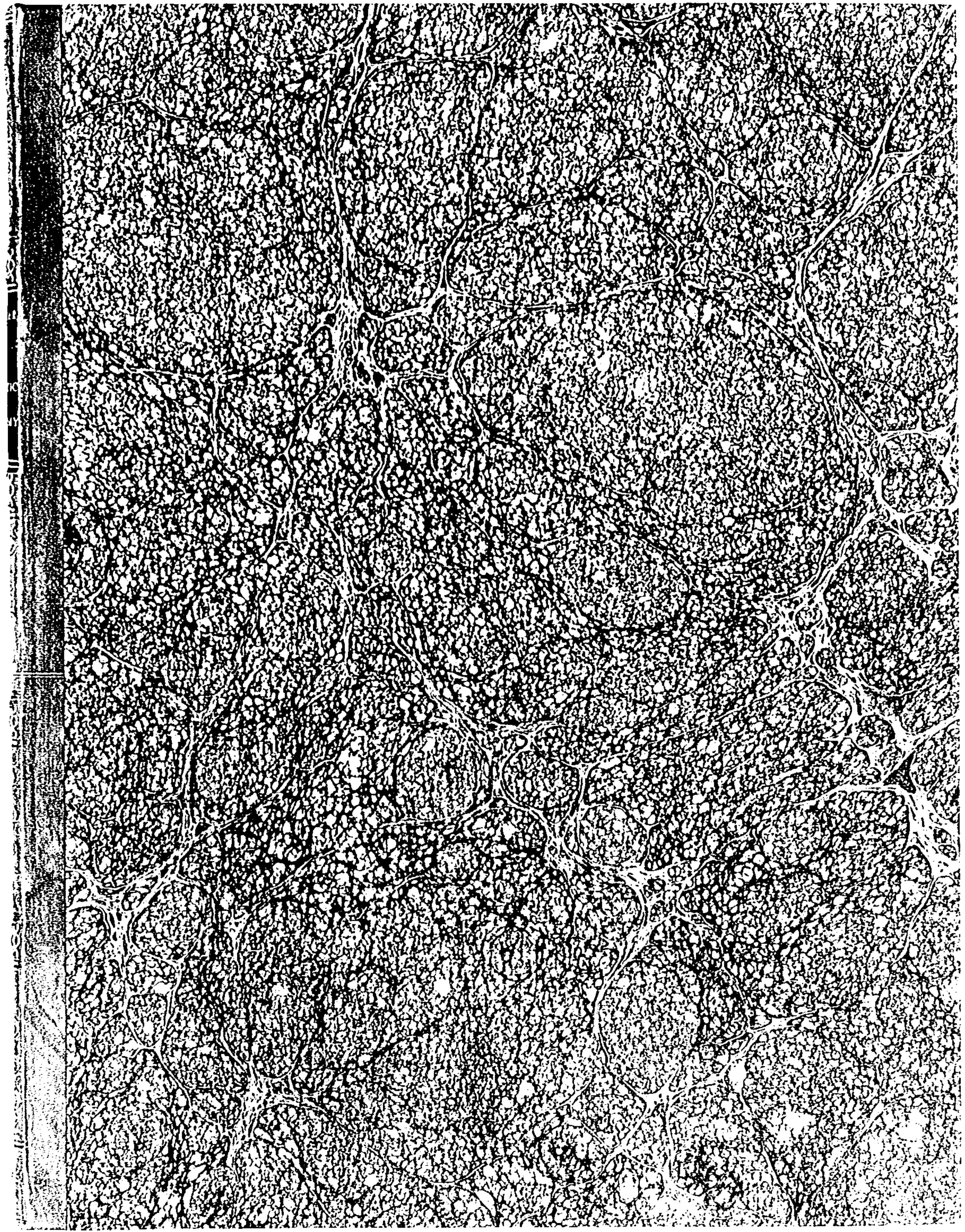
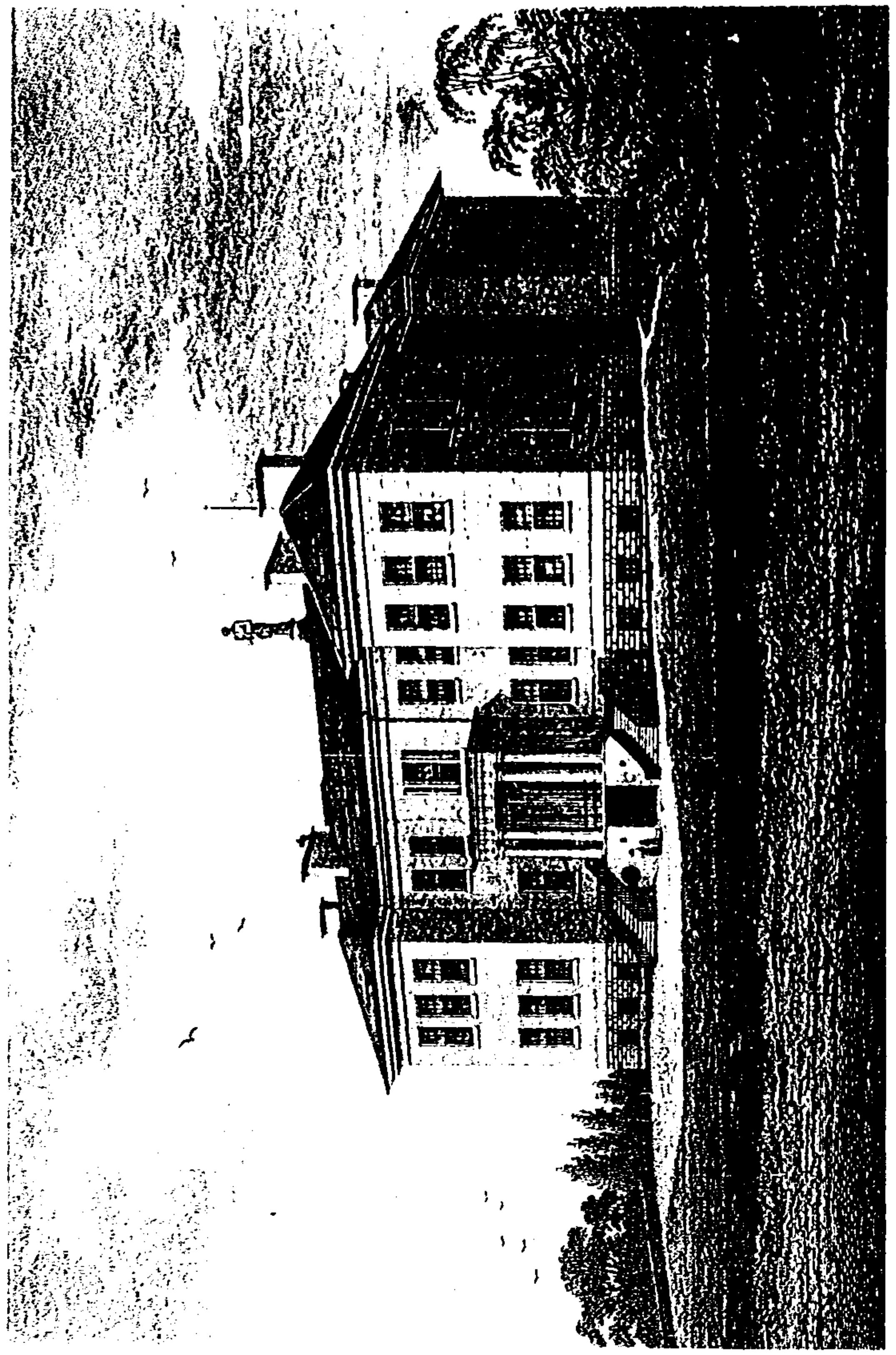




VIEW OF THE DERBYSHIRE GENERAL INFIRMARY.

THE

PHILOSOPHY

OF

DOMESTIC ECONOMY;

AS EXEMPLIFIED IN THE MODE OF

WARMING, VENTILATING, WASHING, DRYING, & COOKING,

And in Various Arrangements contributing to the

Comfort and Convenience of Domestic Life,

ADOPTED IN

THE DERBYSHIRE GENERAL INFIRMARY,

AND MORE RECENTLY, ON A GREATLY EXTENDED SCALE, IN SEVERAL OTHER PUBLIC BUILDINGS, NEWLY ERECTED IN THIS COUNTRY;

Together with an Explanation of the Principles on which they are performed.

THE WHOLE ILLUSTRATED BY NUMEROUS ENGRAVINGS BY W. LOWRY.

BY CHARLES SYLVESTER, ENGINEER.

Nottingham:

PRINTED BY H. BARNETT, HIGH STREET;

AND SOLD BY LONGMAN, HURST, REES, ORME, AND BROWN, LONDON.

1819.

TO

WILLIAM STRUTT, ESQ. F. R. S.

Dear Sir,

Independently of the personal gratification it affords me to associate your name with the following pages, there is no one to whom my work could with so much propriety be inscribed as to yourself. Among the numerous and munificent patrons of the Derbyshire General Infirmary, you stand distinguished, for the benevolent attention which you have unremittingly bestowed upon its interests, no less than for the eminent ability displayed by you in the original plan, and all the subsequent arrangements, which have rendered this institution the just object of general admiration. To the exertions of your powerful and well directed intellect, the inventions and improvements detailed in the work now submitted to the public are entirely due; and it is with the most lively gratitude that I recollect the hours we have passed together, in discussing the philosophical principles on which they are founded. If I have been able to add any thing to the suggestions of your capacious mind, or, by entering into their detail, to render more useful your valuable discoveries, still I owe this dis-

tinction to the steadiness of your friendship.—A friendship which has soothed me in affliction, cheered me in the hour of despondency, assisted me under the pressure of difficulties, and encouraged me to persevere in every useful or virtuous effort which I have been capable of forming. That you may live long, to confer those benefits on mankind, to which your thoughts are unceasingly directed, and to enjoy in the bosom of your interesting family, the satisfaction arising from the consciousness of well intended and successful exertions, is the wish of

Dear Sir,

Your very Grateful and Affectionate Friend,

CHARLES SYLVESTER.

Derby, February 25th 1819.

PREFACE.

IT was during the building of the Derbyshire General Infirmary, in the year 1807, that I had the pleasure of first knowing WILLIAM STRUTT, Esq. of Derby; and since that time a constant intimacy with that gentleman has been the means of directing my attention to the many excellent inventions introduced by him to that establishment.

The general admiration in which this place has been held, and the frequent applications that have been made from different parts of the kingdom, as well as from other countries, with a view to be acquainted with its merits, first gave rise to the intention of publishing an account of it. This Work was also intended to embrace the general subjects belonging to domestic economy; at least so far as related to the conveniences of dwelling houses. Although most of the inventions, for which this institution has become so distinguished, were new to the world, they all, in some form or other, had been adopted in Mr. Strutt's house, and by some of his particular friends, so that their success in the large scale of the Infirmary was never doubtful. Their utility however, is now confirmed by ten years experience.

Those parts of this establishment which are the inventions of Mr. Strutt are as follows:

The warm air Stove and the general arrangement of flues, and turncaps, for the purpose of warming and ventilating the building. This invention he first made in the year 1792, and improved it very considerably, as opportunity offered, in some years immediately succeeding.

The Roaster he invented in the year 1797,

and has used it in his own family ever since, for roasting meat of every description, and for general baking. It has the rare advantage of being of the same heat on all sides. The Steaming Table is a contrivance for more conveniently exposing different bodies to be steamed, than the common method. This he invented in the year 1807, and has since improved it considerably.

He contrived another vessel to be heated by steam, which is kept constantly full of hot water for general purposes.

The Laundry he invented in 1796; and it was applied with great success in getting up and finishing stockings, previous to its use for linen. The Laundry in the Infirmary is a great improvement upon the original invention, in causing a larger quantity of air to pass through the linen, giving all the effect of exposing it to the open air.

The Washing Machine was adapted by Mr. Strutt from the common washing Wheel, used by

Bleachers. The great saving of labour in its use renders it very valuable in every family, independent of its not being liable to injure the Linen.

In most of the present public Hospitals, nothing is more conspicuously bad than the Water Closets; the Derbyshire Infirmary is, however, a striking exception to the contrary. They are so contrived that the person who enters them, by the action of the door, and without any attention on his part, expels all the foul air; which is, at the same time, replaced by the warm fresh air of the house: and, in returning, leaves this fresh air in its place; whilst by the same action of the door, the bason is washed in the usual manner.

This invention he made, on purpose for the Infirmary, in the year preceding that in which it began to be built; and it has been in use by himself and several of his friends ever since. These are the particular inventions of Mr. Strutt,

which are also applicable to houses in general; there are, however, many other conveniences in this Infirmary contrived by him, at different times.

From a strong conviction of the general utility of these inventions, I have, since their successful adoption in the Infirmary, given them particular attention; and more especially as regards their construction. I have introduced them to a considerable extent, as well in private houses, as in public institutions: particulary the plan of warming and ventilating. It will be seen in the course of the work, that I have made some improvements in the stove; rendering it much more convenient to fix, and to manage in using it. By the same alteration, the stoves introduce a much greater quantity of fresh air; affording more complete ventilation, and at the same time preventing its injury by an excess of fire.

In the Pauper Lunatic Asylum which has been built at Wakefield, by Messrs. Watson and Pritchett, Architects, of York; provision has been made for introducing the principal conveniences which have been adopted in the Derbyshire Infirmary. The whole of the flues, and other preparations, I arranged with the Architect, previous to the fonndation being laid. This has afforded most ample means of warming and ventilating the whole house, an object of the highest importance to such an establishment.

The Kitchen, Wash-house, Laundry, and other domestic conveniences, have also been fitted up under my direction.——*See Appendix.*

The New Jail, at Maidstone, is warmed by five stoves, which I have furnished. But the building was erected before this plan of warming was known to the Architect. The flues are, in consequence, not so well calculated for its complete ventilation, as they might have been. It however answers very well.

The North Staffordshire Infirmary was intended to have a preparation for being warmed and

ventilated on the same plan; but from some mismanagement on the part of the builder, it has been introduced to some disadvantage; as well as the apparatus of the kitchen, and other conveniences.

The Nottingham Lunatic Asylum is warmed by one stove, which I furnished in 1815. The building is of a most inconvenient form for warming; and no provision was made for the purpose. The apparatus however succeeds very well; and the ventilation, although tolerable, would have been more complete, if flues had been properly constructed in the first instance.

No public buildings are so difficult to warm as Churches; partly from their great capacity, but more especially from their lofty ceilings. Another great objection arises from their containing graves and vaults, which interfere with the formation of proper flues for the warm air. As ventilation is seldom an object in places of such magnitude, I have found it the most economical to draw the cold air from the Church to be warmed, keeping up a constant circulation; the cold air going from the Church to the stove, and the warm air from the stove to the Church.

A successful example of this plan will be found in the Parish Church at Leek, in Staffordshire, which I executed in the year 1816.

I have introduced these stoves with great success into private families; particularly to warm Halls, Staircases, and Passages. To introduce it into Rooms would require flues in the walls, which should be made when the houses are built.

The following are a few of the private Stoves I have furnished:

William Strutt, Esq. Derby; Benjamin Gott, Esq. Leeds; Samuel Shore, Esq. Norton, near Sheffield; Sir Moore Disney, Hampstead; C. H. Turner, Esp. Rooksnest, Surry; F. L. Chantrey Esq. London.

If science can really contribute to the happiness of mankind, it must be in this department

of life, as the real comfort of the majority of men, particularly in this country, is sought for at their own fire sides. How desirable, therefore, does it become, to give men every inducement to be at home, by directing all the means of philosophy to increase domestic happiness.

INTRODUCTION.

THE end of all philosophical inquiry is, to lessen the number of evils to which we are liable, and to increase the sum of our natural and social enjoyments.

The striking contrast between man in savage life, and his present state of refinement, abundantly shows his capability of bettering his condition; and gives us a lively anticipation of what we may still expect from the increase of human knowledge.

When therefore, we recollect that the blessings of life can be increased only by a more complete knowledge of the objects by which we are surrounded; we cannot be too zealous in promoting the means by which such knowledge is to be acquired.

That branch of natural philosophy which has for its object the improvement of domestic life, as far as relates to our food, clothing, and local habitations, has lately begun to assume a scientific form, under the title of domestic economy. Franklin appears to have been the first who particularly devoted his attention to this useful inquiry, and had he met with support equal to his talents, and the benevolence of his views, he could not have failed to have increased the comforts of mankind far beyond what he accomplished.

Count Rumford has devoted a great part of his life to this laudable study, and has put the public in possession of many useful discoveries, particularly so far as regards the economy of food and fire, on which subjects much beneficial knowledge is to be obtained from his valuable essays.

We have not yet any work which embraces all the advantages to be derived from science, when applied to domestic economy, although it is not difficult to foresee that this department of philosophy must become the most popular of all others, because every class of human beings is interested in its results.

The habitations of man from the humble cottage to the superb palace, have hitherto been constructed without any regard to the best principles for affording the greatest comfort to their inhabitants. The architect seldom aims at more than the perfection of just proportions in the exterior, while those who furnish and decorate the interior, are anxious only about the taste and fashion of things, by which they are rendered rather incumbrances than objects of convenience and utility.

Hence we see the necessity of the architect being acquainted with all the principles of science connected with domestic life. In the first place he should be able to appreciate the relative value of situations, embracing the advantages of agreeable prospects, good air, and pure water. The

nature of the materials of which a house is built is of great importance, the architect ought therefore to be acquainted with their chemical qualities, to know how far they will be acted upon by the weather, independently of their fitness for architectural beauty and durability; the form and arrangement of the rooms also, is an object requiring much consideration, in order to their being warmed and ventilated with the greatest facility possible.

All the apparatus and machinery for warming and ventilating the apartments, for washing and drying linen, and for culinary purposes, should be represented in the original drawings of the buildings, in order to their being adapted in the best manner to their desired end.

For these purposes a variety of tunnels and cavities is required to be made in the foundation, which cannot be so properly made after the building is erected.

The air which is to ventilate the rooms, should be admitted through culverts under ground, in order that such air may be warmed in winter, and cooled in the summer. This would prevent those chilling currents of cold air now admitted by the doors and windows in winter, and the insufferable heat which we expérience in summer on opening the windows with the view of cooling the room.

The situation of a building is very material on several accounts. The water with which it is to be supplied, should be examined in a chemical point of view, and also as to the quantity which the spring is capable of supplying permanently. High situations have been thought the most healthy from the idea of the air being purer in proportion to the elevation enjoyed.

Before the improvement in gaseous chemistry, the relative value of situation so far as regarded the purity of the air, was considered as of the utmost importance; those matters in the atmosphere which were deemed deleterious, were supposed to occupy the lowest situations, and it became a prevailing custom to build houses on the highest ground, for the sake of breathing a purer atmosphere. After the discovery of carbonic acid and oxygen, these prejudices were for sometime strengthened; unguided by experiments, and misled by hypothesis, it was concluded that the air of large towns, from the constant formation of carbonic acid, at the expence of the oxygen, ought to be highly contaminated. Experiments however, the only test of truth, soon discovered that the carbonic acid and the oxygen were in the same proportions to the rest of the air, in the middle of the largest town, and in the open air. Gay Lusac found that the air 6000 toises above the surface of the earth, exactly agreed in its analysis with the air in the middle of Paris. The only way in which we can account for the relative advantage of high and low situations, is from the relative quantity of moisture in those situations; vallies are much warmer than high mountains, and also undergo greater transitions from heat to cold; during the warmth of the day much moisture is taken up into the atmosphere, in consequence of the increased temperature which is deposited in the night. When the atmosphere of confined and low situations is thus charged with an excess of moisture, and is not carried off by the winds with the same facility as in open situations; the inhabitants of such a place must in general breathe more than an ordinary quantity of aqueous

vapour. This is hurtful in two ways; viz. they do not inspire the same quantity of oxygen, by the bulk of the aqueous vapour, there is also a defective expiration of moisture from the lungs.

Very elevated situations have also their inconveniences; they are cold in a certain proportion to their height; the tops of hills of a moderate height, will be found colder by some degrees than the vallies below. The Alps and other high mountains merely from their elevation, are constantly capped with snow. Hence we may conclude that situations of a moderate height, are most fit for the habitation of man.

The most bleak and chilling situation may be much ameliorated by planting, so as to shelter it from the colder winds, and by cultivating the soil around it, for the earth becomes warmed in an increased degree, by the action of the suns rays upon it; and this is the only means of warming the air of the atmosphere. It is from this circumstance, that climates become milder by cultivation, as has been proved in the history of civilized countries.

In several points of view the materials of a building is a subject of some importance. In the first place the walls exposed to the air, should consist of the worst conductors of heat. Their aggregation should be quite equal to the superincumbent stress. They should not be acted upon by air or moisture, and should be incombustible. When stone is employed, it should be such as has been known to bear the action of air and water, for a considerable length of time.

Stones which are acted upon by the air, owe their perishability to several causes. Some stones crumble to powder when exposed to the air or moisture, although their induration is considerable when taken out of the earth, this is generally the case with such as abound with an excess of clay (alumine.) The great affinity which that earth has for water, induces an absorption of moisture from the air, by which the volume (or bulk) of the stone tends to increase, and the aggregation is destroyed by the distending force of the water.

Other stones lose much of their aggregation by the loss of water, this is the case with some marbles, and the crystallized carbonats of lime, and with other stones which are composed of an acid and earth combined with water, which water by chymists is called water of crystallization. The difference between marble and common chalk, consists in the latter having lost its water of crystallization. Those varieties of lime stone which are perishable by time, doubtless owe their reduction to this cause. All lime stones placed in situations where an excess of carbonic acid and water is present, will become slowly dissolved; and the matter thus carried off in the state of supercarbonate of lime will be deposited in stoney masses, called petrifactions when their formation is rapid, and stalactite when the aggregation is more perfect. No variety of gypsum is permanent in water, because this saline compound is soluble in about 500 times its weight of water. It is however very durable when kept dry. Another kind of stone used in building, is destructible from its want of solidity and compactness. It mechanically absorbs moisture, which frequently though gradually destroys its aggregation, and this change is much facilitated by freezing. For in this instance water suddenly increases in volume, and sometimes breaks the

stone with an explosion; it however more generally causes its reduction by gradually crumbling from the exterior during a thaw. Stones consisting principally of silex, of which the millstone grit is an instance, are the most durable, when they are sufficiently indurated to be impermeable to water.

No material used in building, has stood the test of time like brick, as is evinced in the remains of the triumphal arches of the Romans. It possesses many other advantages over the best stones. It is a worse conductor of heat; mortar adheres more firmly to it, and in some instances absolutely penetrates it. It absorbs moisture with great facility, and hence prevents the dampness of walls during those atmospheric changes, when moisture is often deposited upon them. The choice of clay of which bricks are formed is a matter of great importance. Some bricks are seen to decay rapidly when exposed to the air. This decay is generally accompanied with a white efflorescence which is found chiefly to consist of sulphat of magnesia. When clay abounds with magnesia and pyrites, which is frequently the case, the salt above mentioned is formed and effloresces upon the bricks. It is during this process that their aggregation is destroyed.

The most important of the modern discoveries, is the means of rendering buildings fire proof by substituting iron and brick in the place of wood. The utility and practicability of this invention has been fully evinced in the erection of cotton mills.*

* Large public buildings were formerly erected with ceilings or roof of stone, of which King's College Chapel, in Cambridge, is an eminent

The greatest defect in the construction of dwelling houses, public buildings and manufactories, is observable in the means of warming and ventilating them. Notwithstanding the boasted comforts of an Englishman's fire-side, we see it accompanied with evils, which loudly call for remedy. The common construction of fire places, and the means of admitting air into the rooms, is quite sufficient to convince us

instance.—But such buildings are very uncommon, very expensive, and the principle upon which they are constructed is not at all adapted for the common purposes of life. The infinite advantage to be derived from houses and other buildings indistructible by fire, may be estimated by considering the dreadful destruction of persons and property, which is almost daily taking place in every part of the kingdom, but particularly in London. Although the improvement in question, has been made more than twenty years, it seems to have extended no farther at present, than to those cases, where the proprietors of the building to be made fire proof, have been themselves able to direct, and be responsible for the proper construction of the building.

The first fire proof mill that was ever constructed, was built by Mr. W. Strutt, of Derby, in the year 1792; this building is 115 feet by 30 wide, and six stories high, and forms at present but a small portion of the buildings erected by himself and partners on the same principle. At Shrewsbury, Manchester, and some other places, also, immense buildings have since been similarly constructed, which completely answer the intention. The plan has been applied to small houses, stables, &c. It is eligible with some variations for the most superb mansions, as is exemplified in the spherical arches over the large baths at the Infirmary in Derby. This subject has hitherto received so small a share of attention, that it is probable the historians of the next century may instance our building houses, that may be burnt down, as a proof of our little progress in civilization; just as we now do the practice of former times, when houses were warmed by making fires in the middle of the room. Were the Derbyshire Infirmary now to be erected, it would probably be done without any wood being used in its construction; and without even iron pillars and beams.

that these principles have never been investigated in a philosophical point of view.

When a house is built, a tunnel is made from each room, for the escape of smoke and vapour, the greatest part of which ought to be consumed. This is also a channel for the escape of the air of the room, which cannot be replaced, but by the cold air from the atmosphere; for the entrance of which no provision is made, except by the accidental crevices formed by the shrinking of the wood, forming the doors and windows.

The evils resulting from these defects are, first; those sitting before a good fire are scorched on one side, and chilled by the cold air on the other; secondly, the cold air entering the chimney without passing through the fire destroys its draught, and renders the combustion of the fuel so imperfect, that a considerable portion passes away unburned, or comes into the room in the form of smoke, producing the greatest of domestic evils. That which goes out of the top of the chimney, annoys the neighbourhood. And that which adheres to its sides, would soon entirely stop the chimney funnel, if not removed by means, in the greatest degree degrading to human nature.

None of these evils need now exist, especially in houses yet to be erected. The combustion of coal may be now rendered complete, not producing the least smoke, and at the same time avoiding the nuisance of ashes from the grate.

Instead of the annoyance of cold air, which comes into the rooms by the doors and windows, a current of warm air at any desired temperature, may be made to escape at the same aperture in a contrary direction. The air which supplies the room, should enter at the ceiling over the fire place. This air, in winter, should first be warmed by passing along a culvert underground, and the additional heat given to it by a stove which we shall hereafter describe. In summer the air may either be admitted immediately from the atmosphere through the same passages, or underground when the weather is very hot.

That branch of domestic economy devoted to the preparation of food, has not till the time of Count Rumford, been considered in a scientific point of view. Nothing can be more preposterous and unappropriate than the prevailing construction and management of a gentleman's kitchen. Before the discovery of the stew hearth, all the culinary processes were carried on with one immense open grate, burning as much fuel in one day as might do the same work for ten. The cook and the furniture of the kitchen get a proportion of this heat, the articles to be dressed another portion, but by far the greatest quantity goes up the chimney.

The introduction of the stew hearth has in some degree reduced the magnitude of these grates, but they are yet disgraceful to science and common sense.

In the present state of culinary improvement, a kitchen may be fitted up with apparatus, requiring much less labour and attention, with much less consumption of fuel; rendering the food more wholesome and agreeable, and also preventing that offensive smell which has made it so often necessary to detach the kitchen from the rest of the house.

Most of these improvements will be particularized in describing the kitchen of the Derbyshire Infirmary.

That branch of domestic economy which has for its object the virtue of cleanliness, is by no means beneath the attention of the philosopher. The disagreeable labour attending it, is so great a draw back upon its performance, that every contrivance by which this object may be attained with the least manual labour, will be deserving of encouragement. This more particularly relates to the washing and getting up of clothes, and is confined to the business of the wash house and laundry. Every wash house should be furnished with hard and soft water, by pipes, and with other pipes to convey steam, so as to render fire places unnecessary. The washing should be performed by a machine, much more fitted for extricating the dirt than the hands of the washer woman, and at a much higher temperature than she can bear.

The vessels employed should be provided with stop cocks for steam and cold water, so as to avoid the labour and inconvenience of lading and pouring.

The laundry should be provided with a hot closet, through which a current of hot air is constantly passing, from a stove which also heats the irons. The clothes should be dried by the warm air, which will as perfectly preserve the whiteness of the linen, as if dried in the open air.

Having pointed out some of the most important objects in domestic economy; I shall next proceed to describe how far these improvements have been realized in the Derbyshire General Infirmary. This description will be accompanied with observations and notes, shewing the adaptation of the various improvements to private houses, manufactories, churches, and other public buildings.

General Derbyshire Infirmary.

WHEN the erection of this building had been finally agreed upon; a committee was appointed to fix upon the most eligible situation, to purchase land, and according to the usual custom to advertise for plans. The advertisement pointed out the objects which the plan should embrace, which were as follows; that the building should be of stone; that it should contain fever wards, having a separate entrance, as far removed from the principal entrance as possible; that there should be convenient access to every side of the building; that the fever wards should contain 12 beds; and the whole 80 beds at least; and that besides the usual conveniences of an hospital, it should have two day rooms for convalescent patients. In consequence of this advertisement a considerable number of plans were sent; none of these however answered the expectation of the committee, nor was any of them either wholly or partially adopted. Agreeably to the promise held out in the advertisement, the author of the best of these plans, which was Mr. Rostern of York, received a premium of 20 guineas.

To secure the objects which the committee had thought desireable in such an institution, they undertook themselves the task of making the plan for the Infirmary; from which design Mr. Samuel Brown, then practicing as a drawing master in the county, and as it afterwards appeared, well versed in architectural drawing, was employed to make all the necessary drawings and working plans. These being approved and adopted at a general meeting of the subscribers; a wooden model on the scale of an inch to a foot, was ordered to be made under the direction of Mr. Brown, which was well and neatly executed, with a cast iron dome, designed by himself; this also was highly approved of, and the model was found particularly useful to the workmen in the erection of the building.

The scite of the Derbyshire Infirmary, is on the south side of the Town of Derby, a small distance from the London road. The building from its elegance and magnitude, and from the great taste with which its grounds are laid out, has rendered that entrance into the Town, particularly striking and agreeable.

The frontispiece of this work, is a perspective view of the building, and is a faithful portrait of its north east aspect.

It consists of three stories; the basement story being a little sunk and surrounded by an area. The middle and principal story is a little elevated; it is approached by steps and a portico, supported by four doric pillars, of the same stone as that of which the walls of the building are formed, which is a hard compact millstone grit, of an agreeable colour. The upper story is approached by a stair case leading from a spacious hall in the middle of the building,

which is lighted by several skylights placed in the dome over the hall in the centre; this staircase as will be seen in the plans in plate 9, terminates in a gallery surrounding the interior of the hall on three of its sides. This and the other stories, with the different rooms will be seen in the plans above mentioned; in which the use of every room is pointed out, so as to render a general description unnecessary. Every thing which may require a particular description in the different stories, will be given separately.

This building is of a cubical form; the central part being the hall into which the doors of the rooms open. The roof of the central part is drawn into a conical form, terminating in a dome containing six windows, which completely illuminate the hall from the floor of the principal story upwards. The roof of the surrounding rooms is separate from that of the central part, the sloping sides of which terminate in a gutter which surrounds the central roof. Within this central part is also an outlet provided with a turncap, for the escape of foul air by flues communicating with every room appropriated for the patients. It may be proper here to mention that the gutter which receives the water from the dome and the surrounding roof, has a contrivance to obviate the evils attendant on the gutters being filled with snow and ice; this is effected by covering the gutters with slates elevated by wood slips of about two inches square, with sufficient space between the ends of the slates, for the water of the melted snow to drain into the gutter and run off. The great inconvenience of removing the snow on those occasions, however deep it may be, is by this means entirely removed.

The turncap above mentioned would of itself insure a certain degree of ventilation to the rooms: it is however strongly aided in this effect by a similar turn cap, a short distance from the building, communicating with it by a subterraneous culvert; the opening from the former one, is by the power of a vane presented in a direction opposite to the wind; while the latter is by a similar contrivance always turned to the wind. These being both connected with all the rooms occupied by the patients, a current of air is constantly passing through the same. The operation of these we shall have occasion particularly to describe, when speaking of the warming department; independently however of any means of warming, such a contrivance for ventilating, would be found an acquisition highly important.

During the process of building the Infirmary, great credit was due to the committee and the different managers employed. It often happens on these occasions, that many of the materials are either stolen or wantonly destroyed; and many instances have happened of buildings being destroyed by fire, before they have been finished, chiefly owing to the carelesness of workmen. Evils of this kind were prevented by employing watchmen, who were bound to do their duty.

* Nearly twenty years before this period, W. Strutt, Esq. who was one of the committee, had invented a curious watch-clock, which I am sorry to say has not yet got into

* This piece of mechanism is so truly simple and ingenious, that although a little foreign to our subject we have given an engraving of it in Plate VII. Figures 2, 3, 4, and 5. Fig. 5 is a front view of the face of the clock; the movements are the same as those to produce the motion of the index of

general use, notwithstanding its superiority over every other contrivance yet offered to the public. This is probably owing to no account of it having been hitherto published.

One of these clocks was put up on the spot, and was used every night till the building was finished.

It is not here intended to enter into the history of the building, but merely to state such particulars as are not commonly practiced. In describing what is permanently established in this Infirmary, we shall begin with the basement story, taking the different objects as they occur, and proceed in succession to the stories above.

a common clock, to show the hour. Instead of the hour index, the part *F* turns round in twelve hours, carrying with it the figures which pass the fixed index *I*, and thus point out the hour. Fig. 2 shows the interior of the part *F*, seen in the other figures. The pins *P*, pass through holes in two concentric rings, and all point to the centre. These pins are stopt when down by the concentric part of the snail *S*. Under each pin is a fine brass spring, as seen at *p*, Fig: 4, which is a side section of Fig. 2. The snail *S* is fixed while the part *F*, which contains the pins revolves. It will therefore be easy to see that the pins, by their ends moving upon the snail, will be forced out when they come in succession to the exentric part at *S*. At this point the pin is pushed out to its full extent, and immediately after comes to the index *I*, under the end of the lever *L*, seen in *Fig. 3*. By the action of the wire *W*, which works the crank, the lever forces down the pin at *p*. The spiral spring *S*, brings the lever to its former position. It will be easily conceived that if the pin by the motion of the dial, passes beyond the lever before the pull is made, that it cannot be afterwards put down, till it has made another revolution, and will become a certain evidence of the watchman's inattention, and also point out the time of his neglect. The dial and the whole face of the clock is inclosed in a glass case, and may be otherwise inaccessible to the person who attends it.

This clock is made by Mr. Whitehurst of Derby, who has added to it a very valuable improvement. It will be seen from our description that if a number of rooms or places are to be visited by the watchman,

Basement Story.

The descent to this story is by steps under the portico of the principal story, as may be perceived in the perspective view.

Baths.

In the plan of this story will be seen the baths to the right and left of the entrance; these baths are open to the public, and produce a considerable revenue to the charity. They are warmed by steam; that on the left is kept at 84°. That on the right at the temperature of 92°. In all other respects they are perfectly similar. The superficial area of the bottom of each bath is 162 square feet; this at 5 feet in depth will hold 810 cubic feet, or 4860 gallons of water.

it would require a similar clock in every place, which in some establishments would be very expensive. The improvement made by Mr. Whitehurst, consists of a piece of machinery attached to the clock, which is connected by wires with every room. The watchman is therefore obliged to go to every room, and always in the same order of succession; the pull of the first wire prepares the second to be pulled, the second prepares the third, the third the fourth, and so on to the last which pushes down the pin. The pins are at a distance from each other, requiring attendance every quarter of an hour; but these might be made to any other intervals. If for instance a certain walk or round is pointed out for the watchman, there may in its course be required any number of pulls, and these points to be in situations where his attention is particularly required; so that the number of pins to give the intervals of time, will vary with local circumstances.

A small stream of water is constantly running into them in the day time. The boiler of the steam engine supplies them with steam, through one pipe for each, 1 inch in diameter; this pipe terminates in a larger pipe, carried quite round the bottom of the bath, and concealed in a recess in the wall, covered by a thin stone plinth; the bottom of this plinth is perforated with small semicircular arches, the top being placed about half an inch from the wall, to allow the water of the bath to circulate freely in contact with the outside of the large pipe. These pipes are about 4 inches in diameter, and must be of cast iron, since from the vacuum formed by condensation, they would be liable to collapse, or otherwise to burst. If one of these baths were filled to the depth of five feet in water at 32°, and were required to be raised to the temperature of 96°, it would demand for that purpose 304 gallons of water in the form of steam; which will consume about 50lbs. of Newcastle coal. This mass of water if the door be kept closed, would cool in the course of twenty-four hours, about four degrees, and would require to keep up the temperature a daily supply of coal a little exceeding three pounds. If this water were entirely to be changed once in fourteen days, by a given adjustage of the outlet and inlet; then the annual consumption of coal, would be one ton, supposing the bath to be constantly kept up at 96°, and the water supplied at 32°, but as this is less than the average temperature, this estimate will be quite sufficient. These are facts derived from experiments by observing the times of cooling. The calculation for the fuel is taken from the economy of Bolton and Watts', Steam Engines.

The sides of the baths here described are coated with glazed tiles, which gives to the water an agreeable appearance. The condensation which is constantly taking place on the walls and door, does not admit of the presence of wood, which would very soon decay. The door entering the bath is made of thick shistus slate, and the jambs are wood plated with copper; the window frames are of iron faced with copper.

The walls are covered with roman cement, and the ceiling is formed of earthenware pots of a cylindrical form, about five inches in diameter, and the same in depth. They are made to form a spherical arch, the axis of each cylinder pointing to the centre of the sphere. This arch is particularly light, and little less in strength than if the cylinders were of solid brick.

These baths are kept constantly at the temperatures above mentioned, and are considered as a great public accomodation. A single bathing is charged two shillings; but twenty tickets transferable to the members of the same family may be purchased for twenty shillings.

Steam Engine and Warming Stove.

On the opposite side of this story is the warming stove and the steam engine. The latter is of one horse power, an excellent piece of workmanship, executed by Mr. Fox of Derby. The boiler is of a size suitable to a six horse engine, in order to furnish steam to the kitchen, the public baths, the wash house, salt bath, &c. The steam engine works a forcing

pump, which raises water from a well to a cistern at the top of the building, from which the house is supplied with cold water. It also gives motion to a horizontal shaft communicating with the wash house, and turns the washing machine. The fire places *F* and *G* (plate VIII.) of the steam engine and warming stove are contiguous, for the convenience of superintending the fires; both of which are managed by the porter, who also attends to the baths.

The stove occupies a small room called the stove room, with which the cold air culvert communicates; the fire place *F* in front, having no communication with the part where the air enters the stove. The recesses 29 and 30, contain coal for supplying the fires, which is taken from the holes *h*, *h*, with a shovel, the bottoms of the recesses being inclined to the same.

Description of the Warming Stove.

Plate the 1st. Fig 2, is a plan of the stove. Plate the 2nd. Fig. 1, an elevation viewed from the left side. Plate the 7th. Fig. 1, is another elevation viewed from the back of the stove. The section of the plan in Plate the 1st. is taken at the height *S*, *S*, as seen in Plate 2nd. The elevation (Plate 2nd.) is a section, cut by a plane passing through the middle of the stove perpendicular to the front. The elevation (Plate the 7th.) is a section cut by a plane, parallel to the front, passing through the line *Q*, *O*, Plate 1. The same parts visible in all the different views are marked with the same letters.

The square *A*, *A*, in Plate 1st. contains all the parts for warming the air, the wall *W*, *W*, *W*, and G, G, G, serving merely to support the arched cavity called the air chamber, as seen in Plate 2nd. *L* is a hopper shaped fire place; *c*, *c*, the bearers for the fire bars; *a*, *a*, *a*, *b*, is a frame containing a sliding plate to let out the cinders and other refuse; *F* is a hollow four sided funnel of cast metal, called the feeder or mouth piece, through which the fuel is introduced. A section of this is seen in Plate 2, and in Plate 1, it may be seen in dotted lines. The part *P*, is an arched cavity in the wall in order to get nearer to the fire, and lessen the length of the feeder. Over this fire place is placed a vessel with the mouth downwards, with a broad flange *f*, *f*, (Plate 2,) covering the smoke flue. This vessel is called the cockle, made of wrought iron, and rivetted together in the manner of steam engine boilers.

The upper part of the cockle terminates in cross arches forming a groin. The thickness of the iron should not be less than 3-16ths. of an inch.

On the right and left of the fire place, is a bar of cast iron *I*, *I*, (Plate 1;) between each of these bars, and the sides of the cockle is a narrow opening, not more than half an inch wide; this immediately communicates with the flue under the flange of the cockle, and is for the purpose of conveying the smoke into the flue, and from thence into the chimney; the smoke is made to pass off at this level, in order that the hot vapour may have parted with the greatest portion of its heat, while confined in the upper part of the cockle. Its specific gravity increases as it cools, until it passes off at the bottom. It will be easily imagined that this narrow opening would be liable to be filled with soot, ashes, &c. this is prevented by the rakes *R*, *R*, which slide in sockets rivetted to the cockle. At the end of each rake is a projecting piece *e*, *e*, Plate 1, which fits the opening above mentioned. Every time the fire is mended, the rakes are drawn out and returned, which has the effect of keeping the passage free. This opening is quite sufficient to keep up a vigorous fire, and does not allow the heat to pass away by the chimney, which is too often the case. The side flues communicate with the back flue, and the smoke passes to the chimney in the wall *W*, Q. Above this flue, and over the flange of the cockle is a cavity immediately surrounding the latter, measuring eight inches from the surface of the cockle to the brick work *B*, *B*, *B*, which runs parallel with the sides of the same, up to *D*, and then terminates in a groin, concentric with the groin of the cockle.

On the four sides of the wall *B*, are holes left in the brick, opposite to the side of the cockle as seen at *B*, in Plate 7; these holes are continued within three quarters of an inch of the cockle, by the square tubes *t*, *t*, of sheet iron or earthenware, as seen in Plates 1 and 2. These apertures are for the admission of cold air, the tubes serving to bring the whole of the air into close contact with the hot surface before it can enter the cavity between the cockle and the wall. The air which has by this means been heated, now rises into the superior cavity between the groins, but it will be evident that before it can pass out at the openings through the brick groin, it will form various eddies, frequently striking the cockle, and at length enters the mouth of the iron tubes, which like those below are within three quarters of an inch of the cockle. It now enters the hot air chamber having acquired its full heat; and rises through the hot air funnel to be disposed of as we shall afterwards explain.

After the walls *B, B, B, B,* and *G, G,* are raised to *D,* the walls *W, W, W,* being the walls of the room, which if wanting, would be supplied with the walls similar to *G, G, G.* The interior and exterior walls are connected by the large stones *D, D,* going quite round. These stones have the effect of cutting off the communication between the atmosphere and the hot air chamber, so that the cold air is constrained to enter at the apertures below *D,* and to escape through those above *D,* into the hot air chamber. From the back of the stove are two openings *s, s,* Plate 7, into the back flues, and opposite to the ends of the side flues *E, E.* These are filled up by stone plugs with iron rings, by which they may be taken out at any time for the purpose of cleaning the flues, which from their horizontal position, would in time be filled with ashes. It is essential to the principle of this stove, that it should be placed considerably below the room to be warmed; from fifteen to twenty or even thirty feet is desirable where it can be obtained; reckoning from the bottom of the air chamber upwards. This necessity will be evident, since the velocity of the heated air is as its temperature, and as the square root of the height.

It is better to heat a large quantity of air, through a small number of degrees, than the contrary. Hence the necessity of a rapid current; since the quantity of air which passes

through the stove, will be as the velocity; the aperture being the same, the cockle becomes hotter, and a similar quantity of air will be heated to a greater extent. The limit of this will be in not allowing the cockle to be much more than 280°.

If the air be heated too hot, it has a tendency to injure the materials of which the flues are formed. It is also heated with less economy, since the smoke will pass away at a higher temperature. From these facts we come to the following conclusion; that in order to keep rooms at a given degree above the common temperature, a certain quantity of caloric or matter of heat must be supplied in a given time, so that this supply may be just equal to that carried off by the foul air chimney, and the conducting power of the walls, window, &c.

In this method of warming rooms, the air is made the medium of vehicle for supplying caloric. The quantity of caloric will be as the quantity of coal or other fuel consumed. But since the heat of the cockle and the air when heated should not vary much, from what has been before stated; it will be evident that in adapting stoves for different magnitudes of space to be warmed, the effect must be varied by varying the surface of the cockle, and the altitude of the column, or the length of the air funnel.

It appears from an experiment made with the stove above described, that 1lb. of coal will raise 5085 cubic feet, or 339 lbs. of air through 59 degrees, which will be adequate to 1lb. of coal rising 20000lbs. of air one degree. By a recent experiment made with a portable stove on the same principle, but with some advantage in the construction, I have found that 1lb. of coal is capable of raising 22400lbs. of air one degree. These experiments show the economy with which different stoves operate; but they do not give us any definite idea of the ultimate effect of the heated air, in raising and keeping up the temperature of the apartments to be warmed. The experiment last mentioned was conducted with the additional view of ascertaining this particular fact.

The cockle of this portable stove is 18 inches square at the base, and its sides run parallel two feet high; it then terminates in a groin, the altitude of which is one foot, so that the whole height of the cockle from the middle of the base to the apex is 36 inches. The fire place is hopper shaped, 11 inches square at the top, inside measure, 7 inches square at the bottom, and 8 inches deep. By keeping a fire in it burning for twelve hours, it consumed 60lbs. of coal, and raised 344600 cubic feet of air through 56 degrees. The capacity of the room was 4500 cubic feet, and its average excess of temperature above the atmosphere, was 21 degrees of Fahr. It appears therefore from the data, that by burning 60lbs. of coal in twelve hours, a space of 4500 cubic feet was kept 21° above the atmosphere. More or less might have been burned, producing a proportionate effect.

This room was not joined to any dwelling house, and had not had any fire in it for some time. A very different result would be found to take place if the stove was continued in action every day. As a proof of this we shall give the result of some observations made at one of the Cotton Mills, of Messrs. Strutt, at Belper. The stove is of a construction very similar to that already described in the Infirmary; but does not contain so many tubes in the same surface of the

cockle, which is not in its favour. This stove warms a space of 206247 cubic feet, the rooms are 9 feet high. The observations were made morning and evening for four days. The average temperature of the air during the time was 35°. The average temperature of the rooms the whole time was 60°. The coal consumed during the time was 1474lbs. which is nearly 184lbs. in 12 hours. It should be remembered that the lamps burned in the evening and morning, and the necessary presence of a number of persons would contribute something to the heat. The latter was however only during the working hours, which were but twelve out of the twenty-four, although the heat was kept up in the night.

The purity of the air in this mill, was strikingly different from that experienced in Cotton Mills, heated by steam, owing to the want of ventilation in the latter, for which no provision is made.

When however we find that heating by steam, falls very short of the warm air method now described, in point of economy, and exceeds it greatly in original cost; there can be no argument left in favour of the employment of steam for heating buildings.

In order to shew how far we are warranted in the above assertion, we have drawn some facts from Mr. Buchanan's work on Heating by Steam, which are the result of his own experience. He finds that a quantity of steam capable of supplying an engine of one horse power, will warm a space of 50000 cubic feet. Now according to the average estimate of such a power, it will require a supply of steam equal to 36 cubic feet per minute. This according to Mr. Watt's authority, will consume 168lbs. of Newcastle coal, in twelve hours, or about 240lbs, of the coal used in the stove above mentioned. The relative effects produced by the same coal burned in warming by steam, and by warm air in the stove above alluded to, is something more than 6 to 1. This advantage of warm air over steam, is doubtless to be attributed in part to the difference between the specific heat of air and water; the latter being nearly four times that of the former. We have learned from experiment upon the Infirmary stove, that 1lb. of coal raises 20000lbs. of air one degree. During the time of the year when a stove is employed, the average range through which the air is heated, is about 100°. Therefore 1lb. of coal would raise through 100°, 200lbs. or 2800 cubic feet of air. If the coal be consumed at the rate of 240lbs. in twelve hours, 66.6lbs. or 933 cubic feet of air, at 140° would be furnished every minute. This air is dispersed with such facility through the space to be warmed, that no want of uniformity of temperature is perceived in the largest rooms.

In heating by steam we have in the place of 66.6lbs. or 933 cubic feet of air at 140° in one minute, 2lbs. of steam furnished in the same time and with the same fuel. Considering the latent heat as temperature; this may be reckoned 1112°. If this steam were first condensed in the room, and the water cooled down to the temperature of the room; it would give 1052° to the air of the room, which would be doubtless nearly equal to the effect produced by the warm air heated by the same weight of coal. But we have seen from facts derived from good authority, that the steam falls very short of the effect produced by making air the vehicle of heat.

In the first place the heat lost in the conveyance of the steam, is much greater than that lost in conveying air. The temperature of the steam is 212°, the air being 130°. The loss of heat will be greater in the same time on this account. But the greatest difference is caused by the ratio of the surface, to the solid content of the air channel, being so much less than that of the steam pipe. The ratio of the areas of an air channel, to that of a steam pipe to supply the same sized room being not less than 30 to 1.

Another source of deficiency in heating by steam, which must be very considerable, is the heat which escapes with the hot water and uncondensed steam.

The steam pipes exposed in the rooms in which the steam is condensed, are probably always above but never less than 180°.

At this temperature only one half of the original steam is condensed, and of course gives out only half the heat which would be given out if the condensed water were allowed to cool down to the temperature of the room. This loss with those already stated will go far to explain the great difference in favour of warming by air.

The portable stove above mentioned has no brick work about it except the fire place, which is of wrought iron on the out side and lined with fire bricks. Instead of the brick wall which surrounds the cockle and contains the iron tubes, as is the case with the stove already referred to in Plates, 1, 2, and 7, the portable cockle is surrounded with a thin iron casing; in which the tubes are rivetted. These tubes are round, and two inches in diameter. The ash pit is of cast iron.

Since making this portable stove, I have made those of a larger size, with an iron casing for the tubes, instead of a brick wall. The cockle is also longer than formerly, by nearly the depth of the fire place. The fire place is made of wrought iron, hopper shaped on three sides, but coming square up to the cockle in front. This is lined with fire brick on the three sloping sides, being open in front for the admission of fuel. In this arrangement the smoke flue commences in a small space between the right and left sides of the cockle, and the outside of the fire place, about half an inch wide. This space from the hopper shape of the fire place becomes wider downwards, so that at the level of the grate it is sufficiently capacious on each side to constitute the smoke flue. These side flues unite in a similar cavity at the back of the fire place, from which the smoke descends into a cavity under the flange of the cockle, and from thence into the smoke chimney. In fact this cavity is common to the flues and the chimney, and is seperated from the ash pit by an iron door, which can be opened at pleasure for the purpose of cleaning the flues or the chimney.

In Plate 2, Fig. 1, *I, M,* is the space through which the cold air ascends. It will be evident that the air which enters at the lowest tier of tubes, has to rise between the tubes of the second tier; that which enters the first and second, will pass between the tubes of the third, and finally the air which has entered all the tubes below the uppermost tier of the cold air part, will have to pass between these before it gets into the hot air part, where it is discharged. It will hence appear that the space between the tubes of the uppermost tier must be equal to the sum of the areas of the

mouths of all the tubes below that tier, in order that the air in its course may not be required to change its velocity. These considerations have induced me to give the stove the form represented in Fig. 2, Plate 2. *a, b, c,* is the iron casing containing the tubes which approach the cockle *d, e, f,* within half an inch. *D,* is the door for feeding the fire *g, h,* in the hopper shaped fire place, marked with the same letters; in Fig. 2, *n, n,* is an opening for the smoke; *r, r,* are rakes which work backwards and forwards along the opening *n,* to prevent its being choaked with soot; *A,* is the ash pit; *E, F,* the level of the floor where the fire is fed; *S,* the cold air culvert communicating with the open air by a turn cap, the mouth of which is presented to the wind. This cold air is therefore entirely cut off from the ash pit and fire place, and passes freely between the pillars *K*; from thence it ascends up the cavities *I, M,* on all sides entering the small tubes, and is forced against the hot cockle. It afterwards passes through the upper set of tubes into the cavity *C,* which is called the hot air chamber. Here it has attained its full degree of heat, and is now transmitted through different flues to the apartments to be warmed. The proportionate areas of the different flues will be governed by the main flue. If the air moved as freely through the small tubes as in the large flue, it would then be a rule to make the main flue equal to the sum of the areas of all the tubes in the hot air portion of the stove; but it will be sufficient to make it equal to $\frac{3}{4}$ of that area.

The section of the cold air flue should be such as to present the greatest interior surface, in order to warm or cool the air passing through as much as possible, and should therefore be a long parallelegram, the length at least should be three times the breadth. The hot air flue should present the least interior surface, in order to preserve the heat of the air while passing to its destination. For this purpose its section should be a circle, and the inside of the flue as smooth as possible. The cold air flue should be made of the best conductors of heat; the hot air flue of the worst conductors.

The greater the distance the cold air flue passes under ground, the greater will be its effect in warming the air passing through it in winter, and in cooling it in summer. The change in temperature of the air by passing in this way, is much more than would be supposed. The cold air flue at the Derby Infirmary, is about 4 feet square, and its length 70 yards. In the month of August when the Thermometer in the shade stood at 80°. the air which entered the air flue under ground at the same temperature, was found to be 60° at the other extremity, where it entered the stove room; the current at this time was sufficient to blow out a lighted candle. Another experiment was made when the outer air was 54°. This air was reduced to 51, by passing through the flue. We have before referred to two turncaps, by which the current through this passage is much increased. The turncap at the entrance of the cold air flue has a vane on the top of it, which being acted upon by the wind in the manner of a weather-cock, keeps the mouth constantly presented to the wind; this provides the most ample means of bringing fresh air into the building, which air is warmed when its temperature is less than that of the earth, and cooled when the earth is colder than the atmosphere.

From each of the apartments into which the air passes from the stove, a flue proceeds equal in area to the inlet, so that the sum of the areas of the outlets will be equal to the area of the main flue. The outlet flues all terminate in the roof of the building, and the foul air escapes at a turn-cap of the same size with the outer one, having a similar vane but placed the contrary way, in order to insure the aperture being presented constantly *from* the wind. The ventilation by this contrivance is much more complete than by the casual opening of doors and windows.

We have given a view of one of these turncaps in Plate 2, and Fig. 4.

The hot air funnel leading from the air chamber as seen in Plate 2, Fig. 3, rises perpendicularly to the attic story, and terminates in a cavity from whence a variety of horizontal flues proceed; the principal of these go under and quite round the gallery in the attic story; into which the convalescent and principal bed rooms open. This flue will therefore be contiguous to the rooms and give out branches to supply the same; the openings are supplied with registers to adjust the inlet, which can be opened only by a person who goes round with a key for that purpose. The course of the hot air in these and the other flues will be seen in dotted lines in the plan of the attic story, Plate 10. The flues are formed of slate, closely jointed at the corners and ends of each slate, by cement. When these flues are made of brick, they should be well plastered with lime and hair in the inside. If they have to pass under ground, the flue should be double; that is, the part to contain the air should be surrounded by a similar cavity leaving a stratum of air between them. The care employed in securing horizontal flues should be greater than in perpendicular ones. I have seen the latter kind made of rolled iron, which answer very well, receiving very little heat from the air rising through them. And even well seasoned wood will last a long time for perpendicular flues.

Before we conclude this article, it will be proper to make some remarks upon the history of this valuable invention. Its advantage over every other kind of stove or method of warming, cannot fail to ensure its general adoption, especially for public buildings; and the halls and staircases of private houses.

The most remarkable circumstance in its history, is the fact of its being in use in the Cotton Mills of Messrs. Strutt, as early as the year 1792, without having been once noticed in any publication. It was free to the inspection of any enquirer, and the proprietors were always willing to give any information for its construction; yet so far from being brought into general practice, it has been adopted in but very few instances. In the rare situations in which it has been erected, some blunders have been committed, which have prevented its complete success, or it has failed for want of proper management. The first stove which Mr. Strutt the inventor erected, was not so complete as they afterwards became; the brick wall which surrounds the cockle, and which we have described as containing iron tubes, were in the first instance merely square holes in the wall, no tubes being employed. The addition of tubes was found to produce double the effect with the same fuel. One of the stoves without tubes is still existing at the Belpar Mills, from

which by experiment, I have been enabled to make the above statement.

Wash House.

This comprizes a washing machine turned by the steam engine, and a boiler of cast metal in the middle of the room, holding 100 gallons. Its contents are heated by steam, which is brought by cloathed pipes from the boiler of the steam engine. Two sides of the room are provided with stone benches, and a large table stands near to the washing machine to lay the linen upon. There are also several wooden tubs for the purpose of washing by hand occasionally.

Plate 7, Fig. 9, is a perspective view of the washing machine; *C, D*, is a water tight cistern in which the cylinder *A*, revolves. The interior of this cylinder is divided into four compartments, by two planes intersecting each other at right angles. One quarter of the end of the cylinder is removed in the figure to show the interior of one of these cavities.

The proper entrances into these is by a small door in each as seen at *h*. Here the linen is introduced and the doors are closed. The perforations in the cylinder and in the separations of the cavities are for the admission of water.

The linen is previously rubbed with soap the night before washing. Before the operation commences, as much cold water is put into the outer vessel *C, D*, as will rise to the height of 4 or 5 inches in the cylinder *A*. The vessel *C, D*, is provided with a steam pipe from the steam engine boiler. The steam is now let in until the water and linen are heated to the maximum which is something below the boiling point. The part *B* being turned down, the inner cylinder is put in motion; the holes in its sides freely admit the hot water and steam. The velocity of the cylinder should be such, that the linen may be heard to fall from one side to the other every time it is raised out of the water. This discharges most of the water from it, and it becomes filled with a fresh portion every time it dips into the water below. If the motion be too rapid, the linen remains against the sides of the cylinder, if too slow, it slides down the sides. In either case, little or no effect is produced. When the machine moves at a proper speed, one charge of linen will be washed in less than half an hour. It must be observed that during this process, the quantity of soap in the machine should be such as to produce a strong lather, so that if a sufficient quantity has not been rubbed upon the cloaths before they were put into the machine, more soap must be added either in the state of thin shavings, or previously dissolved in hot water. A great advantage will be derived from the use of an alkali when it is used in a proper state, and with caution. That which is known in commerce by the name of pearl ash, is to be preferred. Soda answers very well, but it is less economical than potash, on account of the great quantity of water it contains. The use of this substance is more particularly necessary when the water is hard. If the cloathes be very dirty or abound with grease, the alkali should be used in a caustic state, but very sparingly, as it might injure the texture of the linen. To prepare potash for common purposes, dissolve it in its

own weight of water. If after standing half an hour and having been stirred frequently, any thing remains at the bottom, let the clear liquor be separated, and the residuum thrown away. The clear liquor contains all the real alkali the residuum being impurities. The following is still more simple, but requires a longer time. Let the pearl ash in the state in which it is purchased, be put into a jar of stone ware, capable of holding five or six times the quantity which is put into it; let it be loosely covered so as to keep out the dust, but be freely accessible by the air. In a few weeks the useful part of it which is the alkali will become liquid, what is impure remaining unliquified. This liquid or that obtained by the first process may be used in small quantities for clothes in general, but when as I before observed they are very dirty and greasy, let the liquid as above obtained be prepared as follows. First dilute it with twice its quantity of soft water, to this add as much new slaked lime as is equal to the original weight of the pearl ash, boil the mixture gently half an hour, stirring it frequently, let it cool, and stand to settle, drain off the clear liquor for use, add to the dregs as much more soft water boiling hot, let it stand till it becomes clear, and drain off the clear liquor. This process should be repeated till the liquor ceases to be acrid to the tongue. This liquor should be kept in a stone ware bottle close corked, and should be used in small quantities. It will be found much more active than the liquid first obtained, and will much economize the use of soap. This caustic alkali may be employed in the machine in a greater quantity than in washing by hand, since the alkali affects the hands of the washer-woman long before it would have any bad effects upon the linen. The operation of the machine consists merely in letting the clothes fall from one side of the compartment to the other, so that the texture is less injured than by any other mode of washing; the water being nearly at the boiling point has a much greater effect in dissolving the dirt, than at the low temperature which can be born by the hand of the washer-woman. The dirty water may be let off in a few seconds, by a cock in the bottom of the fixed vessel, and may be immediately supplied with fresh water and steam to heat it. All the labour of lading and pouring is saved by pipes being laid for the admission and exit of water, and the constant supply of steam renders the presence of fire places unnecessary.

After the clothes are removed from the machine, some of them require to be looked over, and sometimes a little hand washing is necessary; but the greatest proportion are finished by the machine alone.

The next process is boiling the clothes; which is performed in the boiler above mentioned; it is placed in the middle of the wash house for the purpose of getting round it. There are three pipes attached to it, one introduces cold water, a second steam, and a third carries the waste water away. During the boiling process the boiler is covered; the edge of the cover fits into a groove which goes round the top of the boiler. This groove being filled with water prevents the escape of steam, and by that means economizes the heat. The linen is now taken from the boiler and laid upon a board or tray filled with small holes and placed over the boiler, by which means the water which contains much soap is drained out and used for the process of washing in the machine. At

the ceiling of the wash house there is an opening into a chimney which is for the express purpose of carrying off the vapour.

After rinsing and wringing, the linen is ready for drying either in the open air in fine weather, or in the laundry stove in bad weather. We shall here give a description of the laundry.

The Laundry.

The laundry is a large room as seen in the plan, Plate 8, adjacent to which is the laundry stove, exactly on the principle as the stove already described for warming the rooms. Plate 4 is a plan of the laundry stove, not strictly a section through any particular line, but shewing several things at different altitudes. Plate 5 is an elevation, being a section cut by a perpendicular plane passing through *A*, *B*, in Plate 4, with the exception of the door *D*, and those *d*, *d*, *d*, which are to the front. *S*, Plate 3, are three steps leading from the floor *A*, *B*, down to *F*. The plan of this recess is seen in Plate 4. From this level two other steps descend to *M*, the place where the fire is mended; *m* is the mouth piece for the introduction of fuel. Over the fire place is an iron cockle; its flange *f*, *f*, and the thickness of the metal is seen in Plate 3, part of the flange is cut away to shew the flue which it covers, see Plate 4. This cockle has no dome at the top like that of the other stove in Plate

2, but is a flat cast metal plate and constitutes the bottom of a recess which the door *D* closes. The top side of the cockle is for heating the irons employed in getting up the linen. The sides of the cockle, the form of which is a pararellopipedon or an elongated cube, are surrounded with iron pipes *t, t,* similar to those in the large stove; these tubes are inserted into a narrow wall which separates the cavity *K* from that immediately round the cockle. The cold air ascends from a subterraneous passage below *M,* which communicates with the outer air; it then enters the tubes *t, t,* &c. and strikes the sides of the heated cockle; thus heated it rises into the hot air chamber Plate 3, and passes into the hot closet which contains the horses *d, d, d,* and also the linen to be dried. The entrance into this closet is by a door *W,* which is shut during the time of drying. Along the closet and also along the floor of the laundry run the ribs of cast metal *b, b, b, b, b,* these are for the horses *d, d, d,* to run upon. Plate 1, Fig. 1, is a side view of the horse; *W, n,* are cast iron wheels with grooves to run upon the ribs *b,* Plate 4; each horse has two wheels behind at *n,* and one before at *W.* Every horse has five tier of rails one above another, 4 of these being double, making the whole nine rails; these are for hanging clothes upon. The horses it will appear are drawn out into the laundry for the purpose of loading and unloading; when the horse is quite out, the back end comes to the front and closes the aperture, preventing cold air from entering the closet. Each end of the horse is kept steady by the guide *g,* in the ceiling. When all the horses are in the closet they constitute its front, and fit perfectly. As the hot air cools

it descends with the aqueous vapour through the linen, and escapes into a funnel *C,* at the floor of the closet, by this means the heated air is compelled to pass from the top to the bottom of the hot closet, affording the most effectual means of carrying off the moisture, with the least expence of fuel.

It would be idle to attempt any comparison between the laundry here described and those in common use. Where the drying has been performed by a stove instead of a common fire, we have not any thing, before the method here recommended, superior to placing an iron stove in the middle of a room, or having the smoke flue a naked iron pipe passing through the same. The top of the stove is used for heating irons, and the linen is exposed in the same apartment where the laundress is obliged to exist. The stove is generally hot enough to set fire to dry linen, an evil from which destructive consequences may be expected, and which have frequently happened.

The laundry here described is entirely free from any of these inconveniencies. *First.*—That part of it which is occupied by the laundress, can be entirely cut off from the source of heat in hot weather; and in winter may if necessary, be supplied with any portion of the hot air from the drying closet. *Second.*—The part appropriated for heating the irons, is completely shut off from the room; and the fire, (as seen in Plate 4 and 5,) opens into a distinct apartment, so that it is impossible any accident should happen from fire. *Third.*—To do away any prejudice which may exist in favour of drying in the open air; we shall only observe that in consequence of the constant current of fresh air which passes through the drying closet, more of it comes in contact with the linen in a given time, then would on the average be the case in the open air. This is all that can be required to keep linen of its proper whiteness; light is the only other agent which could be supposed to interfere; and it is known to have an effect upon animal and vegetable substances, the very contrary of bleaching, that process depending entirely upon the presence of moisture and oxygen. *Fourth.*—The clothes during drying are not exposed to the dust of the room, nor have they any other chance of being dirtied by accident. The same closet in which the clothes are dried, is not less important in keeping them clean and properly aired after mangling and ironing, until they can be disposed off. An extra horse is sometimes added to these in the laundry, which when drawn out, has a part to turn down upon hinges, on which a feather bed can be laid; this part then turns up with the bed, and the whole slides into the closet: this is a most speedy and effectual method of airing damp beds.

These stoves have long been applied upon an extensive scale, to the drying of cotton yarn and calico, in the works of Messrs. Strutt; and they would not be less important to the paper maker, potter, sugar baker, &c. In the manufactory above mentioned, it is found much more economical than any method hitherto used. To give some idea of the power of one of these stoves, the following experiment was made upon pieces of calico; it was commenced with the fire in full vigour, at 9 o'clock in the morning, and continued until 3 o'clock in the afternoon, leaving off with the fire in the state in which the experiment commenced.

During this time 104 pieces, 25 yards long were dryed.

Their weight in the wet state was 1140lbs. and when dried 547lbs. Hence the water carried off was 1140—547=593lbs. The coal consumed to producet his effect was 338lbs. From this it will appear that 1lb. of coal expelled 1.56lb. of water. The air and vapour from the closet passes off at the temperature of 100; but the quantity of water in a cubic foot was not more than might have been held at the temperature of 70°; so that if the hot air in the passage through the goods, had made a more circuitious rout, much more water would have been carried off with the same quantity of fuel and in the same time. If the medium at 100 had been saturated with vapour, it would have passed off at 90°. and instead of 593lbs. of water, a little more than 1200lbs. of water would have been expelled.*

* In order to form an idea of the relation between the coal and the water to be expelled;

Let F=the weight of coal consumed in a given time.
W=the water to be carried off from a quantity of goods, equal to $2W$, in the same time.
M=the weight of air which passes through the stove in the same time.
T=temperature at which the air and vapour escapes when the space is saturated.
t=that of the outer air.
Q=quantity of water in a cubic foot of space at T.
d=that contained in a cubic foot of air at the dew point.
a=the weight of wet goods raised 1 degree by 1lb. of coal=1000.
q=the weight of air raised one degree by 1lb. of coal.
c=the weight of water converted into steam by 1lb. of coal.
g=the number of cubic feet in 1lb. of air at T.

Thus as a : 1lb. of coal : : $2W : \frac{2W}{a}$ the coal required to raise $2W$ one degree. Then $\frac{2W(T-t}{a}$ will be the weight to raise it from the t to T.

The Kitchen.

Along the wall on the left of the entrance (See Plan of the Basement Story.) are arranged the stew hearths, a small fire place on the Rumford plan, a roaster for large dishes on the right of the fire place, which is also an oven in which the bread is baked, and a small roaster on the left of the fire place; to the right of the large roaster is a steaming appa-

But every cubic foot of air which passes away must contain a quantity of water equal to $Q-d$, which has been carried off from the wet goods. Hence $\frac{W}{Q-d}$ will be an expression for the air in a cubic foot. Add $\frac{W}{g(Q-d)}=M$; then by substituting this value for M; we have $\frac{W(T-t}{gq(Q-d)}=$the coal consumed in raising the air from t to T, collecting these several quantities of coal together, we have $\frac{W(T-t}{gq(Q-d}+\frac{2W(T-t}{a}+\frac{W}{C}$ $=FW=\frac{Fcqag(Q-d}{ca(T-t)+aqg(Q-d)+2cqg(Q-d)(T-t)}$. T and Q may be found in terms of each other by the table, of the force of vapour, refered to in the text.

The drying power of the atmosphere at the common temperature or assisted by artificial heat, is directly as the change of surface either of the body to be dried, or the medium: and inversly as the quantity of water already in the atmosphere, or as the difference between the *dew point* and the temperature of the air.

This is a term used by Mr. Dalton to express that temperature of the air which would just sustain the water contained in it. Below this temperature, water would be deposited in the form of dew; above it, evaporation would take place in a certain ratio of the temperature. If the dew point be at the

ratus of a new construction. This completes the culinary apparatus of the kitchen.

The roaster is represented by two sections and a plan, in Plate 6. The front section shews the interior of the oven, the door being removed, and also the cavity surrounding the oven, the bricks being removed from the front for that purpose.

temperature of the atmosphere, no evaporation would take place. This however very seldom happens entirely, although it sometimes nearly approaches to it. We are indebted to Mr. Dalton for a very simple and ingenious method of finding the dew point at any time. Take a clean glass vessel, such as a decanter, and fill it with water or any other fluid which can be made a little colder than the minimum of the thermometer the night before the experiment. This may sometimes require the aid of ice or a freezing mixture. Let a delicate thermometer be placed in the fluid when the observation commences. In the first instance, while the fluid is colder than the dew point, the glass vessel, which is previously wiped clean, will soon be covered with dew. This must be wiped off from time to time until the dew ceases to be formed. At this period observe the degree of the thermometer in the vessel, and this will be the true dew point, or that degree when water would begin to be precipitated. The temperature of the air is in general higher than this point. In long continued dry weather the dew point is generally near the minimum of the thermometer.

The following table which Mr. Dalton has formed partly from experiment, and the rest from calculation, shows the force of aqueous vapour in inches of mercury from the degree of —40° up to 212°. The meaning of this will best be explained by supposing a tube like that of a barometer, filled with mercury, and having a bulb at the lower end, capable of containing all the mercury. When the pressure of the atmosphere is removed, let a portion of water then float upon the mercury, in the bulb. This being done let the bulb be exhausted of its air by an air pump, and in this situation be hermetically sealed. If this could be effected in a temperature of —40°, the mercury in the tube would stand higher than that in the bulb by .013 inches. This elevation being occasioned by the force of the aqueous vapour at —40°. If the temperature of the bulb were now raised through all the degrees in the table, the corresponding height of the mercury would be seen as expressed in the same.

The oven rests upon bricks placed edgewise along each side, which forms a cavity under the oven similar to that seen on the top and its other sides. An opening into this cavity is at *E*, in the side section. The fire which is introduced at *D*, it will be seen, does not immediately act upon the oven. The flame branches on each side along the flues *F*, *F*, and then ascends perpendicularly; inveloping the back, the two

The heights of the mercury expressive of this force of vapour, will be seen not to be as the temperature nor in any constant ratio of the same. This gave Mr. Dalton much trouble in constructing that part of his table in which experiment could not well be applied.

He found afterwards that when the scale of the mercurial thermometer was divided into degrees increasing as the square of the temperature from the freezing point of mercury; and when the force of vapour was measured with such a thermometer, it was found to increase in a constant ratio to the temperature. If therefore such a scale were adopted, and if the ratio and the force of vapour for any degree were known; the force of vapour for any other degree would be determined by calculation. Let F be the force of vapour at 212°, which is the height of the barometer, and T any other temperature above or below 212°, and let f be the force of vapour corresponding with T, and R the ratio which for 1 degree $=1.0285$. Then $f=\frac{F}{R^{212-T}}$ when T is less than 212° and $f=FR^{T-212°}$, when T is greater than 212. Let $t=$ the degree of Dalton's scale corresponding to T put $s=7.1714$ and $n=.01105$, Then $T=(nt+s)^2-40$, and $t=\frac{(T+40)^{\frac{1}{2}}-s}{n}$ so that if t be found by this theorem f may be found for any degree of Farenheit's scale.

At the temperature of 212° and under the mean pressure of the atmosphere the density of aqueous vapour is such, that a cubic foot of space would contain 253 grains; and since the density is as the force of compression, the quantity of water in a cubic foot of space at any other temperature will be as the force of vapour answering to that point. In order to save the trouble of calculation, I have added a third column to Mr. Dalton's Table, which gives the weight of water contained in a cubic foot of space answering to each degree of heat.

A TABLE

Shewing the Force of Aqueous Vapour, the Quantity contained in a Cubic Foot of Space, and the Depth of Water Evaporated in an Hour, for Every Degree of Tempedature from—40° to 325°.

Temperature.	Force of vapour in inches of mercury.	Weight of vapour in a cubic foot of space in grains.	Depth evaporated in an hour in inches.	Temperature.	Force of vapour in inches of mercury	Weight of vapour in a cubic foot of space in grains.	Depth evaporated in an hour in inches.
—40°	.013	.1098	.0008	44	.305	2,572	.0183
—30°	.020	.1686	0012	45	.316	2 664	.0189
—20°	.030	.2530	.0018	46	.328	2,762	.0196
—10°	.043	.3626	.00·6	47	339	2,858	.0203
				48	.351	2,960	.0210
0	.064	.5397	0 38	49	.363	3,061	.0217
1	.066	.5560	.0039	50	.375	3,162	.0225
2	.068	.5734	.0040	51	.388	3,233	.0232
3	.071	-5989	.0042	52	.401	3,457	.0240
4	.074	.6274	0044	53	.415	3,499	.0249
5	.076	.6109	.0045	54	.429	3.617	.0257
6	.079	.6660	.0047	55	.443	3,735	.0265
7	.082	.6915	.0049	56	.458	3,862	.0274
8	.085	.7168	.0051	57	.474	3,997	.0284
9	.087	.7337	.0052	59	.490	4,130	.0260
10	.090	.7590	.0054	59	.507	4,242	.0304
11	.093	.7843	.0055	60	.524	4·419	.0314
12	.096	.8096	.0057	61	·542	4·510	.0325
13	.100	.8433	.0060	62	·560	4,722	,0336
14	.104	.8773	.0062	63	·578	4,874	,0346
15	.108	.9114	.0064	64	·597	5 034	.0358
16	.112	.9446	.0067	65	·616	5 194	,0369
17	.116	.9782	.0069	66	,635	5,355	,0381
18	.120	1.120	.0072	67	,655	5,523	,0393
19	.124	1.457	.0074	68	,676	5 700	,0405
20	.129	1.878	.0077	69	.698	5,886	,0418
21	.134	1.130	.0080	70	.721	6,080	,0432
22	.139	1,172	.0083	71	·745	6.282	,0447
23	.144	1.214	.0086	72	·770	6.493	,0462
24	.150	1.265	.0090	73	.796	6,712	,0477
25	.156	1.315	.0093	74	823	6,940	,0493
26	.162	1.366	.0097	75	.851	7,176	,0510
27	.168	1.416	.0100	76	.880	7,421	,0528
28	174	1.467	.0104	77	.910	7,577	,0546
29	.180	1.51	.0108	78	.940	7,694	,0564
30	.186	1.568	.0111	79	.971	8,188	,0582
31	.193	1.620	.0115	80	1 00	8,466	,0600
				81	1.04	8,770	,0624
32	.200	1.686	.0120	82	1.07	9,023	.0642
33	.207	1.745	.0124	83	1.10	9,276	,0660
34	.214	1.804	.0128	84	1.14	9,614	,0684
35	.221	1.863	.0132	85	1.17	9 867	,0702
36	.229	1.931	.0137	86	1 21	10 29	,0726
37	.237	1.998	.0142	87	1 24	10 45	,0744
38	.245	2.066	.0147	88	1.28	10 79	,0768
39	.254	2.142	.0152	89	1.32	11 13	.0792
40	.263	2.217	.0157	90	1.36	11 46	,0816
41	.273	2.302	0163	91	1.40	11.80	,0840
42	.283	2.386	.0169	92	1.44	12.14	,0864
43	.294	2,479	.0176	93	1.48	12,48	,0888

Table Continued.

Temperature.	Force of vapour in inches of mercury.	Weight of vapour in a cubic foot of space in grains.	Depth evaporated in an hour in inches	Temperature.	Force of vapour in inches of mercury	Weight of vapour in a cubic foot of space in grains.	Depth evaporated in an hour in inches.
94	1.53	12.90	.0918	147	,87	57 33	.4122
95	1,58	13,32	,0943	148	7,05	59.45	.4250
96	1.63	13,75	,0978	149	7,23	60,97	.4339
97	1,68	14,16	,1008	150	7,42	62 57	.4152
98	1.74	14,68	,1011	151	7,61	61,14	.4560
99	1 80	15,18	,1213	152	7,81	65,26	.4686
100	1 86	15 68	,1116	153	8,01	67,33	.4806
101	1 92	16.19	,1152	154	8,20	69,15	.4920
102	1.98	16 59	,1168	155	8,40	70 81	.5010
103	2.01	17,20	,1221	156	8,60	72,52	.5160
104	2.11	17.79	,1260	157	8,81	74.29	.5280
105	2,18	19 99	,1308	158	9,02	76,06	.5112
106	2.25	18,97	,1350	159	9.24	77,92	.5544
107	2 32	19,55	,1392	160	9.40	79,77	.5670
108	2 39	20 15	,1431	161	9.63	81,63	.5808
109	2.46	20,74	.1470	162	9.91	83,57	.5943
110	2.53	21,33	,1518	163	10,15	85,59	.6090
111	2.60	21 92	,1560	164	10,41	87,79	.6246
112	2 68	22,26	.1608	165	10,68	90,08	.6418
113	2.76	23.21	,1650	166	10,96	92,42	.6576
114	2 84	23.93	.1704	167	11.25	94,87	.6750
115	2 92	24.39	.1418	168	11,54	96,98	.6924
116	3.00	25 30	,1800	169	11 83	99,76	.7098
117	3 08	25 97	,1844	170	12 13	102,29	.7311
118	3 16	26 64	,1896	171	12 43	104 82	.7458
119	3 25	27.40	,1950	172	12.73	107.35	.7638
120	3 33	28.08	,1998	173	13 02	109 80	.7832
121	3.42	28 84	,2052	174	13 32	112 33	.7992
122	3'50	29.51	,2100	175	13,62	114 80	.8172
123	3 59	29 01	,2154	176	13 92	117.39	.8352
124	3 69	31.17	,2214	177	14,22	119,92	.8532
125	3.79	31.99	,2274	178	14 52	122 45	.8618
126	3.89	32,80	,2 34	179	14 83	125 06	.8898
127	4 00	33,73	,2400	180	15,15	127.76	.9090
128	4.11	34,66	,2466	181	15 50	130.71	.9300
129	4,22	35 58	.2532	182	15 86	133.75	.9516
130	4.34	36 59	.2604	183	16.23	136.87	.9738
131	4.47	37.69	.2694	184	16,61	140 07	.9966
132	4.60	38 79	,2760	185	17,00	143.36	1 020
133	4,73	39.63	,2839	186	17,40	146 74	1.014
134	4.86	40 98	,2916	187	17 80	150.11	1.068
135	5,00	42,16	,3000	188	18.20	153.48	1.092
136	5,14	43,34	,3084	189	18,60	156 86	1,182
137	5 29	44 61	,3110	190	19,00	160 23	1.140
138	5,44	45 87	,3264	191	19,42	163.77	1.165
139	5 59	47,14	,3354	192	19.86	167.48	1.191
140	5,74	48 40	.3444	193	20.32	171 03	1.219
141	5 90	49,75	,3540	194	20,77	174.19	1.246
142	6.05	50 31	,3630	195	21,22	178.95	1.273
143	6,21	51,37	,3726	196	21,68	182.50	1.300
144	6,37	53 72	,3822	197	22,13	186 62	1 661
145	6.53	55,06	,3918	198	22,69	191 33	1.361
146	6.70	56,63	.4020	199	23,16	195 31	1 389

Table Continued.

Temperature.	Force of vapour in inches of mercury.	Weight of vapour in a cubic foot of space in grains.	Depth evaporated in an hour in inches	Temperature.	Force of vapour in inches of mercury	Weight of vapour in a cubic foot of space in grains.	Depth evaporated in an hour in inches.
200	23 61	199.36	1.418	207	27.20	229.38	1.632
201	24 12	203.41	1.447	208	27.74	233.94	1.664
202	24.61	207.54	1.476	209	28 29	238.57	1.697
203	25 10	211.67	1.506	210	28 84	243.20	1.730
204	25.61	215.97	1.536	211	29.41	248.02	1.764
205	26.13	220.36	1.567	212	30.00	253.00	1.800
206	26.66	224.83	1.599				

sides, and the top of the oven, it is not however allowed to escape till it descends to *E*, there being a similar hole on the other side. It is now compelled to pass under the oven, and from thence into the chimney *C:* so that the bottom of the oven, which is generally the hottest part in others ovens, is

Mr. Dalton has found by experiment, that the evaporating power of the atmosphere is directly as the difference between the quantity of water in a given space at the dew point, and at the temperature of the atmosphere. If for instance the dew point, found by experiment, be 42°, then the water in a cubic foot of space at this time will be found, in the third column, to be 2.38 grains. If the temperature of the air at this time be 66°, then look in the table for 66°, and in the third column will be found 5.35, the grains of water which a cubic foot of space at this temperature would contain if saturated. This shows that a cubic foot of air under such circumstances will appear to to take up 2.7 grains of water. And that if such air were made to pass through any substance to be dried, till its dew point became equal to its temperature, we should know before hand how much water would be carried off in a given time, the velocity of the current being known. It will appear from the above facts, that the artificial process of drying may be conducted in two ways; first by means of artificial heat with sufficient ventilation to carry off the vapour; or at the common temperature, when the dew point is a certain degree below the atmosphere. In this case the air would be forced through the goods to be dried by machinery.

the coldest in this; since the hot vapour does not reach it until it has given the greatest part of its heat to the top and sides. In the front section (*o*) is an opening, being the mouth of a tube fastened into an iron plate, which is seen to close the front of the under cavity. This tube proceeds in a straight direction under the bottom of the oven, the whole length; it then turns in a curve

We are indebted to the same philosopher for some experiments by which he ascertained the ratio of evaporation at different temperatures. He found from a cylindrical vessel of six inches diameter, exposed in an open window, and kept boiling, that on the average 160 grains of water were carried off in a minute. In these experiments he further ascertained, that the quantities evaporated at different temperatures in the same time, was as the force of vapour. From this circumstance he was enabled to give by calculation the quantity evaporated at different temperatures, in a given time. I find that the quantity evaporated, is also as the surface, when the temperature is uniform throughout the whole mass of liquid. Hence it is better not to take the surface into consideration, but the depth. It appears from Mr. Dalton's experiments, and from the facts derived from steam engine boilers, that about 1.8 inches of water, in depth, is carried off in an hour. The table to which we have alluded will on this consideration contain an additional column expressing the depth of water evaporated in an hour at each temperature, or under any force of vapour; supposing no water to be previously existing in the air. But since the quantity evaporated is as the force of vapour; it will be as the difference between the force at the dew point and at the temperature of the water. Hence if we wish to find the ratio of evaporation, the dew point being 40°, and the temperature of the air, or the artificial heat of the liquid be 70°: look in the table for 40° and in the fourth column will be .1330, the depth evaporated in an hour under that force of vapour. Next look for 70°, and it will be found that the depth in an hour answering to this, will be .3641. Then .3641—.1330=.2311 will be the effective depth evaporated in an hour. If the atmosphere were in a state answering to these data, it would show that the rivers and lakes would be diminished at the above rate

and comes back on the opposite side, where it terminates in the bottom of the oven, which communicates with the cavity as seen in the side section at *c*. This cavity is formed of sheet iron similar to that of which the rest of the roaster is formed. One side of it coincides with, and is attached to the inside of the wooden door *G*. A piece of thick paper steeped in pulp of clay

by evaporation. In this way it may be at any time known, not only what quantity of water is at any time contained in a given volume of air, but the rate at which evaporation is going on.

If water were presented to a perfect vacuum, the space would be instantly occupied by a quantity of aqueous vapour of an elasticity and density agreeing with its temperature. If however the temperature were suddenly increased, a fresh quantity of vapour would be formed, but it would not like the first be instantaneously dispersed, but would require a length of time proportionate to the density of that already existing in the space. The mechanical resistance of the air in the same way, but in a less degree, retards evaporation. It appears that if the vapour already in the air did not resist evaporation, the resistance of the air alone would be such as to allow the vapour to be dispersed with an equal velocity under all temperatures, because the quantity evaporated is as the force of vapour and the density, which is in the same ratio. Therefore the velocity of dispersion would be uniform, and would be about 50 inches in a minute. Since however the presence of vapour retards the evaporation as it accumulates till the dew point and the prevailing temperature are equal, the velocity of dispersion will decrease as the difference between the force of vapour, at the dew point, and at the common temperature.

Let $F=$ the force of vapour at the prevailing temperature, and (f) that of the dew point, and let U be the velocity in inches per minute, when the force of vapour is F, and no water in the atmosphere, which we have before stated to be 50 inches. Then $F : 1 :: F-f : \frac{F-f}{F}$. Hence $\frac{F-f}{F}V$ will express the velocity of dispersion under all circumstances.

In order to find the velocity in numbers, let the force of vapour at the dew point be made the numerator of a fraction, the force of vapour at the higher temperature being the denominator of the same. Subtract the fraction from unity, multiply this difference by 50 and the product will be the and water is placed between the iron and the door to prevent the latter from being injured by the heat. At the top of this cavity in the door is an aperture (*h*,) opening into the oven. The tube *p* communicates with the oven and the chimney above the damper *d*. Now it will be evident that when the door of the roaster is shut, a current of cold air will enter at *o* in the front section, and will become heated in passing along the curved tube under the oven: it will then enter the cavity *c* in the door *G*, and pass out at the hole *h* into the roaster, and from thence through the pipe *P* into the chimney, to the draught of which it owes its motion. This contrivance has two great advantages.—Its heat is sufficient to have a great effect upon the substances to be baked or roasted, and contributes to the crusty brown so generally liked. Its greatest advantage however consists in carrying off the disagreeable smell complained of when meat is roasted in a common oven. *A* is a register door opening into the ash pit, *D* the door for the fuel, beyond this is a second door which opens by a hook attached to the first door.

Opposite to the cavity on each side, and the cavity under the roaster, are square stones fitted into the wall, which have an iron ring in the middle in order to be occasionally

velocity in inches per minute. Suppose the dew point at 40° and the temperature of the air 60° Then the force of vapour at 40° being .263 and at 60.524 we get $1-\frac{.263}{.524}=\frac{261}{524}$ and $50\times\frac{261}{524}=24.9$ inches per minute, the velocity of dispersion. If the latter, in feet, be multiplied by the evaporating surface in the same, and this be multiplied by the time in minutes, it will give the volume carried off in this time. This last multiplied by the weight of a cubic foot of vapour at 60, will give the weight of vapour carried off in this time.

removed for raking out the soot and ashes. This last operation is not required very often: the top and sides which would soon become clogged with soot, are raked very frequently by another contrivance, which we can better describe then represent in the Plate. In the front section, suppose the dark space *S* which surrounds the roaster, to be a piece of sheet iron capable of being moved backward and forward by means of a rod of iron fastened into the middle of that part which fits the cavity at the top of the roaster, and projecting to the front like the rod of the damper *d*, in the side section. It will be evident that a rake of this form will by its motion completely scrape the top and sides of the roaster, an operation frequently necessary. This rake brings the soot to the bottom of the cavities, which when accumulated to a certain extent, requires to be withdrawn at the openings occupied by the stone plugs above alluded to. The small roaster mentioned above is precisely on the same construction as the large one.

The steaming apparatus which we have alluded to, occupies a recess in the wall similar to that used for the common stew hearth. In this recess there is a horizontal square plate of cast iron surrounded by a groove, and having a hole in the middle connected with a steam pipe provided with a stop cock, the opening of which is adjusted by a scale and index. The plate has been called a steam table, the size, reckoning to the groove by which it is surrounded, is 2 feet 9 inches by 2 feet 6 inches. The groove is for the reception of an inverted

Thus 24.9 inches, or 2.75 feet, multiplied by 4.19 the weight of a cubic foot of vapour at 60°, will give 11.52 grains; the weight carried off in one minute.

tin vessel in the form of a dish cover. This is so suspended that by a handle in the front it can be raised and thrown back at the same time, so as to clear the table for the purpose of placing the dishes to be steamed. The groove which receives the edge of the cover would overflow by the condensation of the steam, but an outlet is made a little short of the top, through a hollow plug to allow the excess of water to run off while the process is going on. That water which remains in the groove keeps the vessel steam tight, so that no steam is seen to escape during the steaming. It is afterwards let out by lifting up the plug.

The vessels to contain the substances to be steamed, which merely require to be placed on the table, are generally of tin perforated with holes like a cullender, in order to admit the steam freely on every side.

The Scullery

Which is immediately adjacent to the kitchen, contains three boilers heated by steam, two of these are occasionally used for making soup, and the other is merely for the purpose of making milk porridge. The milk is heated by steam passing immediately into it. The temperature is a little less than 212°. but is sufficient to effect the union of the oatmeal with the milk, and without the risk of burning it, which produces the odour under which the porridge is said to be bishoped. The stop cock admitting the steam,

is provided with a scale and index, in order to regulate the quantity of steam to be admitted.

In one corner of the scullery and near the top, is placed a cylindric vessel of cast metel, which supplies the scullery with hot water. This vessel is provided with two bottoms, having a separation of about three inches between them. Above the upper bottom, the water is conveyed into the space between the two, the steam has access by a steam pipe coming from the boiler of the steam engine. The steam which condenses in this space, heats the water above. When any hot water is drawn from this vessel, the upper surface on falling, gives motion to the lever of a ball cock, and lets as much cold water in to supply its place. This useful source of hot water therefore requires no care in keeping it hot and constantly full.

Mr. W. Strutt in consequence of inconvenience experienced by the defective construction and arrangement of a similar boiler in his own house, has been induced to substitute another, which is greatly improved. The feeding valve was subject to disorder, which produced great inconvenience; and the drawing off cock being some yards distant from the vessel, as much cold water as filled the whole length of the pipe had first to be drawn off, mixing with and cooling the remainder. For this purpose he procured a cylindrical cast iron vessel, *A*, *B*, Plate 4, *Fig.* 2, twenty-four inches in diameter, and fourteen inches deep within, perfectly water tight; a pipe, *C*, *D*, entering this vessel close at the bottom at *C*, but without any valve or cock. This is connected with a large cold water reservoir *R*, the bottom of which must be higher than the top of this vessel; and from the top of this vessel, a pipe, *t*, no matter how small, must be carried as high as the top of the cold water reservoir; and to prevent water from being thrown out of this pipe by undulation, caused by disengaged air or otherwise, its upper end opens like a funnel. This vessel thus becomes a part of the water reservoir, however distant it may be, and will always be full so long as any water remains in the reservoir.

Middle or Principal Story.

As this story is principally devoted to the household part of this establishment. It will not be necessary to give more respecting it, then is stated in the plan, Plate, 0. The water closets on this story are for the sole use of this part, but we shall describe them in treating of the upper story; those for the use of the patients being on the same construction.

Two cast iron cylinders, *G*, *H*, each two inches deep, and of a diameter as large as the hot water reservoir will admit with ease, are connected together by a pipe *P*, at the centre, separating them to the distance of two inches, and passing upwards, just through the bottom of the uppermost cylinder, and the upper side of the lowermost cylinder, which lowermost cylinder is supported upon three legs, *l*, *l*, *l*. At the distance of two inches from the bottom of the cold water reservoir a pipe *Q* is so contrived as to connect the uppermost of these two cylinders with a steam boiler passing through the side of the hot water reservoir, but having no other connection with it. In like manner, a pipe *W* proceeds from the lower vessel close to the bottom, which pipe, after it has passed through the side of the reservoir, is arched like a syphon to prevent the discharge of any water till the cylinder is full. The hot water reservoir is thus divided into three compartments: one between the two cylinders, one below, and another above. Lastly, into the compartment *M* is inserted a pipe *u*, through the side of the reservoir which is continued to the centre of it, where it is turned up, so that its mouth, which is bell-mouthed, is parallel to and within about half an inch of the top of the reservoir.

The operation of the apparatus so constructed is this: the hot water reservoir suppose now to be full of cold water, and the steam let into the upper cylinder, then empty, by a stop cock, it immediately begins to condense, communicating its heat to all parts of the cylinder, and through it to the surrounding water. That part of it which lies immediately upon the lid or

It may here be proper to explain the uses of the two perpendicular funnels on the right of the water closets. The first funnel, 1, commences in this story by a sliding door, which can be closed and opened to any degree; and terminates in a horizontal hot air flue in the story above. The

top of this cylinder having its specific gravity lessened, begins to ascend and is replaced by the other cooler water above the lid, in succession till the whole is nearly boiling hot, but very little of the water touching the bottom and sides of the cylinder is displaced, and water being a bad conductor of heat, a thin stratum only of water, nearly boiling hot, surrounds the other parts of the cylinder. In the meantime the water condensed from the steam in the upper cylinder has descended into the lower one, communicating all its remaining heat to the water surrounding it. When the steam ceases to be condensed in the upper vessel, it passes into the lower one communicating its heat to its contents, till it also, and the water external to the upper side of the cylinder is boiling hot. The water is then driven through a syphon like pipe, *W*, boiling hot; after which follows pure steam, which must be shut off by the stop cock. The distilled water is received into another small reservoir, and may be used either as boiling water for common purposes wholly, or in part, or reserved for any of the purposes for which distilled water may be wanted.

The upper compartment being rather more than three inches deep holds upwards of five gallons; this is heated nearly boiling hot in a short time after the steam is let in by an inch pipe, the water of the other part of the reservoir remaining cold.

The cold water which supplies the place of that drawn off, does not at all cool that which is next to be drawn off, but gradually receives heat as it ascends.

The reservoir being surrounded by nonconducting substances, and enclosed in a wooden case, preserves the water sufficiently hot for all purposes from the afternoon of one day to the forenoon of the next, when it is usually wanted, without any application of steam in the interval.

The whole being of iron, and there being no valve or cock, or any thing that moves, in or about the apparatus itself, it does not appear when and how it can be out of order, if well put together.

use of this is to allow the excess of hot air to escape, which the rooms above do not require, or which would make them too hot. In this case the hot air is forced down the perpendicular funnel into the middle story. Without this outlet the current of cold air to the stove would be interrupted, and the cockle would very soon become red-hot, which would not only injure the air, but very soon destroy the iron by oxydation.

The second funnel has a similar entrance from this story, and terminates in the roof which is common to the upper turn-cap. This serves to dispose of the air which may be forced down the last mentioned funnel as well as for the complete ventilation of the hall.

At *A*, a section of the perpendicular funnel is seen which brings the hot air from the stove below; this terminates in the horizontal hot air flues in the upper story marked by dotted lines.

The Upper or Attic Story.

The great staircase leads from the middle story to the gallery *G, G, G, G,* which occupies three sides of the hall and communicates with the convalescent rooms and the sleeping rooms. The operation room separates the mens' sides from the womens'. The rooms 3, 4, 5, 6, 7, 8, and 9, on each side, are similar in every respect; these are for the reception of patients in various stages of accute diseases. In most other Infirmaries the want of this still retirement for patients

suffering acute pain, is an evil which cannot be fully appreciated, but by witnessing the benefits of these apartments.

16 is a small room containing a wooden cistern lined with lead, with a steam pipe and a pipe for cold water opening into it.

It is employed as a bath; and can be used at pleasure as a cold or hot bath, or even as a vapour bath.

The bed-steads in the wards are of wrought iron, and with some advantages in their construction, particularly in that part where the sacking bottom is fastened to the iron frame. On each side of the longest sides of the frame, a slip of iron is fastened by screws to the inside of the same, and the edges of the sacking held tight between the iron surfaces, in the manner of a common smith's vice.

Several instances had occurred in which patients had suffered much pain from not being capable of turning in bed, nor of being moved by the nurses without giving great pain. This induced W. Strutt, Esq. to contrive a bed capable of being turned by machinery into various positions, without giving pain to, and almost without the knowledge of the patient. This contrivance is explained in Plate 7, Fig. 6, 7, and 8. Fig. 6 is a side view of this bed; *g, g, h, h,* the side bars to which the sacking bottom is attached. This is shown in the section, Fig. 8; *a, a, b, b,* the sacking. The ends of the bars are seen at *g, h,* and are joined to the parts *a, c, f, e.* Fig 7, which is the end view; *b* is the point of suspension of the moveable part *b, a, f, e, c,* which is attached to the upright supporters *P, m.* It is moved by the toothed wheel working in the rack *l, l*; *k* is a catch which is forced by a spring upon the rachet teeth to keep the bed in any desired position

The bed and the clothes are placed in the recess *S*, Fig. 8, and the motion of the bed upon the centre *b*, in Figs. 6 and 7, is to put the plane, *S*, more or less out of its horizontal position. This bed has been very much approved, and doubtless would be an acquisition to every similar establishment.

The Water Closet.

The situation of these conveniences will be observed at number 7, 12, and 23, in Plate 10; but a more complete representation of them will be found in Plate 5. The superiority of this water closet above all others, is in its preventing any smell, without the least care of the person using it. The person who enters it fills it with fresh air, which is left behind on coming out. The manner in which this is effected we shall now explain by referring to Plate 5. Fig. 1, is a plan of the water closet; *E* the entrance into the first part; *D* is a door attached to and turning upon the arbour *H*; *B* is a bar of wood inserted into the same, and having the same radius with the door. By pushing against the door *D*, which from top to bottom fits the concave cylindric space, the air is driven before and escapes at the ceiling over the seat *S*; by this motion the door is brought up to the wooden division *C*, and the end of the bar *B*, is brought to the point *p*. *O* is a small closet made for the purpose of reducing the space in front of the seat to what is sufficient room. When the person returns he is is obliged to push the bar *B*, which

now is in the position *H P*, before him, till he brings it close against the other side of *C*. During the returning motion one of the pannels of the door is made a valve, and opens inwards and lets in fresh air to supply the place of that driven out by entering the closet see *P*, Fig. 2. At one particular point in returning, the arbour *H* gives motion to certain machinery which lets the water through the seat in the same manner as in the common water closet. Indeed the seat part of this is in every respect the same as those invented by Bramah, in which the water is made to flow by raising a lever. The construction of this part is shown in Fig. 2. The harbour *H* by its motion carries round the wheel *t*, *e*, which in entering the closet does not act upon the lever *I*, but raises on its return and opens the valve *v*, which allows the water above to descend through the seat *S*. It will be seen by examining the wheel *t*, *c*, which is better seen in the perspective sketch on the left, how it affects the lever on its return only. The part *e*, to a certain extent, towards *t*, is a steel spring which bends upwards, so that if the wheel be moving from *t* towards *c*, the part *e* will go over the pulley *r*, and when it gets to the protuberance at *t*, the lever *l* will be pulled down, the valve *v* raised, and the water will flow till the protuberance at *t* passes over. When the closet is entered, the opposite side of the wheel passes under the pulley *r*, and moving from *t* to *c*, the spring is bent downwards and the lever *L* is not acted upon.

The cylindrical cavity is formed of brick-work, and plastered inside. The plaster while wet is scraped by the door, which gives it its proper cylindric shape.

o

APPENDIX.

THE earliest method employed by man for producing artificial heat, in climates where the natural heat was insufficient, must have been from fires made in the open air, as at present practised by savage nations.

A current of heated air is by this means produced perpendicularly upwards, and its place is instantly supplied by a lateral current of cold air in all directions towards the fire.

The benefit derived from such fires, is from the radiant heat only; as the air by which it is surrounded must be nearly of the same temperature as if no fire existed; and being constantly changed, must have a cooling effect upon those standing round the fire; much greater than if the air had remained undisturbed.

Hence it is impracticable to be thoroughly warmed by such a fire, except by turning round, to expose the different parts of the body in succession.

The bad effects of being exposed to such an inequality of temperature are well known to all who have occasionally been exposed to fires in the open air.

The first improvement which would suggest itself, would be to remedy the inconvenience of the lateral current by surrounding the fire with a wall of the best materials they could procure; and the next stage of advancement would be to make a roof, leaving the smoke to escape at the common entrance, or at an opening in the middle of the roof over the fire.

This improvement would not consist merely in preventing the lateral current of cold air, tending to rush in on every side. The surrounding wall would become heated by the rays from the fire, and, in consequence, would cause the same heat to radiate back, towards the fire. Still the same evil would prevail, which we, even in the present times, experience, namely the current of cold air, which must of necessity be supplied for the combustion of the fuel.

The invention of the grate and the chimney seems to be the only improvement which has been made to this rude manner of artificial warming. We are still warmed principally by the radient heat from the burning materials, while we are cooled by the current of cold air, which must necessarily come to the fire, as fire-places are at present constructed. If the cold current could be obviated, which in some instances has been effected, still the part exposed to the radiant heat must be so differently affected, to that on the opposite side, as materially to affect the health of those exposed; and such effects can be only imperfectly obviated by additional clothing, or by making rooms so close as to become unhealthy in other respects, and at the same time pre-

vent the fire from burning.

It will be admitted by all in the least acquainted with the human economy, that when we require artificial heat, it should be applied in the most equable manner, and not in the way we receive it from a common fire.

There is no means of doing this effectually but by our being surrounded by a medium of uniform temperature; and what can be so proper as the air we breath? We ought to have the benefit of its temperature and its oxygen at the same time, and then it should be changed to give place to fresh air, supplying additional heat and oxygen.*

When after being exposed to cold, we enter a room, the air of which is moderately and uniformly warmed, all parts of the body become equally affected by it; and in all probability, if we could always be so accommodated, those affections called colds, so common in this country, would seldom occur.

* It may appear absurd to say, that no hot-blooded animal immediately receives heat from the air at the ordinary temperature, nor even in the hottest season of the year. This apparent anomaly, however, will soon vanish when we recollect, that the air, even under a vertical sun, is seldom, if ever, equal to the temperature of animal heat; and at the same time, taking another fact along with it, namely, that a body never gives heat to another of a greater temperature than its own.

The heat of animals is derived from their own economy, independently of surrounding bodies. It is to the relative rates at which their native heat is separated from them by the surrounding air that we owe our sensations of heat and cold. In the process of life, animals seem to appropriate the latent heat of the air, and to give it back to the atmosphere in the state of sensible heat, as may be observed in every crowded room.

It is wonderful that so many inconveniences resulting from our present method of warming rooms, should not have called forth greater improvements. In all situations where human beings are exposed for a length of time, without exercise, they should be surrounded by air at a temperature not less than 60°. In every dwelling house properly constructed, this object may be attained with less expense than the common method of warming rooms, setting aside the great advantage of being exposed to an equable temperature, and avoiding the bad effects of the radiant heat of open fires.

Our being constantly surrounded by air, makes it difficult to conceive how we should be affected without it, supposing it unnecessary as a medium for respiration.

When we are surrounded with air which is not in motion, its little tendency to conduct heat, keeps us warm by our natural heat being accumulated. But when exposed to air in motion, it becomes the means of carrying off our heat, as we experience by the refreshing breezes in summer.

The pleasurable feeling we experience in a temperature of about 60° with a moderate breeze of fresh air, is during that uniform abstraction of native heat, which leaves no sensation of heat or cold. This temperature will vary with different people, and with the quantity and nature of our clothing.

If we were surrounded by a much denser fluid than air, we should experience much greater inconvenience by change of temperature. In the air, we can bear to be exposed, for some time, to a degree of cold which would congeal mercury, as is experienced by the inhabitants of high latitudes in winter.

And we have many facts on record which shew, that life may be supported, for some time, in a temperature above that of boiling water. To be surrounded with water at 32° would be intolerable; even at 80 degrees it feels so cold as to give a shock on plunging into it. On the other hand, when it gets above 100° it becomes unpleasantly warm, and life would soon be destroyed in water at 120°.

This arises from the water being so much better a conductor of heat than the air. If exposed to mercury, which is a better conductor of heat than water, we should find the range of temperature, that we could bear, much more limited.

Hence it appears, that the air is almost as essential to us in producing equalization of temperature, as it is for respiration. In the middle of the day, when we should be much annoyed by the radiant heat of the sun, the air and moisture diffuses the temperature through the atmosphere. This heat is returned to us during the night, to supply that which is radiated from the earth into space. If the earth were a better conductor of heat, equal, for instance, to that of metal, the excesses of heat and cold at different times would be obviated. The earth, as a reservoir of heat, contributes greatly to this effect, absorbing the excess accumulated during the day, and giving it back in the night. Independently of this, we owe very much to the equalizing agency of the atmosphere. During the night, when no radiant heat comes from the sun, but on the contrary, is radiated from the earth, every substance, in proportion as it is detached from the earth, would have its warmth carried off by radiation, faster than it could recover it from the earth; as is the case with most slender vegetables, such as blades of grass: they are frequently covered with ice, while bodies more connected with the earth, have not been as low as the freezing point by many degrees. It will also be found that a brisk wind has a similar effect in restoring the heat which bodies lose by radiation in the night.—*See Dr. Wells, on Dew.*

Hence we see that the most effectual means of applying external heat to animals and vegetables, for the purpose of keeping up their natural temperature, is by making the air the vehicle of the heat, and more especially for animals; since the same change of air is essential to them as a respirable medium also.

In polar climates, where the temperature of the air is sometimes as low as 50° below the freezing point of water, it would be of particular importance to warm apartments by heated air; but from what has been observed in a former part of this work, advantage may be taken of the earth's temperature, for this purpose.

At a very little depth below the surface of the earth, in all countries, the earth is of the average temperature of the climate, as may be ascertained by the temperature of springs. It will hence appear, that if the air which is requisite to supply a house in the winter of cold countries, were made to pass along a subterraneous cavity, it would become considerably warmed. It has been found by experiment, that a passage of two hundred feet in length, has had the effect of warming the air of the atmosphete passing through it, to

much above the arithmetical mean between the outer air and that of the earth. Such a provision, aided by the power of two turncaps, as we have shown in another part of this work, would be the means of increasing the comfort of dwellings, in countries where severe and long winters are experienced. The same advantages would apply to the cooling of apartments in hot countries. The air, which is sometimes heated to 100° might easily be cooled down to 80° by passing through a tunnel at a considerable depth.

For this purpose it would be necessary to use other means besides the turncaps, to induce a strong current through the building. The doors and windows should be closed; the cold air tunnel should communicate with the lowest story, and the air made to pass through all the rooms, the inlets being at the bottom of the rooms, and the outlets in the ceiling, through which the air should pass into the roof. The roof should be formed of metal, such as sheet copper, and be japaned black. The turncap here should be placed at the top of a shaft or column about ten feet higher than the house, with a vane to keep its mouth to leeward. The outer turncap should not be elevated higher than would be necessary to insure the action of the wind upon it, and its mouth should be exposed to the wind.

The Pauper Lunatic Asylum, at Wakefield, not being finished till the body of this work was printed, it may be proper, here, to say something slightly descriptive of that establishment. This will not only tend to confirm the practicability of what has been detailed respecting the Derbyshire General Infirmary, but it will abundantly show the progressive improvement we may expect, as these useful inventions become more extended.

This building is in the form of the capital letter H a little shortened, the galleries running the whole length of each line, in three directions, from the intersecting points, the bed rooms being contiguous, and opening into the same. These galleries are ten feet wide, and each bed room is seven and a half by six and a half feet. The two principal staircases are in the intersections of the galleries, and are contained in a cylindrical space, with a single entrance at the landing, to each story, by which they are completely detached from the galleries.

The building consists of three stories; and the separation of the male from the female division, is in the middle of the long gallery which unites the two sides of the H. Under each of the staircases, and the middle part of the building, there is a cellar story, in which the steam boiler and one of the stoves are placed.

The stoves are fixed directly under the principal staircases, that on the male side being twenty-five feet below the basement story, the other twelve feet below the same.

Two cold air flues are brought from the external air, directly to the level on which the stoves are placed. The entrances to these flues on the outside, are from two round towers in the walls of the airing grounds. On the top of each tower, is a turncap similar to that already described, by which the air is always forced into the flue with the velocity of the wind.

After the air has passed through the stove, in the way explained in the former part of this work, it passes from the air chamber horizontally to perpendicular flues in the wall which surrounds the staircase. These flues are distinct for each story, and have outlets on all sides of the circular wall, from which the warm air is supplied with such velocity as to pervade the whole extent of each gallery.

There are openings from the galleries over each door of the bed rooms, by which the latter are kept at the uniform temperature of the galleries. From the bottom of each bed room rises a perpendicular flue, which terminates in the roof of the building. There are two openings into each of these flues, one at the bottom of the room, and the other at the ceiling, the former is for the outlet in the winter season; the latter, with a view to promote an increased ventilation, is kept open during the summer; the air then escapes at a turncap in the roof, similar to that at the Derbyshire General Infirmary. To give some idea of the merits of this system of ventilation, the following particulars are stated: When the stoves are in full action, the air, on the average, moves with the velocity of five feet in a second; the area of each of the main flues is twelve feet, which gives 120 cubic feet, the quantity which passes through the whole house in every second. Supposing the whole cubic content to be 400,000 cubic feet, the whole of the air will be changed in a little less than every hour.

In the summer season, when there is no fire in the stoves, the ventilation goes on through the very same channels as in winter. The outlets at the ceiling are now opened, and this, with the assistance of the turncap, will at all times insure a perfect ventilation. The air being cooled to a certain degree, by its passage through the cold air flue.

Much manual labour is saved in this establishment by a steam engine of two horse power, erected by Messrs. Fenton, Murray, and Wood, of Leeds. It is employed for pumping the water, and performs the labour of washing, and mangling linen. The steam boiler is of much larger size than is required for the engine, in order to supply the kitchen, and baths, and to heat water in different parts of the building.

The male and female departments have each a separate kitchen of the same size, and fitted up similarly.

In each there is a steaming table, two roasters, and two soup boilers, heated by steam. In the scullery is a hot water vessel, on the improved plan, as seen in plate IV, figure 2, and described in page 43. These vessels are constantly full of water, which is heated by steam during the day, when the boiler is used for other purposes. And the temperature of the water is so preserved as to be sufficiently hot every morning. The steam condensed in this process produces a considerable quantity of distilled water, which is found a great convenience.

The wash house is doubtless the most complete at present known; its only defect is that of being too small. A washing machine is on the same principle with that already described, with some improvements. It is turned by the steam engine, and may be said to perform 9-10ths. of the labour of washing.

A spacious rain water tank is contiguous to the wash house, from which an elevated cistern is supplied, and constantly kept full, by a small pump, fixed under the floor, and worked by the same shaft which turns the washing machine. A hot water vessel is connected with the above rain water cistern, similar to those in the sculleries. Pipes are carried from these vessels, and terminate in a set of stop cocks, arranged over a stone bench on which the wash tubs stand. These tubs can therefore be supplied with any proportion of hot or cold water, without the operation of lading, and the same can be discharged by a moveable plug in the bottom of each tub.

In the middle of the wash house is placed a large vessel, in which the linen is boiled by steam. During this operation, the vessel is made close by a copper cover suspended over it, and counterpoised so as to be easily moved up and down by the hand.

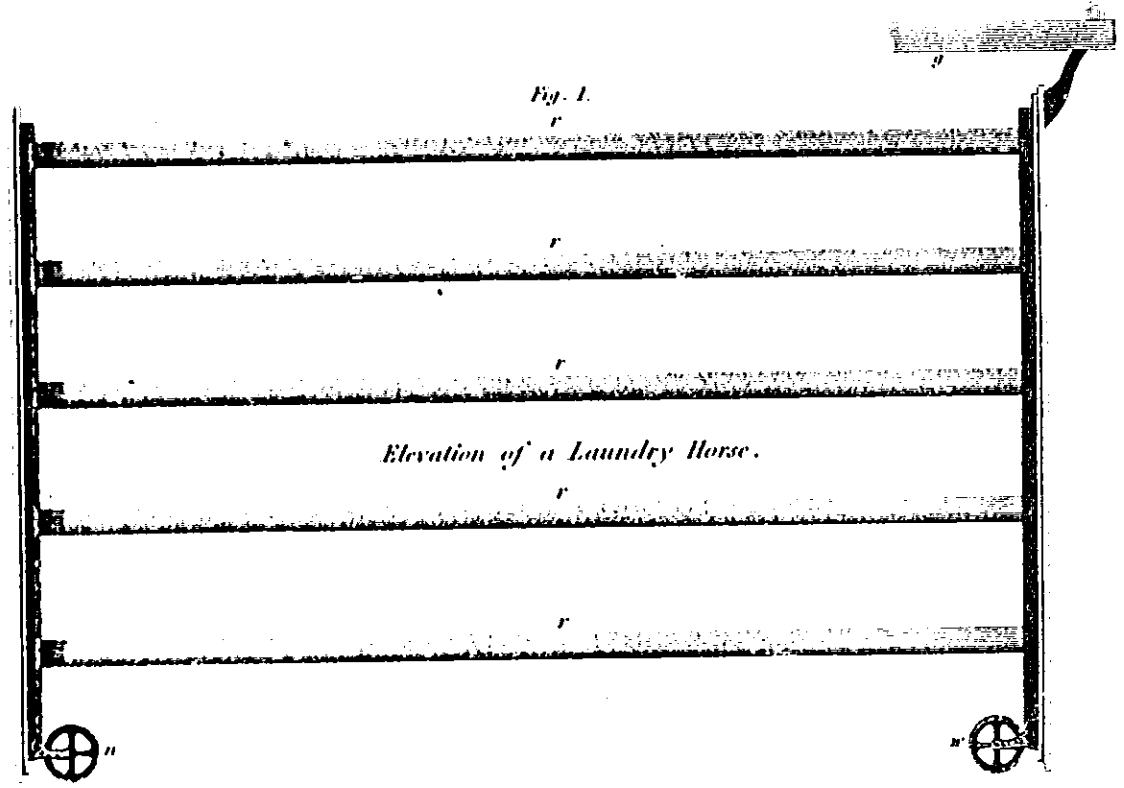
Since the time the wash house of the Derbyshire General Infirmary was fitted up, William Strutt, Esq. has invented a machine to discharge the water from wet linen, in a manner very superior to the common mode of wringing. The linen is placed in a square bag of strong sacking, kept open by wire rings; this bag is contained in a cast iron box, which opens on one side to admit the linen, and then closes firmly. The interior surface of the box is grooved to receive the water when pressed out. The pressure is applied by means of a sliding plate which fits the box, and is forced against the end of the bag by a rack and pinion, and turned by a winch. The sides of the box prevent the bag from becoming wider; the pressure applied has therefore the effect of shortening the bag, till all the water is pressed out into the grooves. By this machine the clothes are squeezed much drier, than by the common method, and the pressure upon all parts being uniform, less injury is done to the texture of the linen.

The laundry is similar to that at the Derbyshire General Infirmary, with the addition of machinery for turning the mangle, by which much labour is saved. A separate hot closet is here fitted up with two sliding horses, similar to those in the laundry of the Derbyshire General Infirmary, employed solely for the purpose of drying and airing beds.

A particular description of this establishment, with plans and sections of the building, is now publishing by Mr. Pritchett, of York.

FINIS.

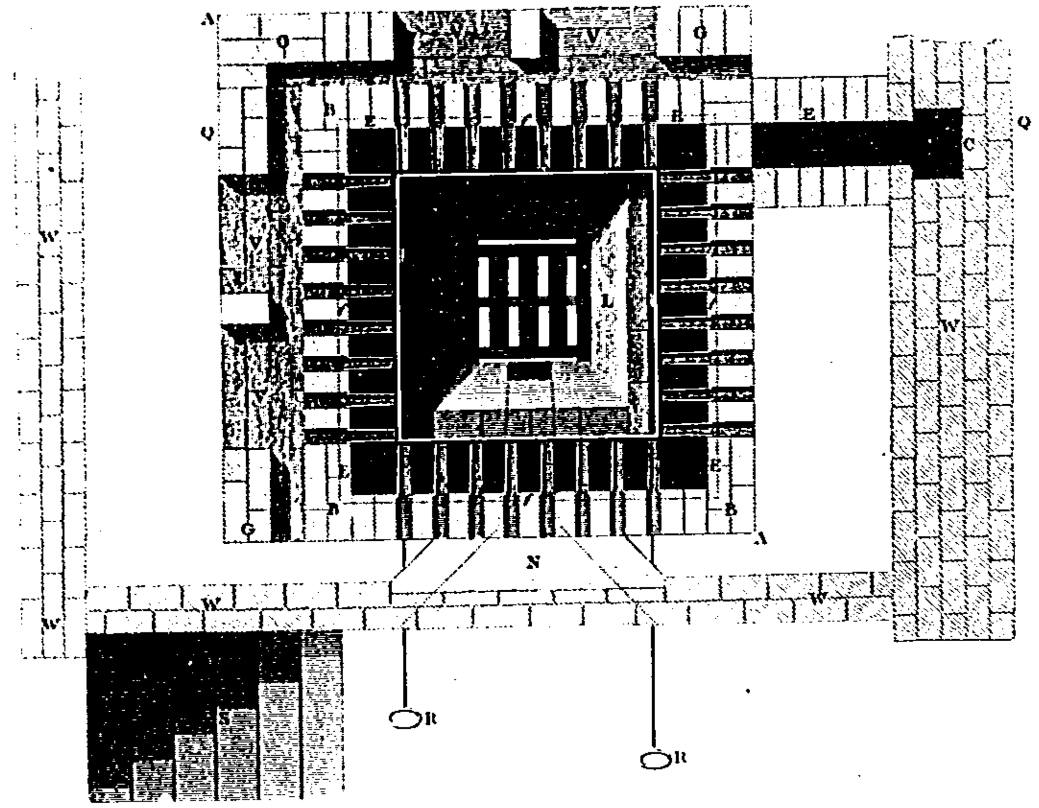
Fig. 1.



Elevation of a Laundry Horse.

Plan of the Hot Air Stove.

Fig. 2.



Published as the Act directs, 1818, by Longman, Hurst, Rees, Orme & Brown, Paternoster Row.

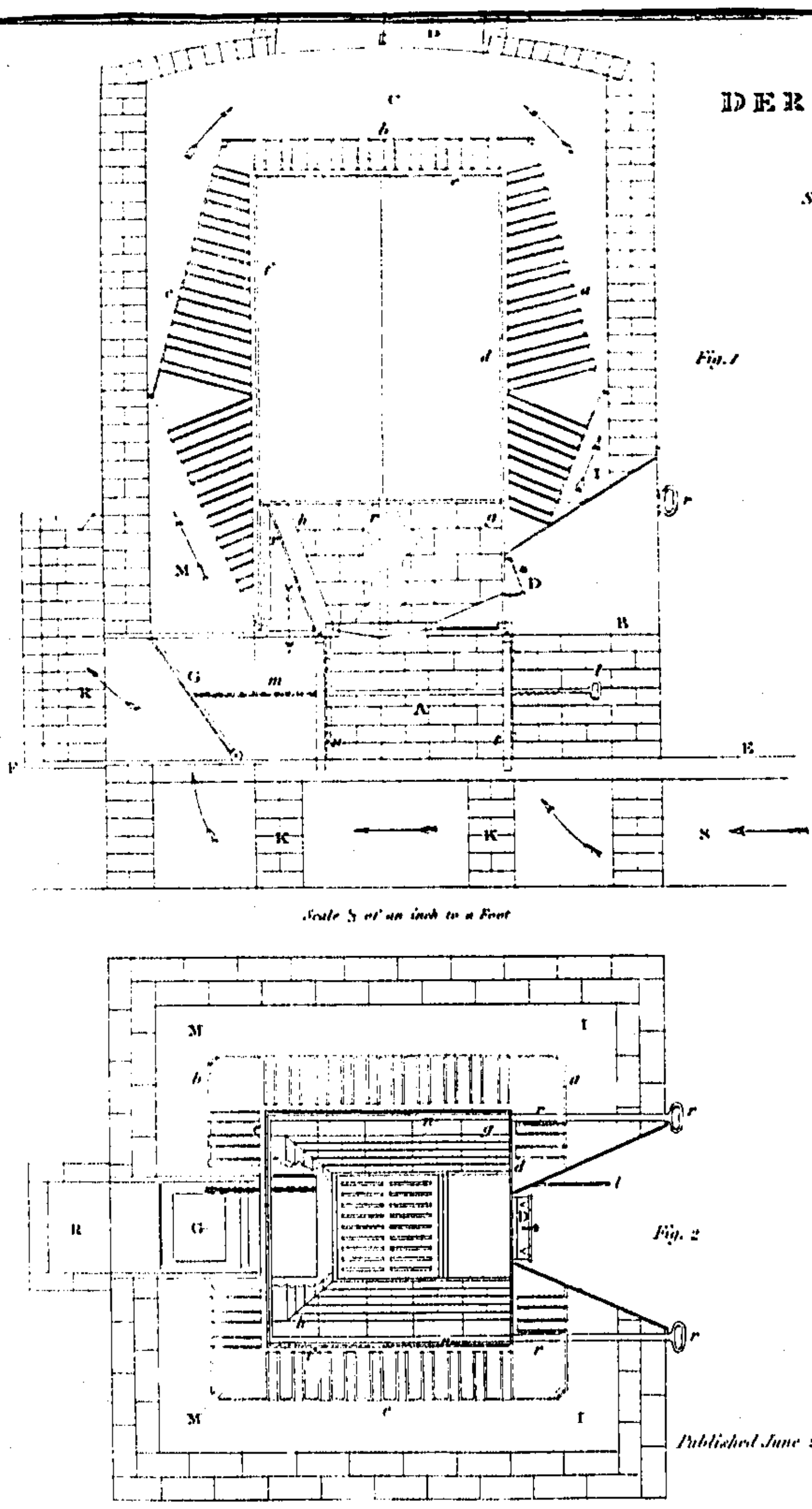
DERBY INFIRMARY.

PLATE II.

SECTION of the HOT AIR STOVE.
The Plan in Plate 1 Fig. 2.

Fig. 1

Fig. 2



Scale ⅜ of an inch to a Foot

Fig. 3

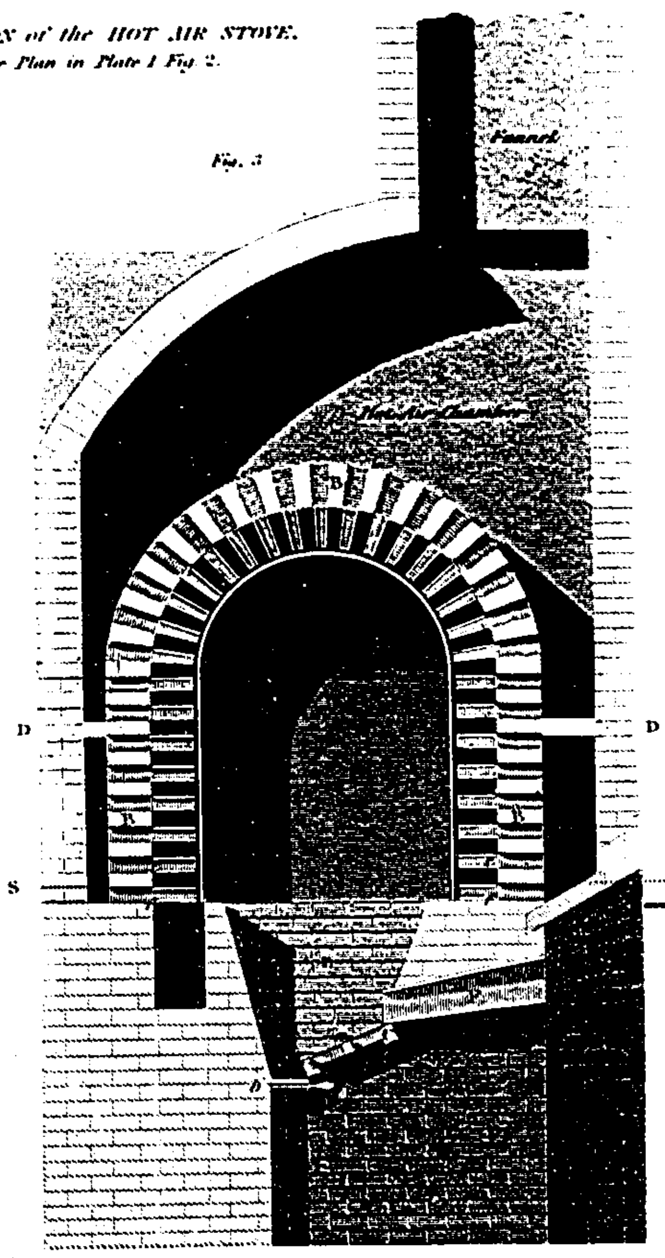
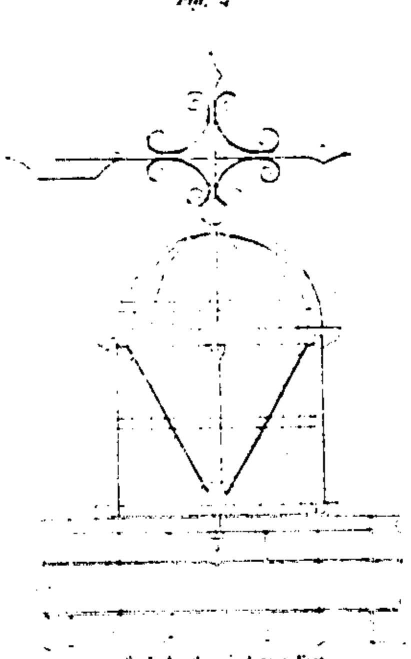


Fig. 4



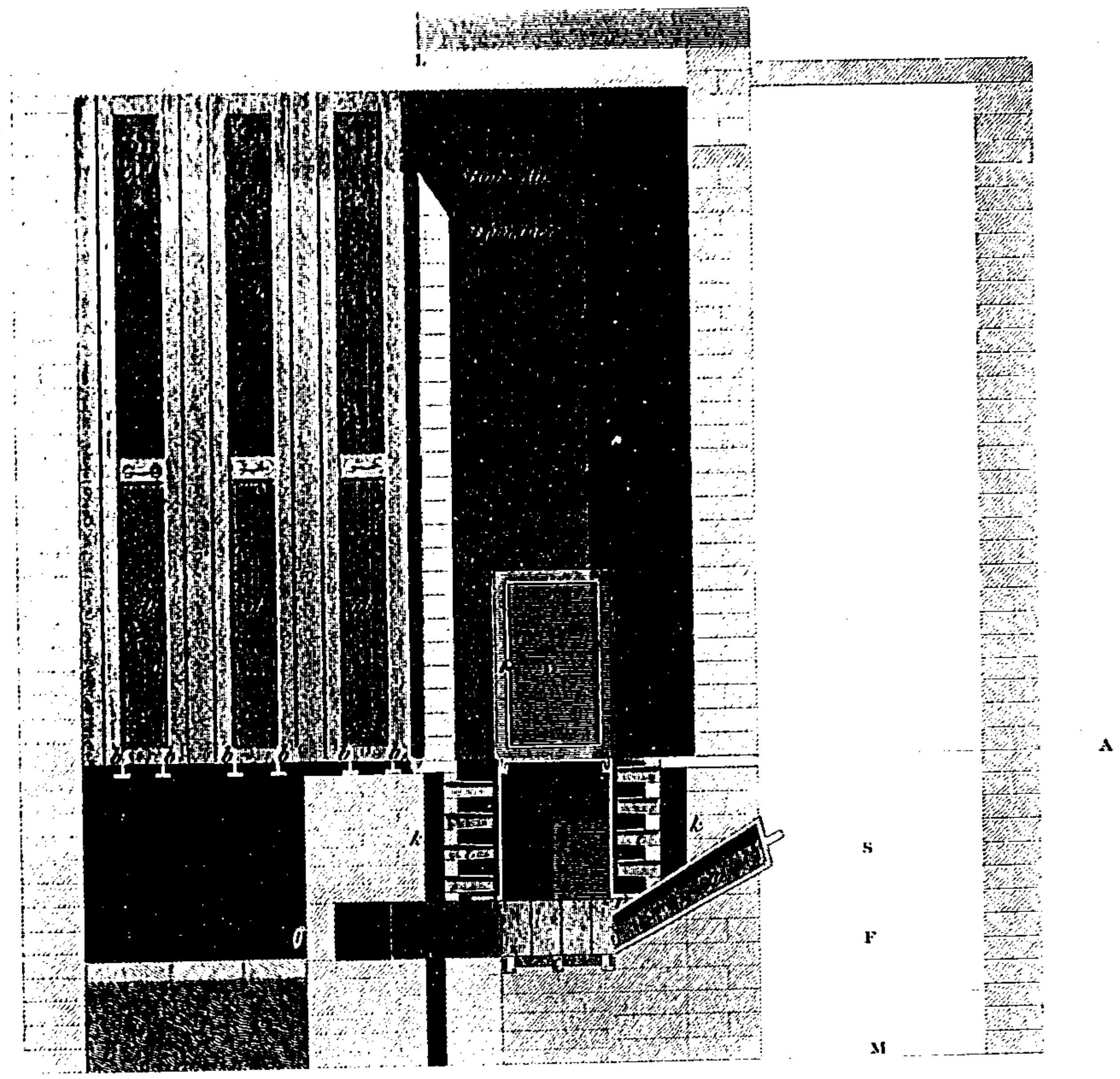
Scale ⅜ of an inch to a Foot

Published June 2, 1818, by Longman, Hurst, Rees, Orme & Brown.

Lowry sculp.

PLATE III.

DERBY INFIRMARY.



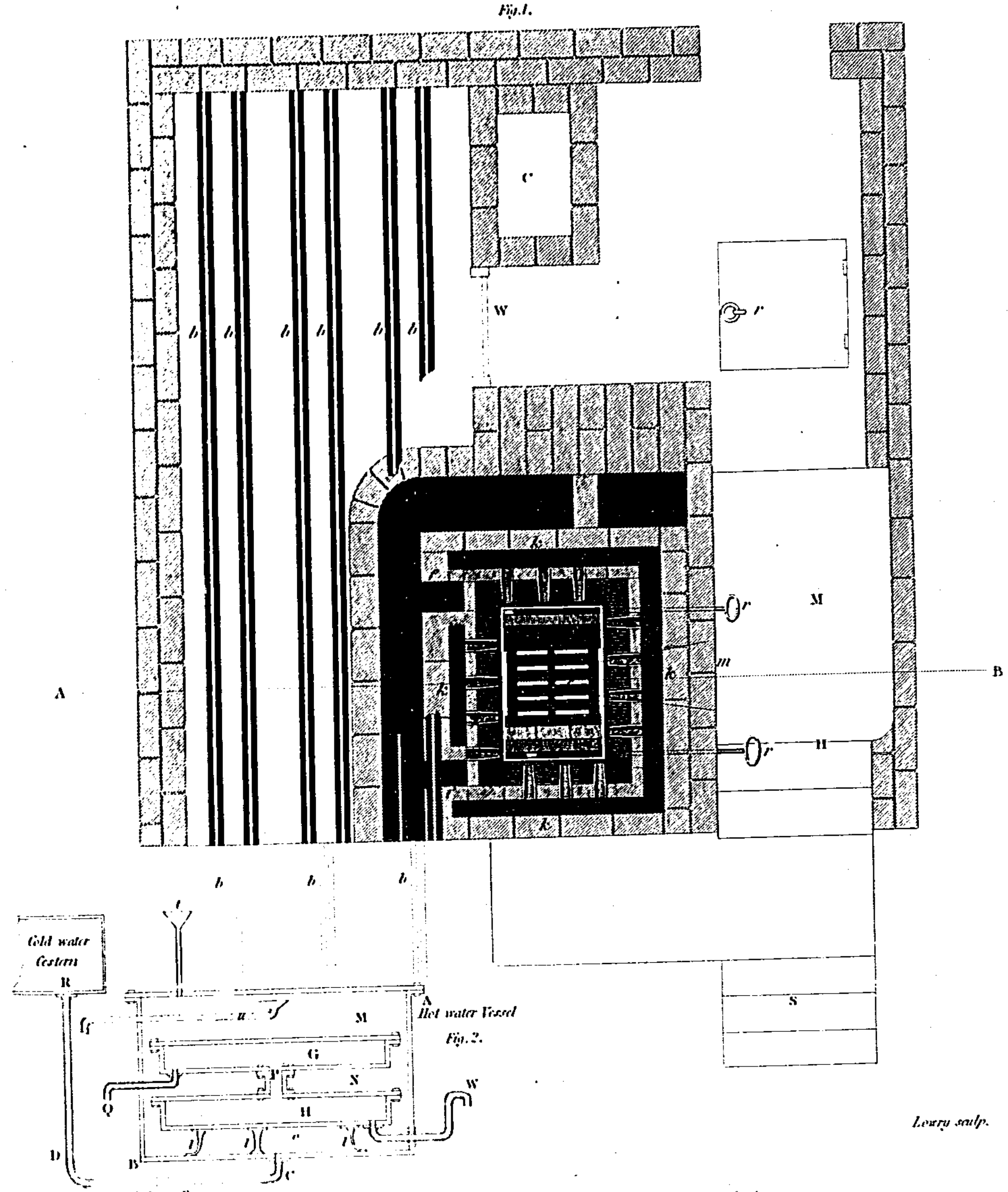
Published June 21, 1818 by Longman, Hurst, Rees, Orme & Brown.

Lowry sculp.

DERBY INFIRMARY.

PLAN OF THE LAUNDRY.

Fig. 1.



Scale 1 inch to 4 Feet

Lowry sculp.

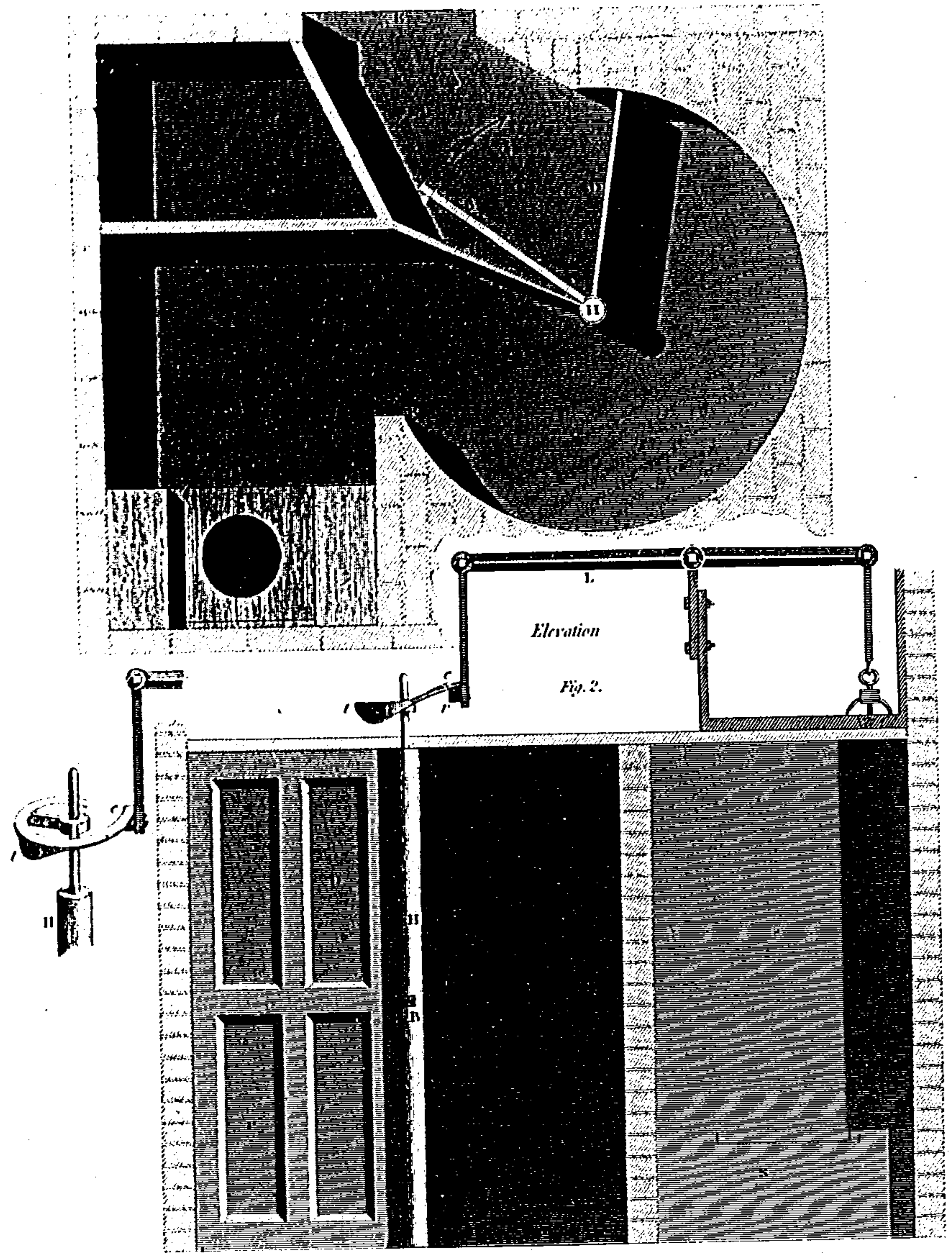
Published as the Act directs, 1818, by Longman, Hurst, Rees, Orme, & Brown, Paternoster Row, London.

DERBY INFIRMARY.

WATER CLOSET.

PLATE V.

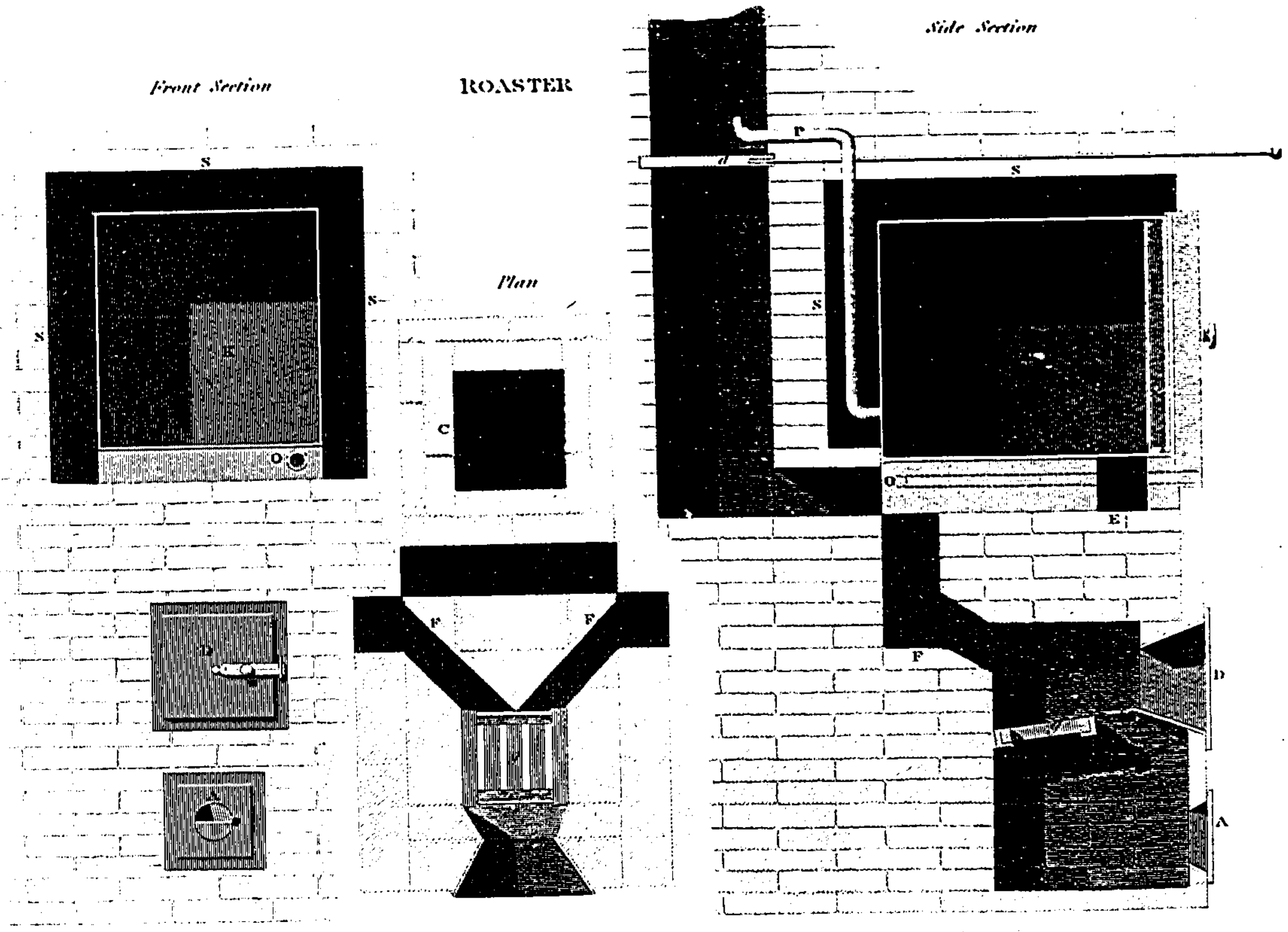
Fig. 1. *Plan*



Published June 21, 1818, by Longman, Hurst, Rees, Orme & Brown.

Lowry sculp.

DERBY INFIRMARY.

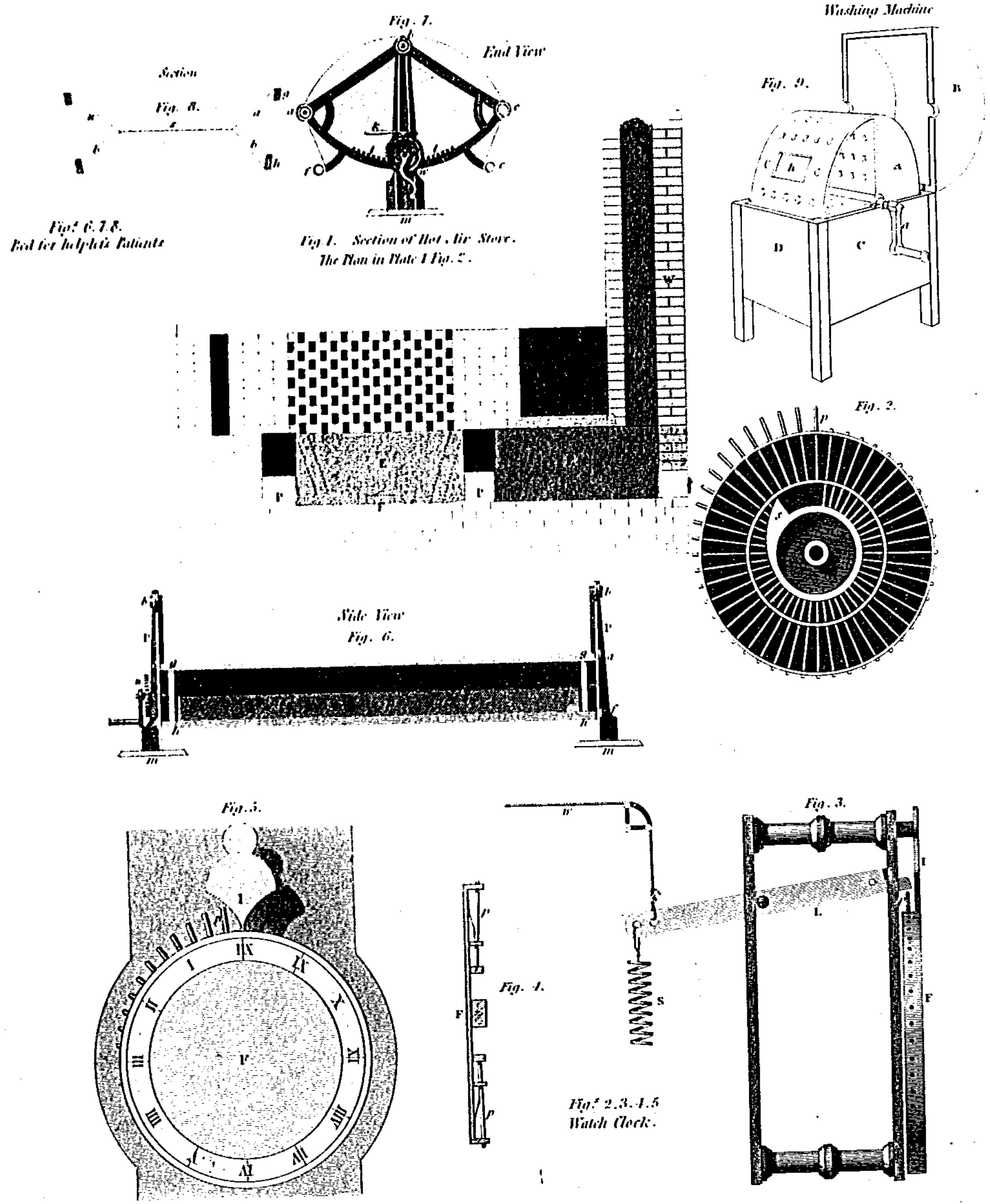


Published June 21, 1818, by Longman, Hurst, Rees, Orme & Brown.

Lowry sculp.

DERBY INFIRMARY

PLATE VII.



Silvester del.

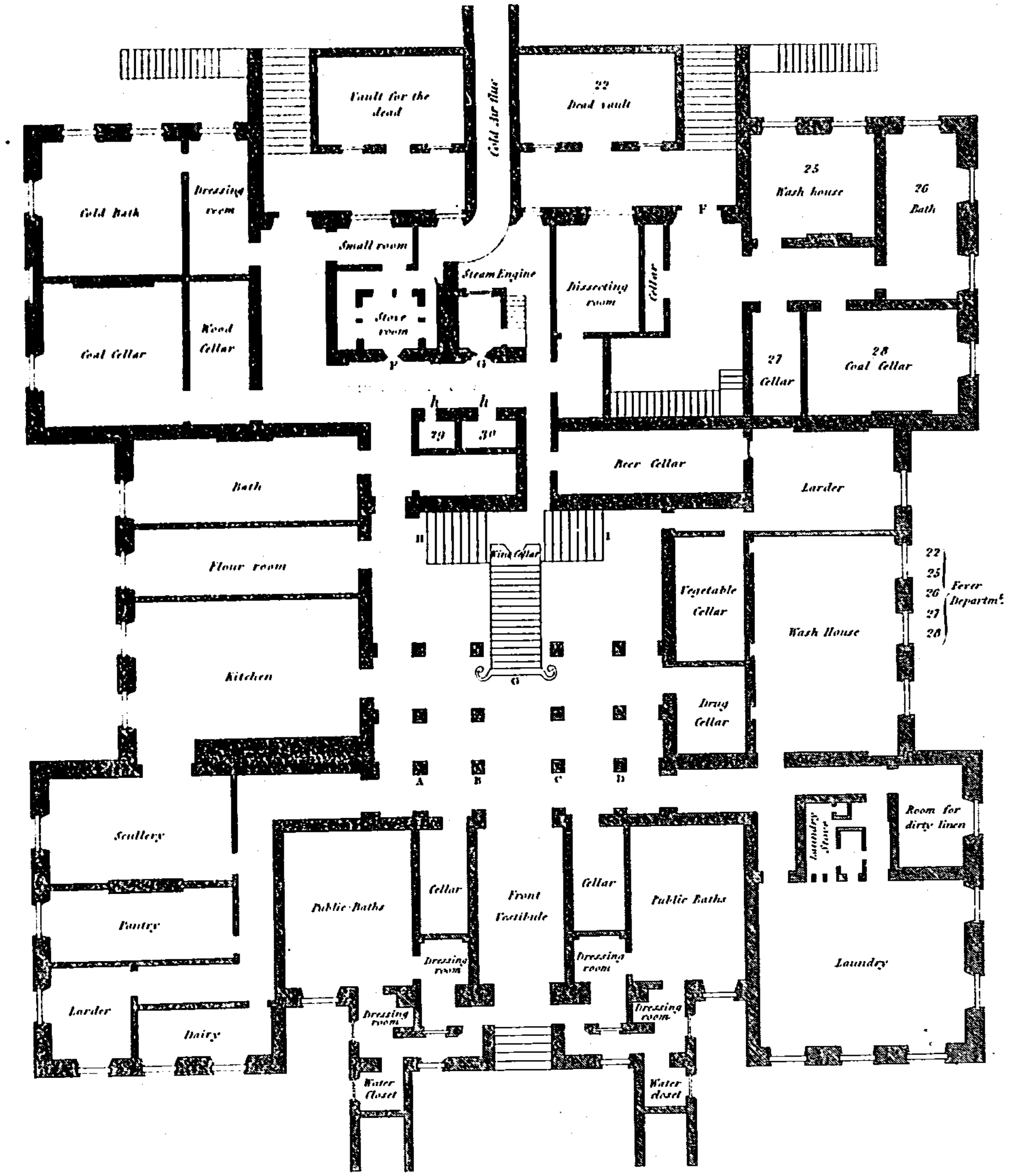
Published as the Act directs, 1818, by Longman, Hurst, Rees, Orme & Brown, Paternoster Row.

Lowry Sculp.

DERBY INFIRMARY

PLATE VIII.

BASEMENT STORY.

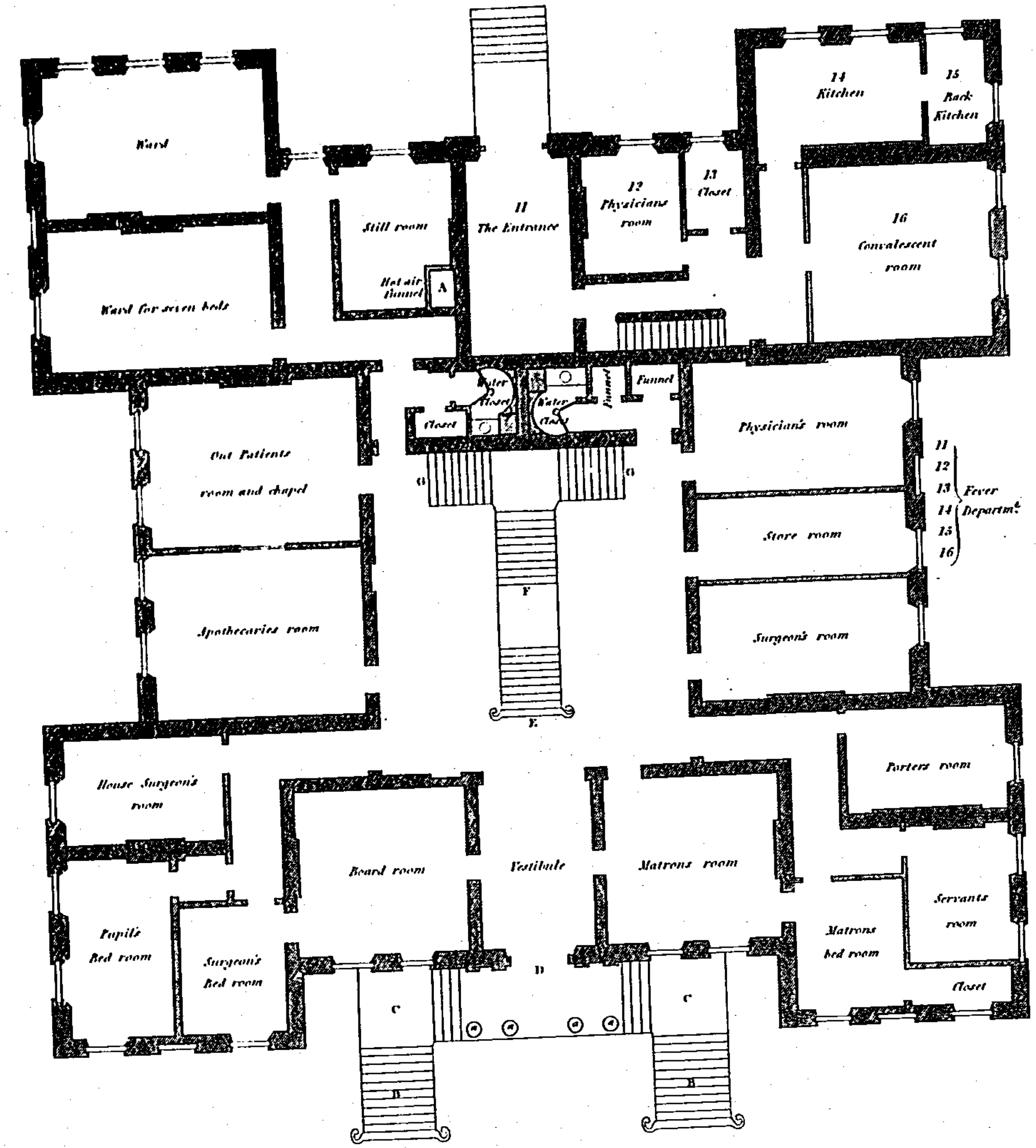


Published as the Act directs, June 21st 1818, by Longman, Hurst and C^o. Paternoster Row.

Lowry Sculp.

DERBY INFIRMARY

MIDDLE STORY.



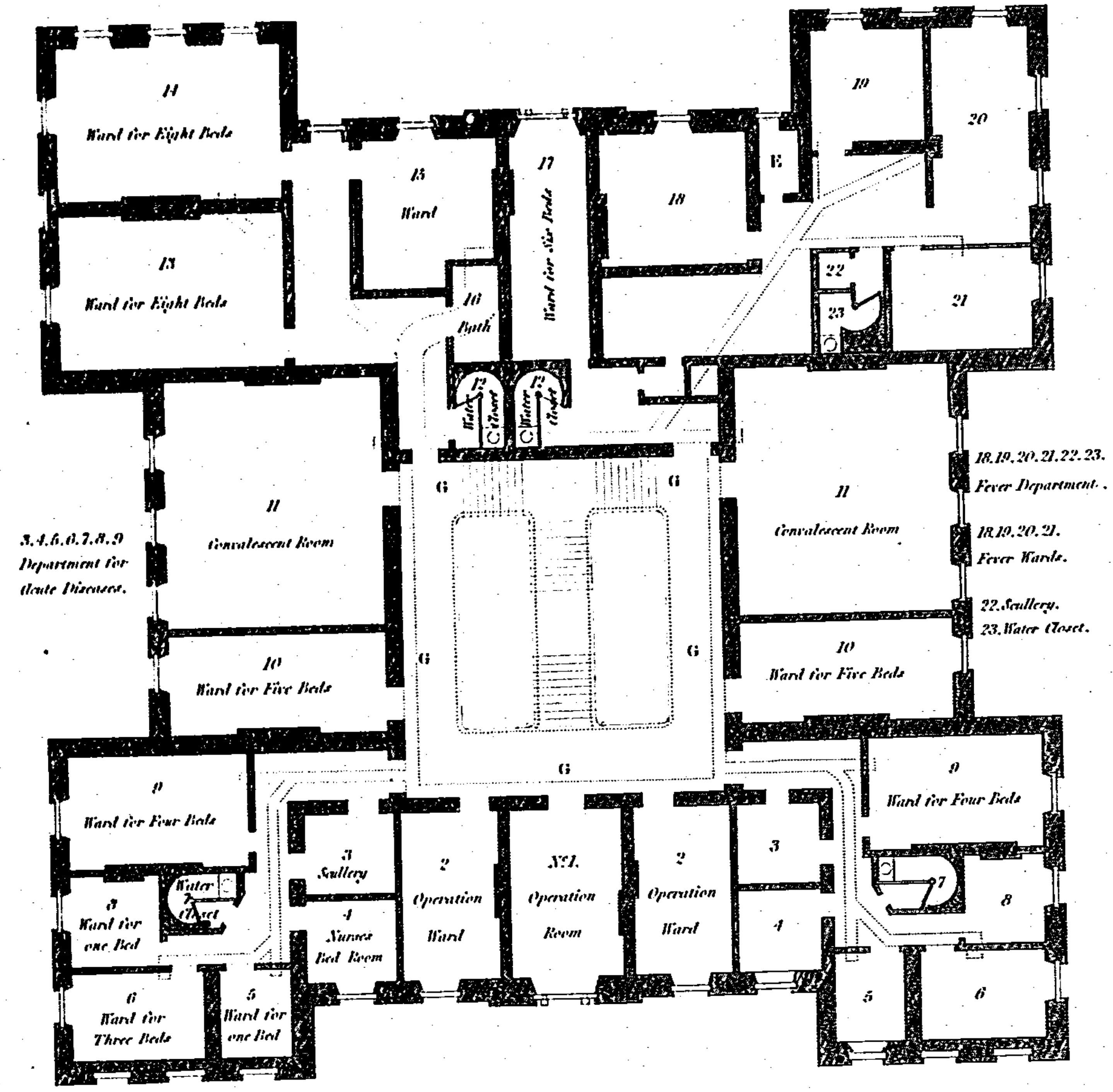
Published as the Act directs, 1818, by Longman, Hurst, Rees, Orme & Brown, Paternoster Row.

Lowry Sculp.

PLATE X.

DERBY INFIRMARY.

UPPER STORY.



Published June 21, 1818, by Longman, Hurst, Rees, Orme & Brown.

Lowry sculp.