OBSERVATIONS

ON THE

VENTILATION OF ROOMS, &c.

CHAP. I.

A View of the Properties of the Air, upon which the Operation of Chimneys depends.

THE fcience of hydroftatics, which explains the laws and properties of watery fluids, was brought to a confiderable degree of perfection by the celebrated Archimedes, more than two hundred years before the Chriftian era.

On this fcience, the philofophers of later times have founded their admirable doctrine of the preffure of the air. Galileo, from analogical reafoning, firft fuggefted the idea, that air, though a light and invifible fluid, muft yet be ſubject to the general law of gravitation, by which water and all other bodies are governed. Torricelli afterward undertook, by a ſeries of nice experiments, to aſcertain the truth of his great maſter's conjecture, and at length happily ſucceeded in confirming it beyond a poſſibility of contradiction. Thus pneumatics became a branch of ſcience at ſo late a period as the ſixteenth century. Before that time the air, from its inviſibility and apparent levity, had been conſidered as totally devoid of weight.

The general properties of the air are now fully underſtood, and have been ſo well elucidated by many accurate writers, that it is unneceſſary for me to give any ſcientific explanation of them. However, as the following pages were written, not for the information of the learned, but principally with a view to inſtruct artificers, whoſe ſituation in life cannot afford them convenient leiſure to enter on a courſe of philoſophical reading, it ſeems requiſite here to notice thoſe properties of the air which have relation to the ſubject before us. For it is obvious, that unleſs a workman be thoroughly acquainted with the principles of his art, he cannot proceed to make a right application of them.

Beſide the *weight* or *preſſure* of the air, which is perfectly analogous to that of other fluids, it is neceſſary to particularize its diſpoſition to be *rarefied* to a great degree by the application of heat, and to be proportionally *condenſed* by cold. The air is thence liable to conſiderable variations in its ſpecific gravity, according to the different ſtates of its temperature.

Since the principal phenomena reſpecting the aſcent of ſmoke, either in the open air or in chimneys, are founded on theſe circumſtances, it may not be amiſs to elucidate them by a few familiar examples, in order to ſhow how much the air is ſuſceptible of rarefaction by heat, and of condenſation by cold.

1. Let a bladder that is moderately filled with cold air, and having its neck cloſe tied up, be brought into a warmer medium, or near the fire: the air included will then immediately expand itſelf, and fully diſtend the bladder.

2. Let the bladder be returned into the former cold medium; and the air contained in it will be condenſed or reduced to its priſtine bulk, the bladder becoming flaccid, as before.

In order to prove that air is rendered ſpecifically lighter by heat, and ſpecifically heavier by cold,

1. Let the ſame bladder be loaded with as much weight as will juſt cauſe it to ſubſide in cold water to the bottom of the veſſel.

2. Let a quantity of hot water be added to the cold, ſufficient to render the whole warm: the air will pre-

ſently be rarefied, and cauſe the bladder to aſcend more or leſs above the ſurface of the water.

3. Add cold water to the hot; and as the air condenſes, the bladder will ſubſide again to the bottom.

The *weight* or *preſſure* of the air is beſt exemplified by that of water, which is more immediately the object of our ſenſes.

It is an axiom in hydroſtatics, that water invariably riſes to the ſame level or horizontal line, whether it be contained in pipes, canals, lakes, or in veſſels of any form whatever, capillary tubes excepted; and likewiſe that it perſeveres in a ſtate of reſt, if no external cauſe interfere. Thus,

Let fig. 1, repreſent an inverted ſiphon. If water be poured into the tube at E till it riſe to A, the other leg of the ſyphon will be filled to D in the ſame horizontal line. The ſame will be found to take place, whatever be the form of the tube, as in fig. 2, 3, and 4.

In every caſe the column of water A B is in equipoiſe to the column C D; which muſt be conſidered as owing to an equable denſity of the fluid.

When fluids of unequal denſity are put in the ſituation above mentioned, a very different effect is produced. The two columns cannot then remain at reſt, but one will immediately overbalance the other.

Let A B, fig. 5, reprefent a veffel containing water, and having immerfed in it a tube C D, whofe lower end is clofed. Now if the end of the tube C be opened, the water will afcend by it up to the fame level E, as in the jar. It is obvious, that the rifing of the water in the tube is caufed by the preffure of the body of water in the jar, which preponderates over the weight of the column of air previoufly occupying the tube. Air and fmoke arife in chimneys from a caufe perfectly analogous to the above. For the air being fufceptible of great rarefaction by heat, and of condenfation by cold, becomes thence liable to confiderable inequalities of preffure; for inftance,

Let fig. 6, reprefent a tube, or inverted fiphon, containing air of uniform denfity. The weight of the column A C will be equal to that of B C, as in the foregoing examples of the preffure of water in like circumftances. But if a fire be fet at D, it will, by rarefying the column of air B C, render that fpecifically lighter than the column A C, and confequently deftroy the equilibrium of preffure which previoufly fubfifted between them: the latter will then preponderate over the former, and raife it up. As the column A C defcends, it muft pafs through the fire at D: hence BD being kept conftantly rarefied, will always afcend, from the fuperior preffure of the other column of air; and thus they would continue to aɑ̃, if no external cauſe interfered, till the equilibrium ſhould be reſtored by an equal degree of heat.

Theſe examples ſufficiently account for the aſcent of the rarefied air and ſmoke in chimneys, from the ſuperior weight of the external air. Yet however obvious the principle may appear to be, nothing is more common than to ſee the conſtruction of buildings interfering with it. Thus, in fig. 6, if we ſuppoſe the aperture A to be inadvertently ſtopped, the column A C could not deſcend, nor the column B C aſcend, any more than if the aperture at B was cloſed up: the ſmoke therefore accumulates, its vehicle being now ſtagnant; and it will be diffuſed through the column A C ſo long as the free circulation of air is interrupted at A.

I may with truth aver that, for the moſt part, chimneys ſmoke from a cauſe perfectly ſimilar to this; and hence appears the neceſſity of uniting ſome knowledge of pneumatics with geometrical ſcience, if we wiſh to have our dwellings pleaſant and healthful as well as durable.

I think it proper in this place to obſerve, that whenever fires are made in the open air, the ſmoke aſcends from them in a perpendicular direction, provided the weather be calm. This does not happen altogether becauſe ſmoke is lighter than air, but is more owing to the aſcent of rarefied air, which acts as a vehicle to the ſmoke. We need not from hence infer, that a perpendicular direction is eſſentially requiſite to the free aſcent of ſmoke. The fact is, in whatever direction water will deſcend by its gravity, rarefied air will aſcend in the ſame by its levity; ſo that the form or conſtruction of chimneys will admit of great variety, without inconvenience.

For example, take the forms repreſented in fig. 7 and 8, and ſuppoſe the fire to be placed at D. The rarefied air and ſmoke will aſcend through the crooked tubes B C as well as they would in a ſtraight one. Or the ſmoke will aſcend from the fire D to B with the ſame facility as it would through O A, ſuppoſing the fire placed at O.

What has been already ſaid, may ſeem abundantly to illuſtrate the effects ariſing from the rarefaction of air in tubes or chimneys. I think, however, conſidering for whom this treatiſe is principally intended, that it will not be amiſs to add a few more examples, and rather err on the ſide of ſuperfluity than otherwiſe.

Let us then ſuppoſe a tube as repreſented, fig. 9, and containing a fire at E. In this caſe the air would become equally rarefied from E toward C, and toward D. Therefore the columns A C and B D partaking equally of the heat, muſt remain at reſt, as neither of them could preponderate over the other. This equilibrium might however be deſtroyed by ſlight cauſes. If the wind ſhould blow into the aperture A and not into B, it muſt give the heat a direction toward D, in conſequence of which the column B D, becoming more rarefied than A C, would aſcend, ſo long as the cauſe continued to act.

Let us next ſuppoſe a fire to be placed at G, and another at F. If the heat is not equal in the two columns A F and B G, the hotteſt column will aſcend and draw the ſmoke of the other downward through its fire.

On this principle the ſtoves in the Bank of England are conſtituted. I ſhall therefore give ſome further illuſtration of it.

The requiſite is, to make a fire at A, fig. 10, the ſmoke from whence ſhall not riſe upward, but deſcend from A to B, and after paſſing under the floor, as from B to D, ſhall aſcend from D toward E, in order to be diſcharged at C, and thereby to keep the room in which A is placed, totally clear from ſmoke.

To produce this effect, a fire muſt be previouſly made on a grate at E, with an iron door cloſely fitted, ſo as to prevent the acceſs of air from without. The column C D will then become much rarefied. Therefore, if a moderate fire be placed in the ſtove A, the ſmoke from it will not aſcend, but paſs downward under the flooring B D, and be all difcharged through the chimney E C. In this direction the current of air and fmoke will continue fo long as the fire is kept up at E*; and no fmoke can arife in the room containing the ftove A. The diftance from A to E need not be precifely limited: whether we fuppofe it three feet, or one hundred, the procefs may go on fufficiently well. However, if the fpace between the two tubes is made very great, the force of afcent in C D will be confiderably diminifhed.

* Were the fire at A wholly inclofed, the fmoke muft neceffarily pafs through the tubes A B, D C, without any fire at E; on which principle the ftoves in Germany are conftructed.

CHAP. II.

On the Ventilation of Rooms, and the Conſtruction of Chimneys.

BEFORE we enter upon the application of the foregoing principles, it is requiſite to obſerve, that the dimenſions of chimneys muſt bear ſome proportion to the quantity of fuel which their different purpoſes require in parlours, chambers, or kitchens.

Let us ſuppoſe the whole conſumption of coal in a parlour to be one hundred weight in twelve hours, and the area of the chimney required to be 196 ſquare inches. If then, in another ſituation, two hundred weight be the conſumption within the ſame time, the area of a chimney adapted to diſcharge freely the increaſed quantity of ſmoke in this caſe, ſhould be nearly double, or equal to 392 ſquare inches, and ſo in the ſame ratio for larger conſumptions of fuel. I do not, however, mean to inſiſt upon it, that theſe proportions muſt be adhered to invariably. Such preciſion is not neceſſary, becauſe the aſcent of ſmoke depends much on the degree of rarefaction in the chimney. Experience alſo informs us, that the tube or ſhaft of a chimney, whoſe ſides are fourteen inches each, or whofe area is 196 fquare inches, fufficiently anfwers for fitting rooms or bed-chambers in general.

The area of a chimney in a large kitchen, where the family is very numerous, fhould be at leaft 588 fquare inches, whether its form be a fquare or parallelogram.

No injury can arife with regard to the afcent of the fmoke from this large capacity of the fhaft; whereas a too great contraction of it frequently produces very difagreeable effects, which are not eafily removed. Befides, the larger the capacity of a chimney is made, the feldomer will it want cleanfing.

In applying the principles ftated in the laft chapter, I fhall begin with buildings of the moft fimple conftruction, and afterward proceed to thofe which are more complicated.

Let fig. 11, reprefent the plan of a cottage, having one chimney C, one door D, and two windows A B.

Suppofe, firft, the door and windows to be air-tight, or fo clofely fitted, that they do not admit a quantity of external air fufficient to carry up the fmoke in the chimney. The houfe will, in that cafe, be incommoded with fmoke and ftagnant air. If then a window or door be opened, the chimney obtains a fupply of frefh air, and performs its office in carrying off the ſmoke properly. This circumſtance points out to us a remedy for the defect, by making ſome convenient aperture into the houſe; which however muſt be done with caution: for if the opening is either at the door or window, the ſtream of cold air flowing from thence will not only be unpleaſant, particularly in winter, but very injurious to the inhabitants. What I ſhould propoſe for the purpoſe, is an *air-duct*, three or four feet long, to be fixed in either corner of the room moſt remote from the fire, as at E; and communicating with the external air through the wall. The diameter of the duct muſt be from five to ſix inches. The air admitted by this means will aſcend in a perpendicular direction to the ceiling; and being gradually diffuſed, will ſoon acquire the temperature of the room. While this proceſs goes on, no perſon within is ſenſible of it, nor is the flame of a candle in the leaſt diſturbed by it. At the ſame time, ſmoke and ſtagnant air are effectually removed. If the air ſhould be admitted near the fire, the chimney will act equally well, but the circulation through the room cannot be ſo perfect; for as the freſh air muſt take the neareſt courſe to the chimney, it would leave that which is contained in other parts of the room nearly quieſcent; whereby it would become leſs fit for reſpiration.

Let us next confider the confequences arifing from two chimneys in one and the fame room, as at C F fig. 12; other circumftances remaining as before.

1. If a fire be placed at C, that chimney will not fmoke, although the door and windows be perfectly clofe; becaufe a fupply of air muft come from the other chimney F, as was formerly mentioned, page 5.

2. If it were requifite to have a fire at F alfo, the fmoke in that chimney could not afcend at all, on account of the current of air paffing down it to fupply C. Or reverfely, if the fire were placed firft at F, the chimney C would then fmoke for the fame reafon.

To remove the defect in this cafe without injuring the inhabitants, and to enable both chimneys to act well at the fame time, it becomes neceffary to apply an air-duct, as in the foregoing inftance, but in a different fituation. Its capacity muft alfo be enlarged, fince two chimneys are to be fupplied with air inftead of one.

A duct whofe fide is feven inches may anfwer the purpofe: its area will then be forty-nine inches, or nearly double to that of the former, whofe fide was eftimated only at five inches. The moft proper fituation for it is at an equal diftance from each fire, as at E, becaufe a ftream of air flowing up from thence will have the greateft poffible effect in ventilating the room. An air-duct at any of the corners might indeed afford a fupply to the chimneys, ſufficient to prevent them from ſmoking, but could only change the internal air partially.

Let fig. 13, repreſent the plan of a cottage, conſiſting of two rooms, with the door D, and windows A B, cloſe. A fire in the chimney C would not ſmoke, ſince it muſt have a conſtant ſupply of air from the chimney F. But if the wind ſhould happen to blow in the direction from C to F, the ſmoke riſing from C would be carried down again with the air in F, and fill both the rooms. One air-duct might here alſo prevent the chimneys from ſmoking; but with a view to ventilation, I ſhould recommend two, ſituated as at E and e, which would always keep up a proper and healthy circulation of air through both the rooms.

Let fig. 14, repreſent the plan of an edifice, conſiſting of two rooms and a veſtibule. Here the ſame circumſtances will take place as were mentioned in the illuſtration of fig. 12. The fire at C muſt take its ſupply of air from the chimney F; conſequently, if a fire be afterward made in the latter, the ſmoke from it muſt be drawn into both rooms. The mode of furniſhing air may be different from that recommended in the laſt example: inſtead of ducts conveying the external air to each room, it will generally be more convenient to fix one ſufficiently capacious in the veſtibule; and then to apply leſſer interior ducts to one or both of the rooms adjoining. If there ſhould be two doors in the veſtibule to which air-ducts are thus applied, when the wind blows briſkly from G to D (or contrariwiſe) the doors being open, it will occaſion both the chimneys to ſmoke. Wherefore it is requiſite to have but one external door, or to keep both conſtantly ſhut in tempeſtuous weather. But of this I ſhall ſay more hereafter.

Let *fig.* 15, repreſent the plan of an edifice containing three rooms on one floor. Now, if the external doors and the windows were perfectly cloſe, a fire in any one of the chimneys, as A, would occaſion the others at C and B to ſmoke, provided the interior doors were all open, and likewiſe thoſe in any of the chambers above.

If a fire were at the ſame time placed at B, only the doors D E being open, both the fires would borrow their air from C; or both from B, ſuppoſing the ſecond fire ſet at C.

If fires were made in all the lower rooms, the intermediate doors, and the chamber doors being open, the chimneys on the ground-floor would all of them act well; but if the door D were ſhut, A and B would ſmoke, and C only act well. If the door E were ſhut, the chimney in that would alſo ſmoke.

Such then are the difagreeable confequences arifing from the exactnefs of the carpenter's work in all houfes where no provifion is made for admitting the external air.

It will appear from what has juft been faid, that the chimneys of the lower apartments often derive their fupply of air from the chambers, the doors being open; and hence it is, that, when feveral flues are comprifed in one and the fame ftack, the chambers are filled with fmoke and foot from the operation of the fires below.

Thefe circumftances point out the neceffity of enabling the chimneys to act independently of each other, by means of one general refervoir in the lower parts of the houfe, from which every apartment may be feparately fupplied with air. Such a plan might be executed without much difficulty, and would be attended with numerous advantages. It would promote a conftant circulation of pure air through the apartments; it would clear away from them the fmoke and foot; it would contribute much to the prefervation of furniture, books, paintings, &c. Laftly, it would prevent the diffufion of infectious effluvia from one room to another.

The importance of thefe objects does not require to be enforced by argument. I fhall therefore proceed to confider the mode of admitting the air, which will moft effectually contribute toward the accomplifhment of the feveral purpofes above fpecified.

Let fig. 16, reprefent the plan of an edifice containing four rooms on a floor, with fundry offices underneath, and with an open communication at S to the lower apartments or cellars.

It will in this cafe be proper that one or more of the paffages below fhould have a free communication with the external air: for by this means every part of the building may be amply fupplied with air, which in the winter feafon will in fome degree conform to the temperature of that within, foon after its admiffion, and which in fummer will be cooler than the external air. A mean temperature may thus be conftantly preferved within between the two extremes.

Thofe openings to the external air fhould be made on the fouth or fouthweft fides of the houfe; becaufe the chimneys require moft aid when the wind blows from thefe quarters *.

If the plan of the building will not allow of an aperture in the directions affigned, the weft fide is then more eligible for the purpofe than any other.

Having provided for a general fupply of air to the houfe, we fhould, in the next place, regulate the mode

* The air being then generally warmer and lighter.

of its admiſſion into each room ſeparately both above and below ſtairs, ſo as not to injure the architecture, or occaſion any deformity; which may be done eaſily and without expence in the firſt conſtruction of a building. I have employed in ſeveral inſtances the following method with advantage: I leave an open ſpace between the upper part of the architrave ſurrounding the door, and the wall, on each ſide of the door, and likewiſe an open ſpace between the caſing and the lintel.

The air then deſcends between the architrave and the wall on the outſide of the door, and aſcends between the architrave and the wall on the inſide of the room. The current thus admitted riſes in a perpendicular direction toward the ceiling, and acquires the temperature of the room, circulating through it imperceptibly to the inhabitants. At the ſame time it prevents any accumulation of ſtagnant air, and removes the ſmoke of candles, which is otherwiſe very pernicious.

A ſimilar mode of ventilation may be applied to all the rooms, however great their number, with the ſame beneficial effects. It renders the ſmalleſt apartments equally pleaſant and healthful with the largeſt, and prevents the ſmoke from deſcending when the door ſhuts. In ſmall rooms more eſpecially, when they are furniſhed with an air-duct, it is proper to have the doors and windows as cloſely fitted as poſſible.

Although the ſalutary tendency of this plan muſt be obvious when fully conſidered, there ſtill remains a prejudice againſt it in the minds of the multitude. They obſtinately maintain that the ſame injuries are to be expected from air admitted in this manner, as from the cold ſtreams of it which uſually flow into a room through the crevices of the door or window. However, the plan I propoſe is not recommended from theoretical ſpeculation: it has ſufficiently ſtood the teſt of experience; and to that alone we can properly appeal. Beſide its own peculiar advantages, it effectually prevents thoſe diſagreeable ſenſations, occaſioned by lateral currents of air, which chill the body on one ſide, while it is heated on the other; nor can its operation at all produce the ſame dangerous conſequences, ſince the air introduced by it, being gradually and inſenſibly diffuſed, diſtributes an uniform heat round the room.

I do not propoſe the method of ventilation above ſtated as the beſt in all poſſible caſes. There is ſo great a diverſity in buildings, that a variety of modes may be adapted to produce the ſame effect. The application of the principles muſt then be regulated by circumſtances, and by the diſcretion of the architect.

A few general hints will however ſerve to facilitate the proceſs. If the kitchen be connected with the houſe by a paſſage, or by any other means, it becomes neceſſary to apply an air-duct of conſiderable ſize for the uſe of that room alone. The area of the tube ſhould not be leſs than a hundred and forty-four inches in a moderate kitchen; for if the chimney there have not a full ſupply independently, it will draw air from ſome or all of the chimneys in the houſe.

Different modes may be adapted to anſwer this purpoſe:

1. A perforation of twelve inches ſquare may be made in the kitchen wall near the bottom, to which a tube muſt be fitted as uſual.

2. If circumſtances do not allow of ſuch an opening, air may be admitted by raiſing the ſaſh five or ſix inches above the ſill, and applying a board at about the ſame diſtance from the window to direct the ſtream of air toward the ceiling. This board ſhould be one foot broad, or ſomewhat more, and may be ſuſpended on hinges ſo as to let down in the night, if the window-ſhutters require to be then cloſed. In lofty kitchens, where there are ſmall ſaſhes, one of the windows is often hung upon an axis horizontally, ſo as to open or ſhut, at pleaſure, by a line fixed to it. The inclination of the open windows affords a ſupply of air to the chimney, and defends the floor from rain; but it does not prevent the inconvenience from the wind blowing downward into the room.

In ſome rooms where it is not convenient to make a perforation, air may be admitted between the folding of the ſaſh-frames *, by cutting away about the eighth of an inch from the frame, leaving the whole ſubſtance at each ſtyle. This is only practicable when there are ſhutters on the outſide, and not on the inſide of the window. For by inſide ſhutters the current of air upward is obſtructed; whence it ruſhes through the crevices in various directions, and produces unpleaſant effects.

When rooms are infeſted with ſmoke, and cannot be conveniently ſupplied with a current of air from without, another expedient for clearing them, is to increaſe the rarefaction of the air in the chimney, by contracting its opening above the fire-place †, as repreſented, fig. 17, which plan likewiſe anſwers other uſeful purpoſes; for when chimneys are too capacious at their

* On a plan ſomewhat analogous to the above, the wards of St. Thomas' Hoſpital were ventilated, under the direction of Mr. WHITEHURST.

In every ſecond window, about an inch and a half of each pane in the bottom of the upper ſaſh is cut away. A frame of glaſs, nearly two feet in width, is ſet acroſs the window, reſting upon the top of the upper ſaſh, and faſtened to it by hinges. The frame can be moved on the hinges, ſo as to make a greater or leſs angle with the window, and by that means admit more or leſs air at pleaſure. The air which enters between the ſaſhes being directed by the frame toward the ceiling, is diffuſed through the ward without any perceptible current.

† This part of the ſubject has been amply conſidered in a work, entitled, "A "practical Treatiſe on Chimneys," firſt publiſhed in the Encyclopedia Britannica, and afterward ſeparately.—Edinburgh, 1776.

lower part, much cold air flows into them at ſo great a diſtance from the fire, that the warm air is condenſed again by it, which not only retards the aſcent of the ſmoke, but alſo renders the room extremely cold. The contraction of the fire-place, as above propoſed, is alſo ſerviceable in old buildings, where the ſmoke of two or more fires is thrown into one tube, and often falls back into ſome of the rooms. It does not however, in all caſes, prove effectual without the application of air-ducts, as formerly directed.

A ſimilar plan is now very generally adopted, with an intention to produce a more uniform temperature in rooms, by regulating the quantity of air to be tranſmitted to the chimney. If but a ſmall quantity aſcends in the chimney, it is obvious, that a proportionately ſmall quantity muſt be admitted from without; and therefore more heat will be retained in the room.

One mode of executing this plan, is by a plate ſliding in a groove over the fire, as at *a a* fig. 17. This groove ſhould not be made horizontal, but to aſcend about two inches from the front to the back of the chimney; and the plate ſhould not extend quite acroſs the chimney, but leave an opening of at leaſt an inch wide.

Another mode adapted to the ſame purpoſe, is the regiſter-ſtove, now in common uſe. It is more elegant than the former, and very convenient, if due attention is paid in applying it. Both of thefe methods are, however, to a certain degree exceptionable, as they favour a ftagnation of air in rooms, and its confequent contamination by the breath, candles, &c. They are hence inadmiffible whenever there is a large concourfe of people, as in affembly rooms. Indeed the application of confiderable air-ducts becomes in fuch circumftances efpecially neceffary; otherwife delicate conftitutions fuffer extremely.

It is proper to obferve that air-ducts, wherever applied, fhould be made fufficiently capacious to anfwer the purpofes required, fince their apertures can be much more eafily diminifhed than enlarged.

When this mode of ventilation is adopted, the air fhould be tranfmitted into rooms, if poffible, wholly by the ducts; fince nothing can be more prejudicial to the inhabitants than currents of air paffing through the chinks of doors, windows, or pannels. Thefe therefore fhould be guarded againft with the utmoft care. I cannot here omit the opportunity of noticing and recommending fome ingenious devices lately invented with a view to fill up the fpace between the bottoms of doors and the floor. They obftruct the entrance of wind, rain, or fnow, in tempeftuous weather; and their application is fo contrived as to clear the inner door of carpets or floor-cloths when it is opened.

By attending to the few ſimple principles laid down in the foregoing pages, rooms may be commodiouſly ventilated, and the ſmoking of chimneys may be in general prevented. It is ſurely better to provide for theſe uſeful purpoſes in the original conſtruction of a houſe, than be obliged to remedy defects in regard to ventilation after the building is completed. Indeed the remedies then uſually employed are ſeldom found to be ſucceſsful: at leaſt pots, or other additions to chimneys, afford but a very trifling advantage, while they certainly deform the edifices to which they are annexed, and are a diſgrace to the ſcience of the builder.

CHAP. III.

On external Impediments to the Aſcent of Smoke in Chimneys.

I PROPOSE in this chapter to conſider ſome external cauſes which may interfere with the regular aſcent of ſmoke in chimneys, notwithſtanding all the proviſions for it hitherto ſtated; and I ſhall likewiſe endeavour to point out the requiſite means for counteracting the operation of theſe cauſes.

1. In tempeſtuous weather, the atmoſphere meeting with more reſiſtance on the ſurface of the earth than at ſome diſtance above it, we may thence infer that the upper and lower parts thereof move with different degrees of velocity; whence it may be preſumed that the winds do not move parallel to the ſurface, but have often a tendency toward the earth; and conſequently to blow downward in chimneys. This effect will be greater or leſs according to the inequalities of the country where the houſe is ſituated.

Thus, ſuppoſe the wind in the above circumſtances ſhould take the direction *b a* and *d c* in fig. 18, it will neceſſarily be driven down the chimney A B, carrying along with it both the ſmoke and ſoot.

In order to remedy this inconvenience, the top of the chimney muſt be guarded by a pyramidical cap, the ſection of which is repreſented, fig. 19. The wind then falling upon an inclined ſurface, would change its direction from *b a* to *d c*, and no longer affect the riſing columns of ſmoke. Such an addition to chimneys, it is preſumed, would occaſion no deformity, but rather be ornamental to the building.

The caps are compoſed either of ſtone or caſt iron: the latter ſeems preferable, as being leſs expenſive, and a better defence to the mortar underneath againſt the injuries of the weather. Iron caps, if caſt about three tenths of an inch thick, will endure for ages: their weight and figure alſo render them not liable to be diſturbed by the winds. It is not requiſite to make their apertures equal to that of the chimney ſhaft; but the proportion ſhould be nearly as the ſquare of 10 to the ſquare of 14. This contraction of the aperture anſwers two good purpoſes: it protects the ſhaft from rain, and in ſome degree defends the riſing column of ſmoke from the external cold.

The caps need not be ſet underneath with brick or ſtone-work, but may reſt on a little mortar: or if they are only laid flat upon the brick-work, they will ſufficiently anſwer the purpoſe.

2. If a houſe be ſituated where there is ſome local obſtruction to the current of the wind, as near a tower or other high building, or at the foot of a cliff, it becomes neceſſary to apply over the aperture of the chimney, a cap or cover with an opening at each end, from whence the ſmoke may iſſue in directions parallel to the adjoining ſurface of the obſtacle. A proviſion of this kind is frequently made by builders in ſuch circumſtances, and executed with judgment; ſo that little can be advanced on this ſubject beyond what is already practiſed.

As the wind generally blows in an oblique direction toward the earth, ſuch cliffs or eminences as are repreſented, fig. 20, not only require that the cover ſhould be parallel to the cliff, but that it ſhould project five or ſix inches at each end beyond the perpendicular part of the chimney.

Fig. 21, gives the end view of a cap or covering proper for the chimney of a cottage, ſituated as in fig. 20.

Fig 22, repreſents the ſide which is parallel to the cliff, and which projects at C D, ſix inches beyond the edges of the chimney. It is to be obſerved, that two courſes of brick are left out at both the open ends, whereas on the two ſides the brick-work is carried up to the cover. Theſe covers are made of caſt iron; they may be conveniently applied to chimneys conſiſting of many flues ranged in one line, as repreſented, fig. 23.

As a further aid to the caps above deſcribed, it will be proper to conſtruct an air-duct into which the wind may blow, in order to counteract its tendency down the chimney. To elucidate this point, let us firſt ſuppoſe that the cottage, fig. 20, has two ſimilar chimneys, one at each end. The apertures of both chimneys being of the ſame width, it is obvious that under ſimilar circumſtances the wind will blow down both of them with equal violence. But if one chimney be covered with the iron cap, fig. 21, 22, the current of air down it will be prevented: a fire being then put in this chimney, we ſhould find that the wind would be driven down the open ſhaft with increaſed force, and aſcend up the covered one. A ſimilar effect may be produced, if in lieu of the open chimney, an air-duct be applied, as at BC, fig. 24, where A repreſents the wall of the cottage; for the current of air entering at B will prove inſtrumental in driving the ſmoke up the ſingle covered chimney, fig. 20. The duct ſhould be placed on the ſide of the houſe neareſt to the cliff. The part CD ſhould be a box of wood, the reſt, brick. If neceſſary, an iron grate may be laid over the aperture B.

3. Suppoſe an edifice to be erected on an extenſive plain, or upon an eminence where there can be no obſtructions likely to change the courſe of the wind from a horizontal to an oblique direction.

Yet even in ſuch a ſituation, and without any internal defect, chimneys are apt to ſmoke in windy weather. The reaſon probably is, that the rapid motion of the wind paſt the building, diminiſhes the preſſure of the air, on which the aſcent of ſmoke depends. This concluſion is warranted by obſervations made on barometers in tempeſtuous weather, when the mercury always falls conſiderably in the tube.

Let fig. 25, repreſent the plan of an edifice conſiſting of two rooms, and ſituated as above. Now, if the wind ſhould blow violently in the direction A B or B A, it will have no tendency to enter the door H, or any of the windows. Hence the general preſſure is taken off, by which the columns of rarefied air ſhould be raiſed in one or both chimneys. The ſmoke therefore deſcends, as if blown down the ſhaft. The pyramidical caps will not avail in this caſe; neither will opening the door or a window produce any effect. The only expedient which proves effectual, is the application of air-ducts through the wall on the ſides

A and B. They ſhould be conſtructed according to the directions given page 28, fig. 24, with the addition of a ſlide applied to the interior aperture of each, and which may be opened or ſhut as occaſion requires. Thus, if the wind blows from A toward B, the aperture in A may be open, the other remaining ſhut; or reverſely, if the direction of the wind ſhould be from B to A. The air will then paſs with force through the open duct, and abundantly ſupply the chimneys, cauſing the ſmoke to aſcend with the ſame freedom as in calm weather. It may ſometimes, more eſpecially in large houſes, be requiſite to conſtruct air-ducts, which ſhall act merely by the force of the wind, without labour or attention from the family.

For example.—In the manſion repreſented, fig. 16, the air-ducts may be conſtructed as follows: let there be openings of ſufficient magnitude in the lower offices at the extremity of each paſſage, having vertical valves applied to each of them. Theſe valves are to be hung with leather ſtraps, to open inwardly at A B C D. If then the wind blow in the direction from A to C, A will be open, and C ſhut. If from B to D, the valve B will be open, and D ſhut; and ſo of every other direction. The ſize of the valves ſhould be greater or leſs according to the magnitude of the building, as from ſix inches to two feet ſquare. The inside of them may be lined with hare-skin, to prevent any noise in their operation.

When a very large building is set on an exposed situation, interior currents of air frequently prove troublesome during stormy weather; for the wind, being freely transmitted along galleries and extensive passages which communicate with each other, passes by the doors of some apartments with a violent and irregular motion, and takes off the uniform pressure by which smoke is carried up the chimneys. The consequence is, that a large proportion of the smoke falls back into the rooms at such seasons. It is therefore necessary, in this case, to apply doors within the passages, or use other similar means for obstructing the currents of air. If this cannot conveniently be done, it only remains to make a plantation of trees at a proper distance from the building on the side most exposed.

Before I conclude this part of the subject, I think it proper to notice an impediment to the ascent of smoke in chimneys, occasioned by smoke-jacks, as they are at present constructed. The vanes usually fold over one another, and make so small an angle with the horizon, that the air is not permitted to ascend with freedom, nor in a sufficient quantity to carry up all the smoke. Now if the breadth of the vanes ſhould be reduced ſo as to leave an interval of three fourths of an inch between each; and if at the ſame time the angle be increaſed to twenty degrees; the alteration would be found not only ſufficient to prevent a ſtagnation of the ſmoke, but likewiſe to improve the power of the jack.

CHAP. IV.

On the Conſtruction of Garden Stoves.

THE different regions of the earth being ſubject to great variations in the length of days, in the degrees of heat and cold, of moiſture and dryneſs, are not capable of producing all plants equally. Thus it appears that countries within the torrid zone yield pines, and a variety of other delicious fruits, which never maturate ſpontaneouſly in cold, nor even in temperate climates. We are however enabled in this part of the world, by artificial means, to bring ſuch fruits to tolerable perfection. For this purpoſe, it is neceſſary to erect ſome kind of edifice to protect the plants from the inclemency of our ſeaſons; and by the application of culinary heat, nicely regulated, to ſupply them with air of a requiſite temperature. Hothouſes adapted for the culture of exotics may therefore be conſidered as artificial climates; and on this view, it muſt appear obvious, that, in order to render the operation of them effectual, their properties, as to temperature, moiſture, dryneſs, &c. ſhould coincide as nearly as poſſible with the qualities peculiar to the climate of the plants which are to be cultivated. In all cafes then, it muft be of confequence to obtain, from a feries of obfervations, an accurate knowledge of the various properties of the natural climates, in order to fettle a ftandard, whereby to regulate the management of the artificial ones.

On thefe ideas are founded the enfuing plan for conftructing garden ftoves, which by proper modifications may be adapted to imitate every climate of the globe. One good example will however afford a fufficient illuftration of the fubject:—The climate of Jamaica feems moft eligible for the purpofe; fince the productions of that ifland, more efpecially the anana, or pineapple, are the chief objects of culture in garden ftoves. I fhall therefore, in the firft place, inveftigate the properties of its atmofphere and foil, through which thofe plants arrive at perfection without the affiftance of art, and afterward endeavour to fhow the mode of producing fimilar effects of vegetation, by means of an artificial climate.

The central part of Jamaica is fituated in the 18th degree of north latitude, and has therefore days and nights of nearly equal length throughout the year. There are alfo material changes in the temperature of its air every twenty-four hours; for the fun at his meridian altitude being nearly vertical, a great degree of heat muft neceffarily be produced in the courfe of the day; and during the eleven or twelve hours of night the temperature will be proportionally lowered.

From theſe circumſtances, added to the inſular ſituation of Jamaica, ariſe the phenomena of land and ſea breezes, which indeed are common to all the tropical iſlands, and admit of an eaſy explanation *; for the ſun no ſooner appears above the horizon, than heat begins to accumulate on the ſurface of the land, while that of the ocean ſuffers little change. Hence the air above the former becomes highly rarefied, and ſpecifically lighter than the air of the ſea; it therefore aſcends by the ſuperior weight or preſſure of the latter; and the cooler air thus flowing in every direction toward the center of the iſland, conſtitutes what is denominated the ſeabreeze. In a ſimilar manner, as evening approaches, the ſun's heat gradually abates, till the two atmoſpheres become equally denſe: a perfect calm then enſues, which remains till the air over the land, from the long abſence of the ſun, is more condenſed than the air at ſea. The latter conſequently aſcends by the ſuperior weight or preſſure of the former, and thus the landbreeze commences, which blows conſtantly till the ſun appears again above the horizon. The ſea and land breezes have more or leſs velocity, according to the relative degrees of denſity in the two atmoſpheres:

* See Mr. Whitehurſt's Inquiry, third edition, page 148.

the grateful alternation of them every morning and evening ſerves to moderate the fervour of the climate, keeps the air in conſtant motion *, and thus renders the ſituation more favorable than it would otherwiſe be to the exiſtence both of vegetables and animals.

It evidently appears from the above account, that the air of Jamaica muſt be ſubject to frequent and conſiderable changes of temperature; whence we may infer, that a perfect equality in the temperature of our artificial climate is not neceſſary.

I think it will be proper here to give, from a ſeries of thermometrical obſervations, a more particular view of the temperature of Jamaica; as alſo of the quantity of rain which falls annually on the iſland; for on a knowledge of theſe circumſtances, the conſtruction and management of ſtoves intended to imitate the properties of that climate will principally depend.

The following table is the reſult of obſervations made with Fahrenheit's thermometer at Spaniſh Town during one year. The firſt column contains the months; the ſecond, the higheſt degree of the thermometer in each month; the third, the loweſt ſtate of the thermometer; the fourth, the monthly variation of the thermometer; and the fifth, the annual variation.

* Sir Hans Sloane obſerved in 1688, that there were only 17 perfectly calm days throughout the whole year.

Spanish Town.					London.				
Month	H	L	M V	A V	Month	H	L	M V	A V
January	83	76	7		January	52	30	22	
February	85	66	19		February	52	41	11	
March	84	71	13		March	53	37	16	
April	86	67	19		April	69	40	29	
May	87	77	10		May	67	51	16	
June	88	84	4	26	June	73	60	13	44
July	88	80	8		July	74	61	13	
August	92	81	11		August	70	58	12	
September	89	77	12		September	68	56	12	
October	87	73	14		October	68	41	27	
November	79	71	8		November	53	37	16	
December	79	70	9		December	56	34	22	

From this table we may deduce that the greatest degree of heat in any month is from 80 to 90, and that the lowest degree is between 60 and 70 *. The variation of heat monthly appears to be on an average 11 degrees, and the annual variation 26 degrees.

* The heat throughout the day is more uniform in Jamaica than in our climate. Mr. Long observes, "There is seldom a variation of more than 6 to 9 degrees on the thermometer in one day at Spanish Town, observed from six in the morning to six in the afternoon."—Hist. of Jamaica, vol. 3. p. 619.

The other part of the table * is put down, in order to ſhow the relative temperature of the atmoſphere of London; and by compariſon, to prove the neceſſity of applying artificial modes of culture to plants whoſe native clime is within the torrid zone.

The year 1775 was particularly ſelected as an inſtance of the great extremes of heat and cold, which occur in our own climate †.

It is not to be underſtood that the preceding remarks on the ſtate of the air at Spaniſh Town will anſwer for every part of Jamaica, which abounds with ridges of mountains, as well as valleys or ſavannahs; ſo that there muſt be a conſiderable variety of temperatures in it, according to the difference of ſituation. It is however to be noted, that the pineapples are moſt luxuriant in the loweſt and hotteſt parts of the iſland, where the foregoing obſervations on the temperature were made.

I ſhall next proceed to inveſtigate the quantity of rain which falls annually in Jamaica. From the obſervations of Sir Hans Sloane and Mr. Long, we learn that the proportion of fair to rainy weather varies much in different years at Jamaica.

* The numbers in this latter part of the table are taken from the Philoſophical Tranſactions for the year 1776.

† The extremes of heat and cold are often much greater than in the inſtance here quoted by Mr. Whitehurſt. The annual variation in 1793 was not leſs than 57 deg.

The annexed table ſhows the number of rainy days at Spaniſh Town, as obſerved by Sir Hans Sloane in 1688; and likewiſe the number of wet days during eight ſucceſſive years, beginning with 1752, from Mr. Long's account.

Sir Hans Sloane 1688.		Mr. Long 1752 to 1759 incl.	
Months.	Rainy Days.	Months.	Rainy Days.
January	9	January	6
February	8	February	17
March	6	March	19
April	no obſervation	April	41
May	9	May	58
June	8	June	55
July	6	July	55
Auguſt	12	Auguſt	58
September	16	September	65
October	10	October	76
November	12	November } December }	32
December	7		
	Total 10 × 8 = 824	Total in 8 years	482

The obſervations * of the latter gentleman were not indeed made at the ſame place, but nearly in the ſame parallel juſt within the ſouth ſide of the mountains. Mr. Long himſelf remarks, that a greater quantity of rain may be ſuppoſed to fall there than on the level maritime parts, and leſs than in ſome places on the north ſide, or on the eaſtern or weſtern; therefore an allowance ſhould be made on that account. We may however ſafely conclude from the average of eight years, that there are not leſs than ſixty rainy days in twelve months.

The quantity of rain falling in each day ſhould be conſidered, as well as the number of wet days in a year. We have more wet days in England, but the rain falls in far leſs quantities. On this head Mr. Long obſerves: "The rains precipitate in Jamaica with an uncommon degree of violence. After being accuſtomed to them, we think the clouds only drop in England, but here they melt in inſtantaneous caſcades." —"Taking the whole iſland throughout, 65 to 70 inches appear to be about the medium of rain that falls upon Jamaica in ſeaſonable years."

We ſhould likewiſe take into the account the falls of dew, which are ſo heavy in all tropical countries. Mr. Long ſays, "I have no meaſurement of the dews

* Long's Hiſt. of Jamaica, page 647.

which fall in Jamaica; but in many parts of the iſland they are very conſiderable, inſomuch that in one of the mountainous diſtricts, where there is a ſcarcity of ſprings, the cattle are ſufficiently watered by the dew, which overſpreads the herbage every morning. In general, in the mountains it is ſo heavy, that a perſon walking among the graſs, or through a cane-piece early in the morning, would ſoon be as wet as if he had gone through a river. It is always leaſt before heavy rains, and moſt copious in the cooler months of the year. In Spaniſh Town the dews are much larger than at Kingſton, owing perhaps to the vicinity of the Rio Cobre."

The above obſervations ſufficiently point out how great a ſupply of watery fluid will be requiſite for an artificial climate, deſigned to imitate that of Jamaica.

It now remains to make ſome inquiry concerning the ſoil, and the uſual modes of treating pine plants in their native ſituation. Several ſpecies of pineapples have been enumerated; and we are told, that if the ſeeds of them were ſown frequently, as many varieties of the fruit might be produced as there are of apples or pears in Europe.

Thoſe principally noticed are,

The bog-walk pine, of a compreſſed form, with white fleſh, and a deep green coat;

The ſame, with a yellow coat;

The pyramidical, or ſugar-loaf pine, with yellowiſh fleſh, and a deep green coat.

The ſame, with a yellow coat.

The ſmooth-leaved, or king pine.

The queen pine, with leaves ſmooth, and ſometimes ſpiked.

The ſmaller green and yellow pyramidical or Montſerrat pines *.

Of theſe the ſugar-loaf and Montſerrat pines are accounted the beſt, or fineſt in flavour. The others differ much in their degrees of ſweetneſs, acidity, and richneſs. They all thrive beſt in a ſheltered ſituation; and when planted in a brick mould, that is, in the clayey earth or marle of which bricks are made. Cow's dung is the manure uſually employed for them. Some perſons cultivate the plants on the tops of ſmall ridges or banks, raiſed about 18 inches, and diſpoſed in ſtraight rows. They grow moſt luxuriantly when thus aſſociated together: the ſuckers from them are alſo

* To the above, Mr. Long adds the wild pine, *tillandſia maxima*, which is very common in Jamaica. It may be made to grow on a broom or mop-ſtick fixed upright on the ground; and therefore appears to derive its nouriſhment by abſorption of moiſture from the atmoſphere. The wild pines are much the largeſt of the claſs, and grow among the thick woods of the interior mountains between the forks and on the branches of trees. Their leaves being capacious, and formed with a hollow baſe, become natural reſervoirs of water, which often afford refreſhment in dry ſeaſons to travellers, and to animals inhabiting the woods.

ſtronger and finer than when they are kept at a diſtance from each other, and the roots are preſerved cooler and moiſter.

From the preceding facts reſpecting the native climate of pine plants, we may deduce the requiſite circumſtances in the conſtruction of garden ſtoves, adapted for their culture in this kingdom.

1. The ſtoves ſhould be capacious, and freely admit the acceſs of light or ſunſhine.

2. They ſhould have a conſtant ſupply of freſh air, by ſome proper mode of ventilation.

3. The air tranſmitted ſhould be kept at a temperature anſwerable to that of the natural climate.

4. It is neceſſary to apply water or vapour to the plants, adequate to the proportion of rain and dew which falls in Jamaica.

5. The plants ſhould not have their roots confined in pots, but ſhould be planted looſe in common vegetable mould ſimilar to their natural ſoil. — See the preceding page.

Under this laſt article I think it right to obſerve, ſince pines at their native place grow to greateſt perfection in the common ſoil, whoſe heat is derived merely from the temperature of the ſurrounding atmoſphere, and not from any ſubterraneous fire, that therefore the application of bark, as employed in our ftoves, with a view to generate additional heat at the roots of the plants, is not according to the analogy of nature, and may be deemed ufelefs.

This opinion, fo contrary to general practice, is not however theoretical. I know from experience, that a plant may remain in the fame parcel of earth four fucceffive years, and without the aid of bark produce each year very perfect fruit. The experiment was made at my requeft by Mr. John Sands, gardener to lord Scarfdale, in his lordfhip's ftove at Kidlefton. A pot was provided to contain the plant, of about 14 inches diameter, and of the capacity of three gallons. This being filled with a clayey foil, well manured with old rotten dung, was placed near the flue, and not plunged in the bark-bed. The product of the plant was as follows:—In the firft year, one fruit and four ftrong fuckers, every one of which yielded the fecond year a fruit and three fuckers. Thefe in the third year produced three fruits and two fuckers, nearly as ftrong as the firft. In the fourth year there were two fruits, but not fo large as the former. The year following the plant died, after having produced one fruit. This plant, while it remained, was generally obferved to be more vigorous, and to yield finer fruit than any of thofe which were fet at the fame time in the bark-bed.

I ſhall in the next place add a few obſervations on the other requiſites for an artificial climate, as above laid down.

1. The ſize of ſtoves cannot be defined by any rules reſpecting vegetation. Their capacity ſhould, however, be as large as conveniency will permit. In general, ſtoves are conſtructed on too ſmall a ſcale to anſwer the ends of them fully, and their roofs are made too low. The defect becomes greater, if there is no proviſion for a free circulation of air, whoſe temperature is properly regulated.

2. The temperature in ſtoves ſhould be nearly conformable to that of the natural climate. We have ſeen, that the greateſt degree of heat in any month at Jamaica is from 80 to 90; and that the loweſt degree is between 60 and 70; that the variation of heat monthly appears to be on an average ten or twelve degrees; and that the greateſt annual variation is 26 deg. We have alſo ſeen how much leſs in general is the heat of an Engliſh ſummer, and how much greater the cold of our winters. It is proper, however, to remark, that theſe plants, while growing in their native climate, require no protection from the weather; whence it ſeems unneceſſary, and would be perhaps injurious to defend them from every degree of inclemency in our atmoſphere.

The great end and uſe of ſtoves is in the winter ſeaſon, when the plants require to be effectually ſheltered from the cold winds and damps; and when the application of artificial heat alſo becomes neceſſary to counteract the ſeverity of the weather.

Mr. Whitehurſt, in his remarks on the conſtruction of ſtoves, objects to a roof conſiſting wholly of glaſs, becauſe that ſubſtance being a very quick conductor of heat, does not afford a ſufficient defence againſt ſudden alterations of heat and cold, particularly where the roof is very low. He obſerves further, that the moiſture aſcending in ſtoves ſo conſtructed, is ſoon condenſed by the external cold, and drops upon the plants, doing them conſiderable injury, and even deſtroying the parts it falls upon *. In ſummer alſo, the roof being nearly at right angles with the ſun about the time of the ſolſtice, he thinks a degree of heat is often produced, which parches the plants, unleſs the attendants take proper care to throw a ſhade over them.

With a view to remedy theſe inconveniences, he propoſes an alteration in the form of ſtoves. His plan will be underſtood from the ſection, fig. 26, in which only part of the roof A B is parallel to the axis of the earth, and compoſed of glaſs in the uſual manner.

* This effect takes place more eſpecially, if the ſtove be not properly ventilated.

The remaining part B C, inclined toward the north, is made of thatch, as being the material leaſt liable to be affected by changes of heat and cold. The width of the building from A to D is intended to be ten feet, the height ſomewhat more; and the walk at the back of the bed, two feet. E D repreſents the ſurface of the ſoil-bed. The line *e q* marks the direction of the ſun's rays at the equinox, and *w r* their direction at the winter ſolſtice: *s s* and *s s* are the ſolſtitial rays in ſummer.

As Mr. Whitehurſt has propoſed no material improvements on the preſent mode of applying heat in ſtoves, I ſhall paſs over his obſervations on that ſubject. I think it, however, not amiſs to mention ſome objections to his general plan, which have been made by experienced gardeners *.

Firſt, It is ſaid, that the plants ſet in ſtoves require perpendicular light, of which, according to the propoſed plan, they muſt be in a great meaſure deprived, unleſs the ſtoves were made of an inconvenient and diſproportionate height.

Secondly, The back part of the ſtove being the loweſt, would not admit of tall plants being ſet there. If theſe were placed in front, they muſt neceſſarily ſhade what is behind them.

* Meſſrs. Forſyth, Driver, and Watſon.

Thirdly, Though extenſive ſtoves may be deſirable, yet their capacity ſhould conſiſt not in height, but in width, for the ſake of conveniency; the object being to raiſe a great number of plants with the leaſt poſſible expence of fuel.

A trial has been repeatedly made of ſtoves with a perpendicular glaſs front, and a ſheltered roof ſloping from thence to the back ſhed. As theſe have been found by no means to anſwer the purpoſe, it is concluded that every approximation toward the upright front will be detrimental to the growth of the plants.

3. With regard to the ventilation of ſtoves, Mr. Whitehurſt obſerves: The pine plants, growing in their natural climate, have the advantage of a continual change and ſucceſſion of pure air, which is found eſſentially requiſite for preſerving the health both of vegetables and animals; for ſtagnant air ſoon becomes unfit for the former as well as for the latter, being contaminated by means of the perſpirable matter, and other exhalations diffuſed through it. In natural climates, thoſe exhalations are carried off by the motion of the winds, and replaced by freſh wholeſome air, from whence both animals and vegetables derive what is eſſentially neceſſary to their exiſtence.

The above circumſtances, which are not the reſult of ſpeculation, but of actual experiment, point out to us the great outline to be followed in the conſtruction and management of garden ſtoves.

A given quantity of air being preſently tainted by the progreſs of vegetation, therefore the more capacious ſtoves are made the greater probability there is of their remaining healthful; yet, as capacity can never be ſufficient to ſupply the want of a free circulation of air, it becomes proper to make ſome proviſion for this purpoſe, more eſpecially when the inclemency of the weather will not permit the doors and windows to be opened *.

This proviſion in the artificial climate may perhaps be found as uſeful as the regulation of its temperature, or the admiſſion of light, for promoting the growth of vegetables, and is therefore a ſubject deſerving of much attention.

Beſide furniſhing the ſtove with a perpetual ſucceſſion of air, warmed, but not vitiated by the fire, it is further requiſite to provide for the regular diſcharge of that which has been vitiated by the plants.

* The caps of the glaſs are ſuppoſed to admit a quantity of air ſufficient to prevent any ſtagnation of putrid effluvia. Mr. Whitehurſt, however, thought that cold ſtreams of air thus admitted muſt be injurious to the plants, at leaſt in very ſmall ſtoves; he therefore recommended that the windows ſhould be conſtructed as nearly air-tight as poſſible, and that a diſtinct mode of ventilation ſhould be applied, by which the air might be made warm before its entrance into the ſtove.

In order to make the ſupply of freſh air, let there be a communication from without to the void ſpace between the flue and the pit, and let the covering of that ſpace be perforated in many places from one end to the other. Holes of half an inch diameter will be ſufficient, whether made in a ſtraight line or otherwiſe, and about half a yard aſunder. The holes ſhould be made in the front part, and not in the return, as in fig. 27. The communication from the external air into the void ſpace to be at A A. Now the greateſt heat being near the fire, the air will thus be prepared for admiſſion, before it arrives at the apertures in front. A regiſter plate may be applied at A A, in order to regulate the quantity of air to be admitted.

With regard to the other requiſite, the mode of diſcharging the vitiated air, and of thus producing a free circulation through the ſtove, Mr. Whitehurſt has left no ſpecific directions. This object may however be accompliſhed without much difficulty, by apertures correſponding to thoſe above deſcribed, made in the oppoſite ſide of the building. Two or three of a moderate ſize, would be ſufficient: their orifices in the back ſhed ſhould be covered with valves, according to the plans laid down in chap. 3. page 30. The external cold air may by this means be prevented from rushing into the stove; and the valves will readily yield to the pressure of the expanded air within, which enters by the assigned direction.

4. Beside supplying the plants with a proportion of fresh water adequate to the quantity of rain observed in their natural situation (see table, p. 39.) Mr. Whitehurst had an idea of imitating, in his artificial climate, the fall of dews, which is so considerable in all tropical countries.

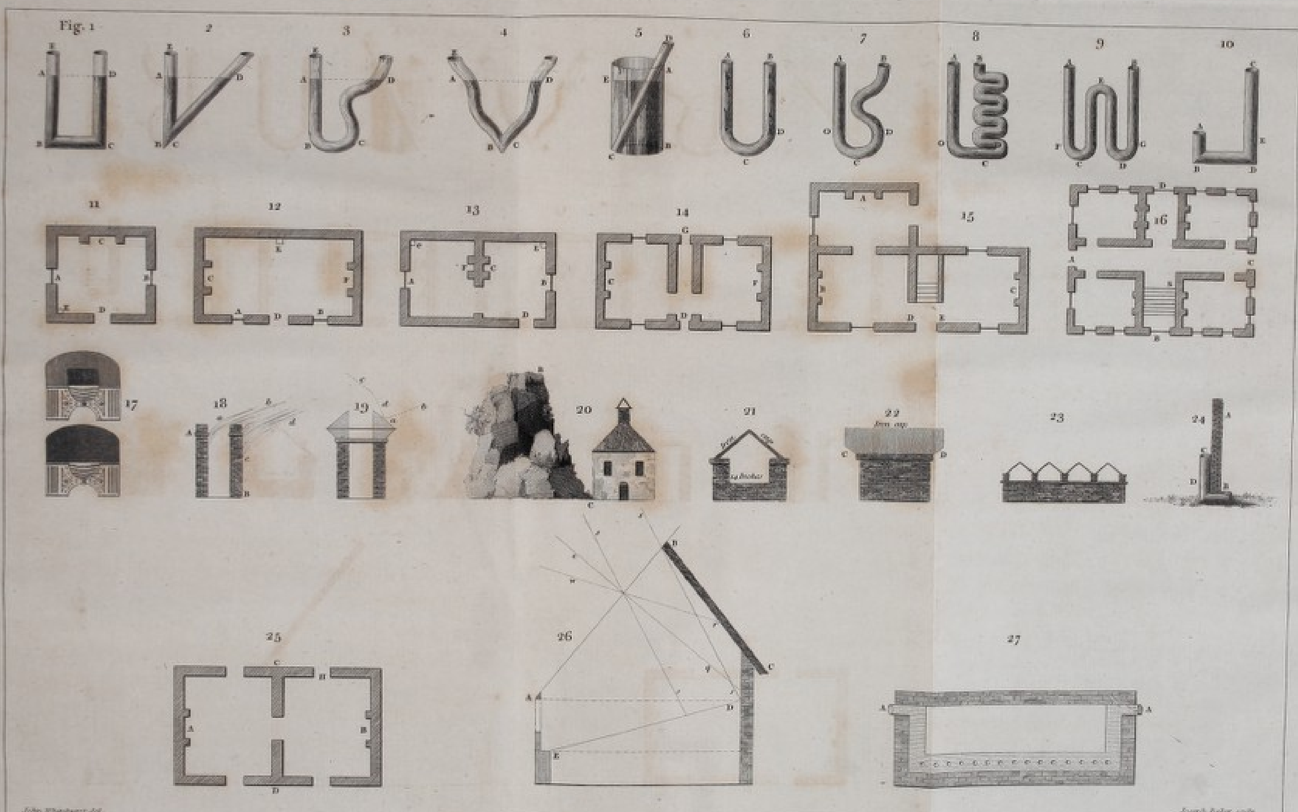
This could only be done by a cautious admission of pure watery vapour, which might afterward condense upon the plants and on the soil. A reservoir of water might be placed with this view, either within the stove, or adjoining to it. An iron or copper vessel should be fixed in contact with the flue near the fire, and have a communication with the reservoir, so as to supply itself without much trouble. The top of the vessels should open by a pipe into the stove.

In order to render this plan safe, the steam must be admitted very gradually; the water should be kept at a heat considerably below the boiling point, and should be thoroughly reduced to vapour, on its transmission into the stove. The vapour should be directed by means of the pipe upward to the roof, so that it may condense before its descent upon the plants.

Mr. Forſyth, his majeſty's gardener at Kenſington, informs me that a plan of this kind was carried into execution, under his direction, in the garden of the Apothecaries Company at Chelſea, and likewiſe in the Duke of Northumberland's at Sion Houſe, with the moſt beneficial effects. The ſame gentleman is of opinion, that ſtoves might be commodiouſly heated by tubes conveying ſteam, on a plan which would very much diminiſh the expence of fuel; and in which alſo a proviſion might be made for ſupplying the artificial dew at pleaſure.

Beſide the plans and illuſtrations above given, there are in Mr. Whitehurſt's papers ſeveral other deſigns relating to the ſubject of garden ſtoves, but left without an explanation. They repreſent different forms of ſtoves; different ſituations of the fire-places, chimneys, and air-ducts; and various modes of diſtributing the flues in a ſtove. It ſeems however unneceſſary to exhibit any of theſe plans engraved, as the preciſe intent for which they were formed, cannot now be properly aſcertained.

F I N I S.



John Whitehurst, del.

Joseph Baker, sculp.