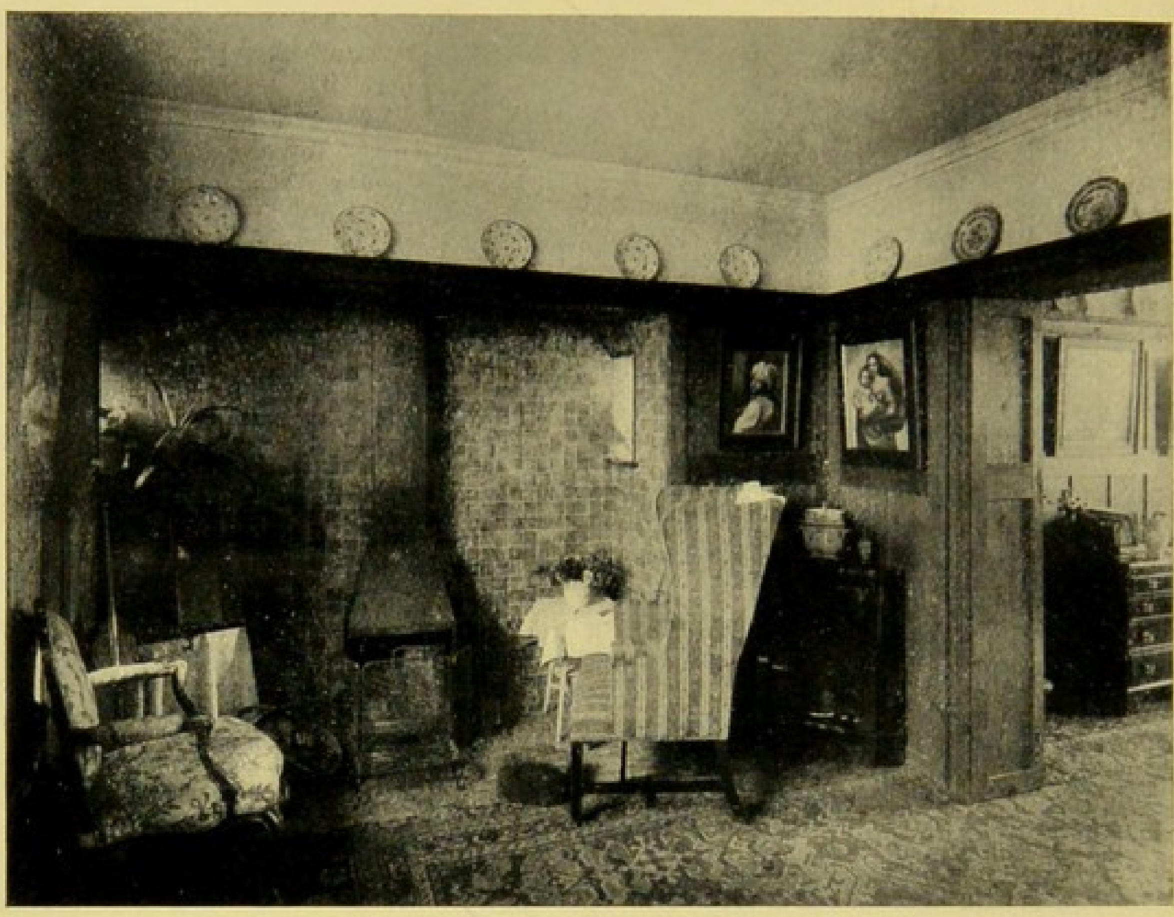
ILL. 236. THE DRAWING-ROOM.



ILL. 237. THE DINING-ROOM.

BANISTER FLETCHER AND SONS, FF.R.I.B.A., *Architects.*

HOMELEIGH, POTTERS BAR



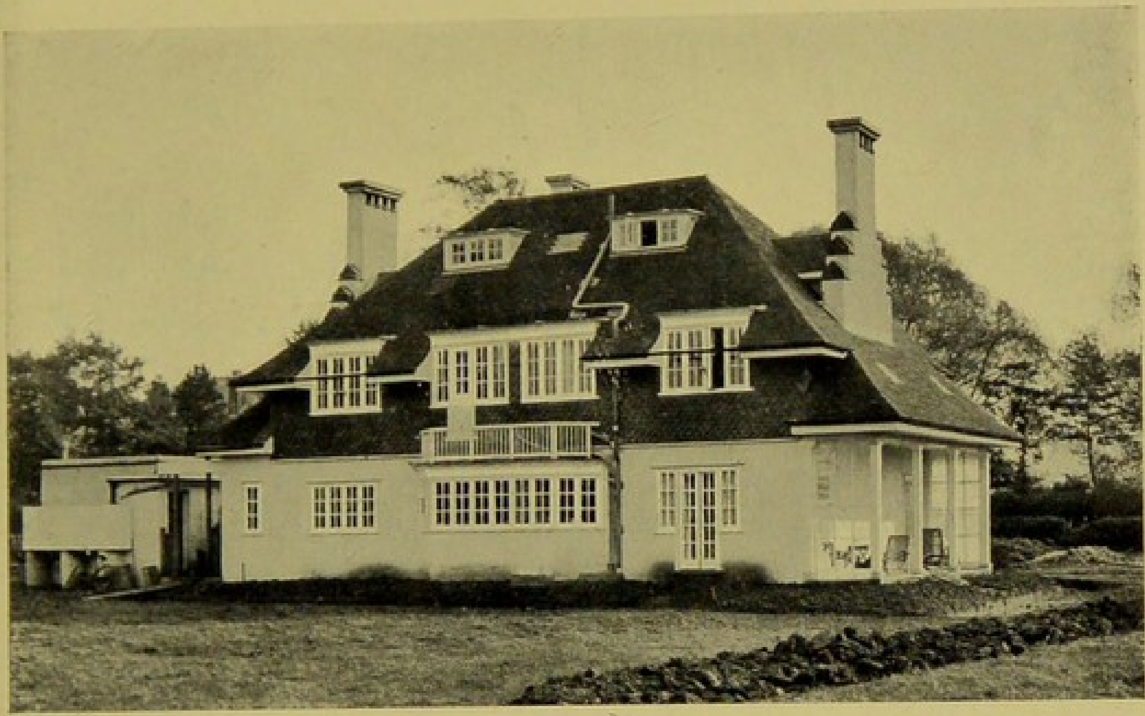
ILL. 238. INGLE-NOOK IN INNER HALL.

THE THREE GABLES, POTTERS BAR

ILL. 239. THE SITTING-HALL AND DINING-ROOM INGLE BEYOND.

BANISTER FLETCHER AND SONS, FF.R.I.B.A., *Architects.*

THE THREE GABLES, POTTERS BAR



ILL. 240. THE GARDEN FRONT.

ILL. 241. THE ENTRANCE FRONT.

BANISTER FLETCHER AND SONS, FF.R.I.B.A., *Architects.*

The Fourth House, Potters Bar, designed by Banister Fletcher and Sons, FF.R.I.B.A.

(Ills. 242, 243, 244, 245, and 246.)

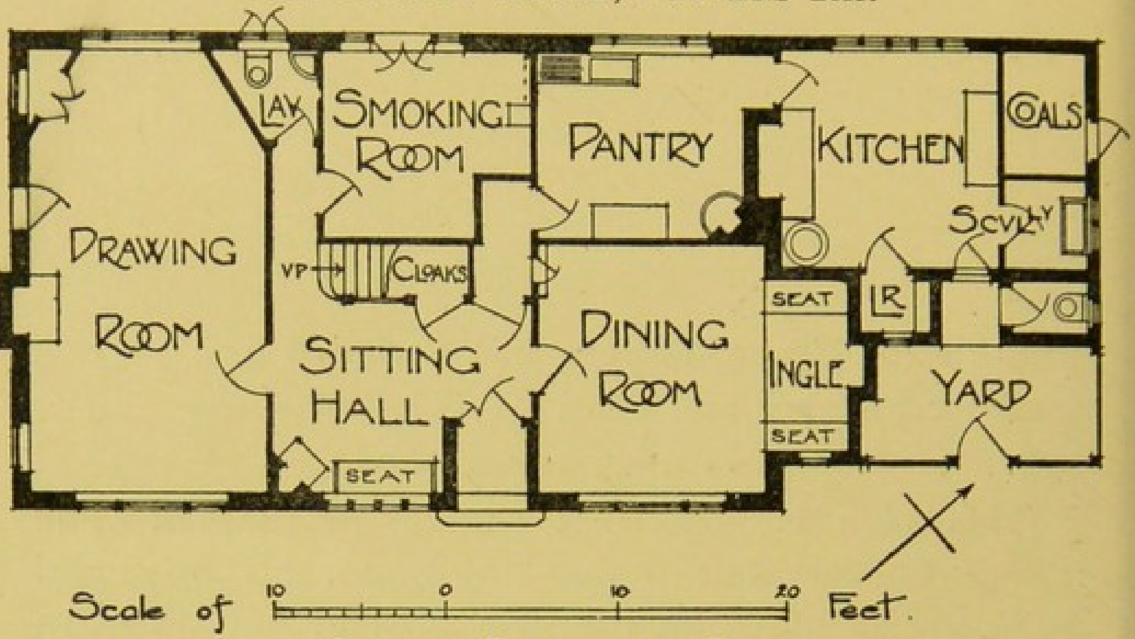
This plan is somewhat similar to that of The Three Gables, but a smoking-room, lavatory and W.C. are included on the ground floor and an extra bedroom is also contrived in the attic story (Ill. 244).

The exterior is Georgian in character, the bricks being specially selected to give a somewhat mottled appearance, which gives a pleasing texture. The wooden cornice has a projection of 2 ft. 6 in., thus throwing a good shadow and protecting the walls from rain.

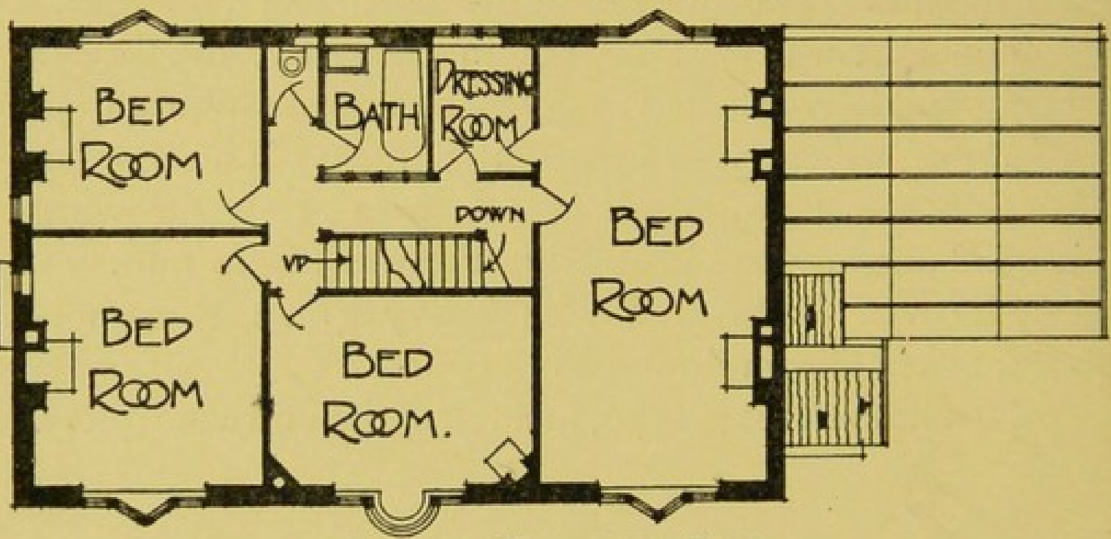
The roof is covered with heavy green Westmorland slates laid in diminishing courses.

This house cost £1570, including the entrance gates.

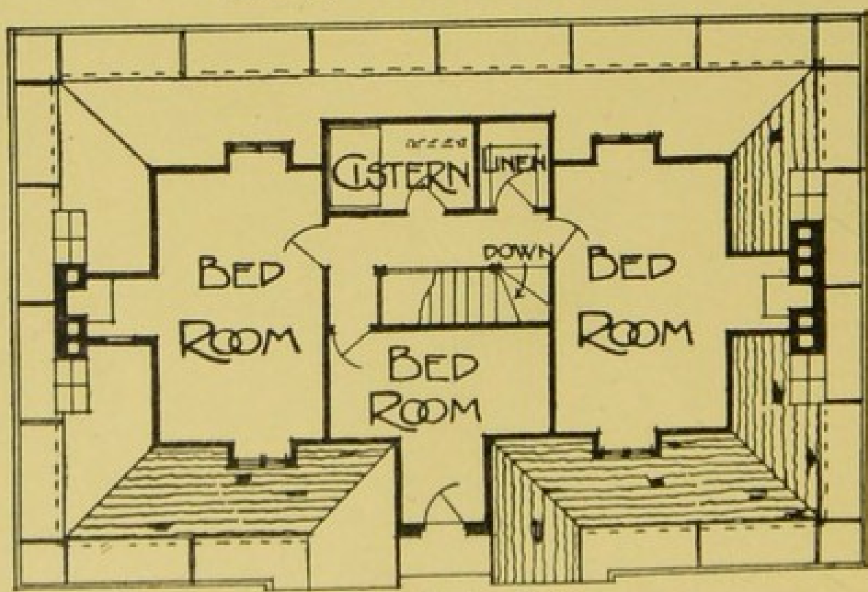
THE FOURTH HOUSE, POTTERS BAR



ILL. 242. GROUND-FLOOR PLAN.



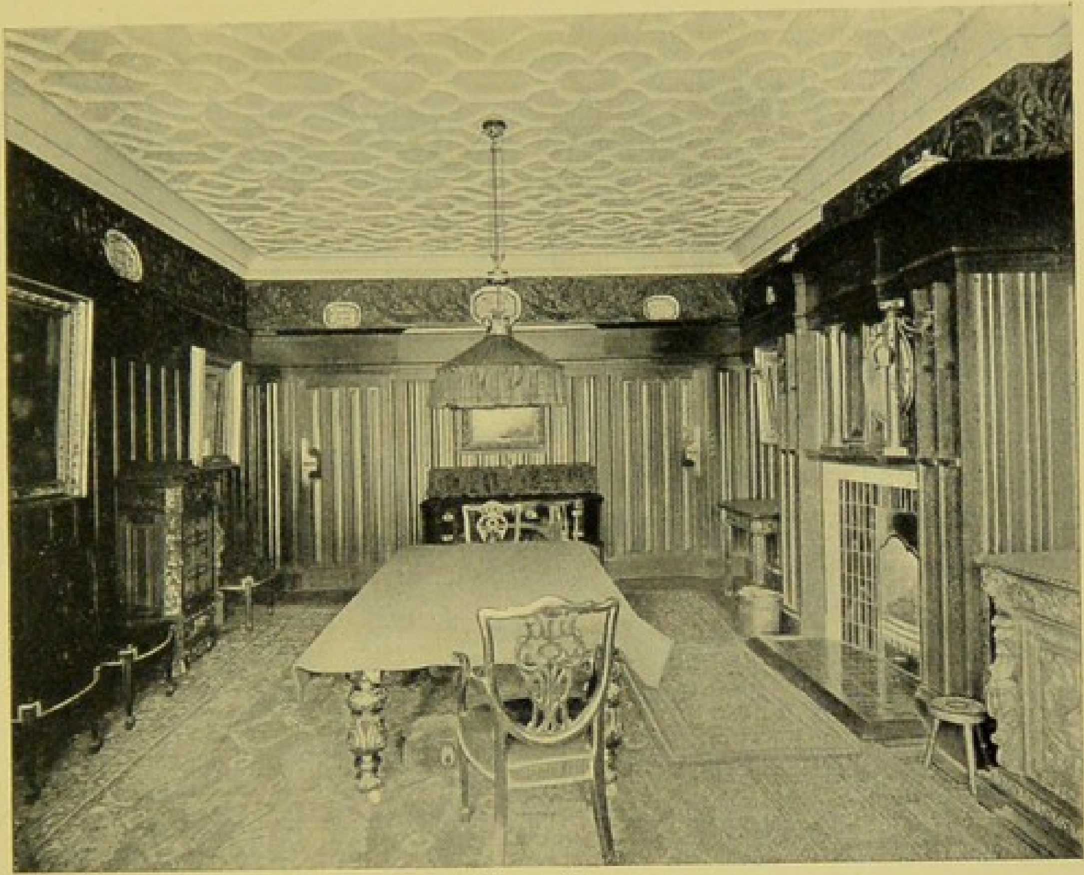
ILL. 243. FIRST-FLOOR PLAN.



ILL. 244. ATTIC PLAN.

BANISTER FLETCHER AND SONS, FF.R.I.B.A., *Architects.*

THE FOURTH HOUSE, POTTERS BAR

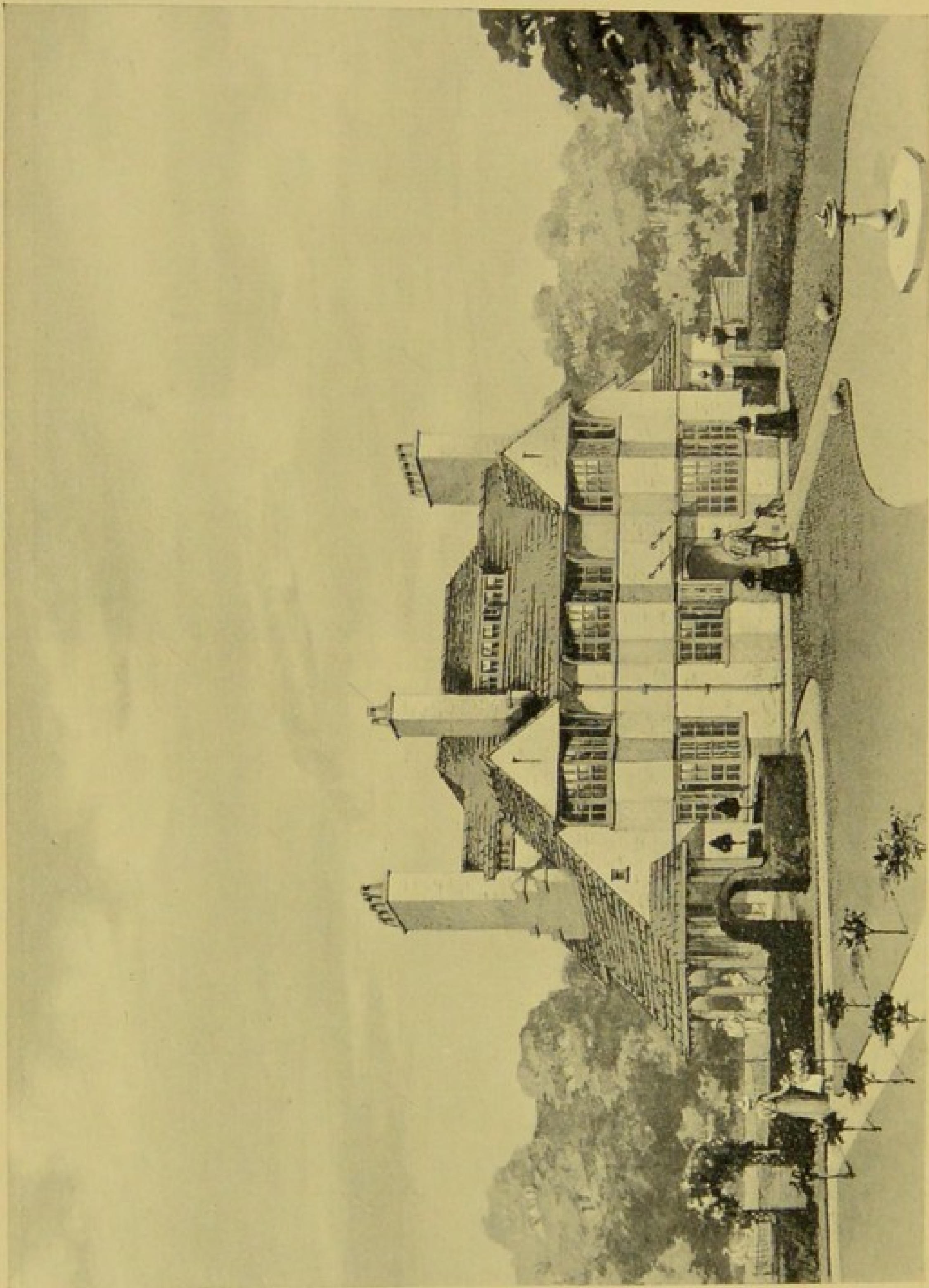


ILL. 245. THE DINING-ROOM.

ILL. 246. THE ENTRANCE FRONT.

BANISTER FLETCHER AND SONS, FF.R.I.B A., *Architects.*

THE FIFTH HOUSE, POTTERS BAR



ILL. 247. THE ENTRANCE FRONT.

The Fifth House, Potters Bar, designed by Banister Fletcher and Sons, FF.R.I.B.A.

(Ill. 247.)

This house has a sitting-hall so screened that it is rendered more secluded. The walls externally are of grooved bricks rough casted, and the roofs are covered with thick Gloucestershire stone slabs laid in diminishing courses and giving a homely appearance to the house, besides keeping the attic rooms cool in summer as mentioned in chapter IV., page 70.

The cost of this house was £1552, including entrance gates.

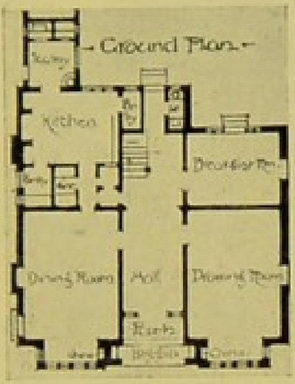
Churchill, West Hampstead, designed by Banister Fletcher and Sons, FF.R.I.B.A.

(Ills. 248, 249, and 250.)

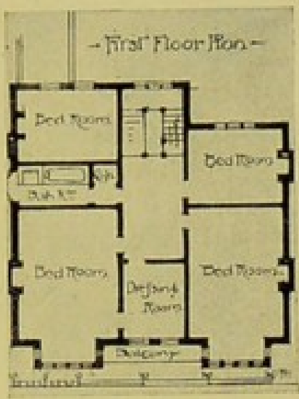
This house was erected upon a comparatively narrow corner plot and is constructed of red brick with Bath stone dressings, the roof being covered with red tiles. Owing to the site the hall is of the gallery form and the staircase is at the end.

The cost of this house was £1650.

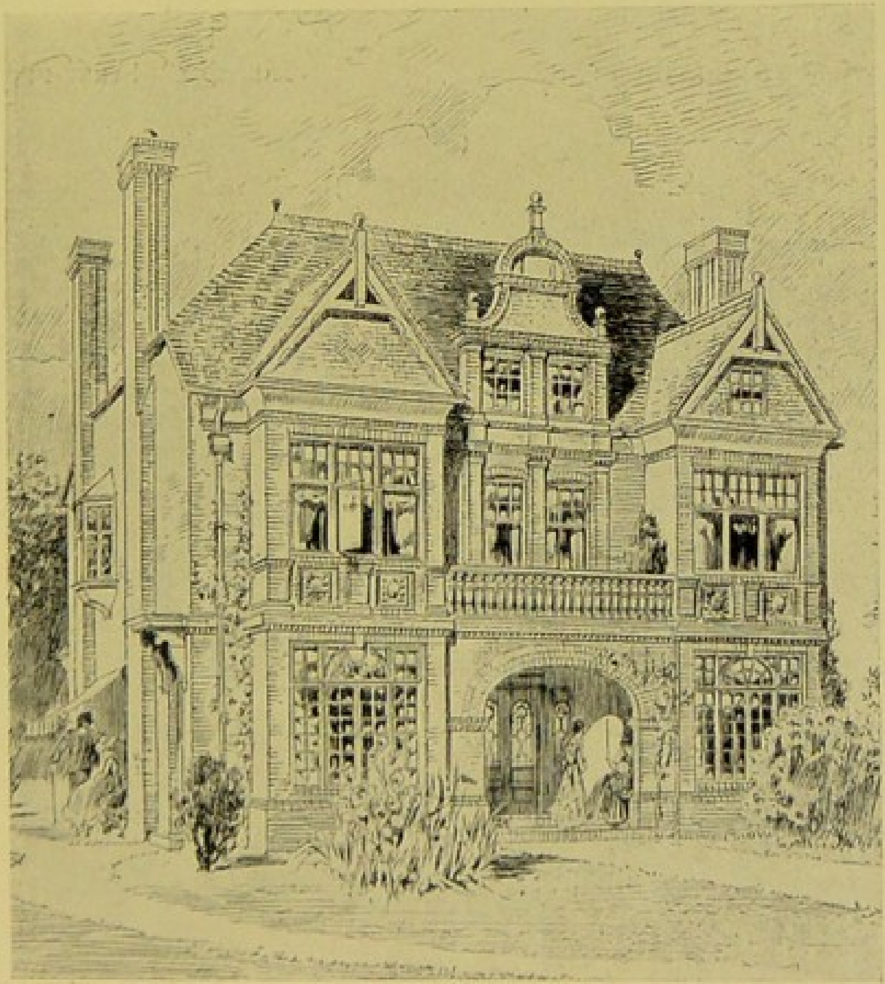
CHURCHILL, WEST HAMPSTEAD, N.W.



ILL. 248.
GROUND-FLOOR PLAN.



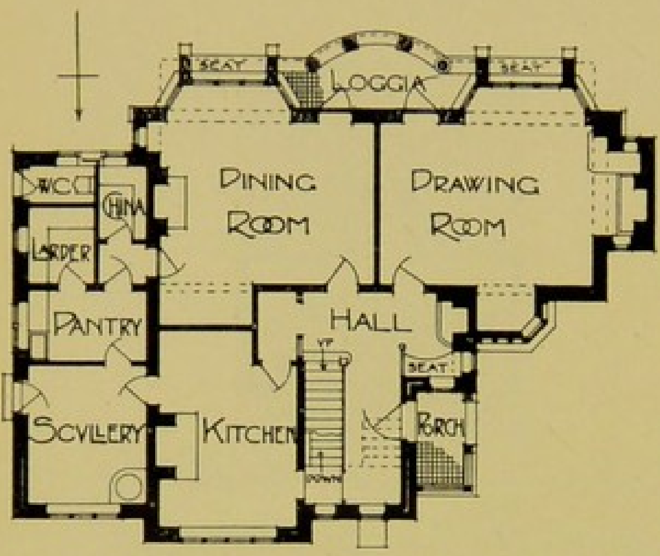
ILL. 249.
FIRST-FLOOR PLAN.

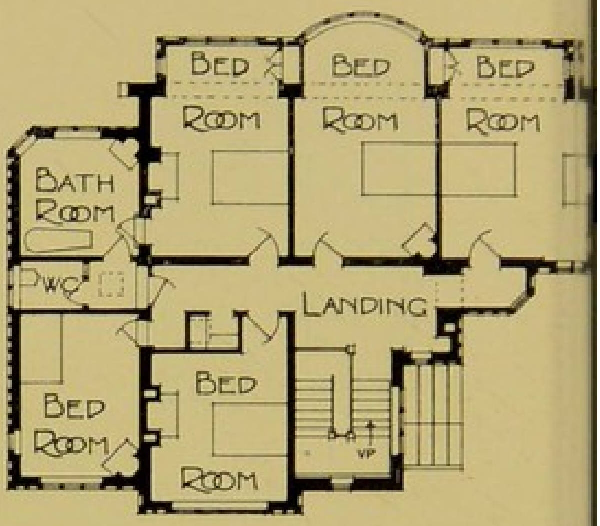


ILL. 250. THE ENTRANCE FRONT.

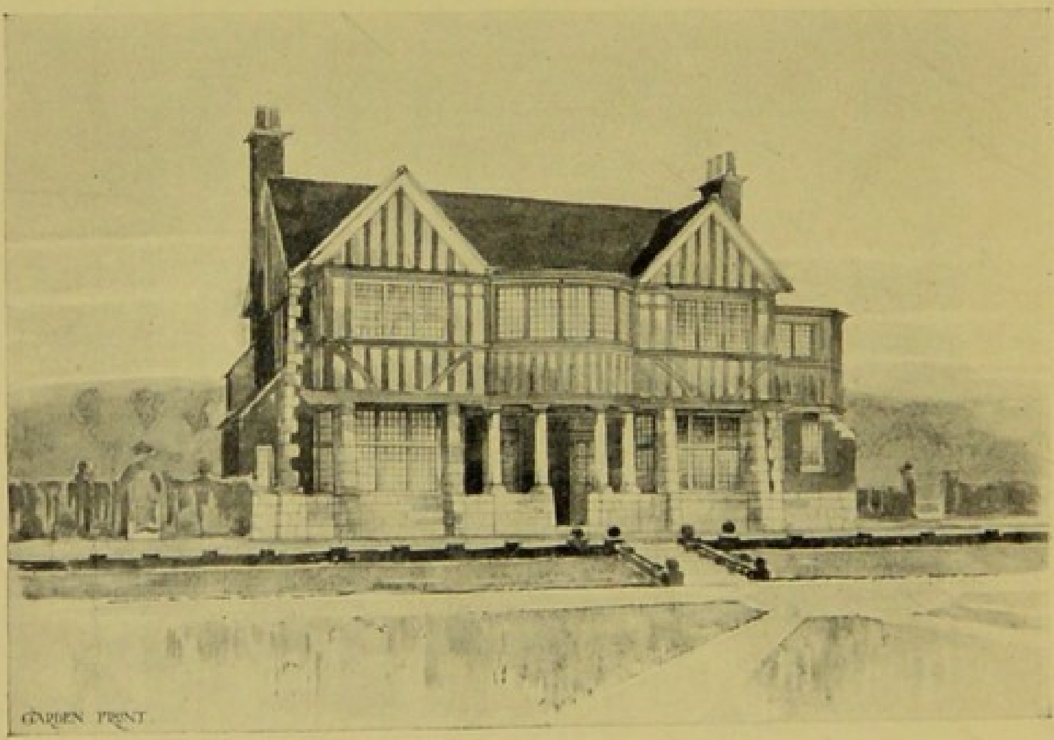
BANISTER FLETCHER AND SONS, FF.R.I.B.A., *Architects*

A BACHELOR'S HOUSE, ASHFORD, KENT





ILL. 251. GROUND-FLOOR PLAN. ILL. 252. FIRST-FLOOR PLAN.



ILL. 253. THE GARDEN FRONT.

BANISTER FLETCHER AND SONS, FF.R.I.B.A., *Architects.*

A Bachelor's House at Ashford, Kent, designed by Banister Fletcher and Sons, FF.R.I.B.A.

(Ills. 251, 252, and 253.)

This house was designed for a bachelor whose instructions as to accommodation were carried out. The idea was that the dining-room would be used as a general living-room and no third reception-room was required.

The service was to be economical, and the way from the kitchen to the front door is conveniently schemed under the main staircase.

Under ordinary circumstances the cost of this house should not exceed £1200.

Cuthbert Villas, Westgate-on-Sea, designed by Banister Fletcher and Sons, FF.R.I.B.A.

(Ills. 254, 255, 256, and 257.)

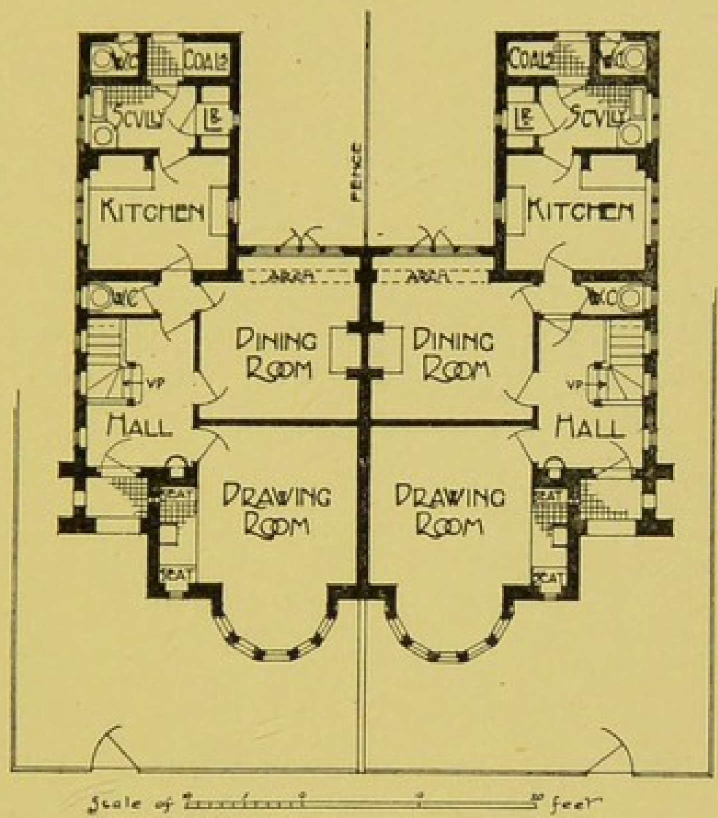
This pair of houses was erected upon ground facing the sea and consequently the drawing-room with a large bay window was designed as the principal living-room, the ingle-nook in it being raised one step above the general level of the room; a small square hall with fireplace is provided. There are folding doors between the drawing-room and dining-room, but these are not shown upon the plan.

The houses are built of local bricks, the base of the main wall being of stone, and the half-timber work of the gables runs right through the walls and is not a mere facing sham.

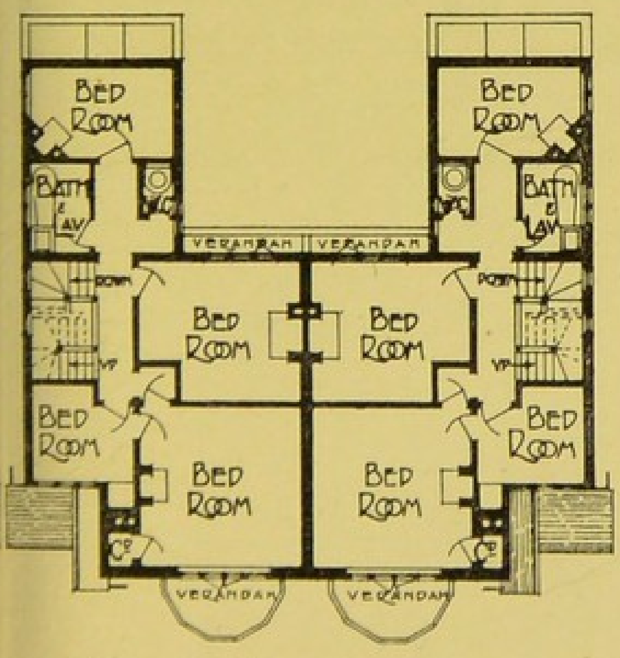
The chimneys are carried up as small towers and are intended to aid the skyline.

This pair of houses cost £1500 including the front fences.

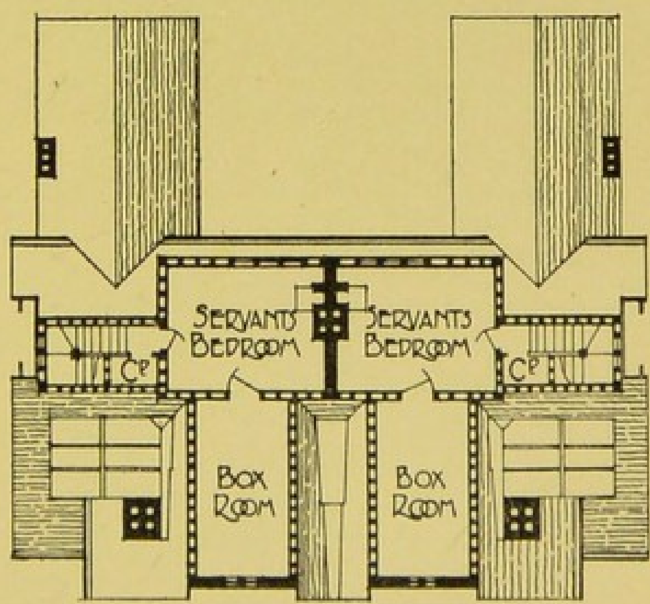
CUTHBERT VILLAS, WESTGATE-ON-SEA



ILL. 254. GROUND-FLOOR PLAN.



ILL. 255. FIRST-FLOOR PLAN.



ILL. 256. ATTIC PLAN.

BANISTER FLETCHER AND SONS, FF.R.I.B.A., *Architects.*

Canterbury Parade, Westgate-on-Sea, designed by Banister Fletcher and Sons, FF.R.I.B.A.

(Ill. 258.)

This row of small houses is constructed of red brick and hanging tile facings with projecting wooden bays on the first floor; an endeavour was made to obtain breadth and architectural effect by a simple treatment.

The roofs are covered with local tiles, while the chimneys are rough cast and crowned with stone caps.

These premises are well suited for conversion into shops in the near future, a large beam being taken across the front, so that the windows to the ground floor, at any time, can be taken out and shop fronts inserted.

The cost of the block of five houses amounted to £4800.

CUTHBERT VILLAS, WESTGATE-ON-SEA

ILL. 257. THE ENTRANCE FRONTS.

CANTERBURY PARADE, WESTGATE-ON-SEA

ILL. 258. THE ENTRANCE FRONTS.

BANISTER FLETCHER AND SONS, FF.R.I.B.A., *Architects*.

The Observatory, Westgate-on-Sea, designed by Banister Fletcher and Sons, FF.R.I.B.A.

(Ills. 259, 260, 261, and 262.)

This house commands extensive views of Westgate Bay. The ground-floor plan (Ill. 259) indicates that a feature has been made of the hall living-room, which has a stone colonnade and is panelled to a height of 7 ft. 6 in. in stone. Ingle-nooks are planned in the hall, drawing and dining rooms, in order that full advantage of the fine views may be obtained. The billiard-room is situated on the first floor (Ill. 260), and has a door leading on to the extensive balcony which is carried over the bays and loggia, and occupies the whole front of the house.

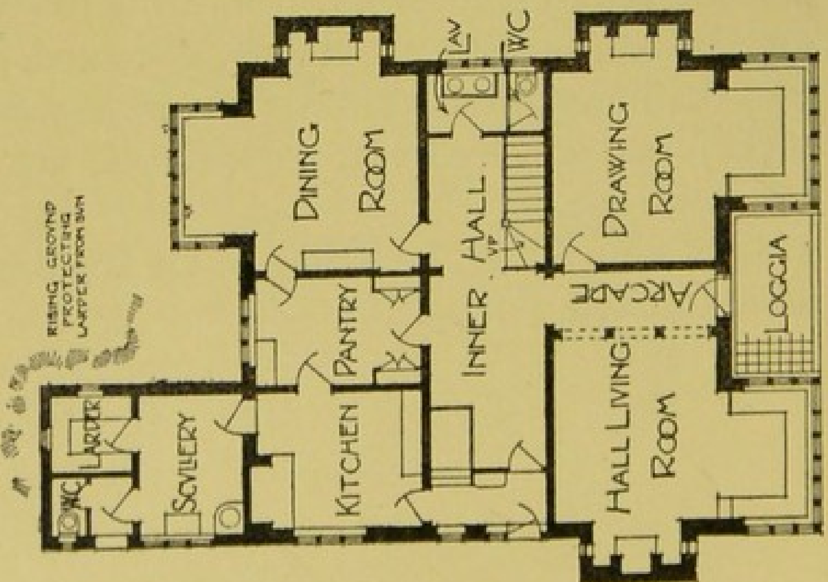
Seven large bedrooms and two bathrooms are also contained on the first and second floors (Ill. 260 and 261).

The building (Ill. 262) is constructed of bricks with tile-hanging, the chimney-stacks being rough cast and crowned with stone copings, and the roof is covered with sand-faced tiles.

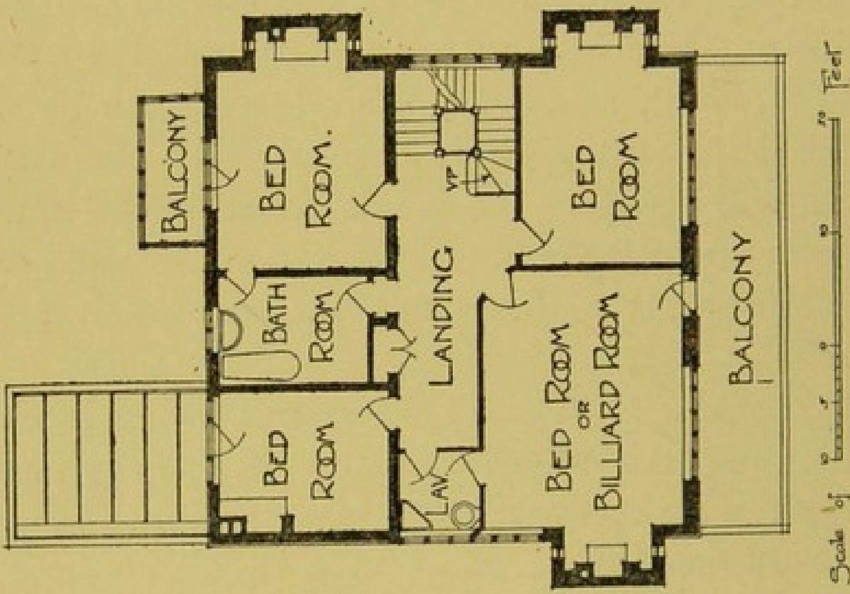
The belvedere, or observatory, from which views of the sea and the surrounding country are obtained, gives its name to the house, and is formed at the summit of the main roof and covered with copper and crowned with a weather vane.

The cost of this house, including fence walls, gates and garden, totalled £2895.

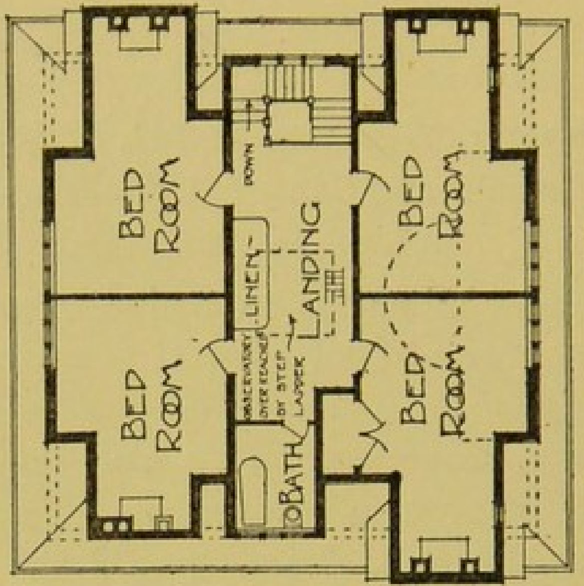
THE OBSERVATORY, WESTGATE-ON-SEA



ILL. 259. GROUND-FLOOR PLAN.



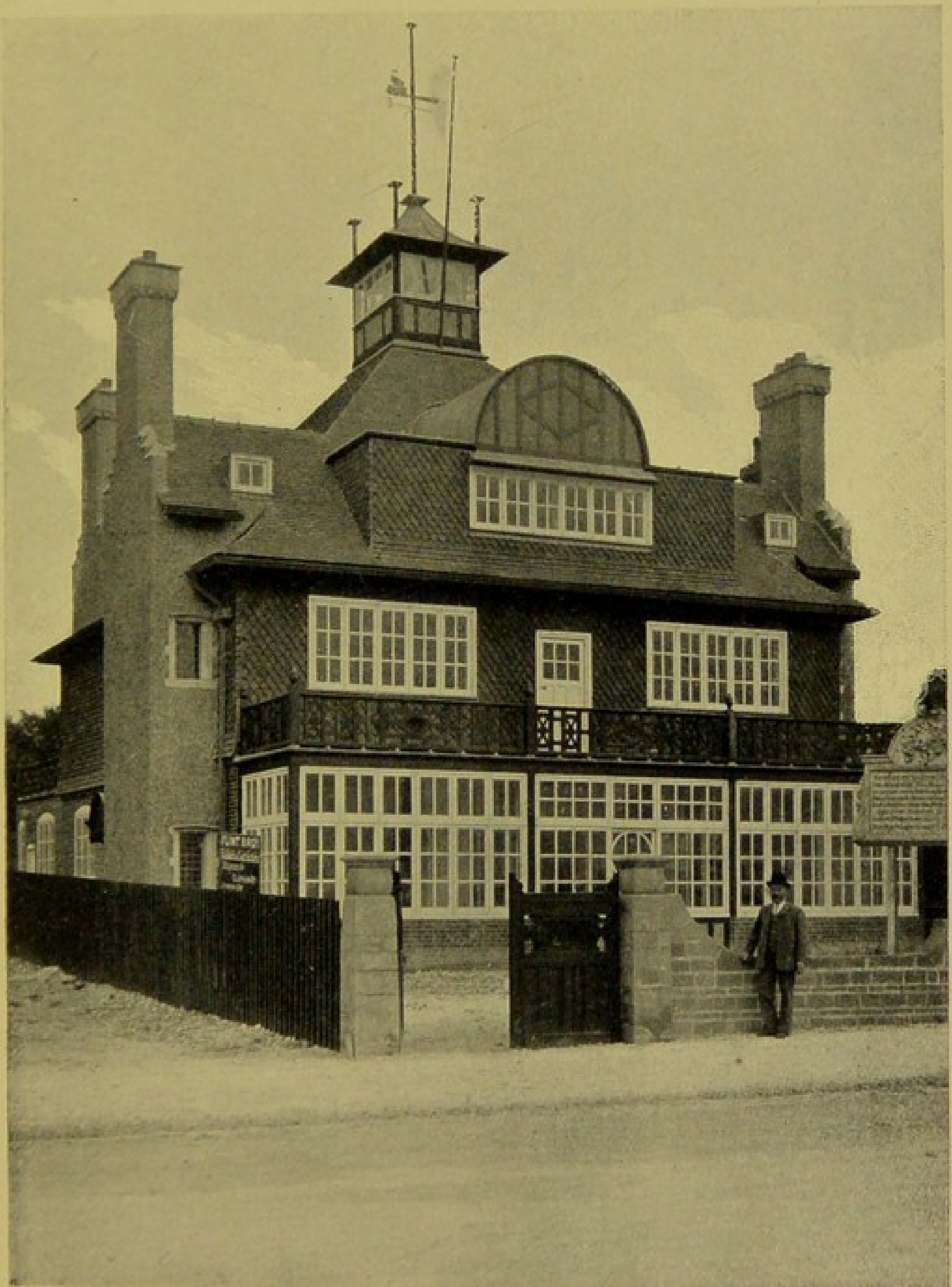
ILL. 260. FIRST-FLOOR PLAN.



ILL. 261. SECOND-FLOOR PLAN.

BANISTER FLETCHER AND SONS, FF.R.I.B.A., *Architects.*

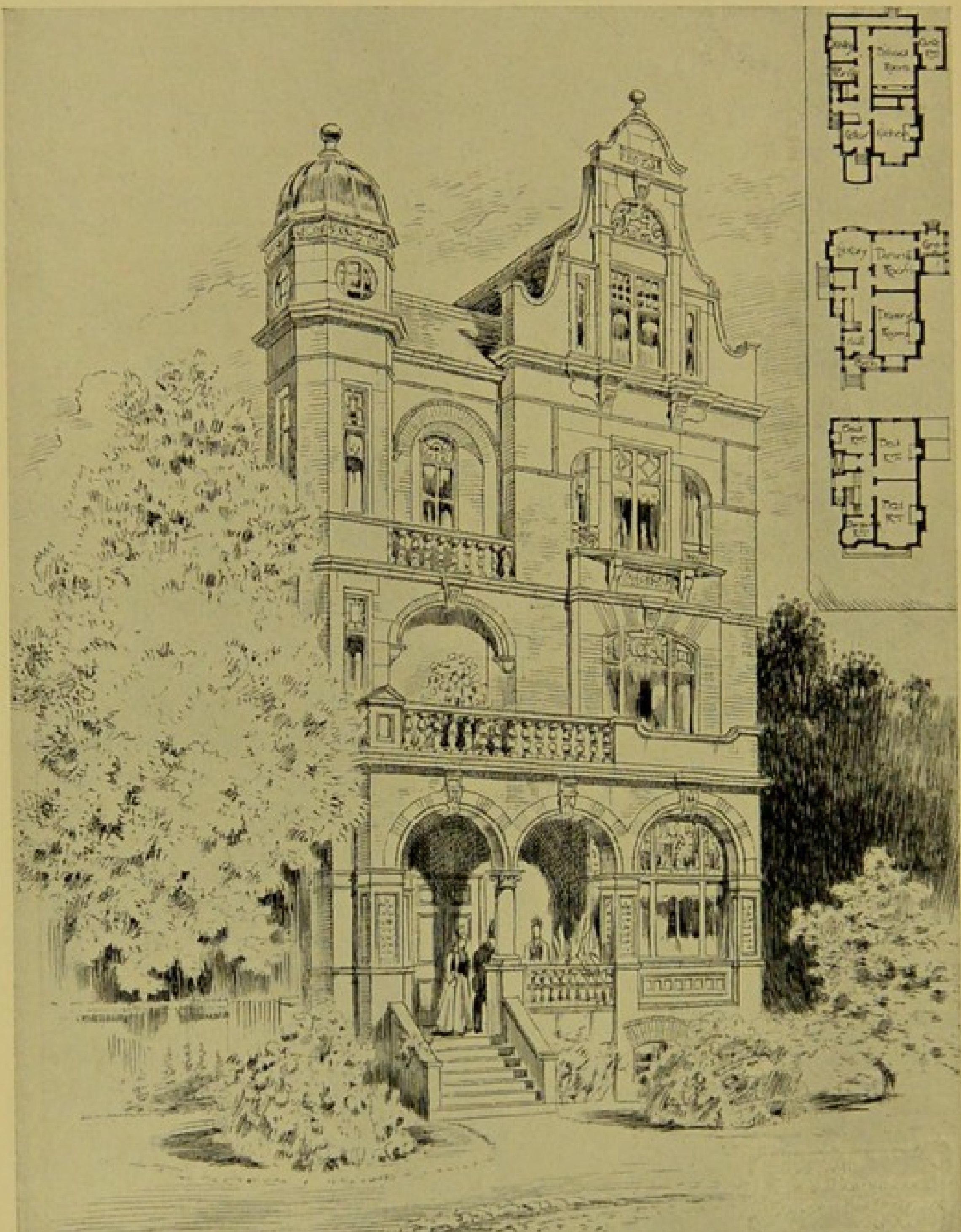
THE OBSERVATORY, WESTGATE-ON-SEA



ILL. 262. THE ENTRANCE FRONT.

BANISTER FLETCHER AND SONS, FF.R.I.B.A., *Architects.*

LADYWELL, WEST HAMPSTEAD, N.W.



Ill. 263. Ill. 264. Ill. 265.

Ill. 266. The Entrance Front.

Banister Fletcher and Sons, ff.r.i.b.a., *Architects.*

Ladywell, West Hampstead, designed by Banister Fletcher and Sons, FF.R.I.B.A.

(Ills. 263, 264, 265, and 266.)

The plan of this house was determined by the narrowness of the site, which is frequently the case in suburban districts. It will be noticed that on the ground floor the dining-room and library are connected by sliding doors for reception purposes (Ill. 264). The billiard-room is situated in the half-basement (Ill. 263).

The building is faced with bricks, and there are Portland stone balustrades and dressings, and a small copper dome is constructed over the angle tower-like structure which forms a bay window on each floor.

This house cost £2650.

A Country House in Surrey, designed by Banister Fletcher and Sons, FF.R.I.B.A.

(Ills. 267, 268, and 269.)

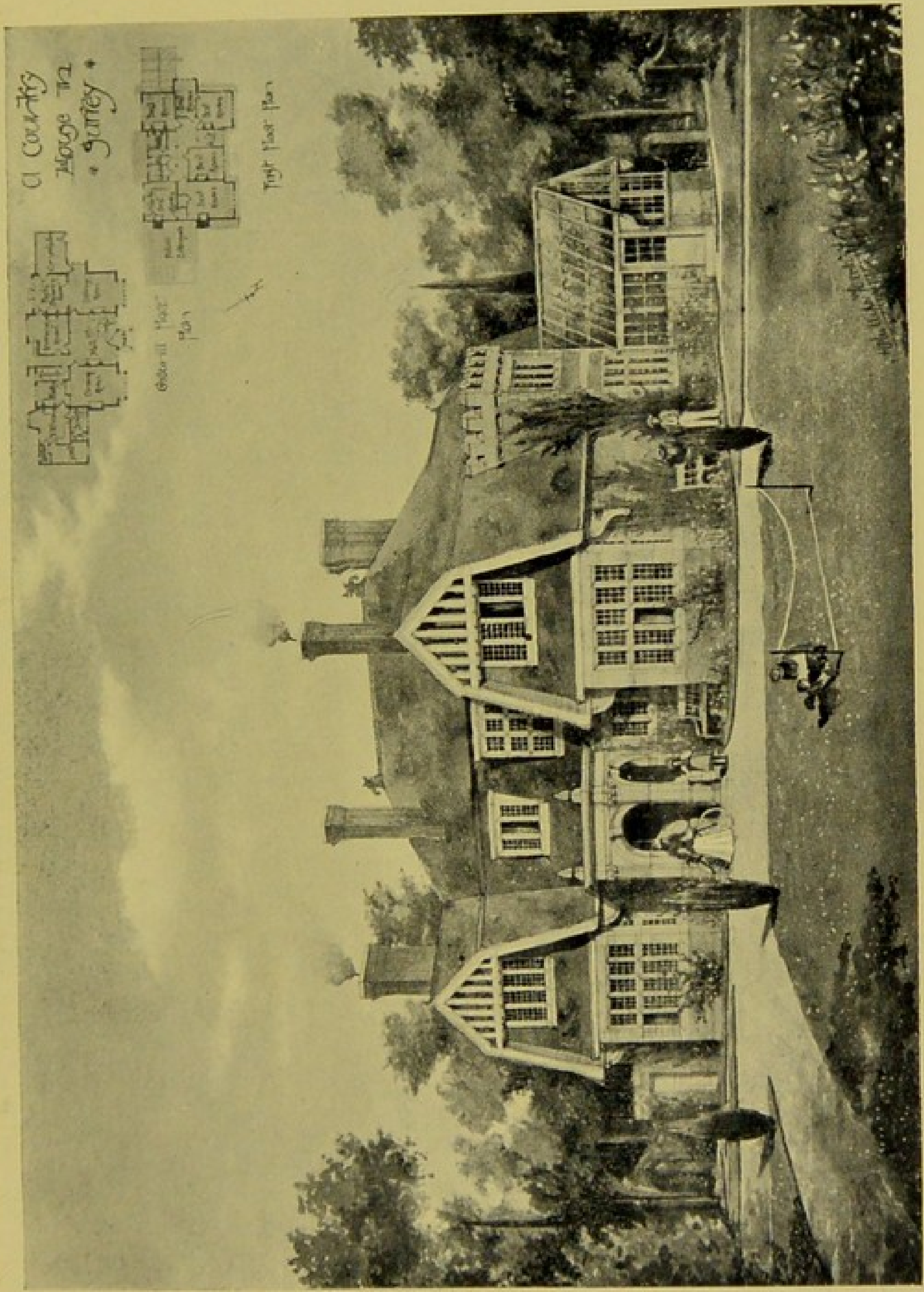
It will be noticed from the small plan (Ill. 267) that the reception-rooms are all *en suite*, thus providing five fair-sized rooms and a conservatory for reception purposes. The first floor (Ill. 268) has seven bed-rooms, dressing-room, etc.

The walls are of stone, the roof being covered with sand-faced tiles, which latter are also used for tile-hanging to the gable-ends, which conform with the mansard treatment of the main roof.

A COUNTRY HOUSE IN SURREY

Ill. 267.

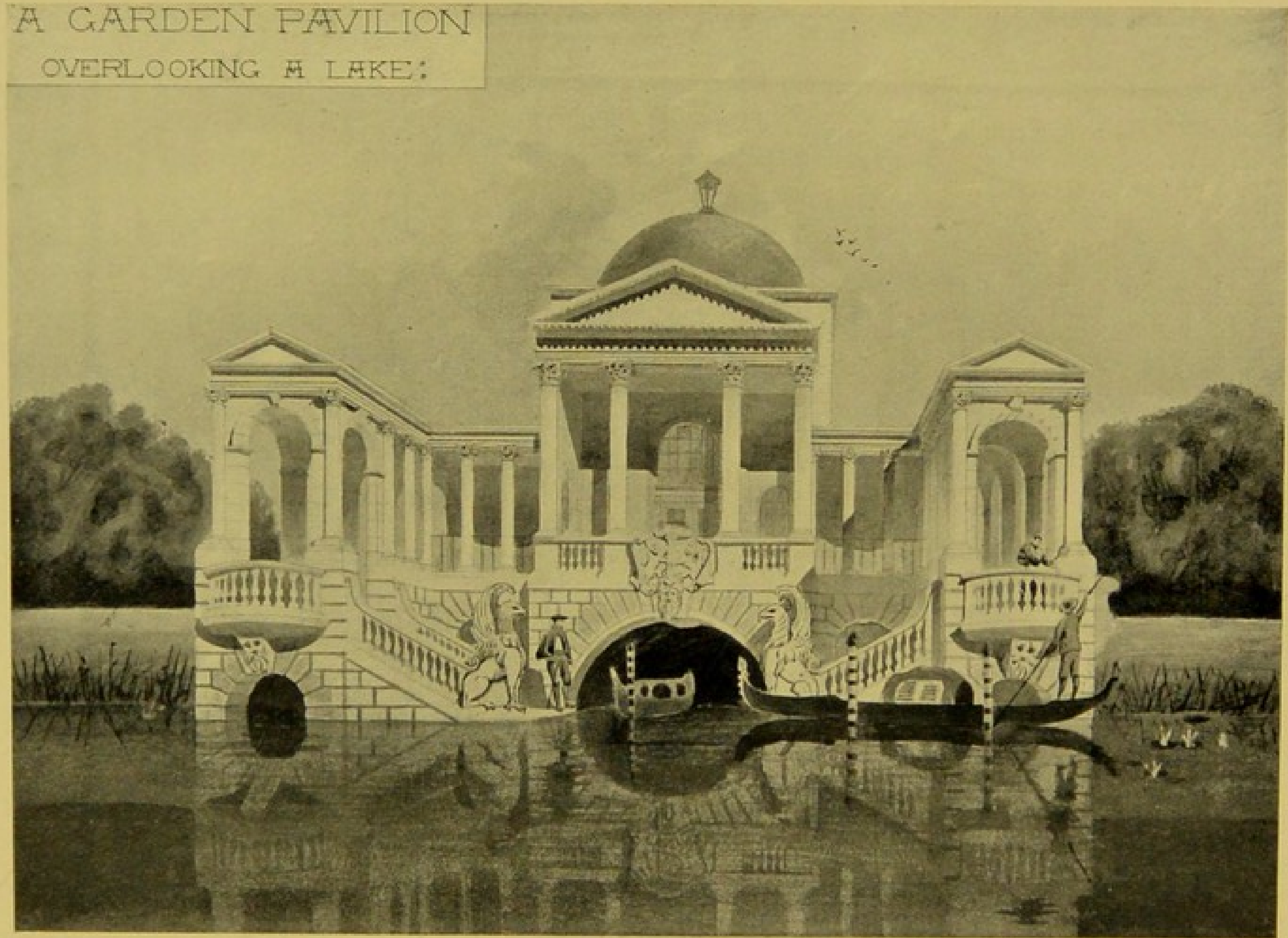
Ill. 268.



Ill. 269. The Entrance Front.

Banister Fletcher and Sons, FF.R.I.B.A., *Architects.*

A GARDEN PAVILION OVERLOOKING A LAKE



Ill. 270. View from Lake.

A Garden Pavilion overlooking a Lake, designed by Banister Fletcher and Sons, FF.R.I.B.A.

(Ill. 270.)

This is a rather monumental treatment of a garden pavilion which can only be adopted in connection with a large country mansion. It is approached from the land side by a drive, and access is also obtained from the lake by two landing-stages leading to either of the wings. A boat-house is arranged by means of the arched opening under the central domed feature.

The enclosing colonnades are formed as "wings" to the main portico which is placed in front of the principal apartment; a small kitchen for cooking light repasts and lavatories for gentlemen and ladies are also provided.

New Farm-house at Astonbury, Knebworth, Herts, designed by Forsyth and Maule, FF.R.I.B.A.

(Ills. 271, 272, 273, and 274.)

This farm-house is situated at some distance from the public road and is designed to accommodate two families, the farmer occupying the larger (western) cottage and a farm labourer the smaller one.

The external walls are nine inches thick, and are covered with plaster finished with a rough surface and not in any way artificially coloured. The chimneys and plinth are built in thin red facing bricks, which vary greatly in colour and have a flush mortar joint.

The roofs and the offsets of the chimneys are covered with old weathered tiles.

Interesting features externally (Ill. 274) are the teak gutters and down pipes. The gutters are V-shaped and are supported on brackets secured to the walls and rafter feet.

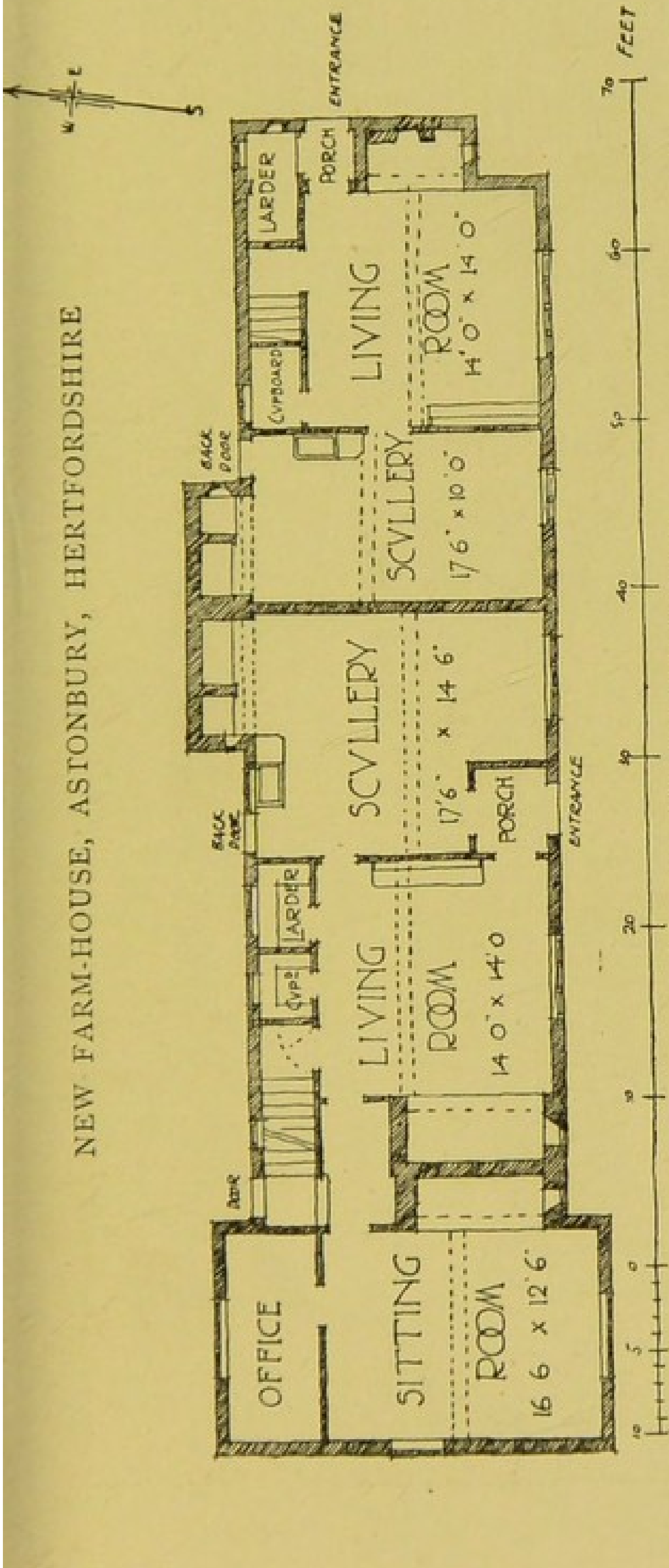
The window frames throughout are in oak and have leaded lights in wrought-iron casements.

The gables have oak verge rafters supported, clear of the plaster face, on plates and purlins carried through the walls.

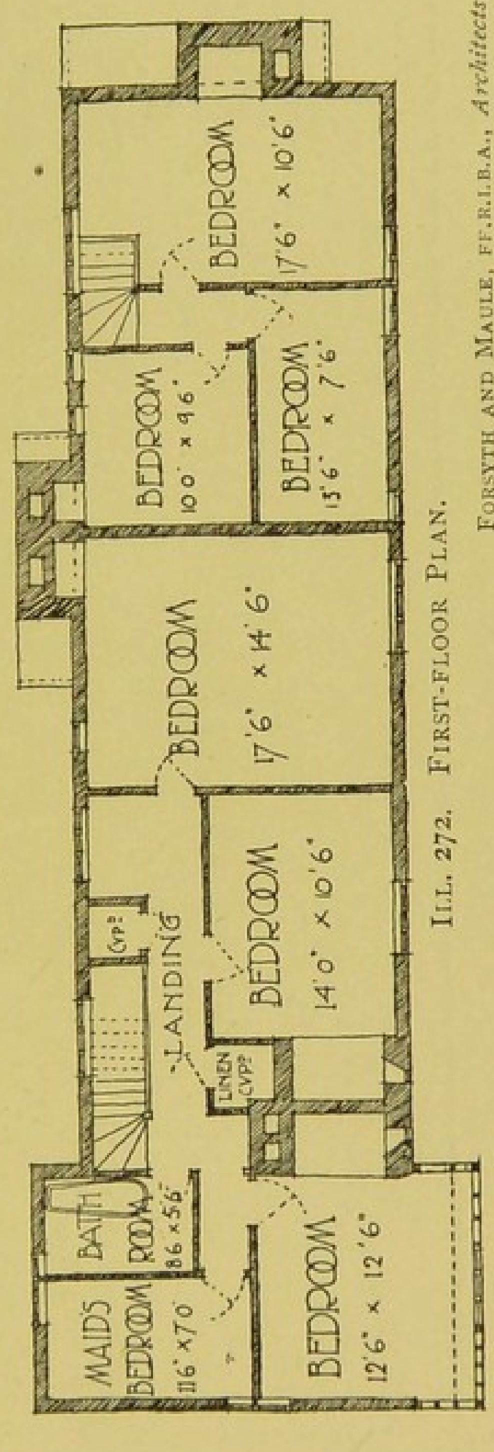
Internally the large open brick fireplaces (Ill. 273) have oak beams over and are paved with red bricks.

Simplicity is the keynote of the design, and local tradition has been as far as possible adapted to modern requirements. It should be said that the elevations have been largely influenced by an old farm-house in Hertfordshire and by its proximity to the fine manor-house of Astonbury.

NEW FARM-HOUSE, ASTONBURY, HERTFORDSHIRE



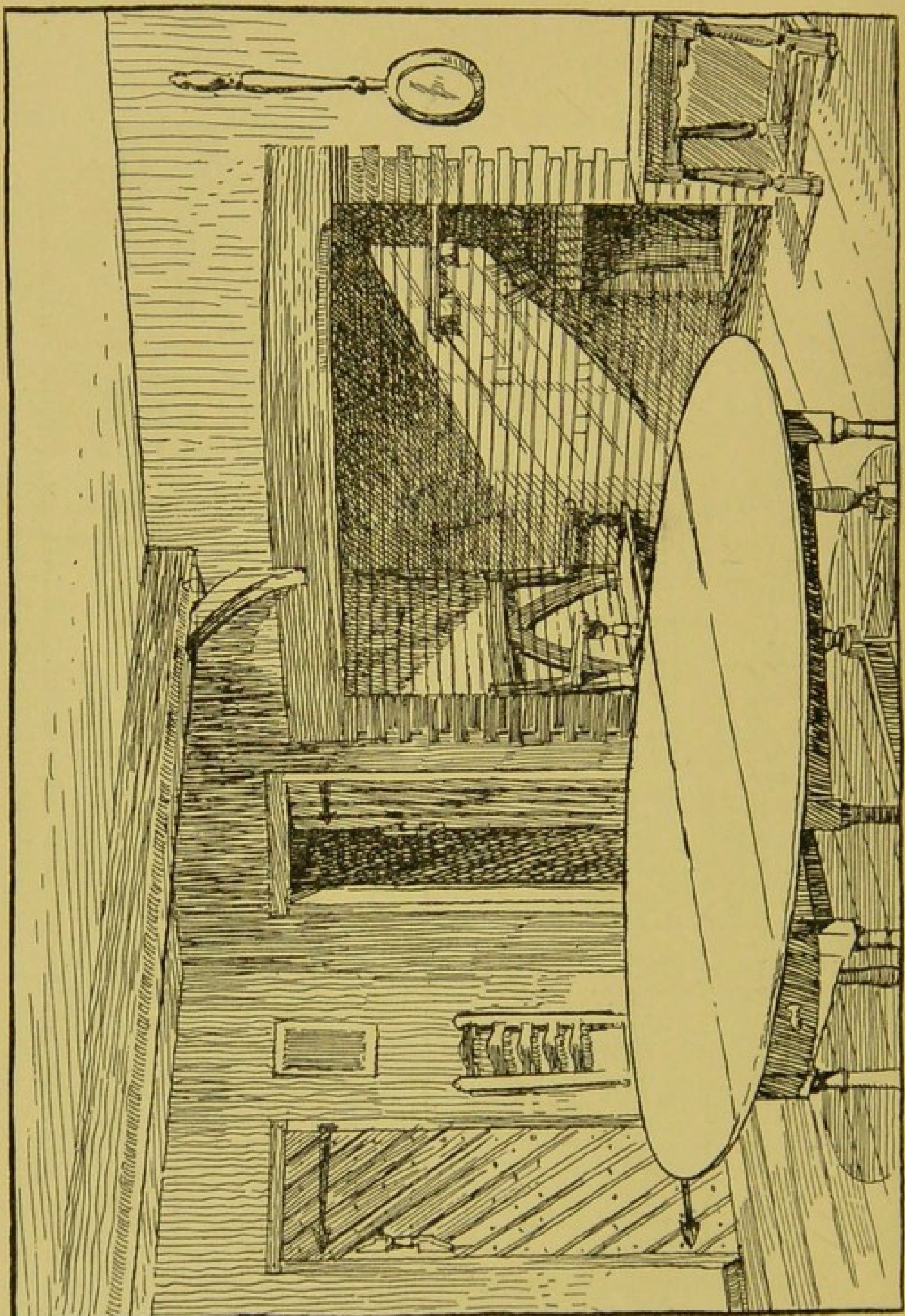
ILL. 271. GROUND-FLOOR PLAN.



ILL. 272. FIRST-FLOOR PLAN.

FORSYTH AND MAULE, FF.R.I.B.A., *Architects.*

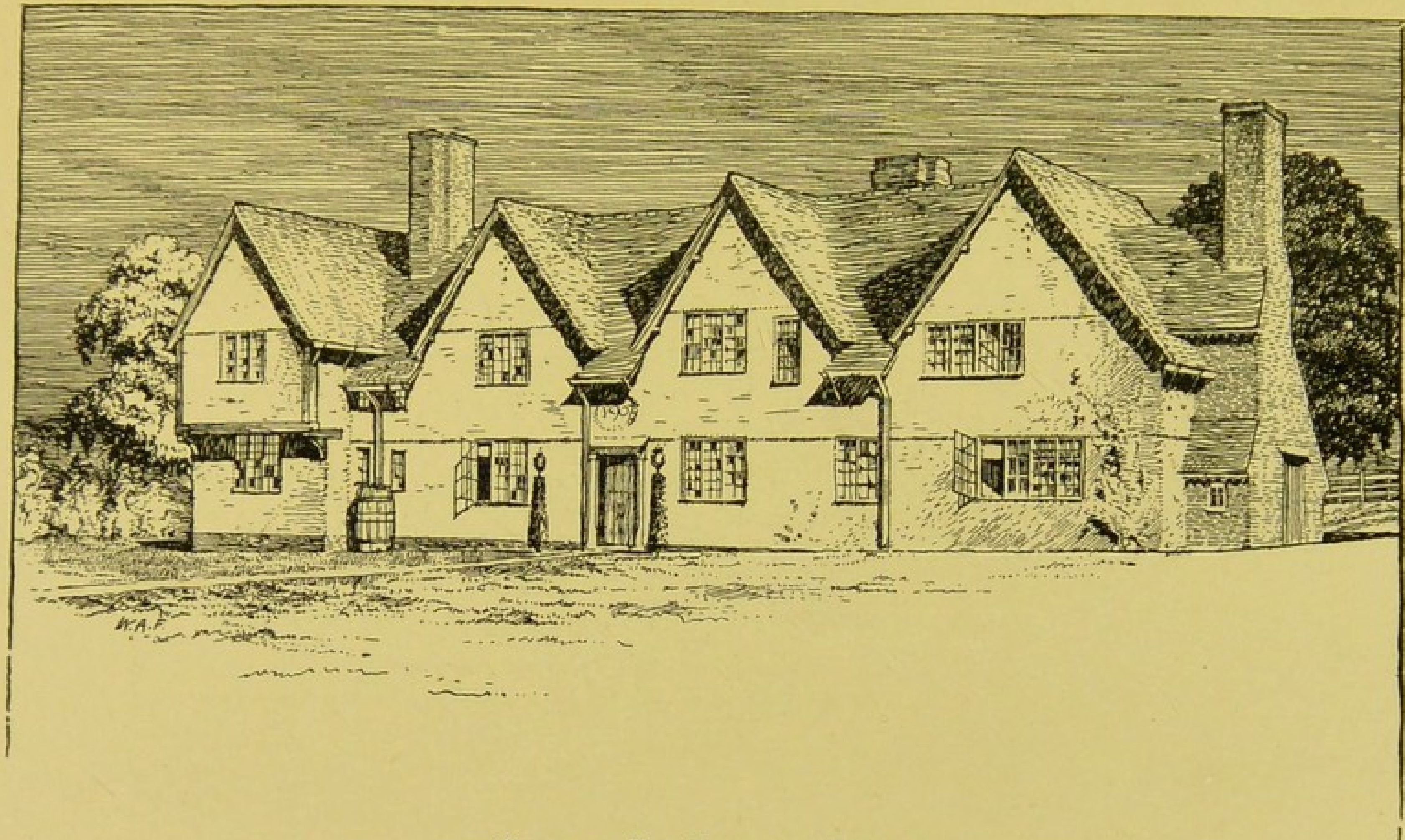
NEW FARM-HOUSE, ASTONBURY, HERTFORDSHIRE



ILL. 273. SITTING-ROOM.

FORSYTH AND MAULE, FF.R.I.B.A., *Architects.*

NEW FARM-HOUSE, ASTONBURY, HERTFORDSHIRE



ILL. 274. THE ENTRANCE FRONT.

FORSYTH AND MAULE, FF.R.I.B.A., *Architects.*

Cottages at Astonbury, Knebworth, Herts, designed by Forsyth and Maule, FF.R.I.B.A.

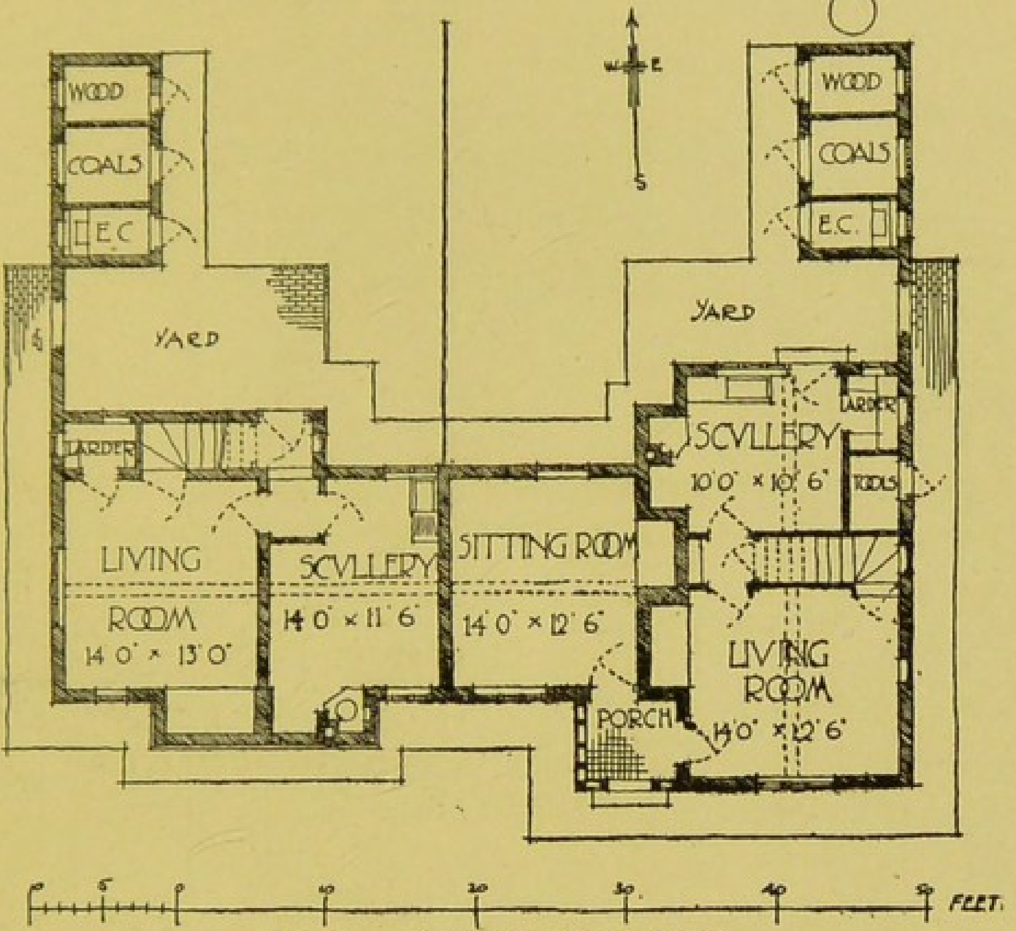
(Ills. 275, 276, 277, and 278.)

The double cottage is designed to accommodate two families.

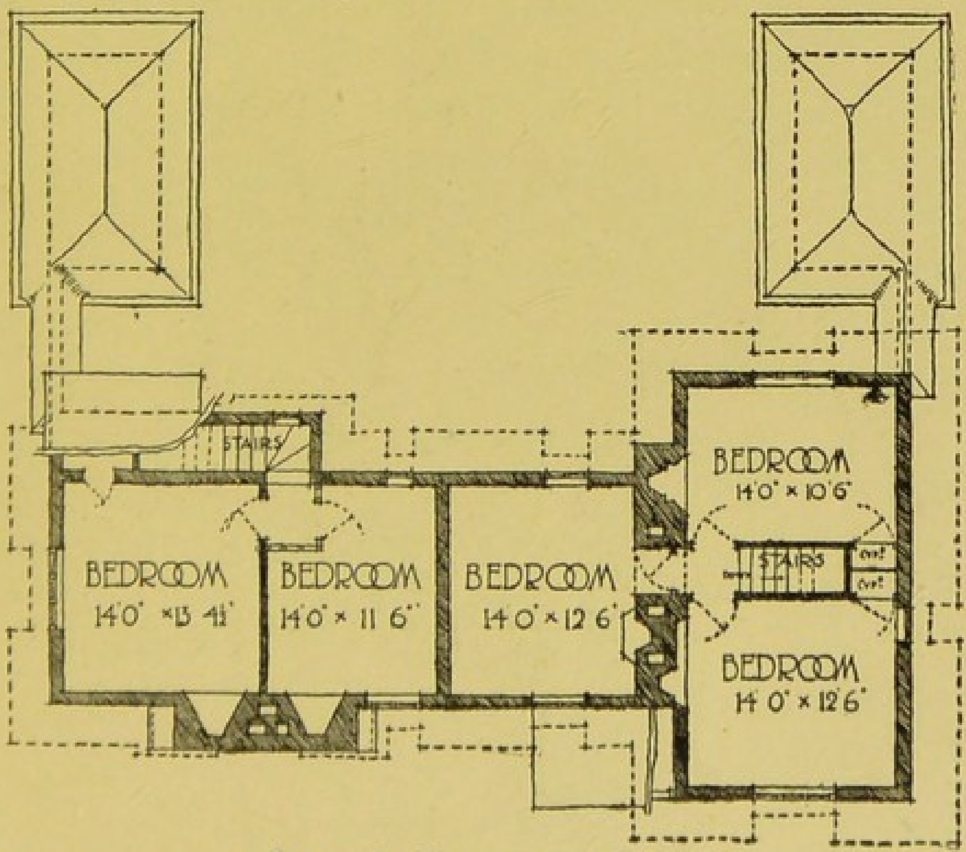
It is built on similar lines to the farm-house (Ills. 271, 272, 273 and 274), but the roof is covered with Norfolk reed-thatch.

The illustrations of this and the farm-house are published by the kind permission of the owner, V. A. Malcolmson, Esq.

COTTAGES AT ASTONBURY, HERTFORDSHIRE



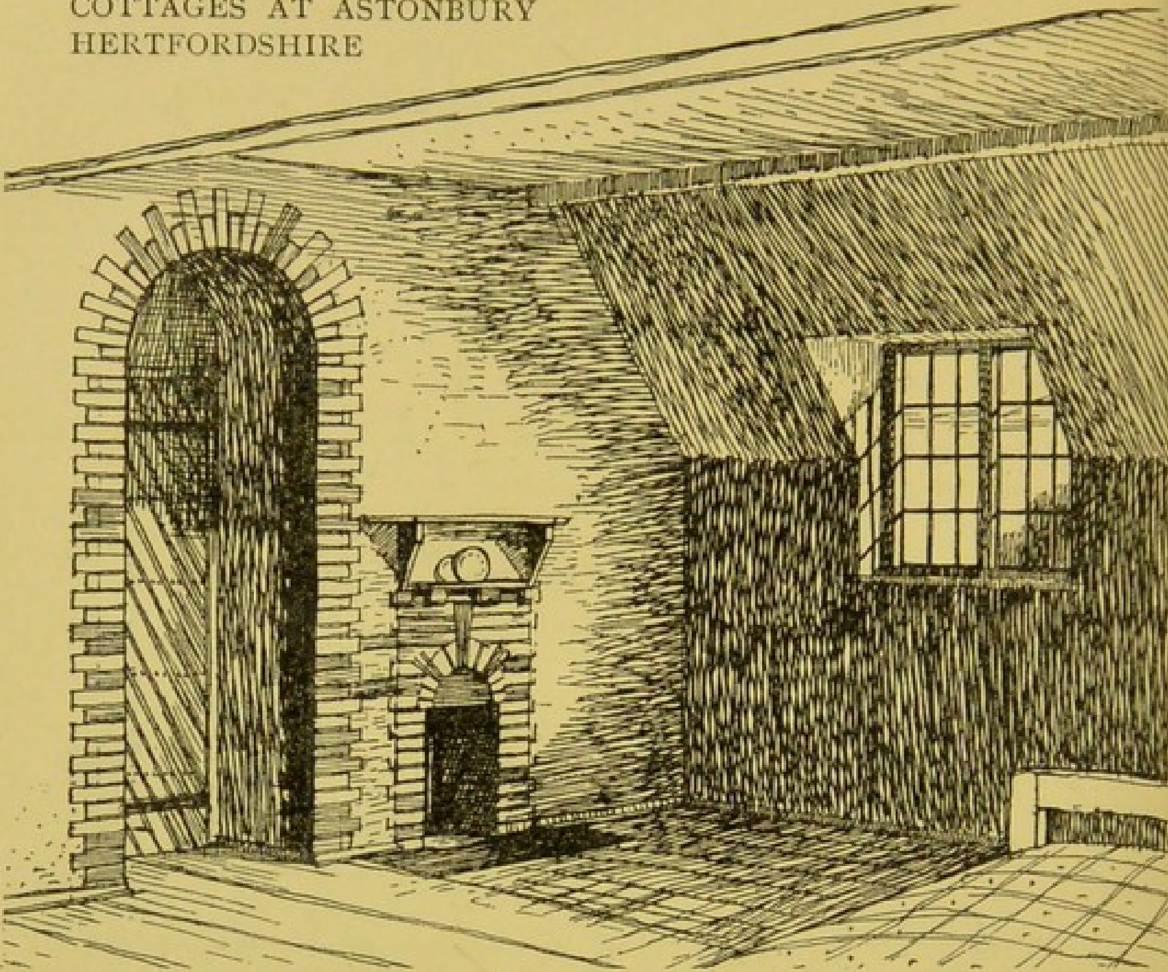
ILL. 275. GROUND-FLOOR PLAN.



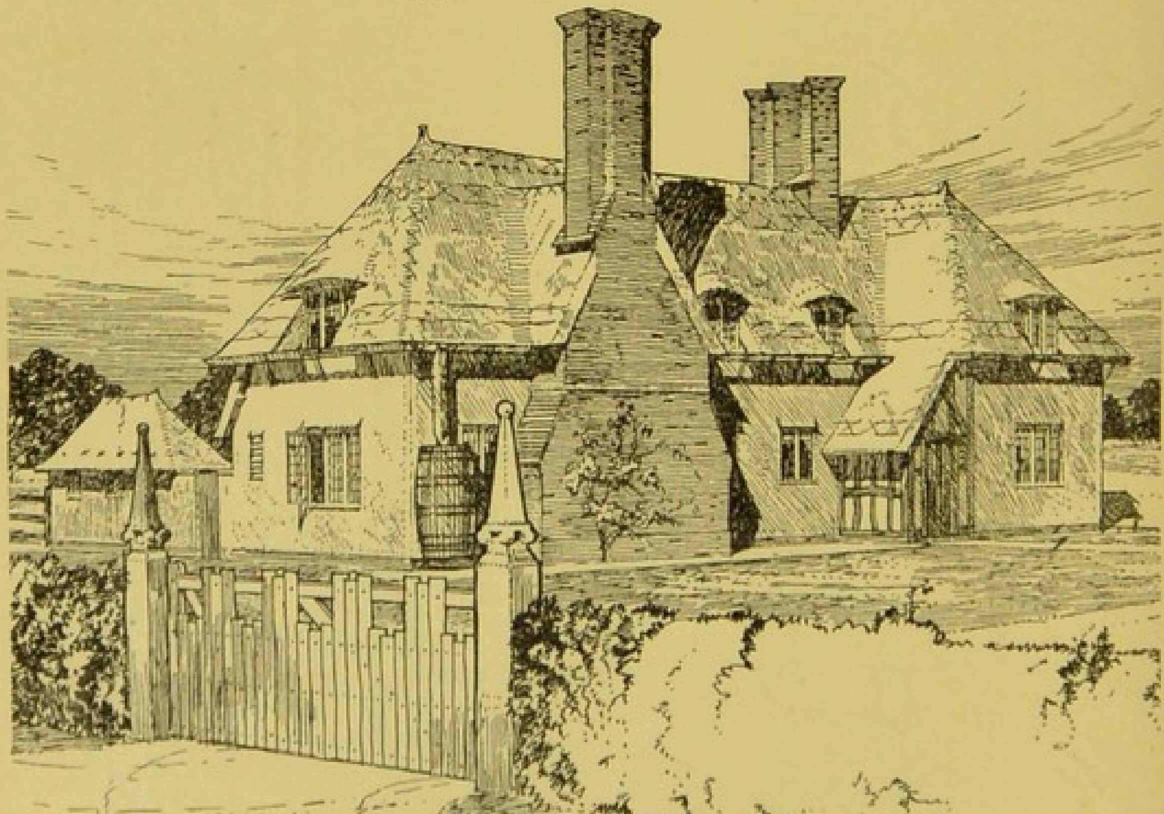
ILL. 276. FIRST-FLOOR PLAN.

FORSYTH AND MAULE, FF.R.I.B.A., *Architects.*

COTTAGES AT ASTONBURY
HERTFORDSHIRE



ILL. 277. INTERIOR OF A BEDROOM.



ILL. 278. THE ENTRANCE FRONT.

FORSYTH AND MAULE, FF.R.I.B.A., *Architects.*

Elmstead, Limpsfield, Surrey, designed by Arthur Keen, F.R.I.B.A.

(Ills. 279, 280, 281, and 282.)

The main consideration which governed the planning of the house, after economy, was the desire of the owner to get direct sunlight into all the rooms and to protect himself as much as possible from the north wind.

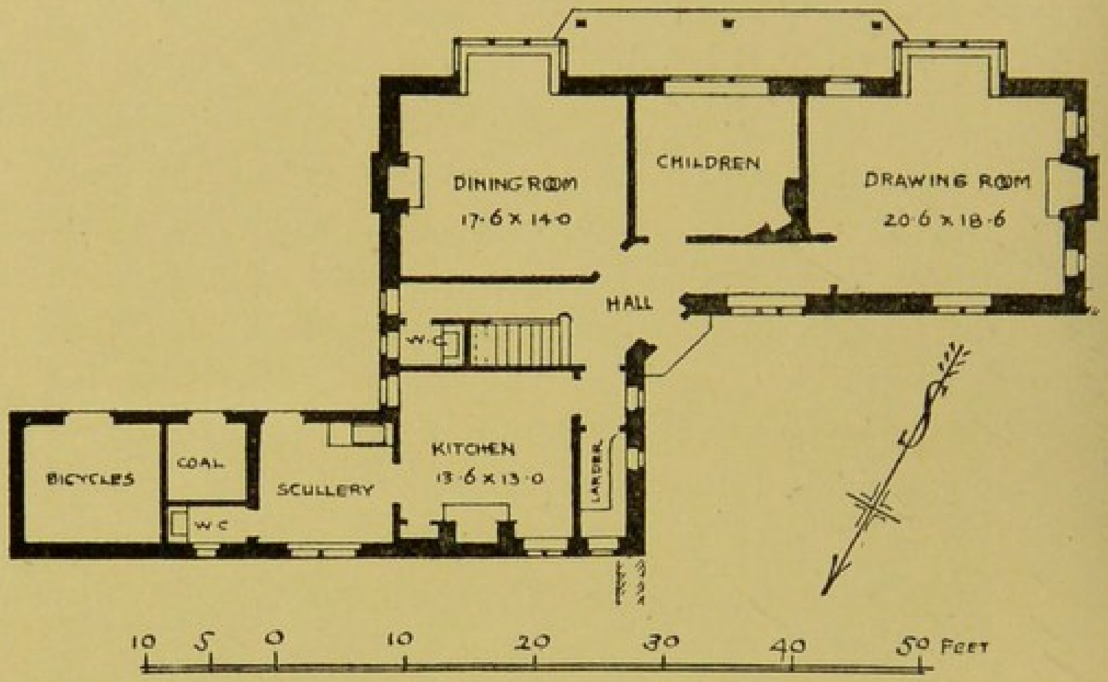
The house faces a large common, and its exterior was made simple and unobtrusive, so as to suit its position.

It is built with hollow walls sixteen inches thick and faced with rough cast to exclude the driving rains, and the tiles were obtained from an old barn on the site which had to be demolished.

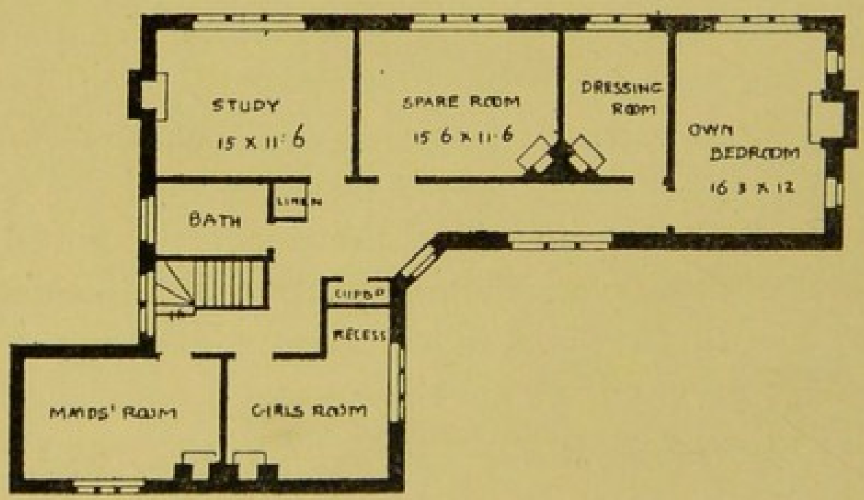
The internal treatment is quite simple, but the work is solid and strong throughout. There are large beams over the sitting-rooms to carry the bedroom floors; the roof has a large storage room in it and is strongly timbered and boarded and felted under the tiling.

The actual cost, including the decoration and drainage, was under £900. The house is a good illustration of the fact that if local materials are used and simple treatment adopted, so that the village builder can be employed with satisfactory results, a great deal of accommodation can be obtained for a small outlay.

ELMSTEAD, LIMPSFIELD, SURREY



ILL. 279. GROUND-FLOOR PLAN.



ILL. 280. FIRST-FLOOR PLAN.

ARTHUR KEEN, F.R.I.B.A., *Architect.*

ELMSTEAD, LIMPSFIELD, SURREY

ILL. 281. THE ENTRANCE FRONT.

ILL. 282. THE GARDEN FRONT.

ARTHUR KERN, F.R.I.B.A., *Architect.*

Grey Walls, Gullane, N.B., designed by Edwin L. Lutyens, F.R.I.B.A.

(Ills. 283, 284, 285, 286, 287, 288, 289, 290, and 291.)

This house was built for the Hon. Alfred Lyttelton, M.P., in 1901. The problem was to build a house which in relation to its cost would have a considerable amount of accommodation.

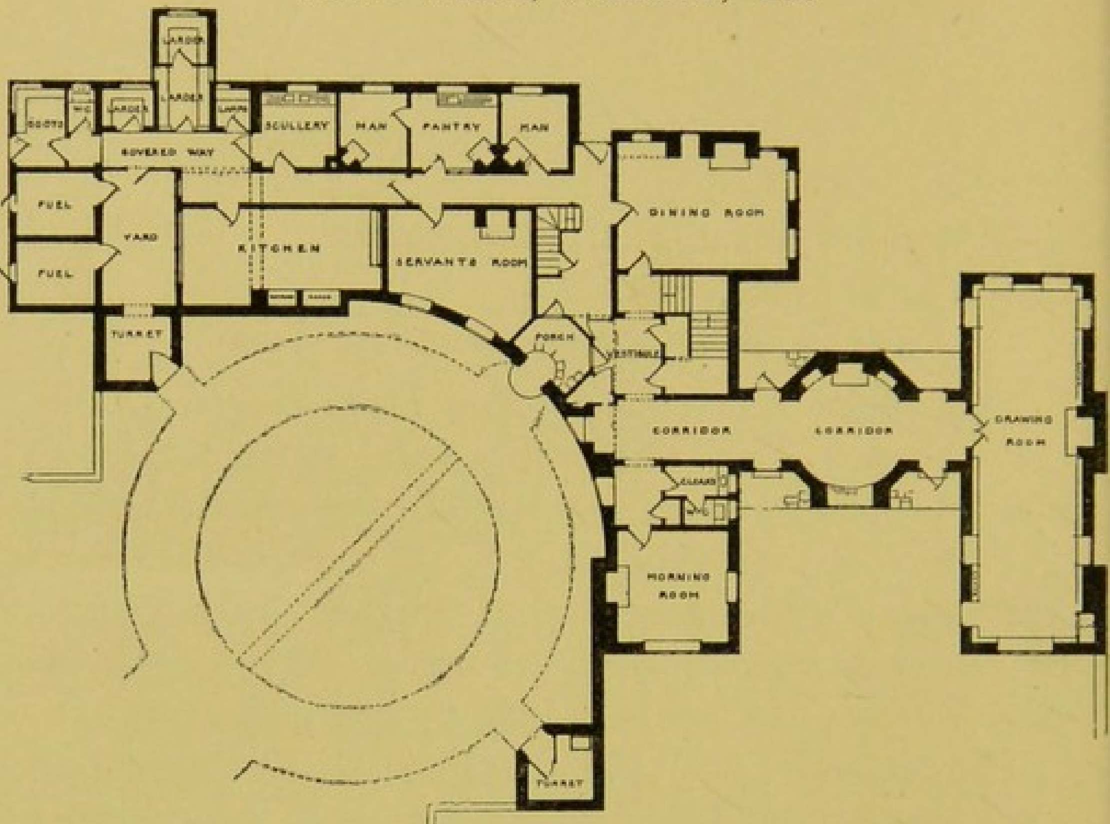
The plan is an interesting example, and the general lay-out shown in Ill. 285 is exceedingly original, the drive to the main building being a special feature.

The ground plan (Ill. 283) shows the quadrant entrance court, and the clever planning of the entrance corridor to the drawing-room (Ill. 290) shows the skilful treatment of this portion of the house. Ill. 289 gives a view of the garden side.

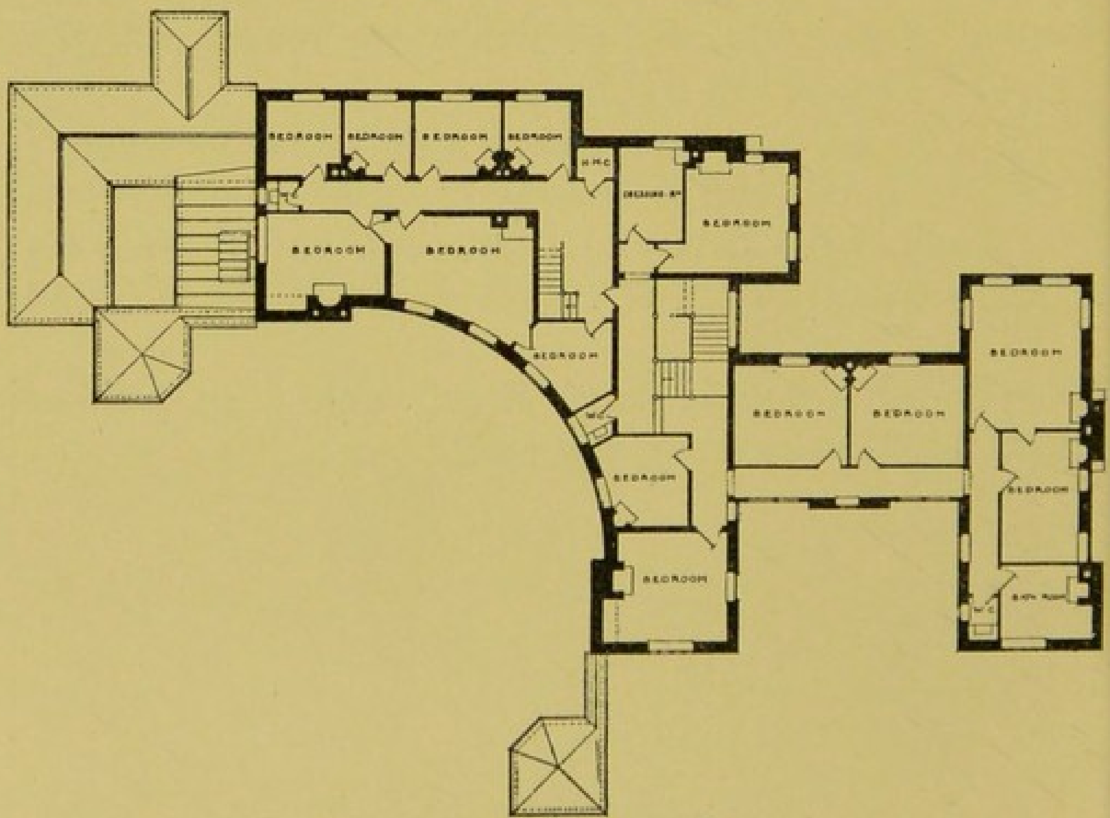
The house has since passed into the possession of Mr. W. James and it became essential to add rooms for additional valets and chauffeurs, and these were arranged in the form of lodges shown in Ills. 285 and 286.

The walls are of local stone, with grey pantiles from Holland covering the roofs.

GREY WALLS, GULLANE, N.B.



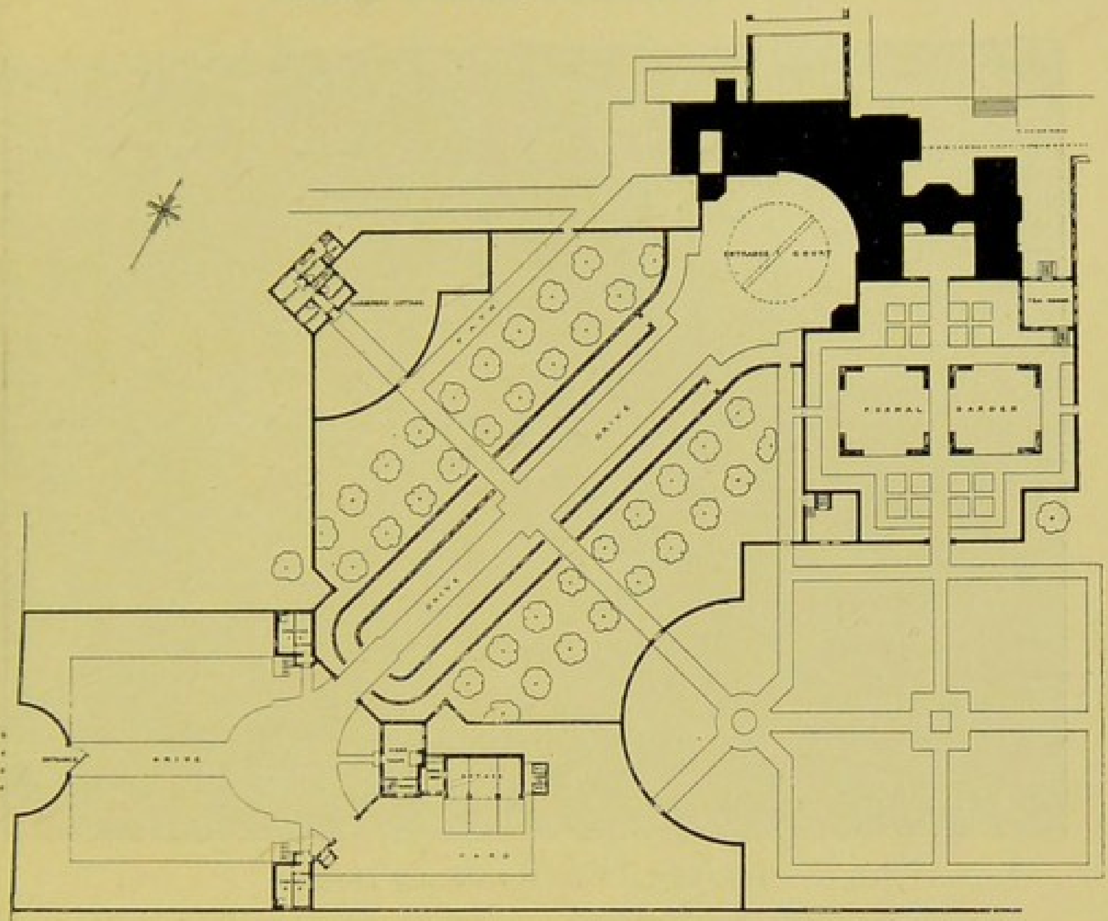
ILL. 283. GROUND-FLOOR PLAN.



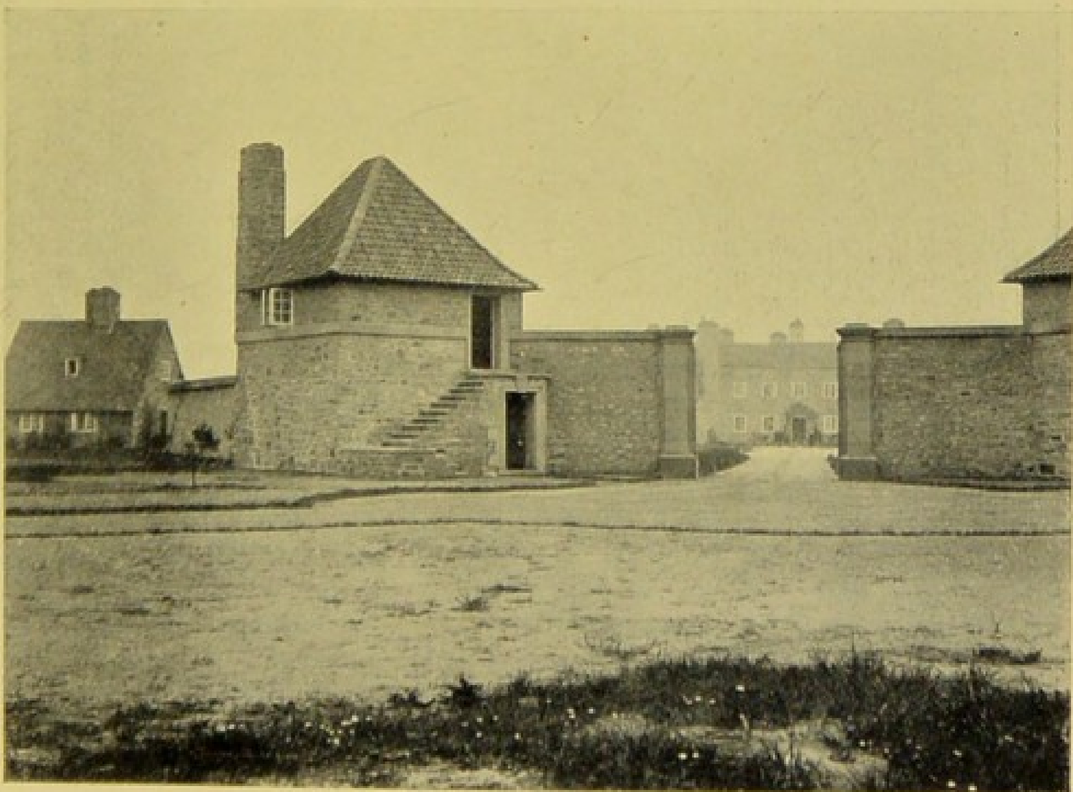
ILL. 284. FIRST-FLOOR PLAN.

EDWIN L. LUTYENS, F.R.I.B.A., *Architect.*

GREY WALLS, GULLANE, N.B.



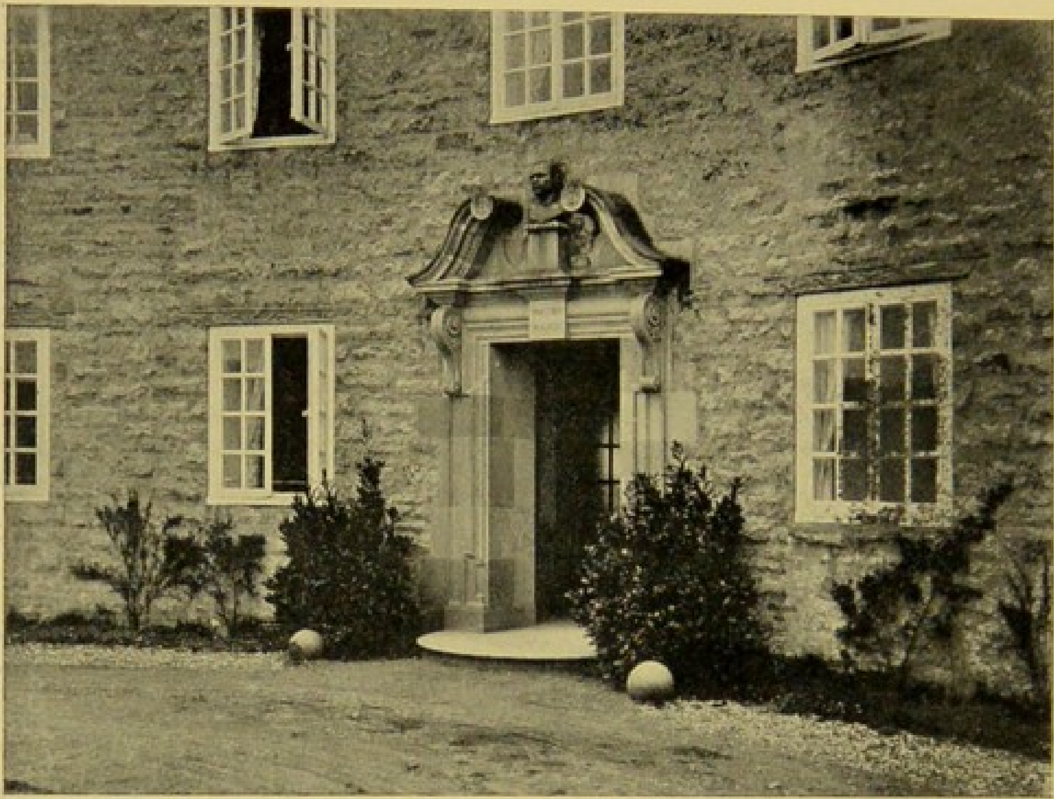
ILL. 285. BLOCK PLAN.



ILL. 286. ENTRANCE LODGES FOR VALETS AND CHAUFFEURS.

EDWIN L. LUTYENS, F.R.I.B.A., *Architect.*

GREY WALLS, GULLANE, N.B.

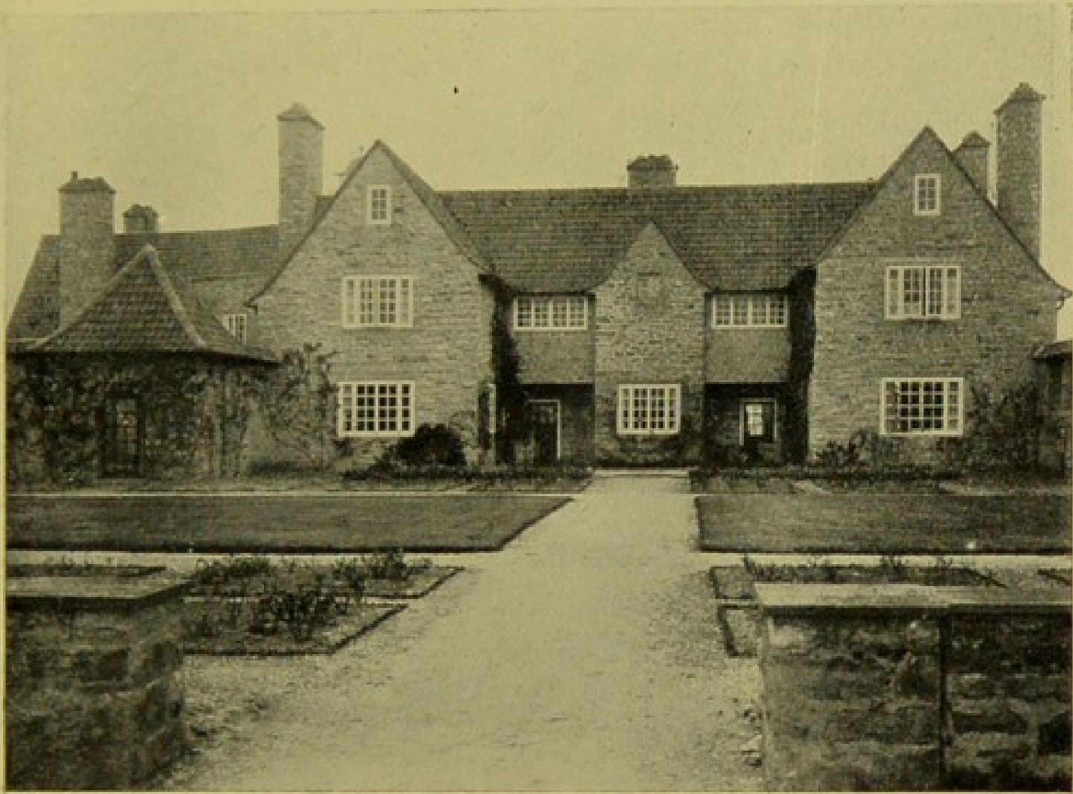


ILL. 287. THE ENTRANCE DOOR.

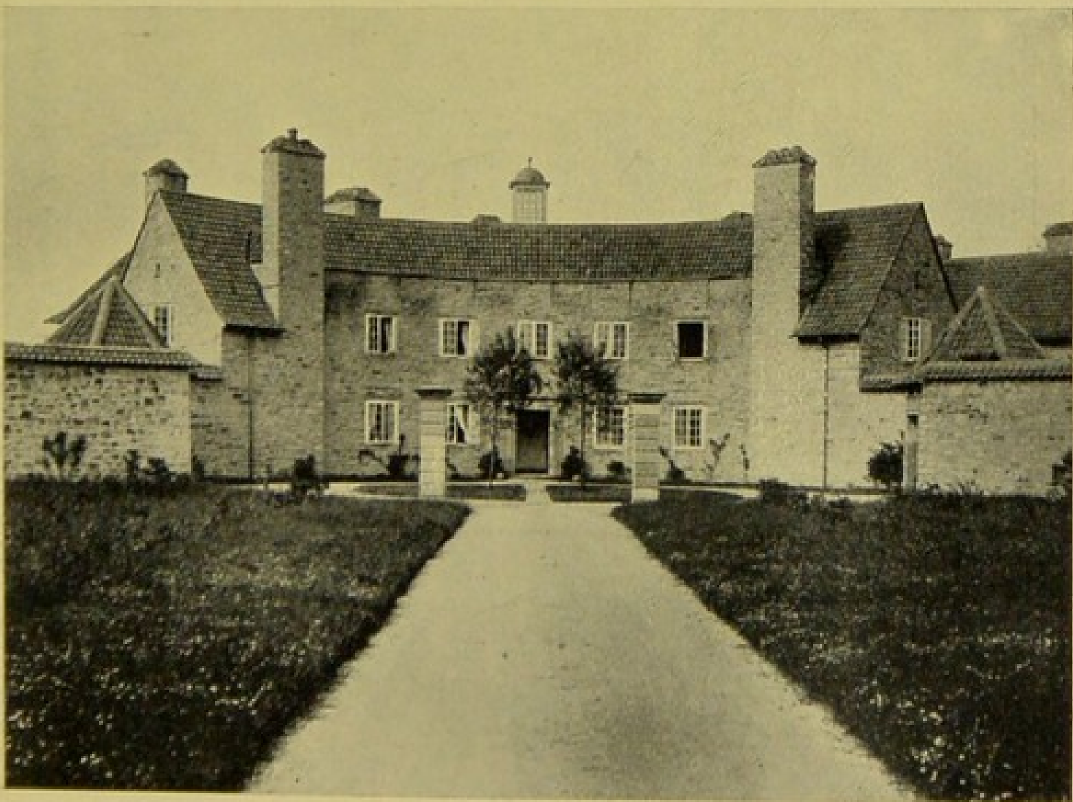
ILL. 288. THE DRAWING-ROOM.

EDWIN L. LUTYENS, F.R.I.B.A., *Architect.*

GREY WALLS, GULLANE, N.B.



ILL. 289. THE GARDEN FRONT.



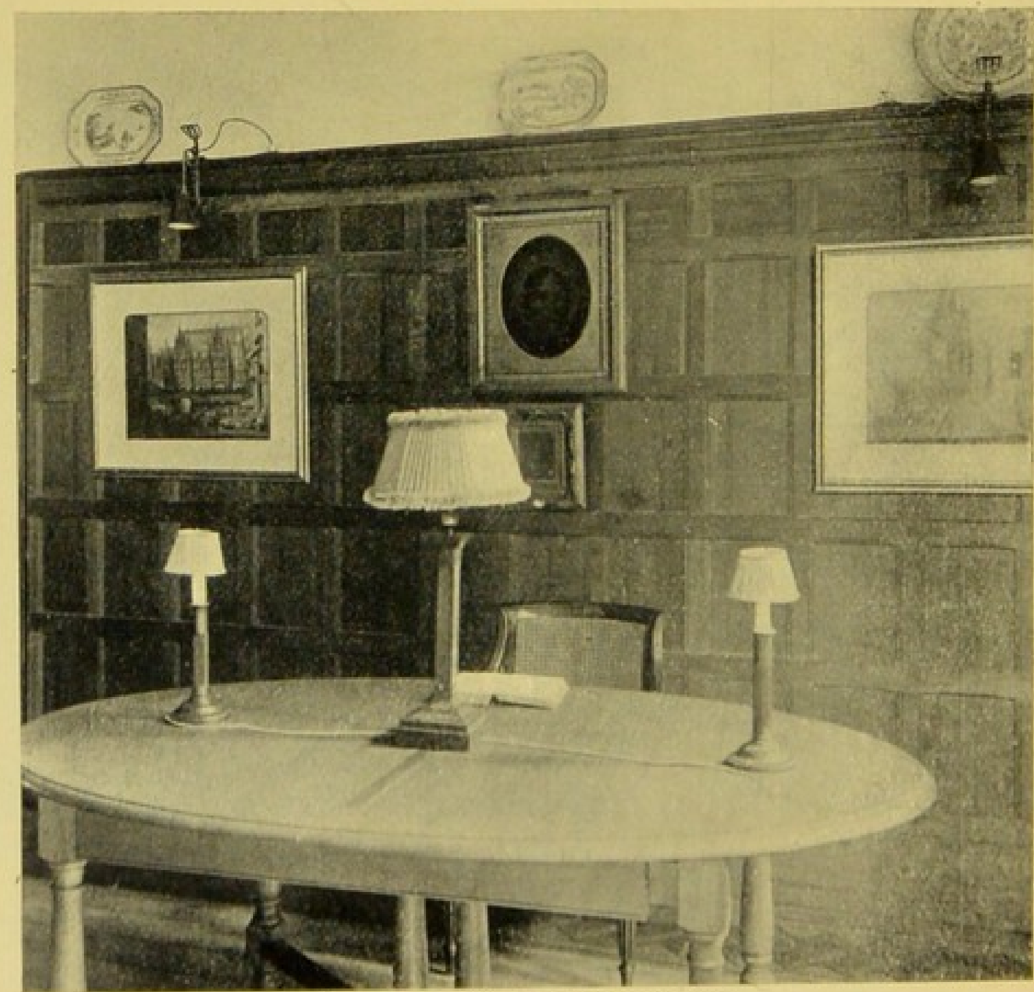
ILL. 290. THE ENTRANCE FRONT.

EDWIN L. LUTYENS, F.R.I.B.A., *Architect*.

GREY WALLS, GULLANE, N.B.

ILL. 291. THE ROUNDELL.
EDWIN L. LUTYEN, F.R.I.B A., *Architect.*

ANGLEBAY, WEST HAMPSTEAD, N.W.



ILL. 292. THE DINING-ROOM.
BANISTER FLETCHER AND SONS, FF.R.I.B.A., *Architects.*

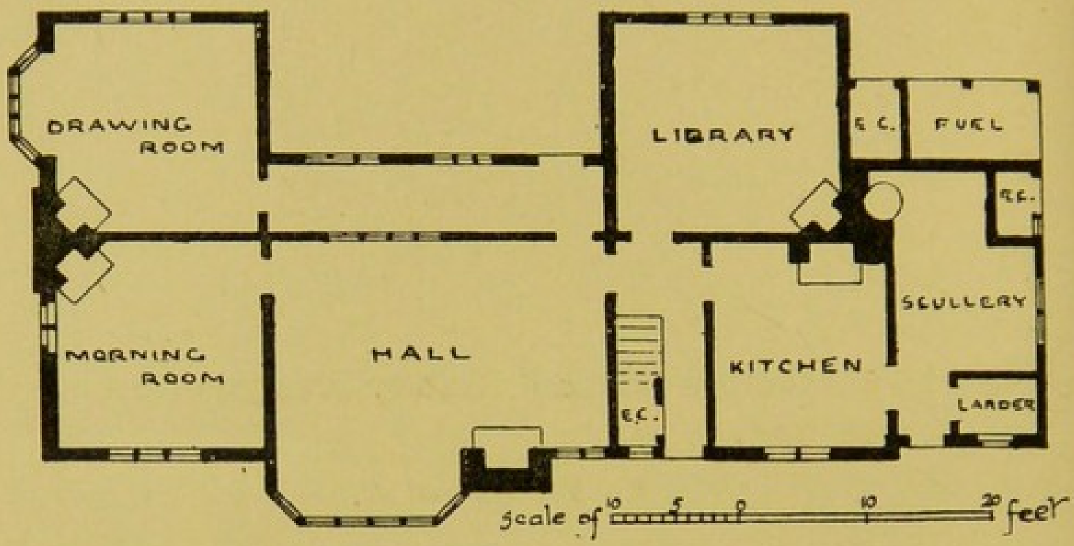
Littlewick Meadow, Horsell, Surrey, designed by Maurice H. Pocock.

(Ills. 293, 294, 295, and 296.)

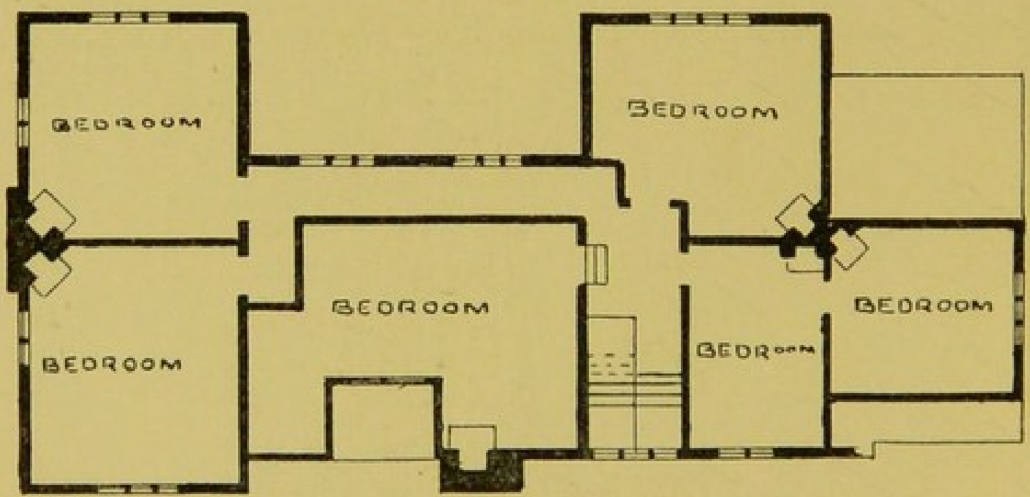
This house, situated on the edge of Horsell Common about two or three miles from Woking village, is built in the traditional English mode with brick and tiles. It has a central house place or hall which is higher than the other rooms.

The exterior has a quiet and restrained character which is reminiscent of old English architecture.

LITTLEWICK MEADOW, HORSELL, SURREY



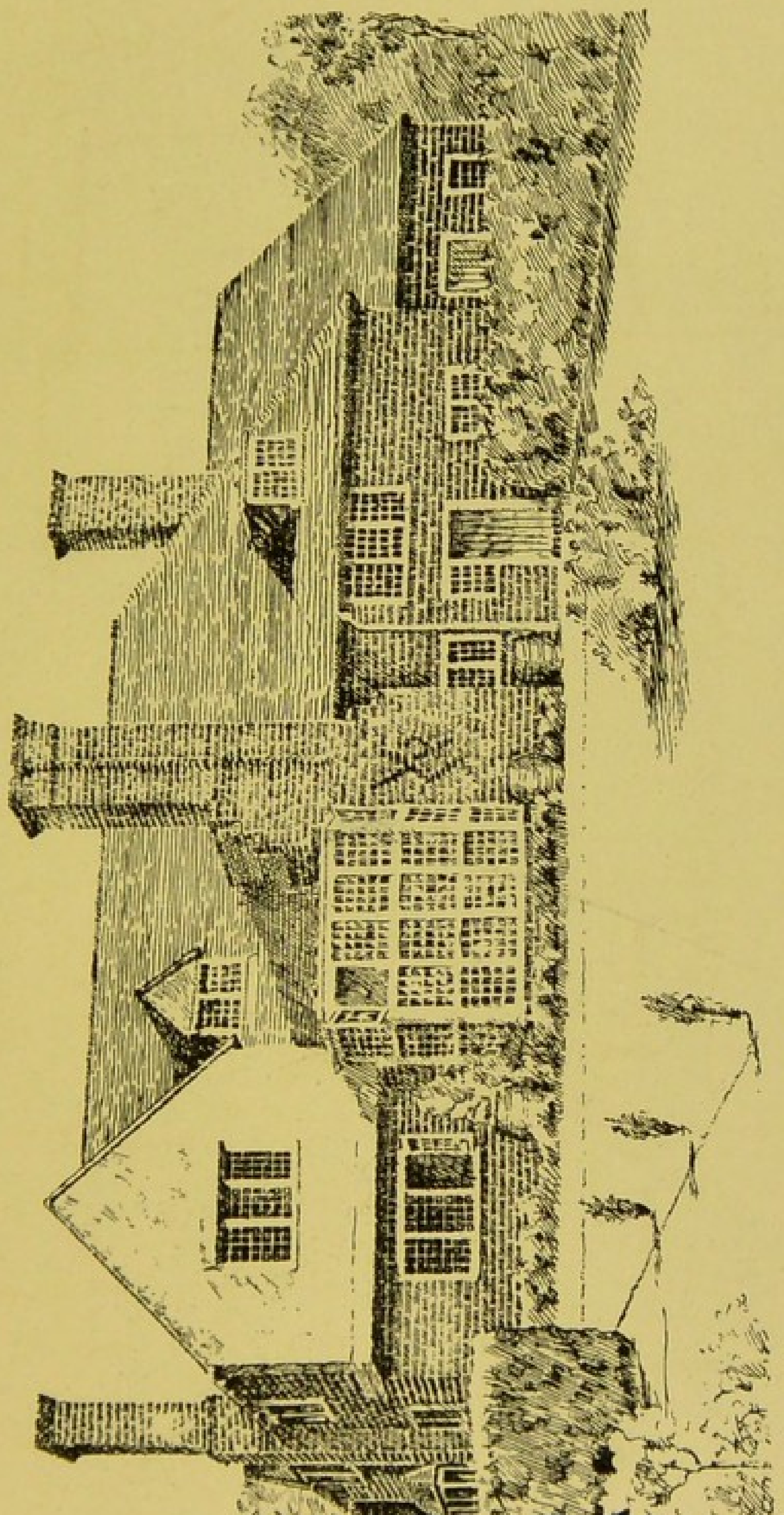
ILL. 293. GROUND-FLOOR PLAN.



ILL. 294. FIRST-FLOOR PLAN.

MAURICE H. POCOCK, *Architect.*

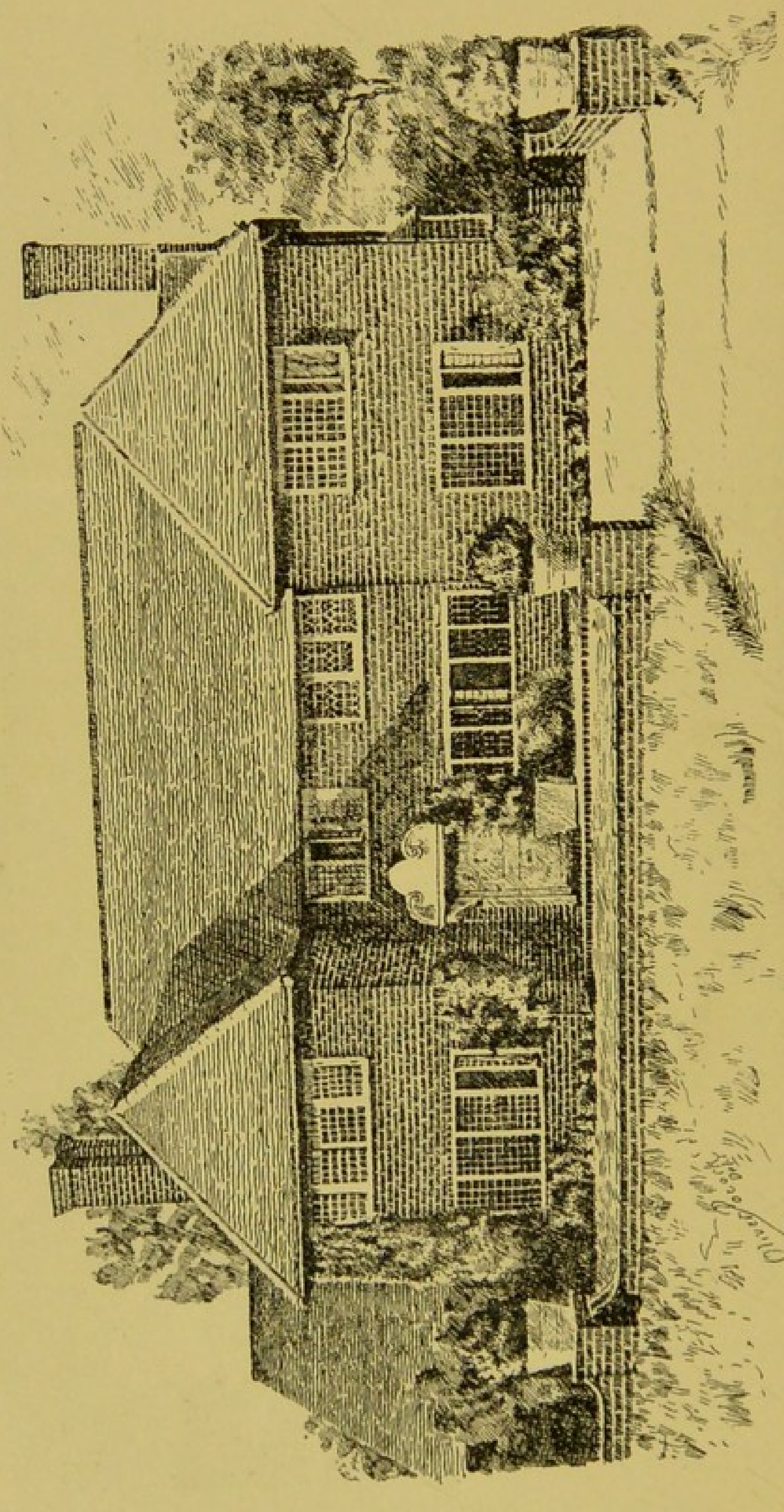
LITTLEWICK MEADOW, HORSELL, SURREY



ILL. 295. THE GARDEN FRONT.

MAURICE H. POCOCK, *Architect.*

LITTLEWICK MEADOW, HORSELL, SURREY



ILL. 296. THE ENTRANCE FRONT.

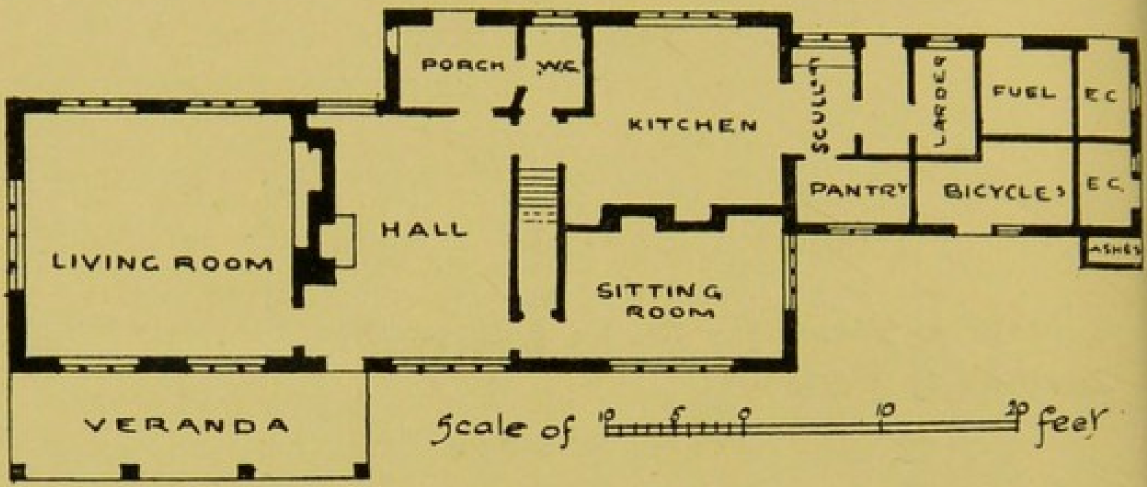
MAURICE H. POCOCK, *Architect.*

Cottage at Wendover, Bucks, designed by Maurice H. Pocock.

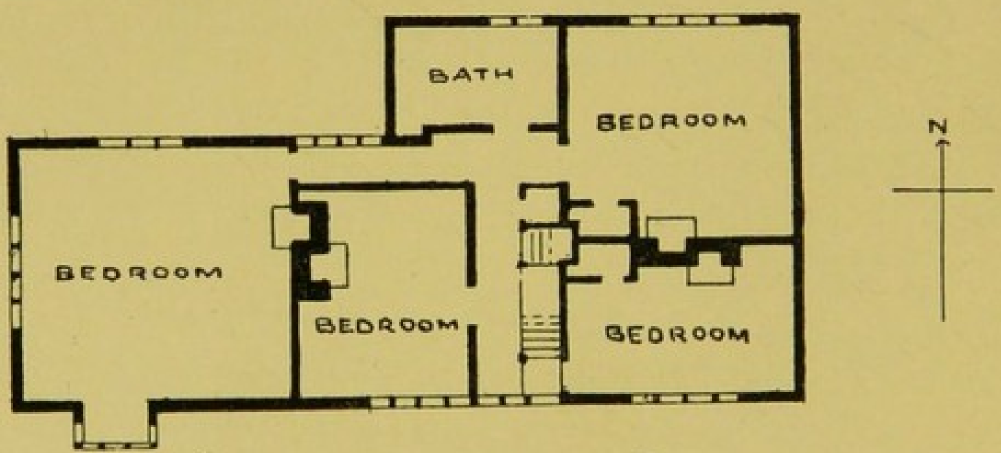
(Ills. 297, 298, and 299.)

This house is built on the hill just above the station and has been built as a week-end house and not for continuous residence. The bricks and weather tiling are whitewashed and old tiles were procured for the roof.

COTTAGE AT WENDOVER, BUCKS



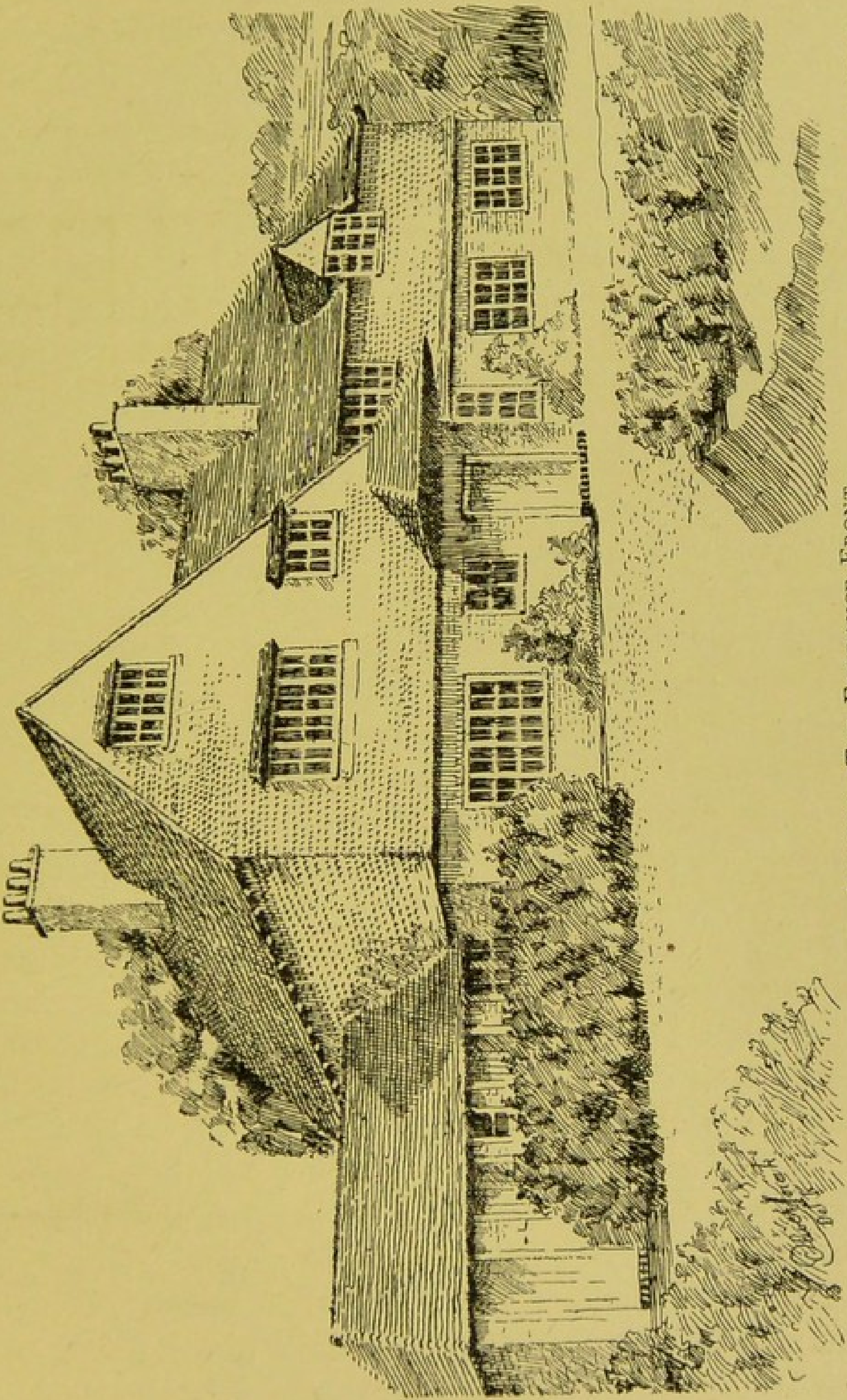
ILL. 297. GROUND-FLOOR PLAN.



ILL. 298. FIRST-FLOOR PLAN.

MAURICE H POCOCK, *Architect.*

COTTAGE AT WENDOVER, BUCKS



ILL. 299. THE ENTRANCE FRONT.

MAURICE H. POCOCK, *Architect.*

The Orchard Farm, Broadway, Worcestershire, designed by A. N. Prentice, F.R.I.B.A.

(Ills. 300 and 301.)

This is an example of an old Cotswold farm-house which has been converted to the modern requirements of a country house. The old house has only been altered externally by opening up a few old windows that had been bricked up, and by replacing some modern windows with stone mullioned ones in character with those that were there originally.

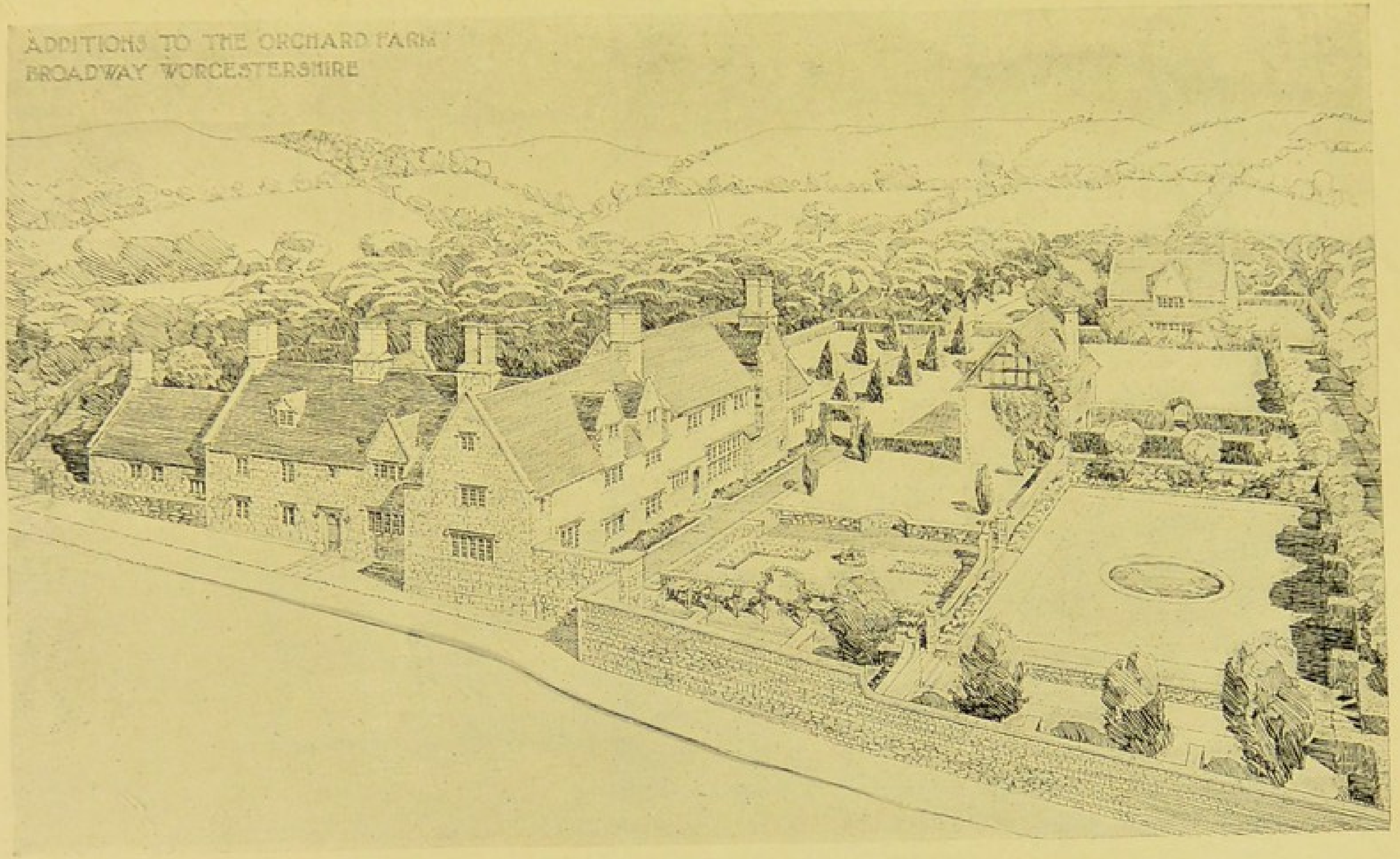
The interior has been adapted for modern reception-rooms and bedrooms, the old fireplaces being retained. Most of the old constructional woodwork was in a decayed condition and has been renewed and the walls and ceilings replastered. The old barn in the rear has been converted into a music-room forty-four feet long by twenty-four feet wide with bedroom accommodation in the upper portion.

The music-room has heavy moulded carved oak principals carrying the beams on which the joists rest that form the floor and ceiling. It is panelled in oak, the upper end of the room being raised to form a dais.

A new kitchen wing has been added containing, besides kitchen and scullery, a servants' hall, larder, butler's pantry and wine cellar.

A brick and stone paved court has been formed between the two projecting wings of the building, and is laid out with flower borders, stone steps leading from the court to the garden below. Ill. 300 shows the grouping of the old and new building and the laying out of the garden as seen from the road.

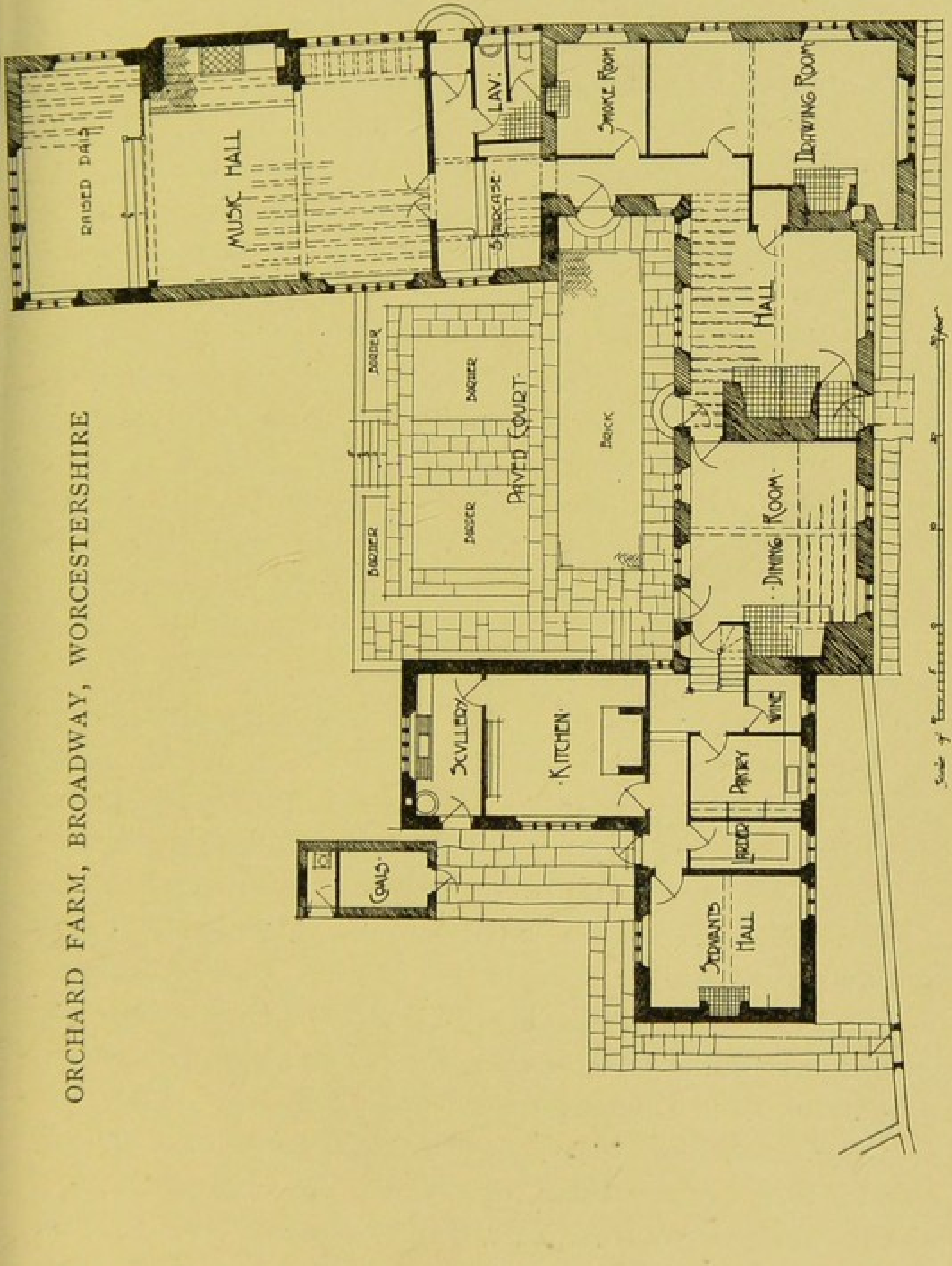
ORCHARD FARM, BROADWAY, WORCESTERSHIRE



ILL. 300. VIEW FROM ROAD.

A. N. PRENTICE, F.R.I.B.A., *Architect*.

ORCHARD FARM, BROADWAY, WORCESTERSHIRE



ILL. 301. GROUND-FLOOR PLAN.

A. N. PRENTICE, F.R.I.B.A., *Architect*.

Semi-detached Houses at Hampstead Garden Suburb, designed by M. H. Baillie-Scott.

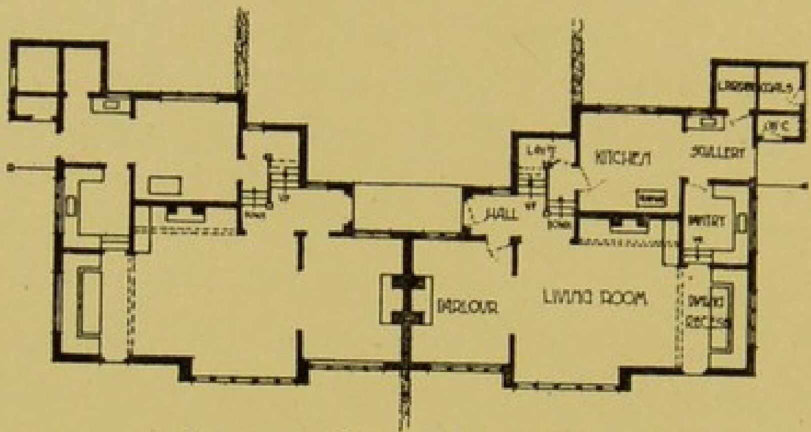
(Ills. 302, 303, 304, 305, 306, and 307.)

The illustrations of the semi-detached houses at Hampstead Garden Suburb represent a simple case of the application of certain principles of planning to small houses advocated by Mr. Scott. In the first instance, in the general conception of a small house it seems desirable that one should think of realizing a large and roomy cottage rather than a cramped villa; that the limited sum available for such a building should be spent in floor space and elbow room rather than in lofty and necessarily smaller rooms. Then it is essential that the plan should not consist of a series of rectangular plastered boxes each too small for comfort, crowded with suites of furniture and absolutely unrelated to each other; but rather that our conception of the interior should hold fast to the ideal of at least one roomy apartment surrounded by such smaller ones as may be required. These smaller apartments may become, in some cases, recesses in the main room or house place, or be divided from it by sliding doors; so that even in a small house, costing it may be only a few hundred pounds, one may enjoy a certain spaciousness of environment, instead of being cramped within the narrow confines of the isolated apartment of the small villa. A reference to Ill. 307 will give some idea of the general effect of the central apartment in the plans we are considering. Here the separate dining-room has dwindled down to a recess, and the space added instead to the enlargement of the central room. The dining recess (Ill. 302) so formed is curtained off from the main apartment while the table is being prepared. Labour is reduced to a minimum, and the effect of this recess with its fixed seats is necessarily more attractive than the minute dining-room of the ordinary type. This incorporation of the dining-room also simplifies the problem of heating a room which is only perhaps intermittently occupied.

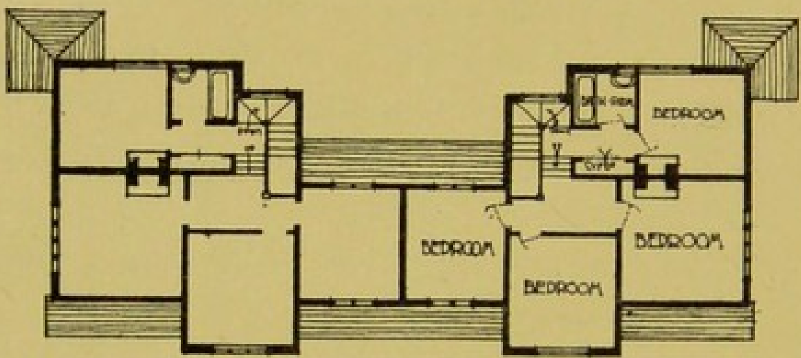
The position of the parlour at the other end of the general house place is such that the visitor can be shown into it without disturbing the privacy of the living-room, and it will be noted that the servant can not only approach the dining recess, but also the front door of the parlour and the bedrooms without passing through the living-room, which, while having all the appearance of a hall, is quite free from traffic.

On the upper floor (Ill. 303) there are four bedrooms and a bathroom.

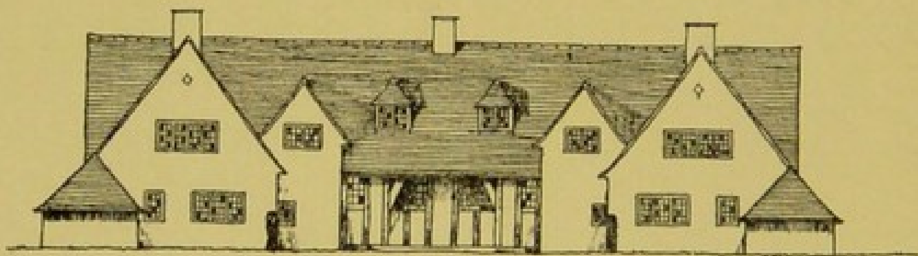
SEMI-DETACHED HOUSES, HAMPSTEAD GARDEN SUBURB



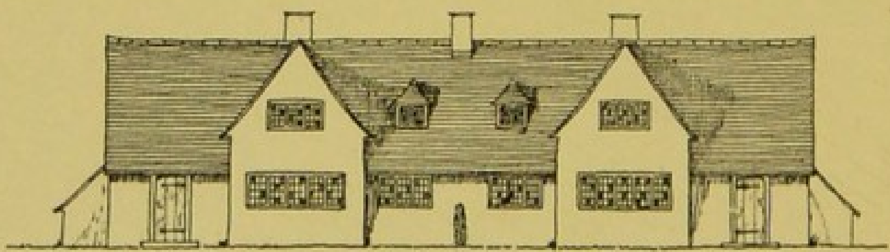
ILL. 302. GROUND-FLOOR PLAN.



ILL. 303. FIRST-FLOOR PLAN.



ILL. 304. THE ENTRANCE FRONT.

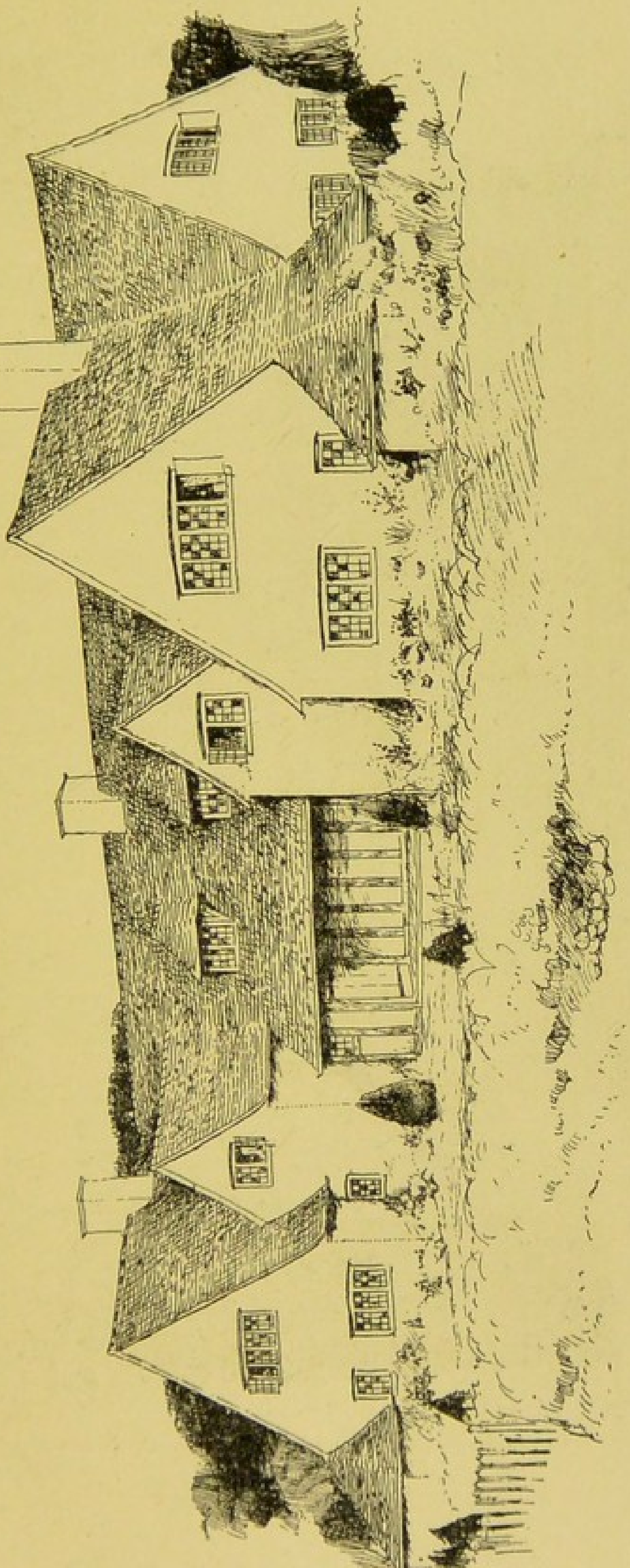


ILL. 305. THE GARDEN FRONT.

SCALE OF 10 5 0 10 20 30 40 50 60 FEET

M. H. BAILLIE-SCOTT, *Architect.*

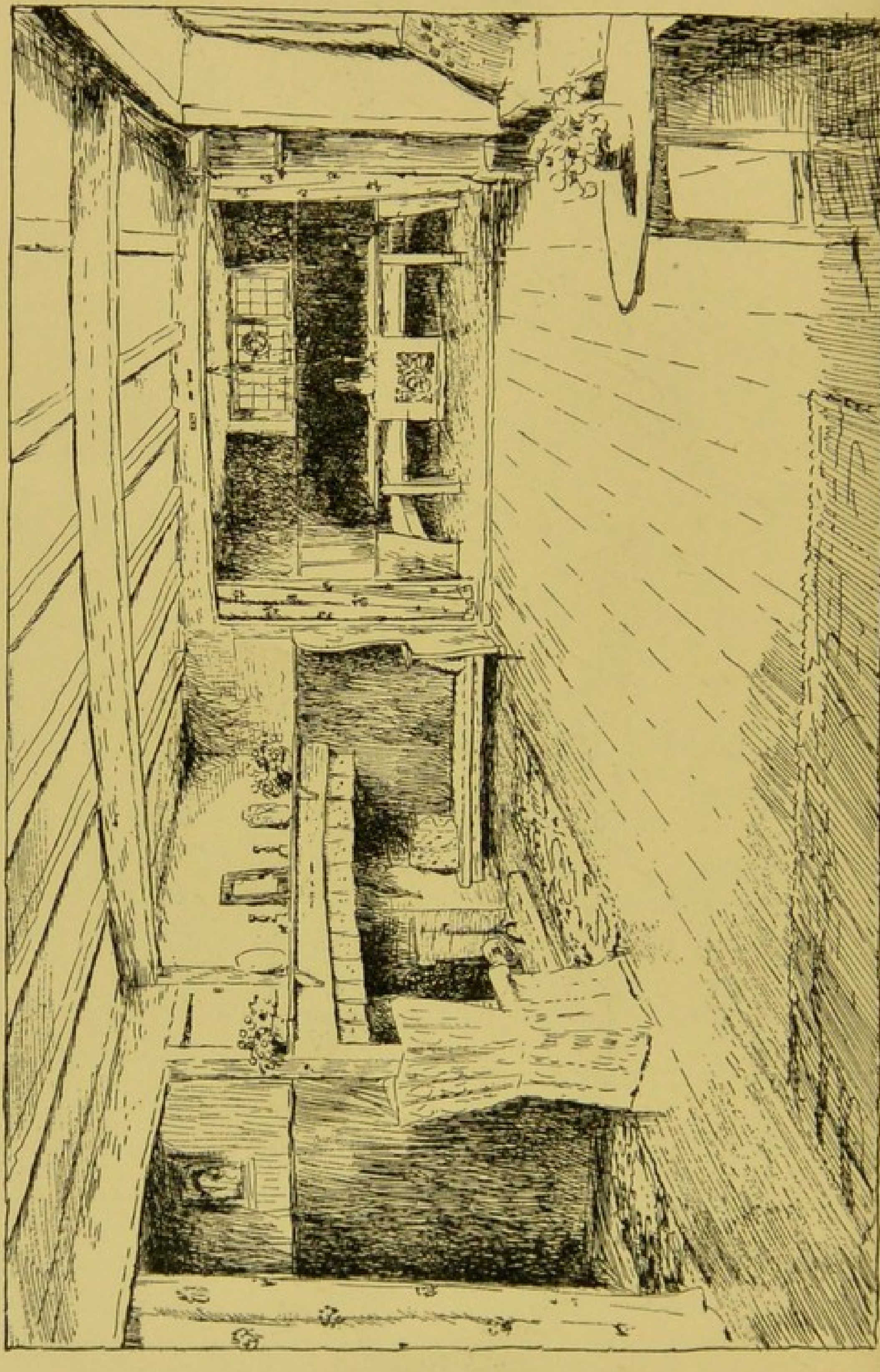
SEMI-DETACHED HOUSES AT HAMPSTEAD GARDEN SUBURB



M. H. Baillie-Scott, *Architect.*

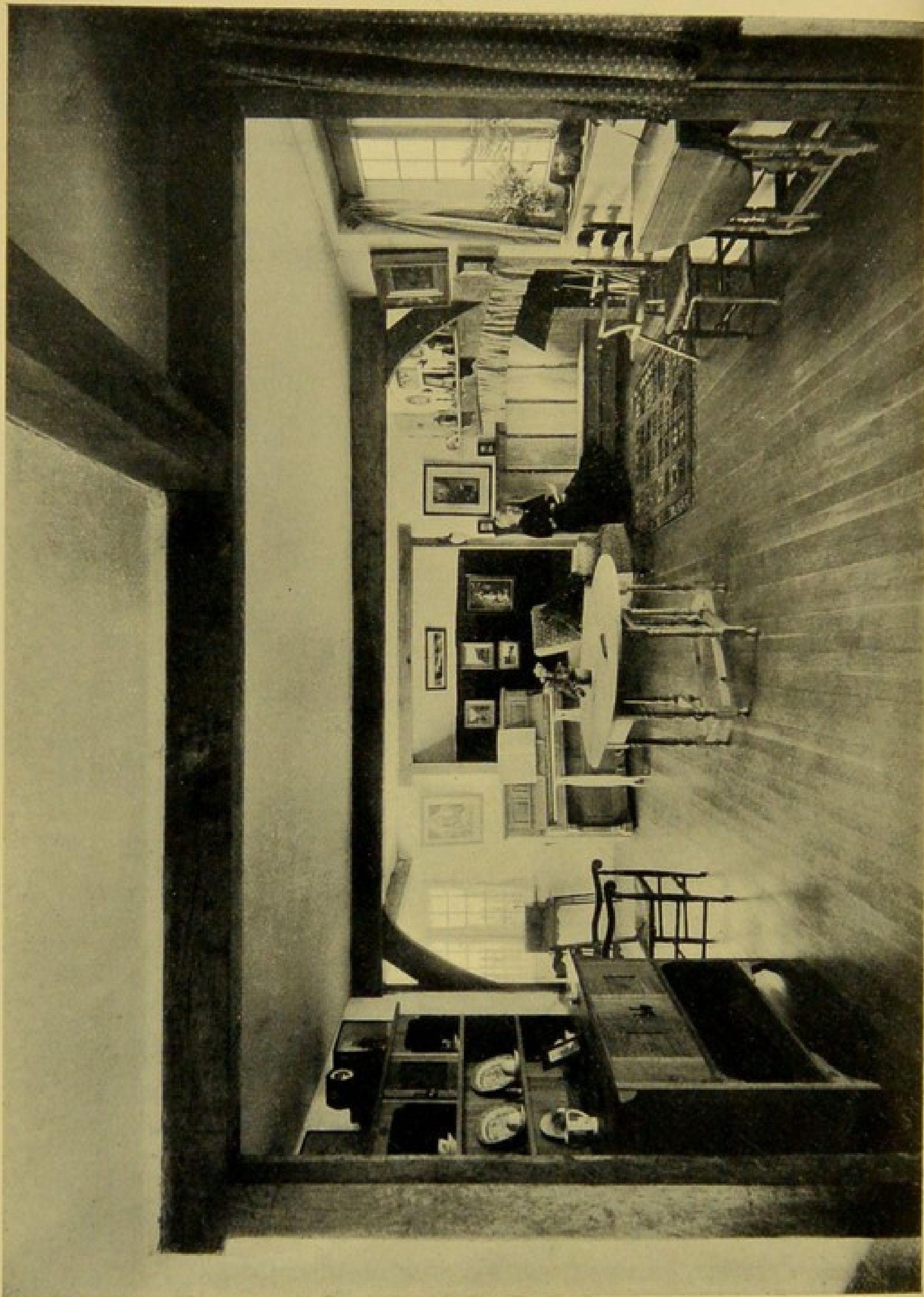
Ill. 306. View from Road.

SEMI-DETACHED HOUSES AT HAMPSTEAD GARDEN SUBURB



ILL. 307. THE LIVING-ROOM.

HOUSE AT BIDDENHAM



ILL. 308. THE LIVING-ROOM.

House at Biddenham, designed by M. H. Baillie-Scott.

(Ill. 308.)

The photograph of the interior of the house at Biddenham (Ill. 308) illustrates a somewhat similar apartment in a small house to that described on page 330, where the same principles of planning are followed. This house contains a second sitting-room besides the one shown, as well as four bedrooms, a bathroom and the usual kitchen premises.

House at Letchworth, designed by C. Harrison Townsend, F.R.I.B.A.

(Ills. 309, 310, 311, 312, 313, 314, and 315.)

This house is situated in Letchworth Glade, one of the conditions attached to the purchase of the land being that a width of twenty-five feet on the boundary next the public carriage way should be left with its natural turf unfenced in and unbuilt upon.

A feature in the plan (Ill. 310) is the width of the veranda, which gives a space of twenty-seven feet by six feet, and, as will be seen from Ill. 314, is sufficiently large to be used for meals, and for sleeping out.

The garden shown on Ill. 309 was laid out, before the house was commenced, principally as a rose garden, and was in a well-developed state when the house was first occupied.

The materials for the lower part of the walls, as shown in Ills. 314 and 315, were stock bricks covered externally with rough plaster, *not* rough cast.

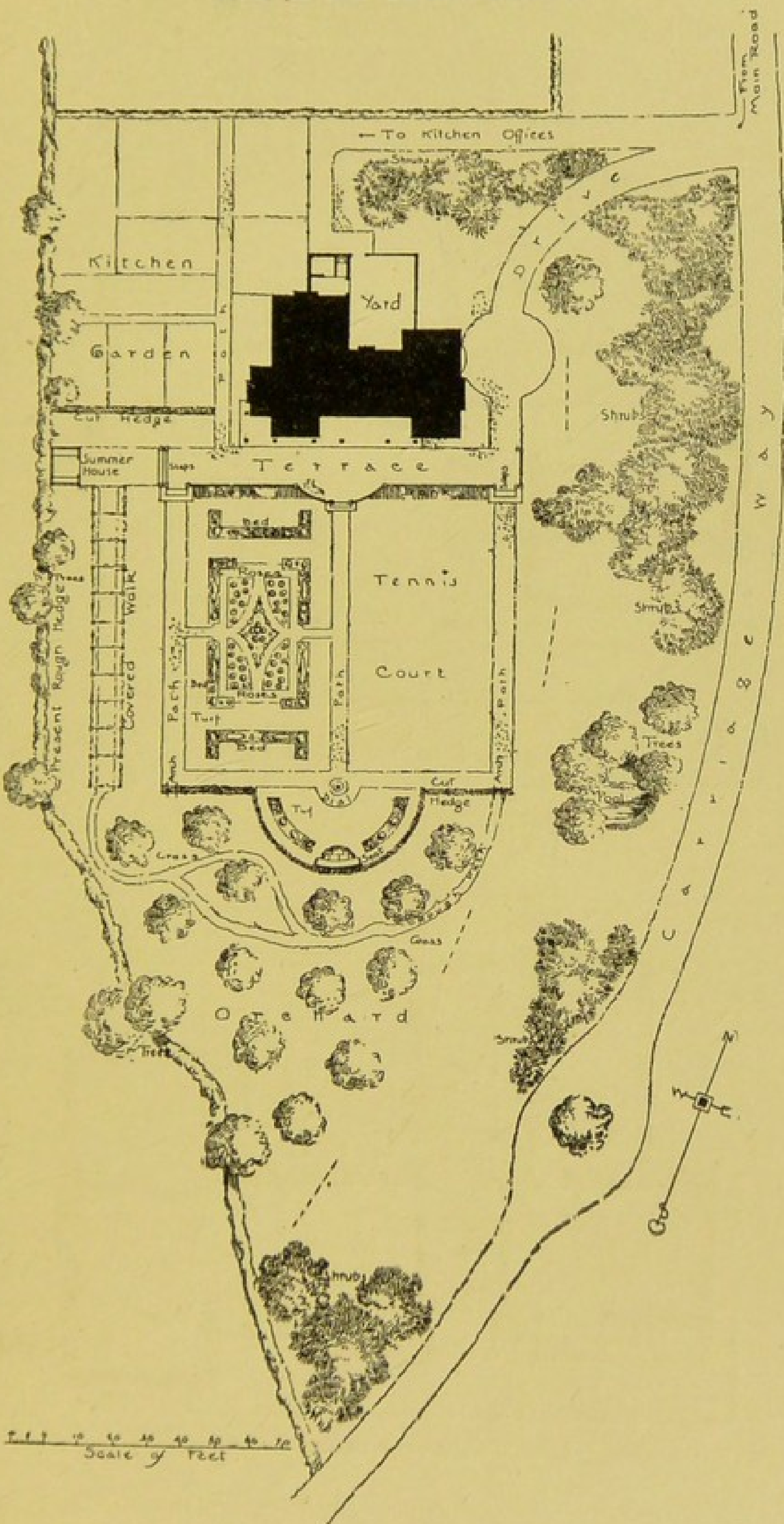
The upper portion of the walls and the roof have specially selected local tiles, which are of a pleasant dark colour.

The chimneys and other facing brickwork are of local bricks, and the dressings are of Doulting stone, left with a rough tooled face.

Most of the paintwork to the house is white, but that to the dining-room (Ill. 313), including ceiling joists and all woodwork, is light green, the walls being whitewashed.

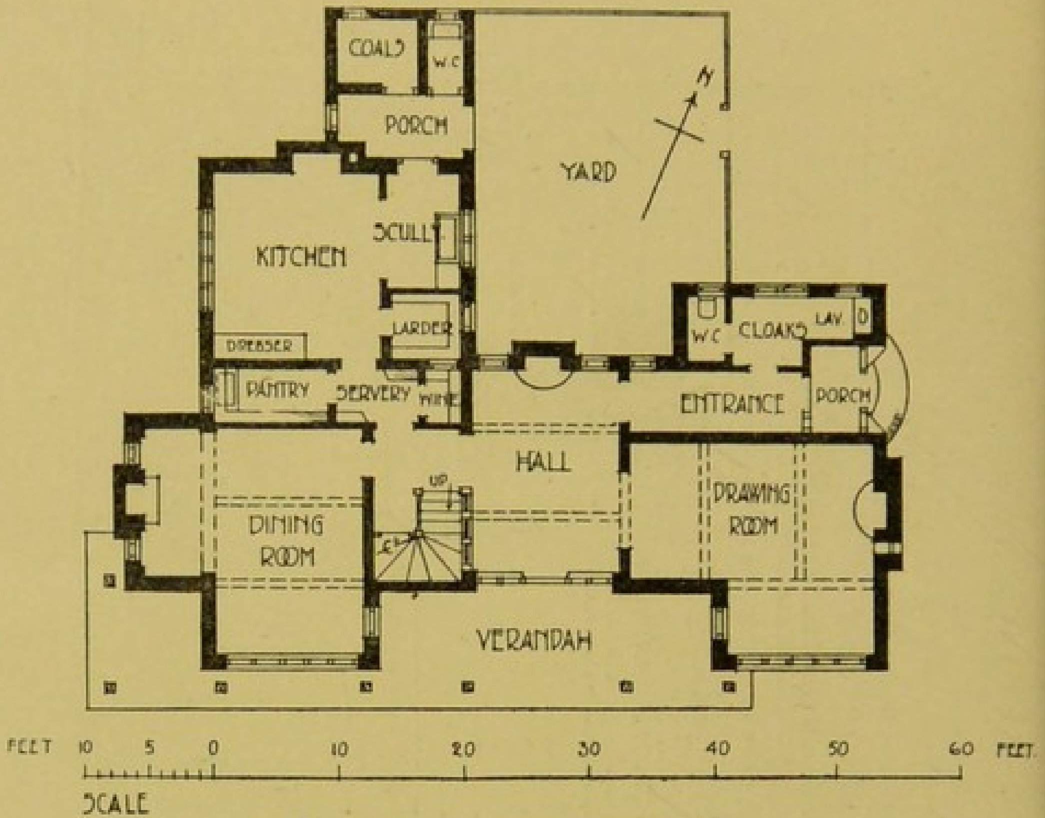
Ill. 312 shows the hall mantelpiece with visible brickwork and the joists of the floor above.

HOUSE AT LETCHWORTH

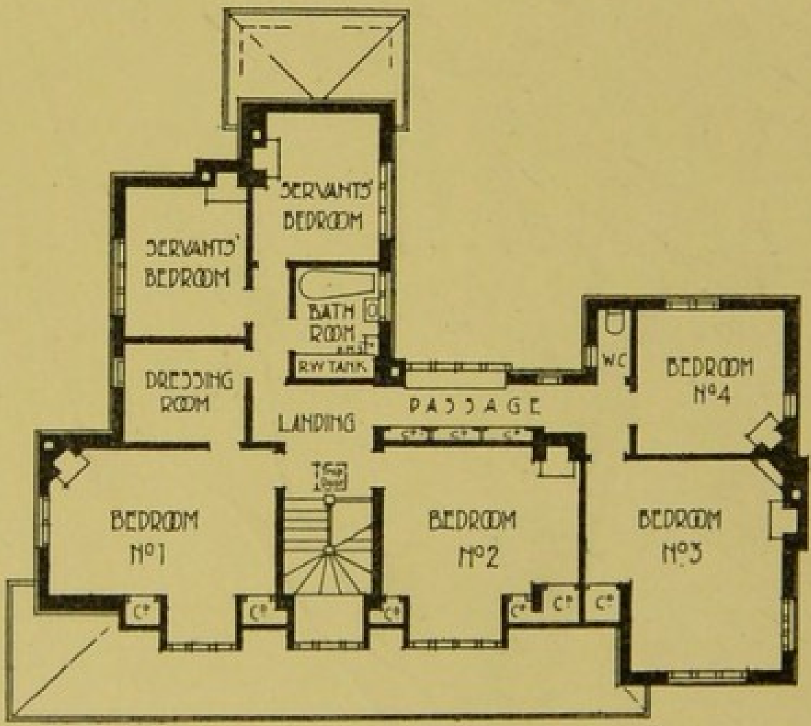


ILL. 309. THE GARDEN PLAN.
C. HARRISON TOWNSEND, F.R.I.B.A., *Architect.*

HOUSE AT LETCHWORTH



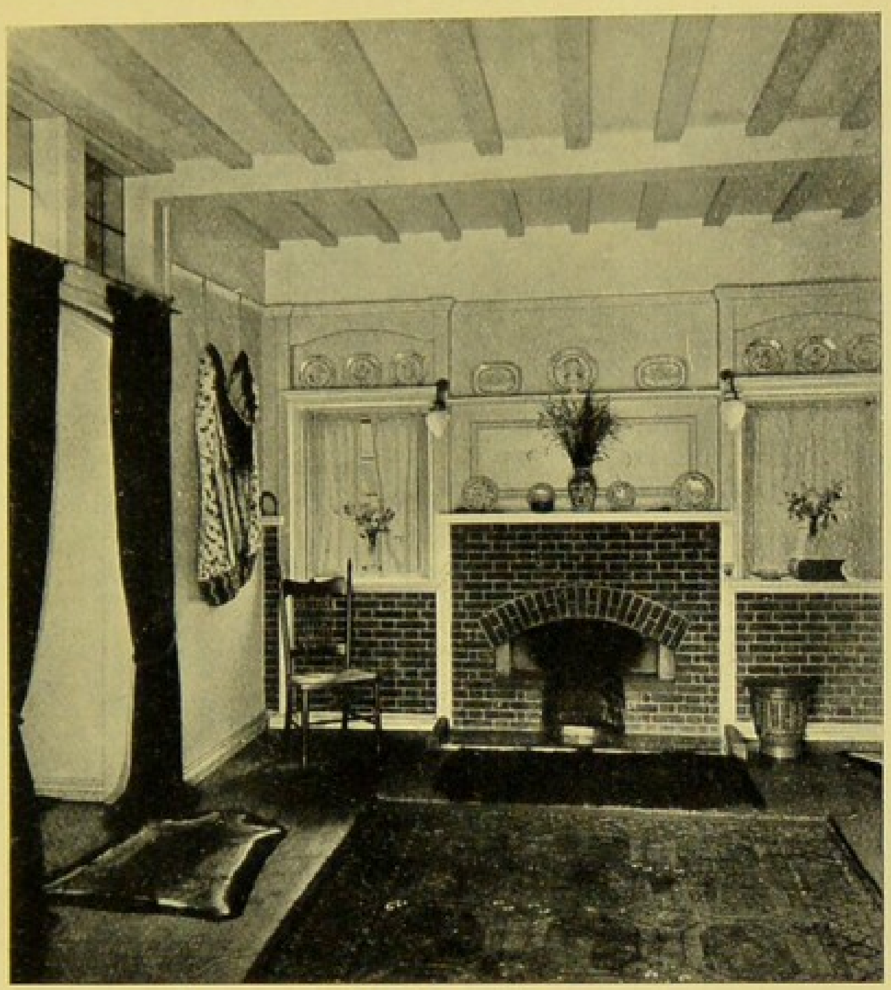
ILL. 310. GROUND-FLOOR PLAN.



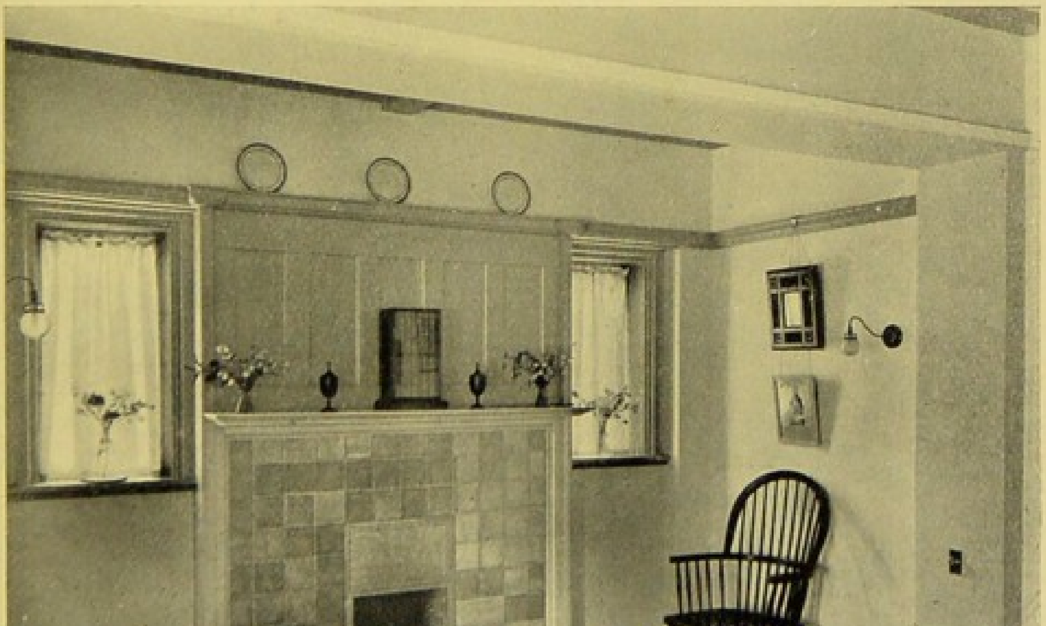
ILL. 311. FIRST-FLOOR PLAN.

C. HARRISON TOWNSEND, F.R.I.B.A., *Architect.*

HOUSE AT LETCHWORTH



ILL. 312. THE HALL MANTELPIECE.



ILL. 313. THE DINING-ROOM MANTELPIECE.

C. HARRISON TOWNSEND, F.R.I.B.A., *Architect.*

HOUSE AT LETCHWORTH

Ill. 314. The Garden Front.

Ill. 315. The Entrance Front.

C. Harrison Townsend, F.R.I.B.A., *Architect.*

The Homestead, Frinton-on-Sea, designed by C. F. A. Voysey.

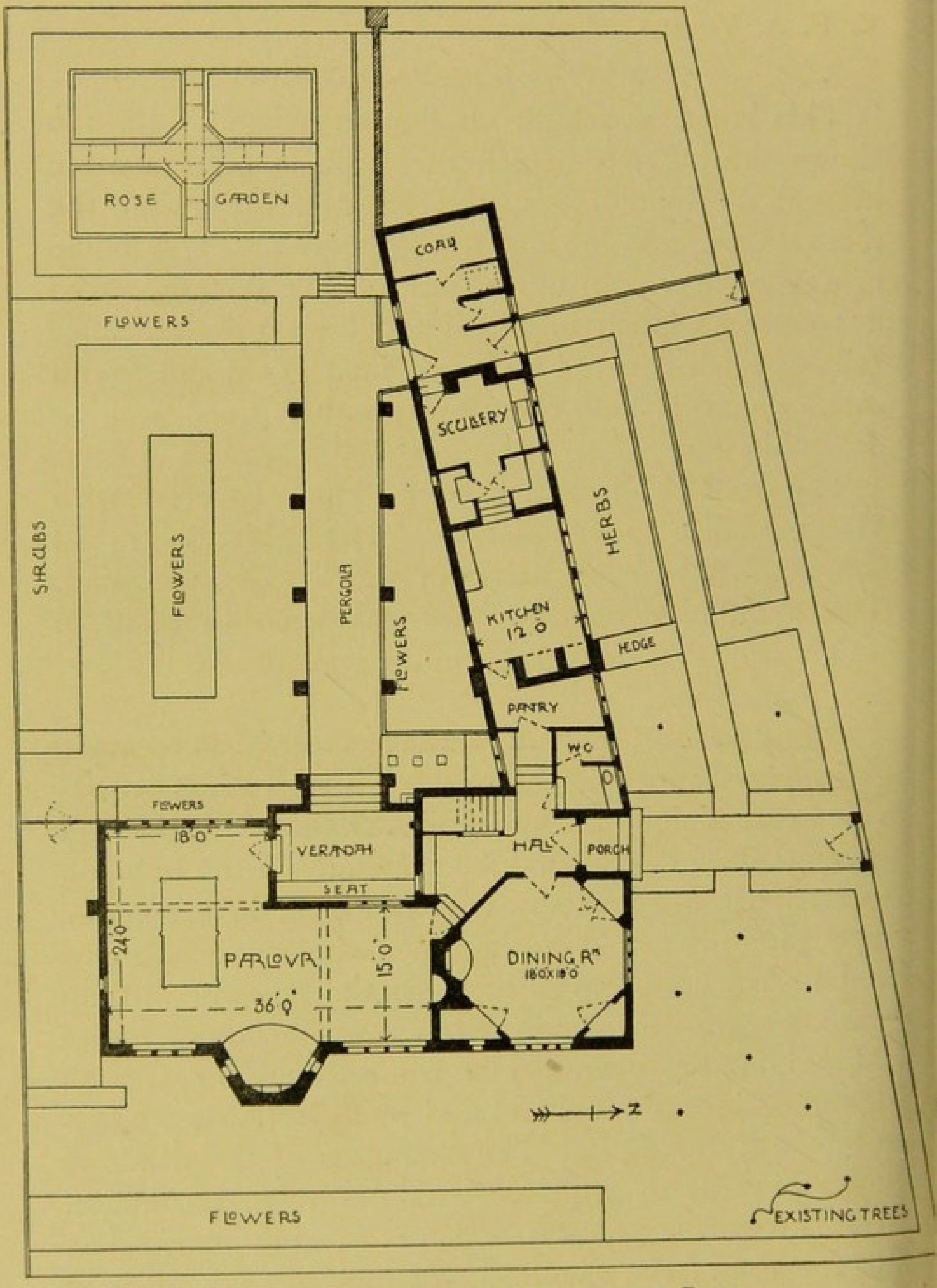
(Ills. 316, 317, 318, 319, 320, 321, and 322.)

This house was built on sloping ground. Ill. 316 shows the plan, of which the main features are the octagonal dining-room, the large parlour and the recessed veranda leading to the pergola. This home is a good example of the art of Mr. Voysey, who has done so much to simplify domestic architecture. It is of brick covered with one inch of cement rough cast, which is the cheapest weather-proof walling devisable.

The roof is boarded, felted and covered with Westmorland green slates. The gutters are of oak, tarred inside; and the down pipes of lead. The main object throughout has been to build in such a way that the cost of upkeep should be reduced to a minimum.

Owing to local by-laws all the rooms had to be made eight feet six inches high, although each room is provided with a nine-inch by nine-inch exhaust air-flue and each fireplace has an air-tube from outside the building to feed the fire and so avoid draughts in the room. The windows are in Bath stone, with iron casements and leaded lights, so as to avoid the noise of rattling windows and to preserve an equable temperature throughout the year. The windows are kept small as the ceilings are low and add by reflection the needful quantity of light. The smallness of the windows helps towards the equable temperature in the house. The site is very exposed, which is an additional reason for the size of the openings, yet they are adequate to give abundance of light. The floors are laid direct on

HOMESTEAD, FRINTON-ON-SEA

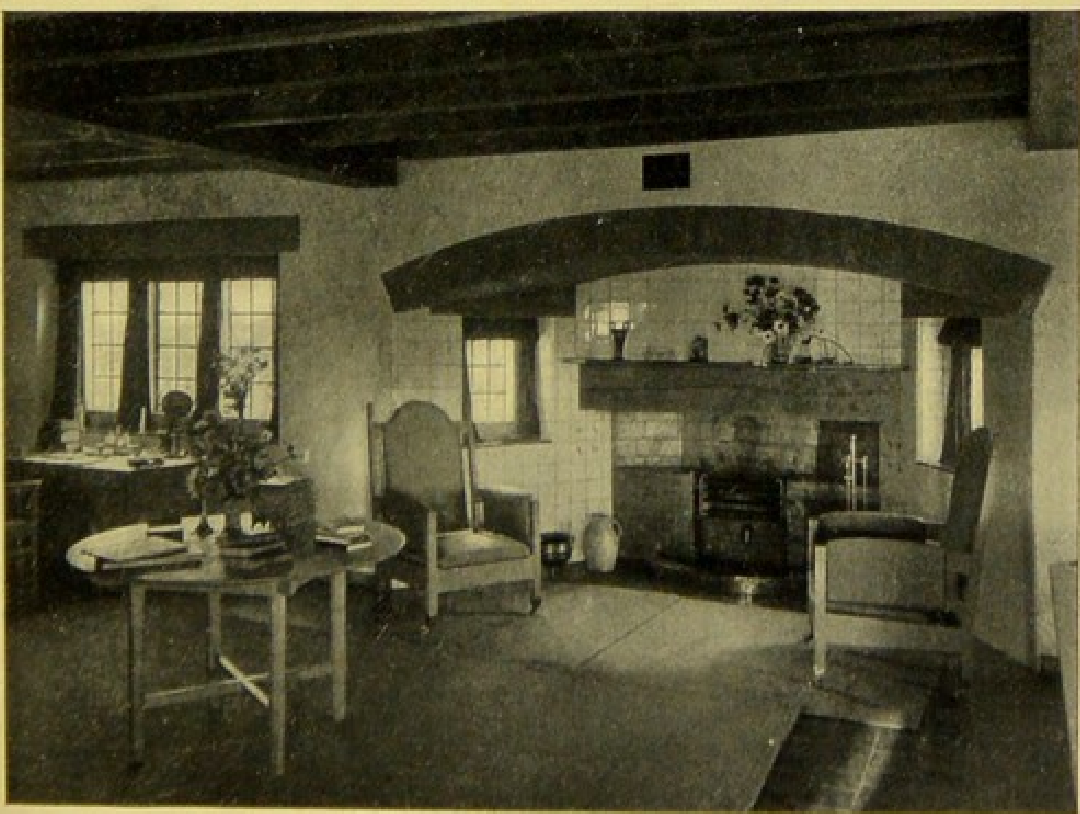


ILL. 316. GROUND-FLOOR AND GARDEN PLAN.

C. F. A. VOYSEY, *Architect.*

THE HOMESTEAD, FRINTON-ON-SEA

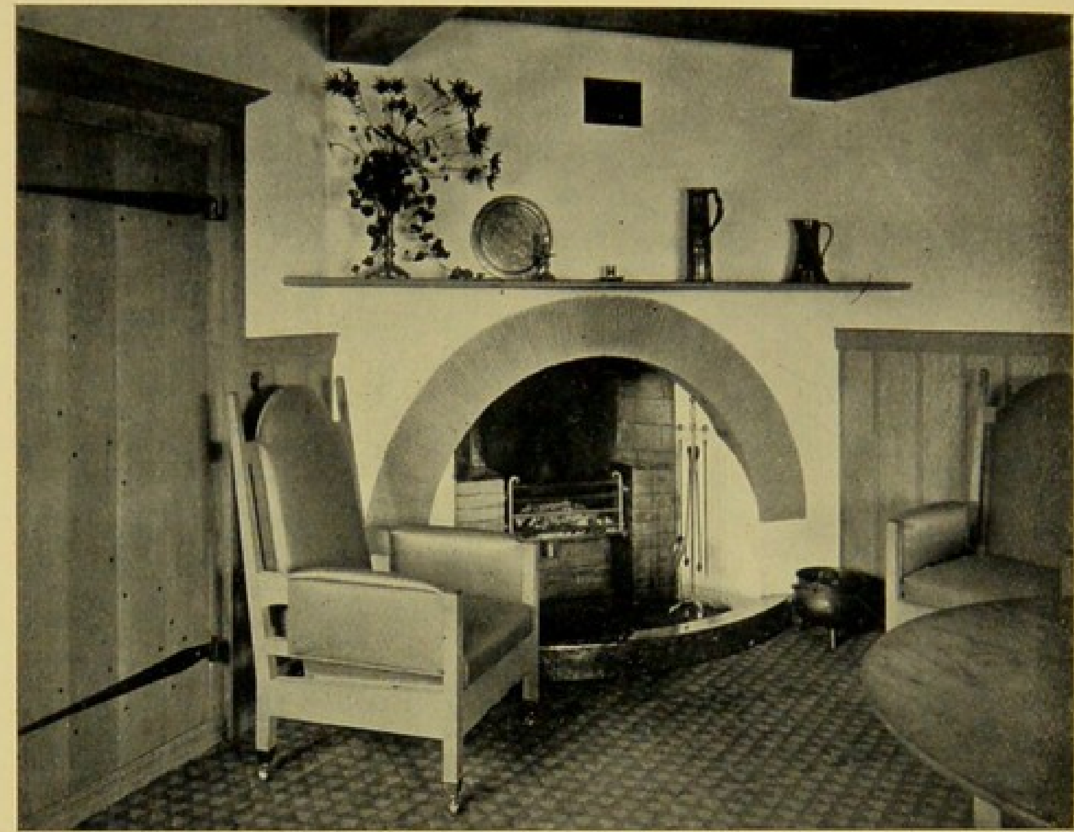
ILL. 317. PART OF DINING-ROOM.



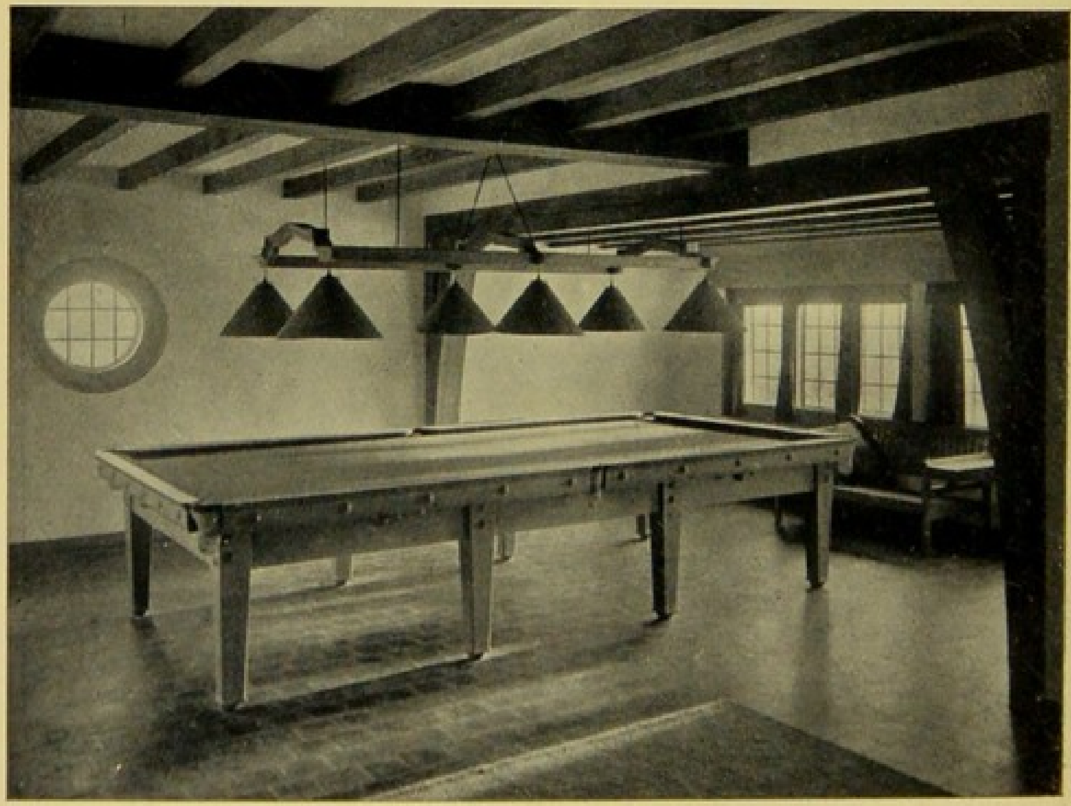
ILL. 318. THE PARLOUR, SHOWING INGLE-NOOK FIREPLACE.

C F A. VOYSEY, *Architect.*

THE HOMESTEAD, FRINTON-ON-SEA



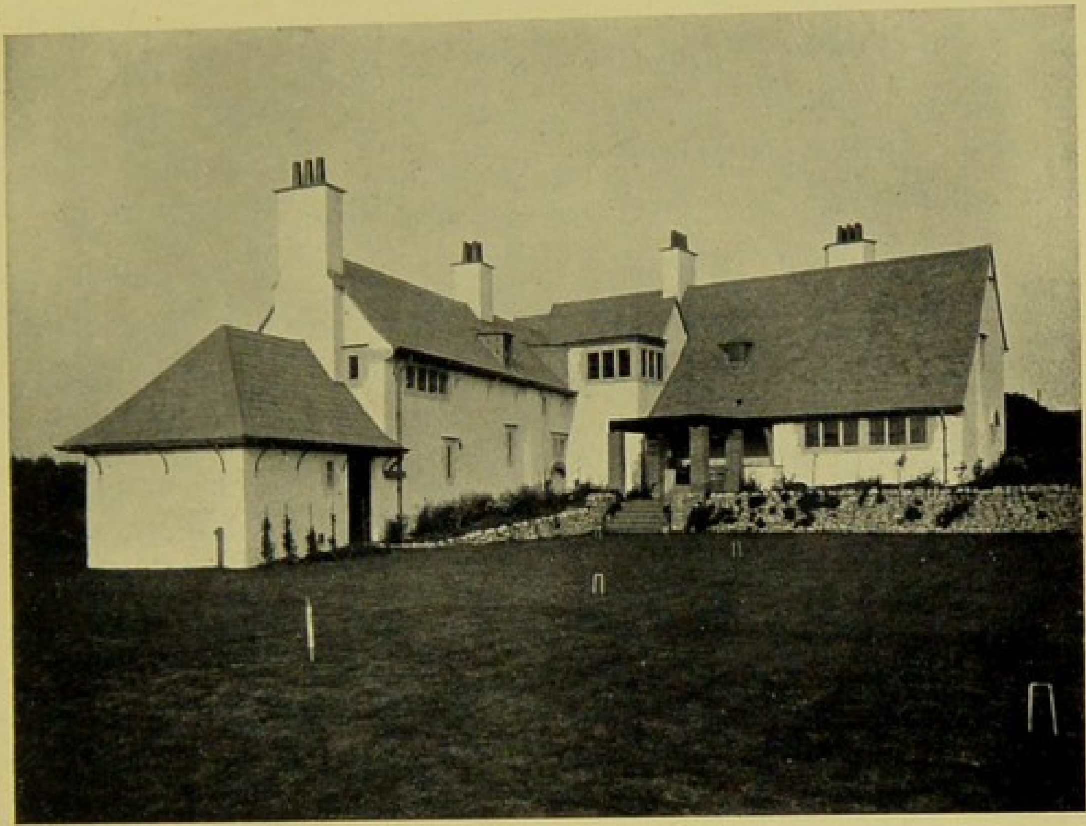
ILL. 319. THE DINING-ROOM FIREPLACE.



ILL. 320. THE PARLOUR LOOKING S.W. AND SHOWING BILLIARD TABLE.

C. F. A. VOYSEY, *Architect.*

THE HOMESTEAD, FRINTON-ON-SEA



ILL. 321. THE GARDEN FRONT.

ILL. 322. THE ENTRANCE FRONT.

C. F. A. VOYSEY, *Architect.*

to the concrete, and have been found to contribute largely to the preservation of an even temperature in the house; with the exception of the dining-room, they are paved with black Dutch unglazed vitrified tiles, producing a pleasant grey-black colour.

All the joinery is in oak, and the oak wardrobes, dressing-tables and washstands are built into the walls, so as to avoid loss of space and dust traps, and there is therefore no space behind or beneath to be papered or carpeted.

The inside walls are finished in rough hand-floated plaster and are distempered white.

The arches in Ills. 318 and 319 are in red tiles. The cheeks of the fireplaces are in small bricks, blackleaded. The decorative scheme is white, with oak left clean from the plane and grey-black tiled floors with red tiles in the arches. The first-floor joists of oak are exposed to view.

All the furniture is in oak, left free from stain or polish of any kind, and is of simple and effective design.

The window sills are green-glazed Dutch tiles. The dining-room has an oak dado four feet high, with white plaster above, and is furnished with side-board and cupboards in three out of the four corners forming the octagon (Ills. 316 and 317).

The only painting necessary is for the gutter brackets and door hinges. All the bells are wire cranked, with different tones for each room, and the house is electrically lighted throughout.

Hollymount, Knotty Green, Beaconsfield, Bucks, designed by C. F. A. Voysey.

(Ills. 323, 324, 325, and 326.)

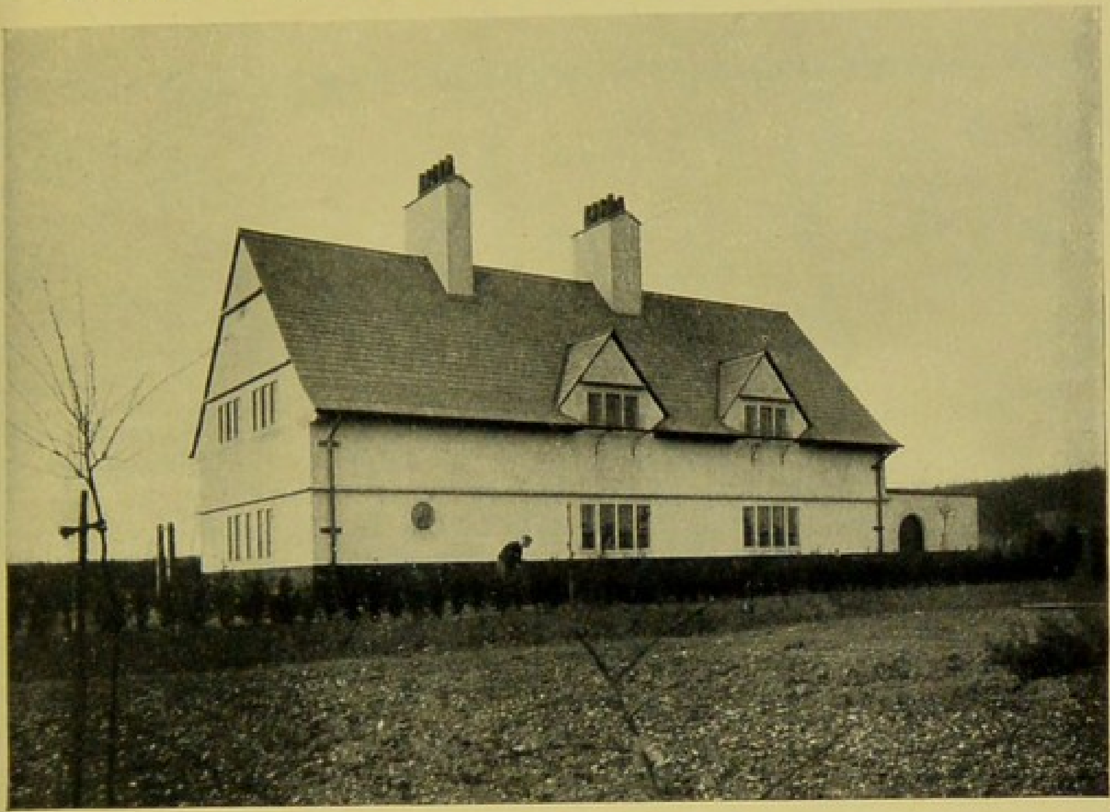
This house was built of brick rough cast for economy's sake and has a green slate roof, Bath stone mullions and iron casements. The base of external walls is tarred to avoid the dirty splashings and produce an effect of repose.

The windows have plaster jambs, wood lintels flush with plaster and green-glazed tile sills.

The chimney-pots are black, because the boiled-out red of the ordinary pot is not such a good combination with a green roof as a black colour. The woodwork is all in deal, painted green outside and enamelled white inside.

Every room has a little ventilator or casement the size of one pane, in addition to the larger casements, and a nine-inch by nine-inch air-flue for carrying off vitiated air.

HOLLYMOUNT, KNOTTY GREEN, BEACONSFIELD, BUCKS

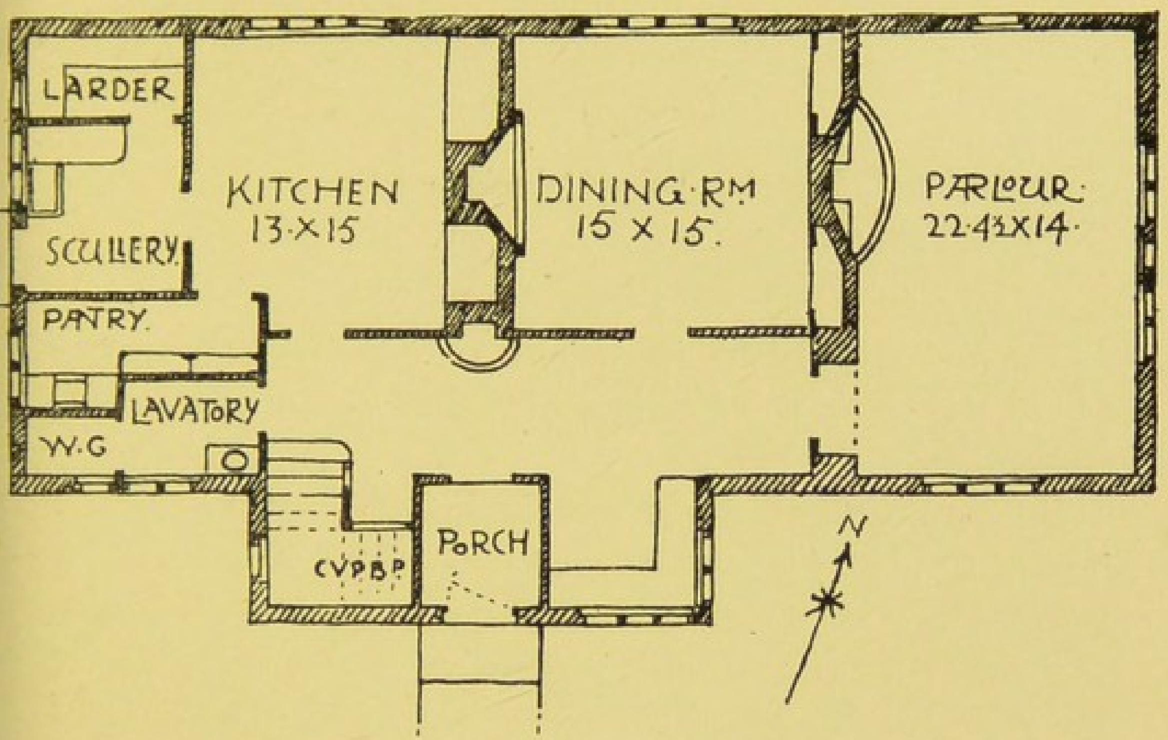


ILL. 323. THE GARDEN FRONT.

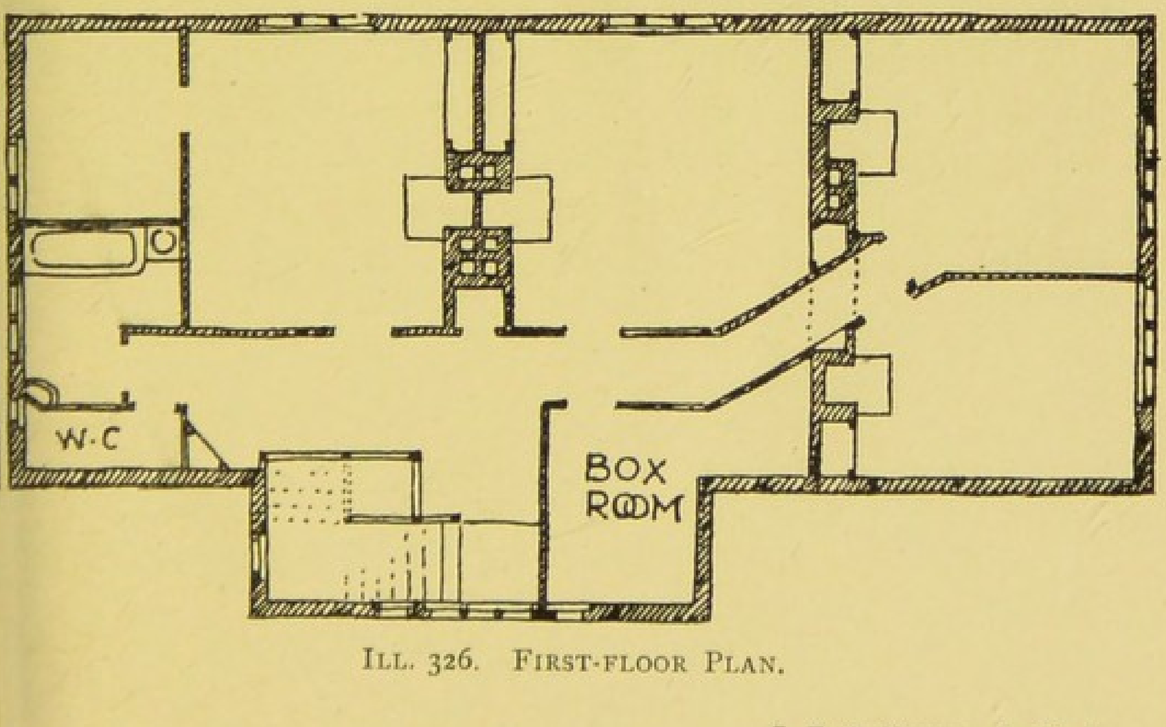
ILL. 324. THE ENTRANCE FRONT.

C. F. A. VOYSEY, *Architect.*

HOLLYMOUNT, KNOTTY GREEN, BEACONSFIELD, BUCKS



ILL. 325. GROUND-FLOOR PLAN.



ILL. 326. FIRST-FLOOR PLAN.

C. F. A. VOYSEY, *Architect.*

The Orchard, Chorley Wood, designed by C. F. A. Voysey.

(Ills. 327, 328, 329, 330, and 331.)

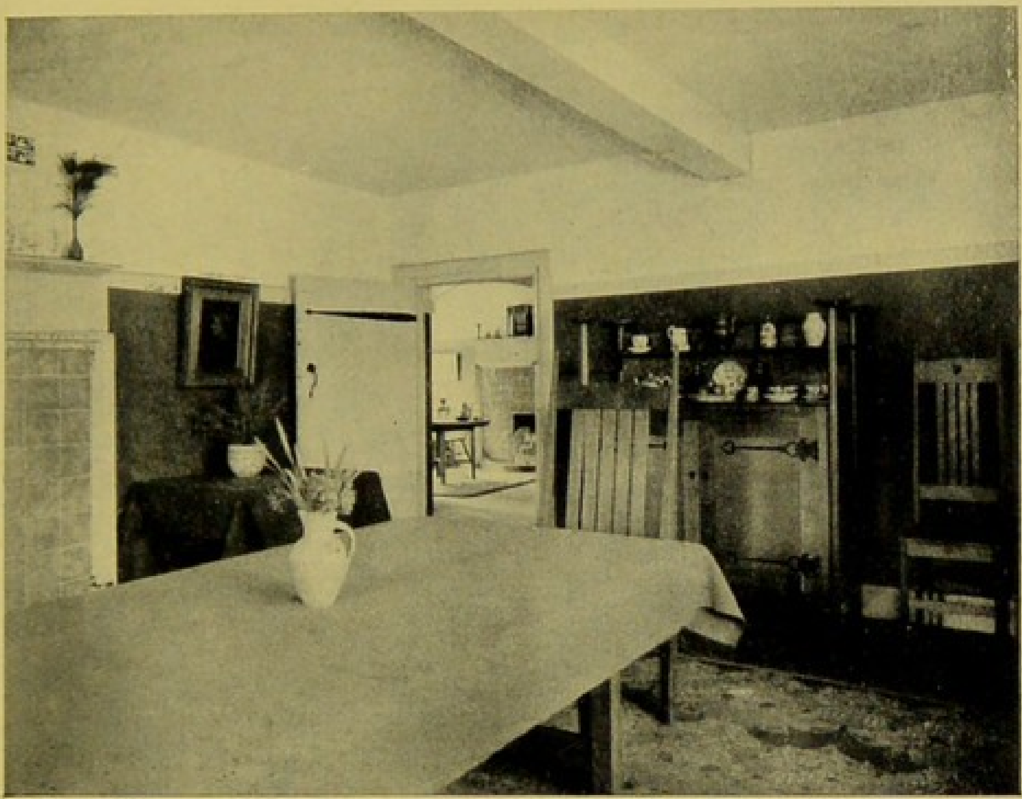
Even temperature, economy of upkeep and restful effect were the chief points aimed at in designing this house.

The rooms are eight feet in height, and never become stuffy on account of the air-flue provided for each room, although lighting had to be arranged by oil lamps.

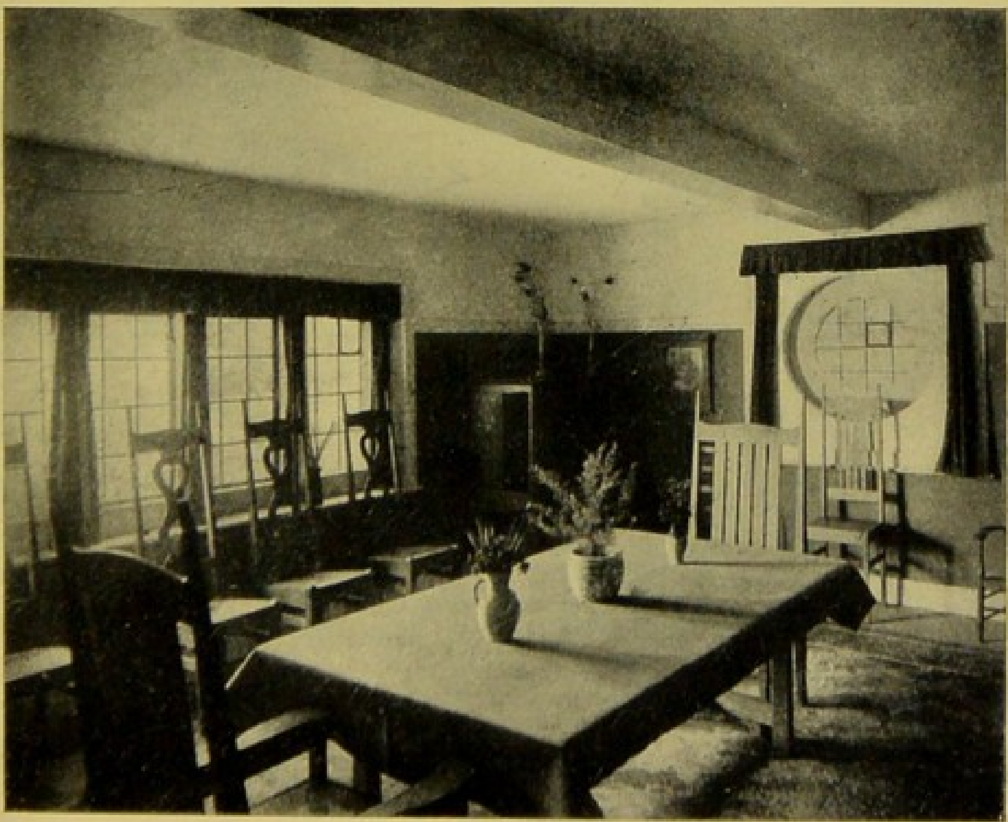
The walls are brick rough cast, the woodwork is painted bright green outside and white enamelled inside, the roof is of green slates. The house was placed so as to capture the morning sun at breakfast time (Ills. 328 and 329), and leaves the room cool in the hottest summer for dinner.

The furniture is of oak, and the walls below the picture-rail plain Eltonbury paper, the frieze above being of pure white distemper. Cornices and mouldings of all sorts have been avoided as much as possible to simplify cleaning.

THE ORCHARD, CHORLEY WOOD



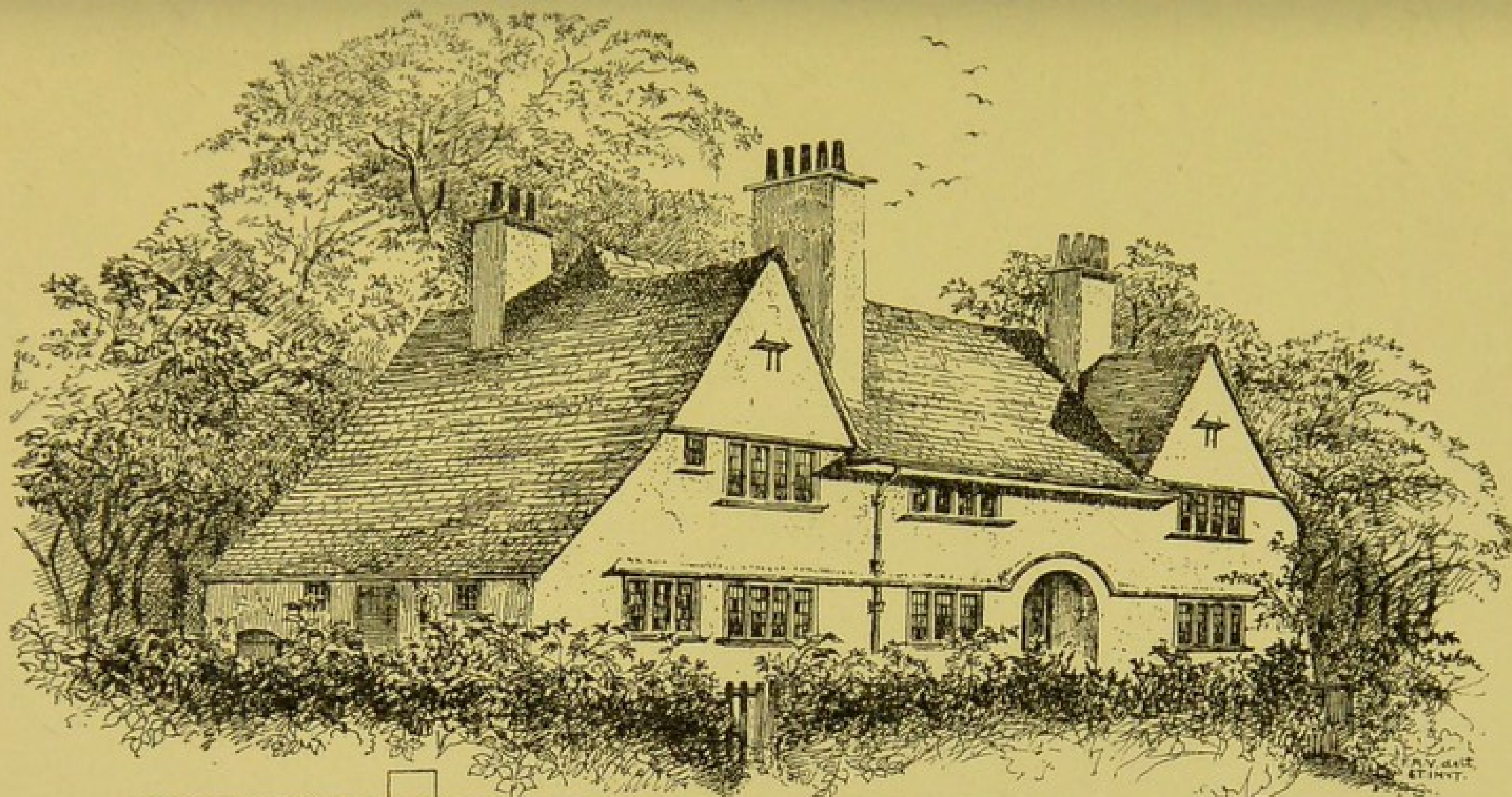
ILL. 327. THE DINING-ROOM LOOKING NORTH.

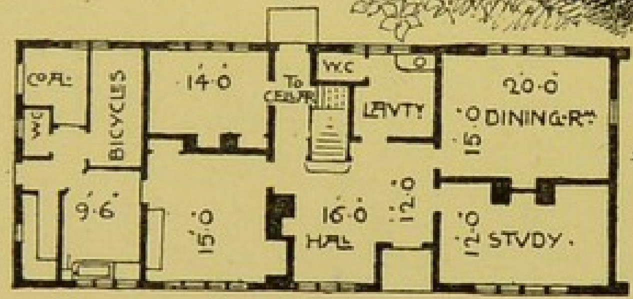


ILL. 328. THE DINING-ROOM LOOKING SOUTH.

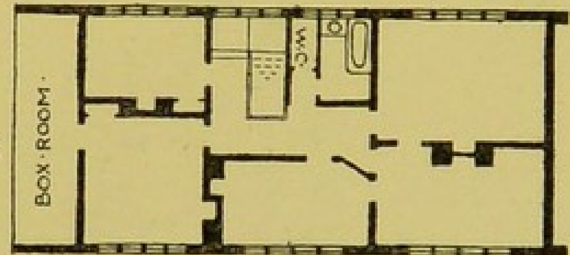
C. F. A. VOYSEY, *Architect.*

THE ORCHARD, CHORLEY WOOD





Ill. 329. The Ground-floor Plan.



Ill. 330. The First-floor Plan.

Ill. 331. The Entrance Front.

C. F. A. Voysey, *Architect.*

CHAPTER XIX

THE GARDEN

General Principles—Carriage-drive—Fencing—Lawns—Paths—Trees—Rock Gardens—Beds—Pergolas—Kitchen Gardens—Illustrations.

GENERAL **Principles**—Space will not permit of dealing with the garden at any great length, but a few general principles may be laid down.

Many points in connection with the house and garden are regulated by the superficial area to be dealt with.

Breadth and repose are the two things desired in a garden of moderate extent, and these can best be effected by fewness of parts and the avoidance of all attempt at ostentation, for the cutting up of the garden is destructive of a restful result.

Subsoil drainage has already been referred to in chapter II., page 41, but it may be stated that heavy clay soils should be drained with agricultural pipes of not less than two inches in diameter laid in a herring-bone pattern, so as to discharge into a main drain of larger diameter.

The turf and top soil taken from the site of the house should be kept for the garden and not carted away by the builder, for if there is a superfluity of soil it may be used for the purpose of potting and making beds.

Carriage-drive—The first point to be decided in a small garden is the carriage-drive, which, though convenient for avoiding the annoyance of getting to and from the front door on a rainy day, has its disadvantages; for in a confined space the turning of the carriage is somewhat difficult, often causing it to pass immediately in front of one or more of the sitting-room windows.

A drive should as a general rule only be arranged where the house is set back at least sixty feet from the road, in order that carriages can easily turn; added to which, if there is not sufficient space, there is an appearance of overcrowding which is detrimental to the setting of the house.

Fencing—A front fence may be treated in several ways, but the conventional dwarf wall and hideous iron railing, which so often disfigure an otherwise presentable house, should be avoided. It is sometimes possible in country or suburban districts to retain the wayside hedge, and this is a great saving in expense, besides adding to the homely appearance of the house, as seen in Ills. 241, 278, 324 and 331. One of the best and simplest fences is of cleft oak, which looks well and is inexpensive; but an open fence, as shown in Ill. 281, is sometimes equally effective. Ills. 225 and 232 show a fence formed of wooden standards with wire between them.

A stone wall, as shown in Ill. 262, or a brick wall with wooden railings, as shown in Ill. 257, may also be satisfactory, while a wall made up of rough concrete is pleasing if treated in a suitable manner.

It is advantageous to be able to see the whole of the ground from some portion of the house, as this will render it easy to supervise and to obtain effective service from the gardeners employed.

Lawns—The garden behind the house is generally occupied by a lawn, which should be at a convenient distance and of sufficient dimensions to permit of a tennis-court (seventy-eight feet long by thirty-six wide), allowing in addition at least ten feet, or, if possible, fifteen feet all round, to prevent the players from being cramped.

Nothing is more delightful than to look out on an expanse of green sward, unmarred by numerous flower-beds which, for a large part of the year, remain devoid of flowers and spoil the quiet and reposeful feeling inspired by the lawn itself. The angles of the lawn can, of course, be filled in with low shrubs provided they do not interfere with the tennis players.

Paths—A raised broad gravel path, say eight to ten feet wide, should come next to the house if the level of the ground admits, for exercise in damp weather and this may act as a terrace and be connected with the lawn itself by a slope or flight of steps, this fall answering the additional purpose of keeping the ground dry around the house.

Paths should only be provided to establish communication between the various parts of the garden; if they are laid out with no definite object they do much to destroy breadth and simplicity.

They should not be less than three feet in width, but the principal paths should of course be wider. They should, if formed in a heavy soil, be drained with open-jointed agricultural drain pipes laid two or three feet below the surface and covered with stones and brickbats, to allow of the percolation of water from the surface (see chapter II., page 41).

The surface should be of gravel at least two inches in thickness and well rolled, the centre of the path being left higher than the sides to allow it to drain naturally. Old flagstones form a very good path, and if the crevices or spaces between them are wide enough to allow moss to grow the effect is distinctly pleasing.

The general plan of every garden should, if possible, be arranged in order to give the most favourable positions to the plants intended to be cultivated, whether they be roses, ferns, shrubs or herbs.

Trees—The question of felling old trees, whose spreading branches would cover a new house, is a very important matter, and has been already referred to in chapter II., page 43. Yet, on the other hand, the destruction of old trees always seems rather sad, although reverence for ancient things must sometimes be sacrificed to modern necessities. An old tree should never be destroyed without careful consideration, and if it is well removed from the house the wish to retain it may be more readily humoured, though, by intercepting the sun, it may interfere with the proper cultivation of the garden.

Large trees in a small garden are certainly out of place, for they give a false scale, and if in close proximity to the house, they are decidedly bad from a sanitary point of view, as they keep off the sun, obstruct the light and air and render the latter moist and stagnant.

It is advisable to plant new trees sparingly in the immediate vicinity of the house, and every tree should be so placed as to improve the general effect of the scheme.

One hint may be given to those who are starting a garden, namely to plant it so as to have a continuity of flowering blossoms from the spring to the late autumn, and so avoid unsightly gaps.

A garden exposed to the north or east is of course liable to have the young plants nipped in the spring of the year, and shelter should if possible be provided.

Rock Gardens—It is well in a small garden not to attempt too much, although a rock garden with rivulet or fountain may be arranged in a quiet corner.

Beds—Beds should as a rule be of some simple geometrical pattern, especially in a small garden, for the extravagant Italian designs are only suitable for large gardens, and even then they should not be too elaborate in character. Trenching, two spits deep, should be carried out in a new or neglected garden, but care must be taken in returning the excavated clods that the top soil and subsoil should occupy the same relative positions and not be reversed, as is frequently the case.

Pergolas—Pergolas consist of an open roof of poles or squared beams laid horizontally and fixed upon upright posts or piers. Brick or stone bases should be provided at the foot of the vertical supports, but where these are not employed the ends of the timbers must be creosoted or tarred before they are buried in the ground, and rough concrete should be rammed around them during this process.

Vines, roses, wistarias, honeysuckle or any climbing plants are trained to grow over the timbers, and thus is formed a leafy canopy which is a charming feature in the garden.

Kitchen Gardens—Where there is only a small amount of land the kitchen garden is perhaps better omitted and the extra ground thrown into the pleasure garden, although walls with a southern aspect may always be used for fruit trees.

A kitchen garden on a small scale near a town is as a rule not a profitable investment, as vegetables are purchased much more cheaply than they can be produced.

Lettuces and the like may sometimes, however, be conveniently grown, as they are often wanted at a moment's notice, and it is then useful to have them fresh and close at hand. A small orchard and kitchen garden are, when suitable and sufficient land permits, most delightful adjuncts, and they should be so planned and constructed as to be easily accessible.

Illustrations—The designs of various gardens are shown in Ills. 285, 300, 309 and 316, which are effective and simple in character, and frame in a satisfactory way the houses to which they belong.

Ill. 285 shows originality with regard to the arrangement of the drives. This can partially be seen in Ill. 290, and a formal garden to the east of the house is shown in Ill. 289.

Ill. 300 is a charming drawing of the grounds around a converted Cotswold farm-house.

Ill. 309 shows a well-conceived plan with an entrance drive and servants' entrance at one angle of the site, with tennis court and rose garden, pergola or covered walk to the south, beyond which is an orchard. The kitchen garden is conveniently placed in the north-west corner near to the kitchen offices.

Ills. 316 and 321 show an original treatment in which a large pergola forms an important feature, beyond which is a rose garden.

CHAPTER XX

STABLES AND MOTOR GARAGES

The Stable (Plan ; Loose Boxes ; Partitions ; Bales ; Materials ; Floors ; Walls ; Doors ; Windows ; Fittings ; Door Furniture ; Mangers ; Hayracks ; Drains ; Ventilation—The Harness-room—The Coach-house —The Coachman's Quarters—The Yard)—Motor Garages (Pit ; Dimensions ; Drains ; Accommodation ; Petrol Store).

THE **Stable**—The stable should be placed so that it is not an annoyance to and does not injuriously affect the health of the occupants of the house ; but it should not be stowed away in some corner simply because it is out of the way, for horses want as much care in their treatment as human beings. The stable should have a southern aspect, which can sometimes be arranged by placing the yard on which the coach-house opens to the north.

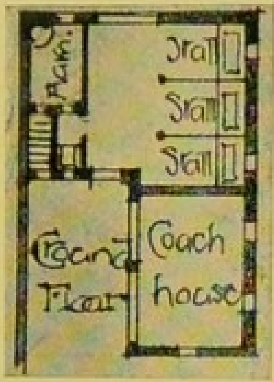
The manure should be collected into a galvanized wirework receptacle, which can be frequently emptied, instead of in a manure pit, and must be placed as far as possible from any doors and windows.

Ills. 332, 333 and 334 show a small stable that was designed in accordance with special requirements.

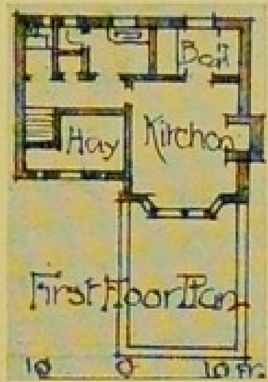
Plan—The stable plan itself is governed by certain standard measurements ; thus a stall should measure 9 ft. to 9 ft. 6 in. from heel-post to wall, and should be 6 ft. from centre to centre of the divisions.

The walking way behind the stall should be at least 6 ft., in order to allow a person to pass without

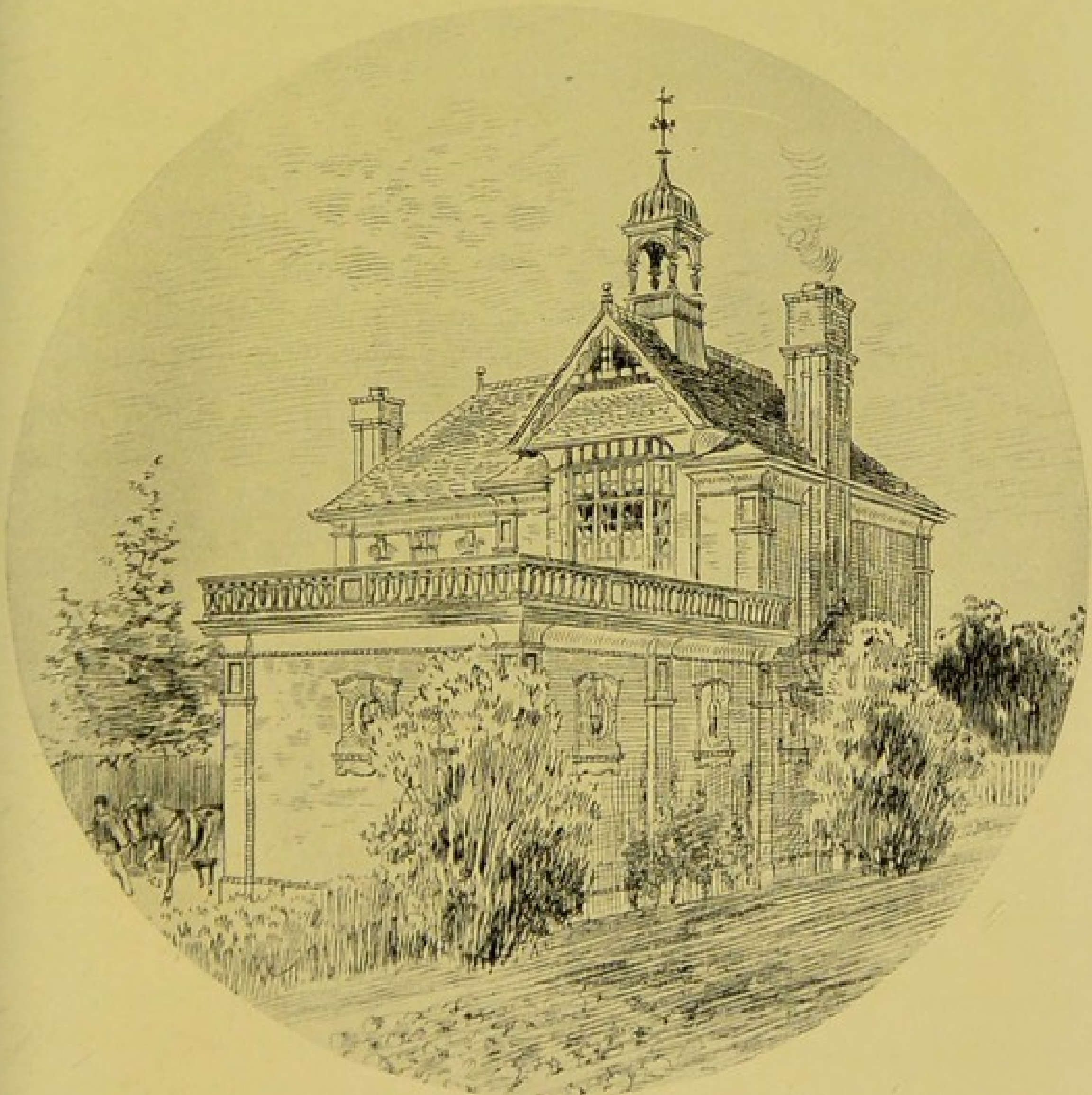
CHURCHILL STABLES, WEST HAMPSTEAD



ILL. 332.
THE GROUND-FLOOR PLAN.



ILL. 333.
THE FIRST-FLOOR PLAN.



ILL. 334. THE ELEVATION.

BANISTER FLETCHER AND SONS, FF.R.I.B.A., *Architects.*

VI

being kicked by a restive horse; but where possible it is advisable to have a walking way 9 ft. wide.

Loose Boxes—One loose box should be provided, even in a small stable, for an old or favourite horse, the usual size for the same being about 12 by 12 ft. or 12 by 14 ft. But where the space is cramped these are often made 12 by 9 ft., and two existing stalls can thus be turned into a loose box by the removal of the division. Loose boxes are preferable to stalls where space can be afforded, and horses seem less likely to acquire such bad habits as wind-sucking and crib-biting when stabled in them. To be tied up by the head day and night is an unnatural and uncomfortable existence.

Isolated sick boxes are absolutely necessary, and even in small establishments it is useful to have one, which, when not in use, can be put to other purposes.

The **Partitions** between boxes or stalls should be as low as possible, so as not to interfere with light and air; they should have a framework of iron, with standards at each end well secured to the floor, and the wood filling between should be raised above the ground at least 2 in., in order that there may be no corners where dirt can lodge, and that the floor may be thoroughly cleansed with the hose. These partitions are sometimes boarded to their full height, but this is not a good arrangement. The upper part above the level of the manger should always be filled in with open ironwork, so that the horses can see one another, for being sociable animals they generally thrive better when in the company of their fellows.

Bales—The military method of separating horses by merely slinging a thick plank (called a bale) between them has much to recommend it from economical and sanitary standpoints, but the chief objection is that horses can bite and worry one another unless they are chained up somewhat tightly. The bale is usually slung from the manger and ceiling, and hangs about 2 ft. 9 in. from the ground.

Materials—The materials employed in the construction of stables should be carefully selected, in order that they may be kept in a sanitary condition.

Floors—A stable floor should be impervious, easy to clean and should not become slippery by use; brick pavements should therefore be avoided, because although they may be impervious in themselves, the chamfered joints form receptacles for dirt and allow fluids to settle and soak through. Adamantine granite concrete, if properly mixed, forms a good floor, and does not get slippery by wear. In stalls and loose boxes it should be laid with a slight fall towards a central groove and also towards the heel channel; shallow grooves may with advantage be formed leading to the centre groove, the latter falling towards the heels of the horses.

Walls should be of impervious materials; the lower part to the height of the woodwork of the partitions should be finished in glazed bricks of a quiet colour, as a glaring white is bad for the horse's eyes, and all angles should be formed of bull-nosed bricks in cement. The walls above this dado should be finished with a smooth cement face and should be distempered annually.

Doors should be at least 4 ft. wide and 7 ft. 6 in. high and be hung in two heights, so that the upper part may be left open for ventilation.

Windows should be placed in the wall between each stall, the sill being kept at least 8 ft. from the floor, so that the eyes of the horses may not be affected by the glare of the light. The sills of the windows in the passage behind the stalls should be 5 ft. from the floor, the windows being formed as casements, but hung to open inwards horizontally from the lower rail.

All **Fittings** and **Door Furniture** should project as little as possible, as serious injury to horses may otherwise be caused.

Mangers should be made of metal, and if enamelled white they look clean and neat, but this often chips with the somewhat rough usage it is liable to receive.

Hayracks should also be made of metal, and must not be placed higher than the manger, owing to the liability of dust and seeds injuring the eyes of the horses.

A semicircular frame fixed to the wall into which the water-bucket can be dropped is a good arrangement, enabling a horse to drink at leisure.

Drains—A typical drainage plan for a small stable is given in Ill. 140 in chapter XI., page 165.

All drains inside a stable should be surface drains, as explained in chapter VIII., page 137, the old-fashioned idea of covered drains being now quite obsolete.

The open channels mentioned above should run the whole length of the building and discharge through an opening in the wall, as shown in Ill. 140, into an external gully trap (see Ill. 103).

An advantage in using the granite concrete as previously described is that the open drain can be made in the cement itself. For the sake of economy in the use of straw, light iron gratings, easily removable, are sometimes placed over the open channels, but in such cases care must be taken that they are removed daily and the channels thoroughly washed down with the hose.

Ventilation—The Commission on the Ventilation of Stables gave it as their opinion that "Animal life is most perfectly developed and its functions most perfectly performed under conditions of free diffusion of the atmosphere, including absence of stagnation, abundance of light, absence of nuisance and sufficient space to live in," and any one who has had to do with horses will endorse the accuracy of these remarks.

A vitiated atmosphere is at the root of many of the diseases to which horses are liable, and one veterinary surgeon, known to the authors, keeps the door and five windows of his stable open day and night all the year round, with a result that his horses are always in an exceedingly fit condition. The windows on the south side of the stable may be kept open in this way provided that the horses are sufficiently clothed, for it is better to have a stable too cold than too hot, although the endeavour should be to keep the temperature within the range of 50° and 70° F.

Windows, no doubt, are the best means of ventilating stables, but care should be taken to avoid draughts by preventing cross currents. Air can be admitted in other ways, one method being to have a three-inch continuous air-brick course above the floor line in the wall at the rear of the stalls; another method is to bring the air by ducts up the heel-posts and regulate it by butterfly valves, but this is not to be recommended, as the ducts become clogged and foul.

Outlets for vitiated air other than open windows can be arranged by means of outlet pipes fixed in the ceiling and carried through to an external ventilating turret, as shown in Ill. 334; it is well that the area of the outlets should exceed that of the inlets, so that by the diffusion of the incoming air draughts may be avoided.

The Harness-room—The harness-room should be close to the stable but not in direct communication, as the damp, heat and fumes given off by the horses injuriously affect and destroy the harness. Wood blocks laid upon a concrete bed form the best method of finishing this floor.

The wall should be boarded all round from floor to ceiling, as this forms a surface to which the harness-racks can be fixed and is a good and lasting lining to the walls. The harness-room should be fitted with a stove which, in small establishments, is used by the coachman for preparing bran-mashes, etc.

The Coach-house—The coach-house should not be less than 15 ft. deep and the frontage must be regulated by the number of vehicles it is intended to hold; it should be at least 10 ft. high.

The openings for the admission of carriages should be about 8 ft. in width. Revolving shutters in confined spaces are to be preferred to doors, as they take up no floor space when opened.

The forage loft is usually placed over the coach-house or stable, and care must be taken that the floor is absolutely dust-proof in order to prevent anything getting through.

The coach-house must be kept quite dry for the proper preservation of carriages, as nothing is more destructive to vehicles and their upholstery than damp.

The paving for the coach-house may be of the granitic concrete already described for the stables, and stone runners may be placed about 5 ft. 3 in. centre to centre, to take the wheels of the carriages.

Coachman's Quarters—The coachman's quarters vary considerably, and if he is a married man they must include a sitting-room, larder, scullery and bedrooms, The rooms should rather be placed over the coach-house than the stable; but if over the latter the floor should be formed of concrete and thus rendered as dust and sound-proof as possible.

The Yard—The yard should be at least 20 ft. by 25 ft. and the washing place should be adjacent to the coach-house and stable and covered over with a glass roof, so that shelter is provided while cleansing the horses and carriages in wet weather. A movable light with a reflector should be placed in such a position that the coachman can thoroughly see to do the cleaning after dark. Everything should be done to induce a coachman to thoroughly groom the horses and wash the carriages immediately upon his return, as this is most essential.

A jointless paving material is not so important for the yard in the open air, but adamantine or other similar bricks laid to a fall towards a central gully may be provided, as these give a good foothold to horses when starting.

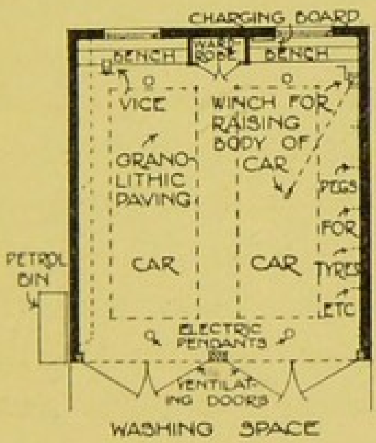
Motor Garages—Having regard to the extensive use of motor-cars nowadays, a country house cannot be considered complete without some provision for their storage, either for the convenience of the owner or his guests.

Ills. 335 and 336 give a plan and section of a small motor garage which has been found to answer the purpose satisfactorily.

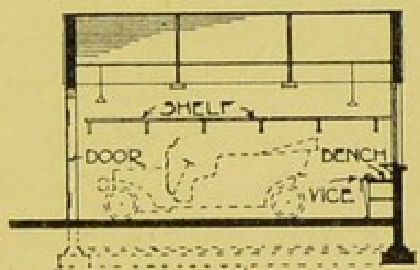
Pit—A pit for access to the machinery from below was formerly an essential in every garage, but manufacturers now make the engines so accessible that most of the machinery can be overhauled without it. Nevertheless it is best if possible to provide a pit which should not be less than 5 or 6 ft. in width and depth.

Dimensions—It is advisable that the garage or motor shed for one car should not be less than 12 ft. 6 in. in width, and as no car exceeds 5 ft. 9 in. to 6 ft. across the wheel base, this allows the chauffeur about 3 ft. to get round the car for examination and to make the necessary repairs and adjustments, and gives sufficient room to bring the car into the shed

A MOTOR GARAGE



ILL. 335. PLAN.



ILL. 336. SECTION.

without damage either to itself or to the garage. The length of a modern car does not as a rule exceed 18 ft. including the lamps, although, of course, there is a tendency to increase this dimension, but if 21 ft. is allowed there will be sufficient room for a bench and vice to be erected at the back, as shown in Ills. 335 and 336, which also show a small wardrobe, a winch for raising the body of the car, and a useful shelf carried round both sides of the building. The height should not be less than 10 ft.

Drains—There are no drains in the motor-house, but the paving has a slight gradient towards the front so that it can be well scrubbed down. It should drain into the washing space, which should have an area at least as great as the motor-house itself, and should contain a catch-pit for sand, etc., so that the drains may not become choked. There should be plenty of ventilation to allow of the escape of the petrol vapour, and we have sometimes arranged for the doors to be built of slats spaced about half an inch apart so as to allow for the free circulation of air. Arrangement should be made to keep the temperature of the garage between about 50° and 70° F. Where more than two motors are kept it is sometimes found best to put them in separate houses.

Accommodation—A messroom and dormitories may also be required for the men, and this has been effected by Mr. Lutyens (Ill. 285) by the construction of small lodges whose external treatment is shown in Ill. 286.

When an electric-light installation has been provided it is usual to build the garage close to it, and a small charging board is useful for charging the accumulators of the ignition coils and the small electric lamps now so usually carried upon cars.

Petrol Store—The position and size of the petrol store are governed by the regulations issued by the Secretary of State under the Locomotives and Highways Act 1906–7, and by those of the local authorities, insurance companies and the London County Council.

Summarized shortly they require that not more than sixty gallons be stored in one place when in approved safety cans of two gallons each, although the amount when stored in tanks is unlimited. The store should be fire-resisting and have protected ventilators, and where possible it should be at least 20 feet away from any other building.

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