An account of a useful discovery to distill double the usual quantity of sea-water, by blowing showers of air up through the distilling liquor: and an account of the great benefit of ventilators in many instances, in preserving the health and lives of people, in slave and other transport ships, which were read before the Royal society. Also an account of the good effect of blowing showers of air up through milk. Thereby to cure the ill taste which is occasioned by some kinds of food of cows / By Stephen Hales.

Contributors

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ACCOUNT

AN

USEFUL DISCOVERY

TO

Diftill double the usual Quantity of SEA-WATER, by blowing Showers of AIR up through the DISTILLING LIQUOR:

AND

An Account of the great Benefit of VENTILATORS in many Inftances, in preferving the HEALTH and LIVES of People, in Slave and other Transport Ships, which were read before the Royal Society.

ALSO

An Account of the good Effect of blowing Showers of AIR up through MILK, thereby to cure the ill Tafte which is occasioned by some Kinds of Food of Cows.

By STEPHEN HALES, D. D. F. R. S. Member of the Royal Academy of Sciences at Paris,

AND

Clerk of the Clofet to Her ROYAL HIGHNESS the PRINCESS of Wales.

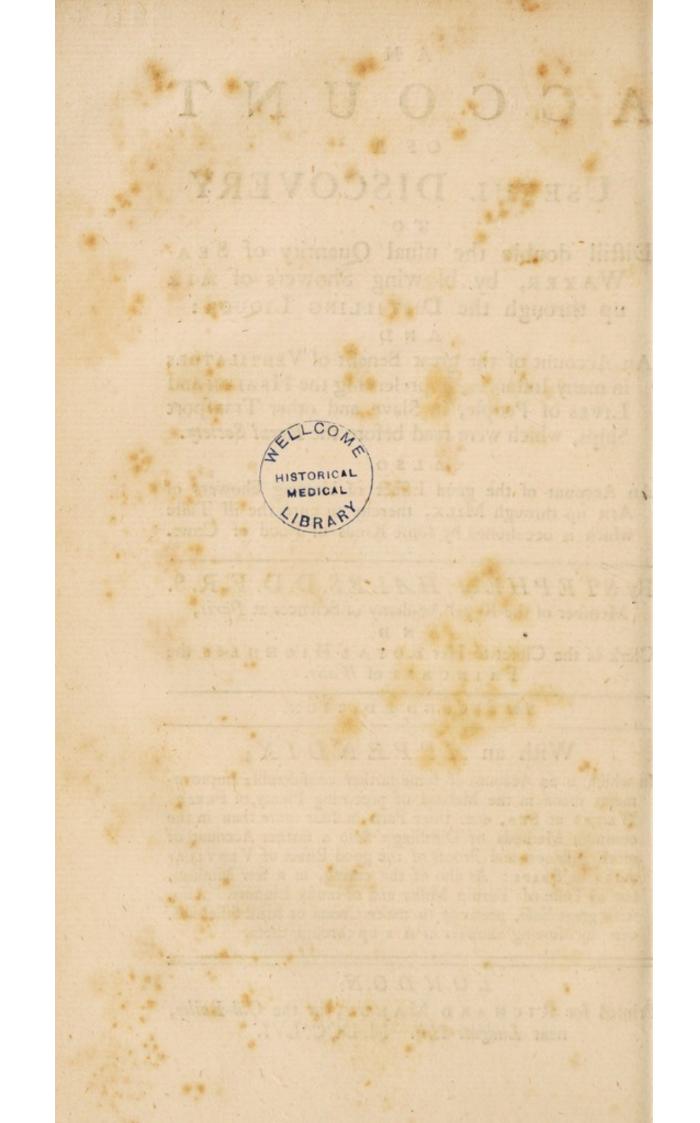
The SECOND EDITION.

With an APPENDIX;

In which is an Account of fome farther confiderable Improvements made in the Method of procuring Plenty of FRESH-WATER at SEA, wiz. three Parts in four more than in the common Methods of Diftilling: Alfo a farther Account of more Inflances and Proofs of the good Effect of VENTILA-TORS in SHIPS: As alfo of the curing, in a few Minutes, the ill Tafte of Turnip Milk, and of mufty Liquors. Alfo, with great Eafe, prefently to make Cream or Milk Sillabubs, wiz. by blowing Showers of AIR up through them.

LONDON:

Printed for RICHARD MANBY, in the Old-Bailey, near Ludgate Hill. M. DCC. LVI.



[3]

AN

ACCOUNT

OFTHE

Great Benefit of blowing Showers of FRESH AIR up thro' DISTIL-LING LIQUORS.

1. The great Importance of having a fufficient Supply of frefh Water in Ships, has been the Occasion of many laudable Attempts to make Sea-water fresh and wholsome; but all the Attempts and Discoveries hitherto made, have laboured under this great and material Objection, viz. the great Quantity of Fuel that was necessary to distill, with a flow Progress, a small Quantity of Water, by any Methods of Distillation hi-A 2 therto

therto known. But I have lately happily, most unexpectedly, discovered an easy and effectual Method to diffill great Quantities of Water with little Fuel; which I was led to by the following Incidents, viz. Mr. Shipley, Secretary of our Society, for the Encouragement of Arts, Manufactures and Commerce, brought me acquainted with Mr. William Baily of Salisbury-Court, the Author of many ingenious Contrivances; who fhewed me, in a fmall Model of a Tin Vessel, a Method, by which he has happily increased the Force of the Engine to raife Water by Fire, viz. by lifting up fome of the boiling Water, at, every Stroke, by means of a conical Veffel, with fmall Holes in it, full of Tow; whereby the Quantity of the afcending Steam or Wreak was confiderably increafed. This led me to think, that a greater Quantity of Liquor might also by this Means be distilled ; but on Trial I found the Increase to be only one twelfth Part, tho' confiderable in the expanded Form of a Steam. Hence I was led to try what would be the Effect of caufing an inceffant Shower of Air to afcend thro' the boiling

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boiling Liquor in a Still; and this, to my Surprife, I found on Trial to be very considerable. There was another Circumflance alfo, which probably conduced to lead my Mind to this Thought, viz. About fix Months before, Mr. Littlewood, a Shipwright at Chatham, came thence purpofely to communicate to me an ingenious Contrivance of his, foon to fweeten flinking Water, by blowing a Shower of fresh Air thro' a Tin Pipe full of small Holes, layed at the Bottom of the Water. By this means, he told me, he had fweetened the flinking Bilge Water in the Well of fome Ships; and alfo a But of finking Water in an Hour, in the fame manner as I blew Air up thro' Corn and Gunpowder, as mentioned in the Book on Ventilators.

2. The Method, which I used to blow Showers of Air up thro' the distilling Water, was by means of a flat round Tin Box, fix Inches Diameter, and an Inch and half deep; which is placed at the Bottom of the Still, on four Knobs or Feet half Inch high, to make room for the Liquor to spread over the whole Bottom of the A 3 Still,

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Still, that the Heat of the Fire may come at it. In larger Stills this Box must be proportionably larger, and have higher Feer. And whereas the Mouth of the Still is too narrow, for the Tin Box to enter, which Box ought to be within two Inches as wide as the Bottom of the Still; therefore the Box may be divided into two Parts, with a Hinge at one Edge or Side, and a Clasp at the other, to fix it together, when in the Still. This Box must be of Copper for distilling Sca-wawater; mine was made of Tin for other Liquors alfo. The Air-pipe, which paffes thro' the Head of the Still, will help to keep the Air-box from moving to and fro by the Motion of the Ship; or, if that should not be found sufficient, 3 or 4 fmall Struts may be fixed to the Sides of the Air-box. They must reach to the Sides of the Still. The Cover and Sides of the Air-box were punched full of very fmall Holes, one fourth Inch diftant from each other, and about the twentieth part of an Inch in Diameter. On the Middle of the Cover or Lid of this Air-box, was fixed a Nofil more than half Inch wide, which was

was fitted to receive, to put on, and take off the lower End of a Tin Pipe, which was twenty Inches long, and paffed thro' a Hole in the Head of the Still : four Inches of the upper end of this Pipe were bent to a Crook, almost at a right Angle to the upright Stem, in order thereby to unite the Crook to the widened Nose of a Pair of Kitchen double Bellows, by means of a short Leathern Pipe of Calves-skin. See Fig. 1st. This Tin Air-box, and many more of them for other Persons, were made by Mr. Tedway, Tinman, over-against the Meuse-Gate, Charing-Cross.

3. The double Bellows were bound faft to a Frame, at the upper Part of the Iron Nofe, and at the lower Handle, in order the more commodioufly to work them. And that the upper Half of the double Bellows may duly rife and fall, in order to caufe a conftant Stream of Air; (befides the ufual contracting fpiral Springs within fide) feveral flat Weights of Lead muft be layed on the upper Part of the Bellows, near the Handle, with a Hole in their Middle, to fix them on an upright Iron Pin faftened on the A = A

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Bellows: That by this Means the Weights may the more commodioufly be put on or taken off. For, according to the different Depths of the Liquor in the Still, fo will the Force of the included Air, against the upper Board of the Bellows, be more or lefs. Thus, fuppoling the Depth of the Water in the Still to be twelve Inches; from the Surface of the depressed Water in the Air Box; then the Preffure of the included Air against the upper Part of the Bellows, will be equal to that of a Body of Water a Foot deep, and as broad as the inner Surface of that Board. It will, therefore, be requisite, to add or take off Weights, according to the different Depths of the Water in the Still, at different Periods of the fame Distillation. The Bellows must be proportionable to the Size of the Still, but need not be very large. Wherever the Stills are fixed in Ships, the Air may be conveyed to them from the Bellows, either thro' a fmall leathern Pipe, diftended with Spiral Coiles of Wyre, or thro' Bamboo Canes, or broad fmall wooden Pipes, like hollow fifting Rods.

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4. WHEN I first distilled in this ventilating Way, in order to estimate, what the Difference might be in the Quantity diftilled, by that or the common Method, I tried both Ways, by receiving the diffilled Liquor into a Quarter of a Pint Glass, estimating the Times, by a Pendulum beating Seconds. Where I found, to my Surprife, that fometimes three times more was diffilled by Ventilation than by the usual Way: But finding Inequalities in the small Quantities thus distilled, in order the more fully and affuredly to afcertain the true Proportion there was in the two Methods of distilling, I put three Gallons of Water into the Still; and, when it boiled, put on the Still-head, and fixed its Nofe to the Worm-tub Pipe; which Tub was full of cold Water. When it had diffilled for an Hour, the Receiver was inftantly taken away. And on meafuring the diffilled Water, found it to be two Quarts and 45 cubick Inches by a Glass divided into cubick Inches. And a Gallon containing 282 cubick or folid Inches, this Quantity of distilled Water, which was

10 To make Plenty of was 186 cubick Inches, is $\frac{1}{1.3}$ th Part of a Gallon.

5. THEN, filling the Still as full of Water as before, and when it began to boil, fixing the Head to the Still and Wormtub, which was full of cold Water; there was diffilled in an Hour, with conftantly blowing Showers of fresh Air up thro' the stilling Liquors, five Quarts, less by seven cubick Inches, which is 345.5ths cubick Inches; that is, little lefs than the double of the Quantity that is distilled in the usual Way. In several other Distillations of a Quart at a Time, I found the Quantity distilled by Ventilation, to be more than the double of that in the usual Way. So that the Quantity by Ventilation, may at a Medium be effimated the double of the usual Distillation. It is the well known Property of moving Air, to carry along with it a confiderable Quantity of adjoining Vapour, as also of falling Water to carry much Air down along with it.

6. It is to be hoped therefore, that so confiderable an Increase in the Quantity distilled, FRESH WATER at SEA. II distilled, will be of great Benefit to Navigation, as it may be done in less Time and with less Fire.

7. IN the Account of Mr. Appleby's Process, for making Sea-water fresh, which is published by Order of the Lords of the Admiralty in the Gazette of Jan. 22, 1754, it is faid that a Still which contains 20 Gallons of Water will diftill 60 Gallons in ten Hours with little more than one Bushel of Coals; and therefore 120 Gallons in 20 Hours, with little more than two Bushels of Coals. And by Ventilation 240 Gallons, or a Tun; and 24 Gallons may be distilled in twenty Hours, making an Allowance for the times of heating those Stills full of cold Water; and a Still fomething larger and wider, will distill a Tun in 24 Hours; which will more than fuffice for a fixty Gun Ship with 400 Men, whofe Provision of Water for four Months is about 110 Tuns. And larger Ships may either have proportionably larger Stills, or elfe two of them. As for Merchant-Ships with few Men, a small Still will be sufficient.

8. THE

8. THE fecond fized Stills contain 10 Gallons, and will produce 60 Gallons in 20 Hours, with half the above-mentioned Fuel; and by Ventilation 120 Gallons.

9. THE least Stills contain five Gallons, and will produce 32 Gallons in 20 Hours; and by Ventilation 64. Gallons in 20 Hours.

10. I have feen fome of thefe Stills at Meffrs. Steel and Stephens, over-againft Mercers-Chapel, in Cheapfide, which have been made for this Purpofe. There are Holes in the Feet of the Iron Frame or Stove to skrew them down to the Deck. They were fixed at the Fore-caftle before the Maft in King Charles the Second's time, when they thought they had difcovered the Way to diftill Sea-water, free from the noxious Spirit of Salt, and from the naufeous bittern Tafte. Or, if it be thought proper, one Part of the Ship's Boiler may be made use of, by adapting a Still-head to it,

II. Now

11. Now supposing a Still to contain 25 Gallons, and that four Parts in five of it, viz. 20 Gallons are distilled off: then, in order to diffill a Tun, or 210 Gallons, the Still must be emptied, cleansed and refilled eleven times; and if the whole be done in 24 Hours, full 16 of those Hours will be taken up in diffilling at the rate of a Gallon in about four Minutes and half; and the remaining eight Hours of the 24, being divided into II equal Parts, they will be each near 44 Minutes to empty and cleanfe the Still, to refill it, and give the Sea-water a proper boiling diffilling Heat : whether this can be done in fo fhort a Time, must be known by Experience, and ought therefore first to be tried at Land.

12. Doctor Butler, in his lately publifhed Method of procuring Fresh Water at Sea, proposes the pouring in more Seawater into the Still, thro' a Funnel fixed in a small Hole in the Head or Upper-part of the Still, when more than half the former Water is diffilled off; by which means the Water in the Still will soon acquire a diffilling

ling Heat; and this to be repeated feveral times; but then it will be requifite to add each time more Chalk, in fuch Proportion as fhall be found requifite. It will be well to try this Method in hopes thereby to increase the Quantity of Water that is diftilled. The Hole in the Head, or Upper-part of the Still, is to be ftopped with a fmall Plate of Copper, fo fixed as to turn to and fro over the Hole.

13. DOCTOR *Butler* used capital Soap Lees, in the Proportion of a Wine Quart to 15 Gallons of Sea-water, which sufficed for four or five times repeated Pourings in of more Sea-water into the Still. But as I have found that a small Quantity of Chalk has the same good Effect, and is cheaper, and more easily to be had, it is therefore preferable to Soap Lees.

14. WHEN there is a Fire in the Cookroom, the Sea-water might be ready heated to put into the Still, without any additional Expence of Fuel, in the following Manner, which I shall here describe; tho' I think it probable that it will not be put in

I

FRESH WATER at SEA. 15 in practice; yet, as farther Improvements may possibly hereafter be made in it, and as it may be of use in some Cases, at Land at least, I shall here give an Account of it, viz.

15. ABOUT the Year 1718, Mr. Schmetou, a German Gentleman, got a Patent here for heating great Quantities of Water, with little Expence of Fuel, which he then shewed me. Having fixed a spiral Iron Worm-pipe, in fuch a Brick Stove or Chimney as Women heat their Irons in, thereby caufing the Water to run from a Veffel, thro' the Worm-pipe, feveral Feet Length round, in the Fire. About 30 Years after I acquainted Mr. Cramond of Twickenham with this, as hoping it might be of Benefit in diftilling Sea-water. Upon which he procured fuch a spiral Iron Worm-pipe, which was about twenty Feet long, and fix-tenths Inch Diameter; the Diameter of the spiral Coile was about fourteen Inches.

16. THIS I fixed in a Brick Stove in my Garden, with its upper End fixed to a Veffel,

Veffel, which contained 45 Gallons of Water. I found the Event of this first Trial to be as follows, viz. When the Water run full Bore, at the rate of a Gallon in 17 Seconds, the Heat of the Water was found, by a mercurial Thermometer held in the Stream, at the lower End of the Pipe, to be 80 Degrees above the freezing Point, 180 Degrees being the Heat of boiling Water. When by means of a Turn-cock, a Gallon of Water was two Minutes in running, then the Heat was 140. At which Rate the 45 Gallons would be an Hour and half in running thro' the Ironpipe; at which Rate 25 Gallons will run thro' in 50 Minutes, with fo confiderable a Degree of Heat; and if it was an Hour running, the Heat would approach still nearer to a boiling Heat, when first put into the Still, which would forward the Distillation if wanted.

17. I PUMPED the heated Water up again into the upper Veffel; and thus continued to circulate the heating Water, till its Heat was 160 Degrees in the upper Veffel, viz. within 20 Degrees, or one-4 ninth

ninth of boiling, the Heat requisite for plentiful Distillation. I was in hopes that if the Water in the upper Veffel could have been brought to a due Degree of Heat, and a Still-head were fixed on it, with its cooling Worm-tub, then Water might have been diffilled in Ships, by having the Iron Worm-pipe fixed in the Chimney of the Cook-room : But I found, that when the Heat of the Water in the upper Veffel was 160 Degrees, viz. within one-ninth of boiling; then in running through the Iron Worm-pipe again, it was fo overheated, as to expand in the Pipe, into an explosive Vapour, which hindered the running of the Water. However I thought it not improper to give an Account of this Attempt, notwithstanding it failed. Not knowing whether this Method of heating Water, may not in fome Cafes, at Land at least, be of use, thereby to fave, in some degree, both Fuel and Time: Perhaps an Iron Worm-pipe of a larger Bore might do better.

18. THE Waste of Fuel will be less in proportion to the Quantity distilled in B large,

large, than in fmall Stills; and the wider the Still-head is, fo much the more Liquor will be diffilled, and more with a Worm-tub than without it. The Wormtub may be fo covered, as to prevent the flowing over of the Water by the Motion of the Ship.

19. It is of great Importance to take care to keep all Parts of the Still clean, that there may be no Ruft or Verdigreafe in the Copper, which will occasion Vomiting.

20. IF it be neceffary, the better to close the Joining of the Still-head, it may be done with a Lute or Passe made of a Mixture of powdered Chalk and Meal, wetted with Salt-water.

21. Now that feveral effectual Means are difcovered, to make diffilled Sea-water wholfome, and alfo to diffill it in much greater Quantity in the fame Still, in the fame Time, and with nearly the fame Quantity of Fuel; it is reafonable to believe, that it will be of great Benefit to A

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Navigation, not only in faving much flowage room, for other important Purpofes; but alfo in procuring frefh fweet wholfome Water, inftead of flinking putrid Water, hitherto ufed; which muft needs have a Tendency to promote that putrid Diffemper, the Scurvy. And if withal due Care be taken, to exchange for frefh Air the putrid clofe confined Air of Ships, which has occafioned the Death of Millions of Mankind; then Navigation will become remarkably more healthy, and with little more Danger to Health and Life, than at Land, except from Storms.

22. Now supposing, that in a facty Gun Ship, the 110 Tuns of Water, for four Months use, were distilled at the Expence of three Bushels of Coals to a Tun, this would confume nine Chaldrons of Coals : And as a Chaldron of Coals weighs about a Tun and half; hence it appears that Coals will distill about eight times their Quantity of Water. And the 110 Tuns of Water weighing (at the Rate of 2240 Pounds to the Tun) 138 Tuns; and the nine Chaldrons of Coals weighing thirteen Tuns and B 2 half,

half, that is 94 Tuns and half lefs than the 110 Tuns of Store-water; and allowing twenty-four Tuns and half for the Still, Water-casks, and Coals, there will be 70 Tuns Weight of Stowage faved thereby for other Ufes. Or if fome Tuns of Storewater are carried by way of Precaution, which it will be advifable to do, efpecially at first, till they can be affured, by repeated Experience, what Quantity can be depended upon by Distillation; even then about half the Tunnage will be faved, which will be a very material Advantage.

23. THO' when the diffilling Liquor runs from the Bottom of the Worm-pipe, thro' a long Pipe fixed to it, the Wafte by the ventilating rufhing Air, is not great when the Water in the Worm-tub is not hot; yet the following Precaution, if needful, may be ufed, in diffilling by Ventilation, viz. to fix at the lower End of the Worm-pipe, by means of a wooden Fawcet, a finall Cask for a Receiver; the Fawcet to enter the upper fide of the Head of the Cask, and in order to give a free Paffage for the great Quantity of ventilating

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ing Air to pass off, and withal at the fame time to prevent the escaping of much moift Vapour with it, it will be proper to fix at the Bung-hole a long upright Pipe of Wood, or of any Metal. I used a Gunbarrel four Feet and a half long; through which fome fmall Degree of moift Vapour escaped; as appeared by the Dampness of a Picce of Paper, fixed at a little Distance above the Mouth of the Gun-barrel. This Vapour became visible, and much increased, when the Water in the Worm-tub was very hot; at which Time, lefs is diffilled into the Cask-receiver; then also there is more Danger of the Spirit of Salt arifing. And it was observable, that the Water in the Worm-pipe Veffel heated much fooner by Ventilation, than in the common Way of diffilling. For which Reason that Water ought to be changed fo much the oftener, which can eafily be done at Sea. The Cocks also at the Side of the Wormtub ought to be large, in order to let the hot Water off the fafter.

24. BUT tho' the Water in the Wormtub was fooner heated by Ventilation, becaule

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cause a double Quantity of hot Steam paffed thro' it, more than paffed thro' it in equal Times in the common Way of distilling; yet in the usual Way of Distillation the Liquor in the Still is hotter, with equal Fire, as is evident by its aptnefs to boil over thro' the Worm-pipe; whereas in the ventilating Way it did not boil over, notwithstanding a very hot Fire was purposely made for a Trial. The continual Streams of alcending fresh Air, not only in fome Degree abating the Heat of the Water; but also inceffantly carrying off the more rarefied Particles of the Water, which, when expanded into a repelling State, do thereby caufe the overflowing' Ebullition of the Water. On which Account it is probable, that lefs Spirit of Salt is formed and raifed by Ventilation than without it. As also on account of the fresh Air ascending, not from the Bottom of the Still, where is the greateft Plenty of Salt, especially towards the latter End of each Distillation; but abour three Inches from the Bottom, viz. principally from the many Holes at the Surface of the Air-box.

25. AND

25. AND whereas the Quantity railed from the Still, and diffilled into the Caskreceiver, cannot be feen ; the proper Quantity to be distilled in each Distillation, may with great Accuracy be known, by having a well closed Pewter Bottle of the Size of about half a Pint, with a Brafs Wyre as big as a Goofe Quill fixed to it, the Wyre to pafs thro' the Receiver-cask, near the Bung-hole, which the floating Pewter Bottle will raife up, till the Marks on the Wyre appear just above the Cask. I made use of a Glass Viol for this Purpofe. This Wyre will rife and fall freely, notwithstanding the Motion of the Ship, if it paffes not only thro' the Wood of the Cask, but alfo thro' a metaline Pipe two or three Inches long, fixed in that Hole. And it will be known by the fimmering or boiling Noife of the Water in the Still, whether it is hot enough to diffill; for the running of the Water into the Receivercask cannot be feen.

26. As it might be fuspected, that more Spirit of Salt would be raised, and diffilled B 4 over

over in the ventilating Way, than without it; having procured 18 Gallons of Seawater by the Margate Hoy, which was taken up at some Distance from the Shore, I put three Gallons of this Sea-water, as foon as I had received it, into the Still; and when it began to diffill, Air was blown up thro' it. For fome Time, as is ufual, in the Diffillation of Sea-water; no Spirit of Salt arofe; but after distilling some Time longer, there were very weak whitifh Clouds, with Drops of Solution of Silver in Aqua-fortis, as in the common Way of distilling. Hence we see, that Ventilation does not increase the Quantity of Salt, but rather probably fomewhat decreafes it, for the Reasons above given, Nº 24.

27. I DISTILLED three Gallons of Seawater, which had flunk and became fweet again; when about ten Quarts of it had been diftilled off, then there began to be very weak whitifh Clouds with Solution of Silver, but none with Solution of Mercury; which fhows the Water to be hitherto good, agreeably to what I formerly had found to be the good Effect of diftilling 3

Sea-water, which had putrified, and become fweet again; of which I published an Account in the Year 1739. But when I continued the Distillation on, a quarter of an Hour longer, viz. till there was but a Pint of Water remaining in the Still, and the Salts were incrusted on its Sides, up near three Inches from the Bottom, and lay in Heaps at the Bottom of the Still, then the diffilled Liquor had whitifh Clouds in it, with the Solution of Mercury in Aqua-fortis. From this Distillation we fee, that Putrefaction, by diffolving the bittern Salt and Bitumen, into very minute Parts, qualified them to combine with the more fixed common Salt, so as to detain them from rifing in Diffillation.

28. I DISTILLED three Gallons of Seawater, with the Proportion of fix Ounces of Mr. *Appleby*'s Lapis Infernalis, and fix Ounces of calcined Bones to 20 Gallons of Sea-water, as he directs. This Water lathered well with Soap, and boiled Peas well.

29. I DISTILLED also fome Sca-water with half an Ounce of Stone Lime to a Gallon,

Gallon, from the Clee Hills in Herefordfhire, which having been preferved ten Months in a Firkin, had flacked to dry Powder. This diftilled Water did alfo lather well with Soap, and boiled Peas well; which proves that the Lime, which is a fixed Body, does not diftill over with the Water. Since I made this Diftillation, General Oglethorpe informed me, that his Father, Sir Theophilus, told him, that Lime was one of the Ingredients, of what he and the reft of the Patentees, in Charles the Second's time, called the Cement, with which they made diftilled Seawater wholfome.

30. I DISTILLED alfo fome Sea-water with the like Proportion of powdered Chalk, which boiled Peas well, and was better tafted than the Waters diftilled with Lapis Infernalis or Lime. I diftilled alfo fome Sea-water with an Ounce of Chalk
to a Gallon, but found no Difference in the Tafte of this, and that which had but half an Ounce of Chalk to a Gallon : So that half an Ounce of Chalk to a Gallon is fufficient; but, where the

FRESH WATER at SEA. 27 the Sea-water is falter, or more bituminous, more Chalk may be added if needful.

31. DR. Alfton of Edinburgh, in the Preface to the Second Edition of his Differtation on Quick-lime and Lime-water, fays, that " the like Effect was found in " diffilling Sea-water with Lime, that it " neither precipitated a Solution of Silver " in Aqua-fortis, nor a Solution of cor-" rosive Sublimate in Water, nor did it " form a Pellicle of various Colours on " its Surface, as did the Water distilled " by Mr. Appleby's Process." And I find, Page 35 of my Book on this Subject, that Lime of Oyster-shells had the same good Effect, but required two Distillations; I might then use too small a Quantity of that Lime. Hence it is probable, that the Chalk, the Lime, the Lime in the Lapis Infernalis, and the Lime in Dr. Butler's Soap-lees, feize on and fix not only the bittern Salt, but also the Bitumen of the Sea-water, as we learn from the like Effect in the Purification of the Salt of Hartfhorn. That the faline Spirit arifes chiefly from

from the bittern Salt, and not from the more perfect Sea-falt, is probable from hence, viz. when I diftilled three Gallons of common Water, made as falt as Seawater with common Salt; no Spirit of Salt arofe, even tho' the Diftillation was carried fo far as to leave the Salt, tho' very damp, to lie in Heaps, and it was incrufted on the Sides of the Still, for about three Inches from the Bottom.

32. It is a confiderable further Advantage, that Water thus diffilled by Ventilation, being thereby repleat and frefhened with Air, has for prefent Ufe a more agreeable Tafte, than Water diffilled without Ventilation, which requires the ftanding a longer Time to have its more difagreeable aduft Tafte go off. And as the volatile Oil of Pepper-mint does rife on the Wings of the ventilating Air during the Diffillation; fo alfo may that Part of the Bitumen, which is volatilized by Heat; as alfo the volatile urinous Salts of the Sea water, which arifes from animal Subftances, be fublimed in the fame Manner.

33. IT

33. It was observable, that the Water diffilled fast, even tho' the Water in the Still was below the Surface of the Tin Air-box, thro' which the greatest Part of the ascending Shower of Air rushed. Hence the ventilating Air, in ascending among the Vapours, carries them off fast. Hence it is to be suspected, that this Method of Ventilation will not do well for simple Waters, or fermented vinous Spirits; because they being very volatile, much of them may be carried off in Waste.

34. IT was observable, that in these Diftillations of Sea-water, no whitish Clouds appeared on dropping in Solution of corrofive Mercury, not even when confiderably more than four Parts in five of the Water had been diftilled over. And it was the fame with the Mixture of Lapis Infernalis, Lime, and Chalk; whence it is probable, that the Lime and Chalk feize on and fix the more volatile bittern Salt, as does also the Lime in the Lapis Infernalis. And it is well known, that Sugar, that fweet Salt, cannot be made without Lime, on which, as its Centre of Union, it fixes and granulates. 35. AND

To make Plenty of

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35. AND whereas with a Solution of Silver in Aquafortis, which was much weakened and diluted with Water, there appeared a faint Degree of whitish Cloud, in all the above-mentioned Diffillations, tho' not with the ftronger Solution of Mercury till the Distillation was carried on, much beyond four Parts in five of the Water in the Still; when both Solutions caused remarkably white Clouds, efpecially the Solution of Mercury; which indicates the Quantity of the Spirit of Salt which was raifed during the former part of the Diffillation to be exceeding finall, fince it could not seize on, nor disengage the Aqua-fortis from the ftronger Solution of Mercury, tho' it did in a very fmall Degree in the weak Solution of Silver, fo as to let loofe a very little of the Silver, which thereby caufed the faint Clouds. When a Drop of the Solution of Mercury was dropped into the diffilled Water, after a Drop of the Solution of Silver, it reforbed the Silver Cloud, and made the Water clear, by means of the great Proportion of acid Aqua-fortis that was in it.

36. Now

FRESH WATER at SEA. 31

36. Now in order to make some Effimate of the very small Quantity of Spirit of Salt in these several distilled Waters, I dropped a Drop of the Solution of Silver into an Ounce, or 480 Grains of pure Rain Water, which gave no Clouds; but on dropping in a Drop of Sca-water, which weighed a Grain, the white Clouds were ftrong. And fince Sea-water can diffolve nine times more Salt than it has in it; therefore, supposing the Drop to be fo fully impregnated with Salt, then the Salt would be the 480th Part of the Ounce of Water. But as there is nine times lefs Salt, therefore the Proportion of the Quantity of Spirit of Salt will be but the 4320th Part. And how much lefs must be the Proportion of Salt in these distilled Waters, which is not fufficient to make a sensible Impression on Solution of Mercury, and but a faint one on much diluted Solution of Silver. Such distilled Sea-water will not therefore, probably be unwholfome; almost all Spring-waters have some Degree of Salt in them: But if there were more of the Spirit of Salt, a VELA

32 To make Plenty of

very finall Quantity of Pot-afh, or Pearlafhes, or Salt of Tartar, combined with it, will turn it into common Salt, the Quantity of which would be extremly little.

37. It may be well to be provided in Ships with fome Silver diffolved in Aquafortis, mixed with pure Rain-water, or difilled fresh Water, in the Proportion of fixty Drops to an Ounce of the Water; tho' it is probable, it may feldom be wanted, unless in fome doubtful Cases, when the Taste may not be accurate enough to perceive, whether there be any Spirit of Salt in the distilled Water.

38. SINCE double the usual Quantity of Vapour may by Way of Ventilation be carried off, common Salt may thus be made much fooner, cheaper, and better; because as there is much less Fire used; fo proportionably, less of the fine acid Spirit of the Salt, in which its Virtue confiss, will be evaporated away: For it is well known, that the Salt is best which has undergone the least Action of Fire in making.

39. THIS

FRESH WATER at SEA. 33

39. Тнія more speedy Method of evaporating will also be useful, in making many other Evaporations; as in making Pot-ash, &c.

40. BUT fome are apprehenfive, that this great Improvement in Distilling, may be of ill Confequence in making those deftructive Spirits cheaper, which are already but too cheap. Had not the Improvement been of great Benefit to Mankind in many other Respects, I should have been far, very far, from endeavouring after it, or discovering it. But should the Event be to make those Spirits cheaper, and consequently, by spreading farther, more deftructive, the confequence of that will be, that the increased raging Devastation will the fooner neceffarily roufe the Nations to put a Stop to what must be done hereafter; for if the Ravages continue increafing, as they have done for fixty Years past, the human Species must needs not only be greatly debased, but even in great measure diminished and destroyed. And yet none of the Nations, whole very Vitals C

To make Plenty of

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tals are thereby confuming and deftroying, endeavour to put any Stop to it, except the Heads of the native Indians in North-America, who have long repeatedly intreated the English to fell them no Rum; which is as effectually extirpating of them, as the Hornet did the unfubdued remainder of the Canaanites.

4.1. IF Mankind, inflead of receiving and entertaining this Peft with almost universal Applause and Approbation, could prevail with themselves to be in earnest to use Means to deliver themselves from it; then much might be done towards it, by lowering and weakening all kind of fermented distilled Spirits with Water, to a falutary Degree, as is now practifed in our Plantations in America, in making Punch fo weak, as not to be hurtful; which, when it was much ftronger, was well known to deftroy Multitudes. And where the like humane, wife, and laudable Practice has been used in Ships, it has had the fame happy falutary Effect.

42. WHAT

FRESH WATER at SEA. 35

42. WHAT Neceffity or even Temptation can there be to be averse to the making them wholfome, inftead of being venomous and destructive? and that not only of the Lives, but even of the Morals of Mankind. How much therefore does it behove all, who have any Concern for the Honour and Dignity of their own kindred Species, any Indignation at its being thus debased and difgraced, any Bowels of Pity for the vast Multitudes, not less than a Million, that are yearly deftroyed all over the World, by this moral as well as natural, and therefore worft of all Evils that ever befel unhappy Man; to use their utmost Endeavours to deliver Mankind from this Peft? But notwithstanding this aftonishing Ravage and Destruction of the human Species, yet the unhappy unrelenting Nations of the World, feem as unconcerned about it, as if only fo many Thoufands, nay, Millions of Caterpillers or Locufts were destroyed thereby. Was there ever a more important Occasion to rouse the Indignation of Mankind? Can we be calm and undisturbed, when this mighty C 2 Deftroyer

36 To make Plenty, &c.

Deftroyer rears up its invenomed Head every where? The most zealous Advocates for Drams, even the unhappy befotted Dramist themselves, the prolonging of whose Lives, and whose real Welfare both here and hereafter, is hereby fincerely intended, cannot find fault with this wellmeant Remonstrance, in Defence of them, and of all Mankind, against this mighty Destroyer, from one who has long been labouring, and that not without Success, in finding Means to preferve Multitudes of Lives, by various Ways.

An

E 37]

An Account of the great Benefit of VENTILATORS in many Instances, in preferving the HEALTH and LIVES of People, in Slave and other Transport Ships.

43. I T is to be hoped that the feveral Means here proposed for having fresh and sweet Water at Sea, will be of great Benefit in preferving the Health and Lives of Multitudes of that valuable and useful Part of Mankind, those who occupy their Bufiness in great Waters; whose Welfare I have long had at heart, and endeavoured to promote by various Ways; especially by finding Means to procure them fresh falutary Air, instead of the noxious, putrid, close confined pestilential Air, which has deftroyed Millions of Mankind in Ships. And it is to be hoped that by diligent Refearches, farther and farther useful Discoveries will hereafter be made for the Benefit of Navigation.

44. THE following, as they are ftrong Proofs of the great Benefit and Usefulness

of

Benefit of VENTILATORS

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of Ventilators in Ships, fo they alfo fully prove that they can most commodiously be fixed and worked in them, in contradiction to the vulgar, false, and groundless Notion, that they take up too much room, and are incommodious, and in a manner impracticable to be worked, whereas the Men are eager to work them; and many more Perfons can be with Safety to their Health and Lives in a ventilated, than in an unventilated Ship; which fully obviates the Objection as to the Room they take up. In new and important Refearches, the likelieft Way to fucceed, is to purfue a Thought not only by imperfect and fallacious Reasonings, but when the Nature of the Thing requires it, with a proper Series of Trials and Experiments. Thus in the present Case, the principal Caule of the Sickness in Ships, is the noxious putrid Air; the obvious Remedy is the exchanging that foul Air for fresh, by effectual Means, which are seldom difcovered by dwelling only on Objections, but are usually the Reward of repeated diligent, experimental Refearches. Neither are we to be discouraged in these our

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our Pursuits by some Disappointments, for I have frequently found that they lead to the Thing fought for : And by the like Clue of Reafoning and Experimenting, there is the greatest Probability that we shall fucceed in another very important Refearch, viz. the preferving much longer from Decay the Timbers of Ships laid up in ordinary in Harbour: For as we are affured by daily Experience, that the Decay is wholly owing to damp, close confined putrid corroding Air; fo the only Remedy for this Evil, is the frequently changing the Air among the Timbers, by plentiful Ventilations; which we find by happy Experience, can be effected to fuch a Degree, as give reafonable Hopes, enough to encourage our farther Trials and Refearches.

45. CAPTAIN Thomfon of the Succefs Frigate, in his Letter to me dated London, Sept. 25, 1749, fays, "That during "the Ventilation, the Lower-deck Hatches "were commonly kept close fhut; by "which means the Air was drawn down "into the Hold, from between Decks, "thro' the Seams of the Ceiling, along the C4 "Timbers

Benefit of VENTILATORS 40

" Timbers of the Ship; by which means " we found the foul Air foon drawn " off from between Decks. Our Rule " for ventilating was for half an Hour " every four Hours; but when the Ven-" tilating was fometimes neglected for " eight Hours together, then we could " perceive, especially in hot Weather, a " very sensible Difference by that short " Neglect of it; for it would then take a " longer Time to draw off the foul Air. " Our general Rule was, to work the " Ventilators till we found the Air from " them fweet. We all agreed that they " were of great Service; the Men being " fo fensible of the Benefit of them, that " they required no driving to work that " which they received fo much Benefit by. " We found this good Effect from Ven-" tilation, that tho' there were near 200 " Men on board, for almost a Year, yet I " landed them all well in Georgia, not-" withstanding they were pressed Men, " and delivered me out of Goals, with " Distempers upon them. This is what " I believe but few Transports, or any " other Ships, can brag of; nor did I " ever meet the like Good-luck before; " which 3

in SHIPS.

"which, next to Providence, I impute to the Benefit received by the Ventilators. It is to be remarked, that we who lay wind-bound, for four Months, with our Expedition Fleet, which foon after invaded *France*, were very healthy all the time, when they were very fickly in all the Ships of that Expedition.

46. "THIS certainly occafioned all kind "of Grain Provisions to keep better and "longer from Weevels, than otherwife 'they would have done; and other Kinds "of Provisions received Benefit from the "Coolnefs and Freshness in the Air of "the Ship, which was caused by Ventila-'tion."

47. MR. Cramond also informs me, that he found the good Effect of Ventilators on board a Slave-Ship of his with 392 Slaves, twelve of which were taken on board, just before they failed from Guinea, ill of a Flux, which twelve all died; but the rest, with all the Europeans in the Ship, arrived well at Buenos Ayres.

The

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The following is a Letter to me from Captain ELLIS, viz.

"SIR,

48. "COULD any thing increase the "CPleasure I have in a literary Inter-" course with you, it would be to find that " it answered your End in promoting the " public Good. The Vis-inertiæ of Man-" kind is not the only Difficulty you have " had to encounter, but their Ignorance " and Prejudices, which are almost infu-" perable. It is to your Perseverance and " Refolution, that the little Progress you " have made is due: Indeed I ought not " to fay little; for it is a great Step to " have found the few that have Hearts " good enough to relifh your Plan, and "Heads fufficiently clear to difcern the " most effectual Method of advancing it. " It does Honour to those noble and other " worthy Perfonages that join you in Acts " of fuch extensive Humanity, as the In-" troduction of Ventilators to Hospitals, " Prifons, Ships of War and Transport, " &c. as they must necessarily render the " Miseries of the first more supportable, " and

in SHIPS.

^{se} and the close and constant Confinement " of the others less prejudicial and fatal to " their Health and Life. It is to be la-" mented that they are not more generally " made use of; for, notwithstanding their " Advantage is apparent and incontestable, " it is fcarce credible how few are to be " found among the vaft Number of Ships " daily employed in carrying Paffengers, " Slaves, Cattle, and other perifhable Com-" modities. Those of your Invention, " which I had, were of fingular Service to " us; they kept the Infide of the Ship cool, " fweet, dry, and healthy : The Number " of Slaves I buried was only fix, and not " one white Man of our Crew, (which " was thirty-four) during a Voyage of 15 " Months; an Instance very uncommon. " The 340 Negroes were very fensible of " the Benefits of a conftant Ventilation, " and were always difpleafed when it was " omitted : Even the Exercife had Advan-" tages not to be despised among People " fo much confined. I must not, however, " forget that Ventilation alone is infuffi-" cient to keep Disorders out of Ships; for often Infections are brought aboard by

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" by the Slaves, or others ; and frequently " Difeafes are produced by feeding on bad " or decayed Food, but oftener still by " Infobriety; for I have ever remarked. " that the immoderate Use of spirituous " Liquors in warm Climates, is more per-" nicious and fatal even than the Malig-" nancy of the Air itself. In cold Coun-" tries too, where I have had Experience, " those Sailors, or others, who accustom-" ed themselves to hard drinking, especi-" ally of Drams, had the Scurvy in a ter-" rible Degree ; whereas those who were " temperate or sober, either escaped it en-" tirely, or had it but moderately. The " Effects of Drunkenness was still more " difcernable among the Indians adjoining " our Settlements in Hudson's-Bay, who " are a feeble, diminutive, chilly, indo-" lent Set of People. On the contrary, " those who come from the inland Parts " (who ure unufed to drink Brandy) are " brave, active, robust, and industrious. " The fame Difference is observable in the " Africans, and perhaps among the Inha-" bitants of most other Nations, did we at-" tend to it. It was to the unufual Sobri-" ety

in SHIPS.

" ety of my Crew, that I afcribed, in fome " meafure, their uncommon Healthinefs; " for Sailors breathe a purer Air, and en-" joy more Exercife and Liberty, than " Paffengers or Slaves; wherefore their " Ailments are owing to bad or diforder-" ly Living, as well as to unwholfome " Air.

" COULD I but fee the immoderate Ufe " of fpirituous Liquors lefs general, and " the Benefits of Ventilators more known " and experienced, I might then hope to " fee Mankind better and happier. I am,

"SIR,

" Your most obediens Servant,

Briftol, Dec. 26, 1753.

HENRY ELLIS."

49. AND, by the like good Conduct, in his next Voyage in the Year 1755, not one of 312 Slaves died; and all his 36 Sailors arrived alive and well at *Briftol*.

50. AND the Earl of Halifax has often informed me of the great Benefit they found by the Use of Ventilators, in several

46 Benefit of VENTILATORS.

ral Nova Scotia Transport-Ships, twelve to one more have been found to die in unventilated than in ventilated Ships. It is indeed a felf-evident Thing, that the changing the foul Air frequently in Ships, in which there are many Perfons, will be a means of keeping them in better Health than not doing it; which makes it the more aftonishing that effectual Proposals to remedy fo great an Evil, fhould be received with fo much Coldness and Indifference by Mankind. They little confider that it is the high Degree of Putrefaction (that most subtile Dissolvent in Nature) which a foul Air acquires in long ftagnating, which gives it that pestilential Quality, which caufes what is called the Goal-Distemper. And a very small Quantity, or even Vapour of this highly attenuated Venom, like the Infection or Inoculation for the Small-pox, foon fpreads its deadly. Infection. Ought not Men therefore, from the common natural Principle of Self-Prefervation, to use their utmost Endeavours to shun this pestilent Destroyer, by which Millions of Mankind have perifhed in Ships ?

An

[45)

An Account of some Tryals to cure the ill Taste of MILK, which is occasioned by the Food of Cows, either from Turnips, Cabbages, or autumnal Leaves, &c. Also to sweeten STINKING-WATER, &c.

51. THIS Method of blowing Showers of Air up thro' Liquors, will be of confiderable Use in several other Respects, as well as in Distillation, as appears by the following Trials, viz.

52. I HAVE been informed that it is a common Practice, to cure the ill Tafte of Cream from the Food of Cows, by fetting it in broad Pans over hot Embers or Charcoal, and continually flirring it, till fealding hot, and till cool again : But when I attempted to do this much fooner, and more effectually, by blowing Showers of Air up thro' it; I foon found it to be impracticable, by reafon of its very great Degree of frothing up. The ill Tafte muft therefore be got out of the Milk, before it is is fet for Cream; which I have been told, has been practifed, and that with fome benefit, by giving the Milk a fealding Heat, without flirring it.

53. May 22. I ventilated fome ill tafted, new unheated Milk of a Cow which was purpofely fed with Crow Garlick mixed with cut Grafs. After 15 Minutes Venti. lation the Tafte was a little mended; in half an Hour's blowing it was fomething better. At the Hour's end it had the fame Tafte, but was fenfibly better than the unventilated Milk. I was difappointed of an Opportunity to repeat the Experiment with Crow Garlick Milk, with a fealding Heat; it would then probably have been foon perfectly cured; as it is reafonable to believe from the Event of the following Experiments, viz.

54. August 23, four Quarts of ill tafted new Milk, from a Cow which had fed eighty-four Hours on Cabbage Leaves only, and drank during that Time very little Water; were put into a leaden Veffel, eight Inches in Diameter, and thirty Inches 3 deep.

MILK to cure.

thes deep. The leaden Veffel was heated in a large Boiler, and fet into a Veffel of hot Water; thereby to give the Milk a fcalding Heat, and alfo keep it hot. In ten Minutes Ventilation it was perfectly cured of its ill Tafte; and after ftanding twenty-four Hours in a broad Pan, there was a thick Scum which was half Cream and half Butter, free from any ill Tafte; the skimmed Milk was not fheer or thin: So here is a Method to make good Butter from ill tafted Milk.

55. THE Froth of the Milk was fo great, by reason of a too brisk Ventilation, as to make it froth over the Veffel, which was thirty Inches deep ; if it had not been kept down, by conftantly lading and breaking the very large Bubbles of Froth. But when the Ventilation is more gentle, the Froth has rifen but three Inches from fix Quarts of Milk, which was nine Inches deep. The Cabbage Milk was but fix Inches deep. I repeated the like Operation the fame Day, with the Evening Milk of the fame Cow; but giving it only a Heat, that I could bear my Fingers in, for a little Time; D

Ill tasted

Time; with this Degree of Heat, after forty-five Minutes Ventilation, the Milk (tho' much better tafted) yet was not fo compleatly cured, as the former Milk. Hence we fee, how neceffary Heat is, to volatilize the rancid Oyl (which gives the ill Tafte) to fuch a Degree as to caufe it to fly off by Ventilation.

56. IT was observed that what was milked from this Cow a Week after she had done eating the Cabbage, had an ill Taste.

57. I HAVE not as yet had an Opportunity, to try to cure, in the fame Manner, the ill Tafte of Milk, which is occafioned by Cows feeding on autumnal Leaves, or Turnips, they having probably eaten this Autumn, the fewer Leaves, on account of the Plenty of Grafs, occafioned by much Rain; which has alfo hitherto prevented Turnips from being rancid, which are obferved to be moft fo, when they fhoot out in the Spring. As Opportunitics offer I purpofe to make Trials, which I conclude others will alfo do, which will probably

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MILK to cure.

probably be attended with the fame good Effects as that on the Cabbage Milk.

58. But tho' the ill Tafte of Milk from feeding on Cabbage Leaves, was thus cffectually cured by volatilizing with Heat, and diffipating by Ventilation the rancid Oil; yet the bitter Tafte of a ftrong Infufion of Chamomel Flowers in fix Quarts of Water, was not fenfibly abated by an Hour's Ventilation of it, while fealding hot.

59. I AM informed that, in Devonshire, they fet the Pans of Milk on Trivets, making Fires under them, to give the Milk, gently and gradually a fcalding, but not a boiling Heat, which would diffurb the rifing Cream; and then fet it on the Floor in the Milk-houfe to cool, where in twelve Hours it has a thick Scum, partly Butter and partly Cream : The skimmed Milk is very thin and fheer; and the Cream in great Plenty and delicious, except it gets a smoky Tafte, which it is apt to do; and which might probably be prevented, by having a Range of as many Stoves, as D 2 there

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Ill tafted

there are Pans of Milk to be used at one Time; all to be warmed by one Fire, cither at one end, or the middle of the Flue or Funnel in the Brick-work, which conveys the Smoke and Heat under the Stoves. And as the Pans nearest to the Fire will soonest have their due Heat, on their Removal to bring the farthest and coolest Pans nearest the Fire; and instantly covering the uncovered Stoves with proper Covers to prevent the Heat and Smoke from coming out; by this Means the Milk would all be soon heated, with any kind of Fuel, and that with much less in Quantity than in the common Way.

60. AND the more effectually to prevent the Smoke from coming at the Milk, it may be well to have the broad outer Rim of the Pans turned perpendicularly downwards, three or four Inches, that it may enter deep into a circular Groove of Sand; and if it fhall be needful the Sand may be wetted in order the more effectually to prevent the Paffage of the Smoke : I thought of this Method about fifty Years fince on taffing the fmoky Butter in Somerfetshire.

MILK to cure.

merfetshire. By the fame Means the Poor might fave much Fuel in boiling the Pot, especially in Summer, when a Fire is wanted only for boiling the Pot.

61. WHEN any Pans are to be removed from the Stoves, the Afcent of the Smoke thro' the uncovered Stove, may be prevented by first closing the Flue near the Fire, by an Iron Sliding-shutter or Register.

62. MILK might thus most commodioufly be heated to a fealding Heat with little Fuel, fit for Ventilation, in a Veffel of a proper Depth, fet in the fame Manner as the Pans in a Stove, to fecure it from Smoke, with Bellows fixed properly near it: (fee Fig. 3.) By this Means there would be little Trouble or Expence in curing ill tafted Milk by Ventilation.

63. May 14th, meerly to fee what the Event would be, a Gallon of new Milk, just from the Cow was ventilated, for an Hour and half, which produced fix Ounces of Butter; and tho' it was ventilated half an

Ill tasted

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an Hour longer, yet no more Butter was made; it was whitish, wanting both the Colour and Taste of good fresh Butter.

64. I AM credibly informed, that in the Places famous for making the beft fresh Winter Butter, they set the Pot of Cream in warm Water, so long as till it has acquired that small Degree of Sourness, which it very soon has in warm Summer Weather, which gives it its agreeable Flavour. And in order to give it Colour, they grate a well coloured Carrot into a little Milk, which as soon as stained, is strained from the Carrot thro' a Sive, and then mixed with the Cream.

65. It is found by Experience, that the Quantity of Cream is increafed, by putting into the Milk a little warm Water in Winter, and cold in Summer; which being thereby, in fome Degree thinned, the Cream is thereby more eafily difintangled, fo as more freely to afcend to the Surface of the Milk. 66. I VENTILATED three Gallons of flinking *Jeffops-well* purging Water. On first blowing, the Smell of the ascending Vapour was very offensive, which Offenfiveness abated much in five Minutes : In eleven Minutes the Smell was much better: In twenty Minutes the Water seemed fweet both in Smell and Taste; and not sweeter at the End of forty-five Minutes, fifteen or twenty Minutes will probably fuffice.

67. July 20th three Gallons of flinking Sea-water were ventilated; in five Minutes it was much fweetened, and no ill Smell in the afcending Air, tho' at first it was very offensive: At the End of ten Minutes it had a small Degree of ill Taste; after twenty Minutes no ill Taste or Smell. It frothed near a Foot high during Part of the Ventilation; this from the Bitumen, $\mathcal{O}c$.

68. SOME Sea-water which was made to flink with Flesh and Isinglass being put into it, was not made perfectly sweet, not even

Ill tasted

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even by a ventilated Diffillation, and and Hour's more Ventilation after it was difilled; fo that Putrefaction with animal Substances, is not eafily compleatly cured by Ventilation.

69. WHEN the Water was 27 Inches deep in the leaden Veffel, no Air could be blown up thro' it by the Force of the Bellows. But at 18 Inches Depth, the Air could freely be blown up in Showers thro' the Water; when therefore it is requifite to blow up thro' great Depths of Water, the Bellows may be worked with a Lever, as Smiths Bellows are worked.

70. As it is found by Experience, that the Milk and Butter of Cows, which drink flinking Water, has a very bad Tafte, this plainly flows that the Water retains its putrid Quality when mixed with the Blood; whence it is much to be fufpected, that the flinking Water which is drank in Ships, by retaining its putrid Quality, even when mixed with the Blood, may thereby promote that pu-3 trid

MILK to cure.

trid Diftemper the Scurvy, as well as fome other Diftempers. And much more does the putrid close Air in Ships, which is mixed with the Blood from the Lungs, promote putrid and other Diforders: By the fame Means alfo, peftilential Infections are taken in: For as the falutary Properties of good Air, are conveyed to the Blood by the Lungs, fo are alfo the malignant Qualities of bad Air.

71. THUS alfo the putrid Water in marshy aguish Countries, may be a Cause of Agues, as well as the putrid Air which they breathe; which, as well as the putrid Water, may probably carry some of its putrid Quality into the Blood thro' the Lungs. This Method therefore of sweetening stinking Water, by blowing Showers of Air up thro' the stinking Water of some aguish Places, may be beneficial.

72. LIVE Fifh may well be carried feveral Miles, by blowing now and then frefh Air up thro' the Water, without the Trouble of changing the Water; for this Ventilation will not only keep the Water E fweet,

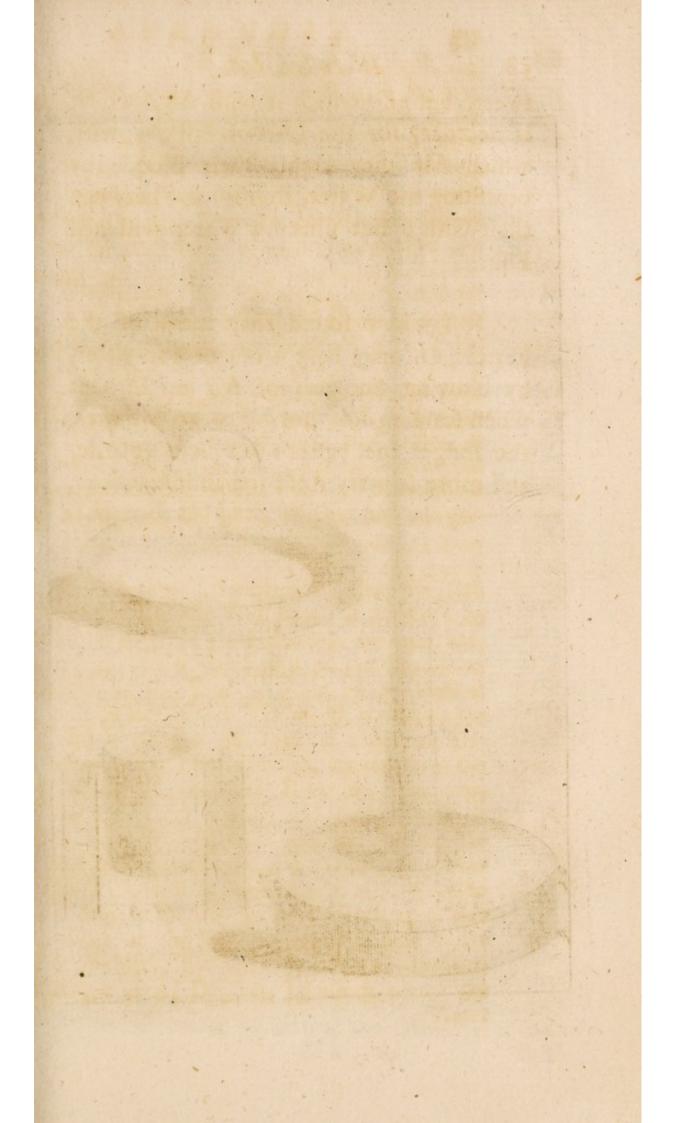
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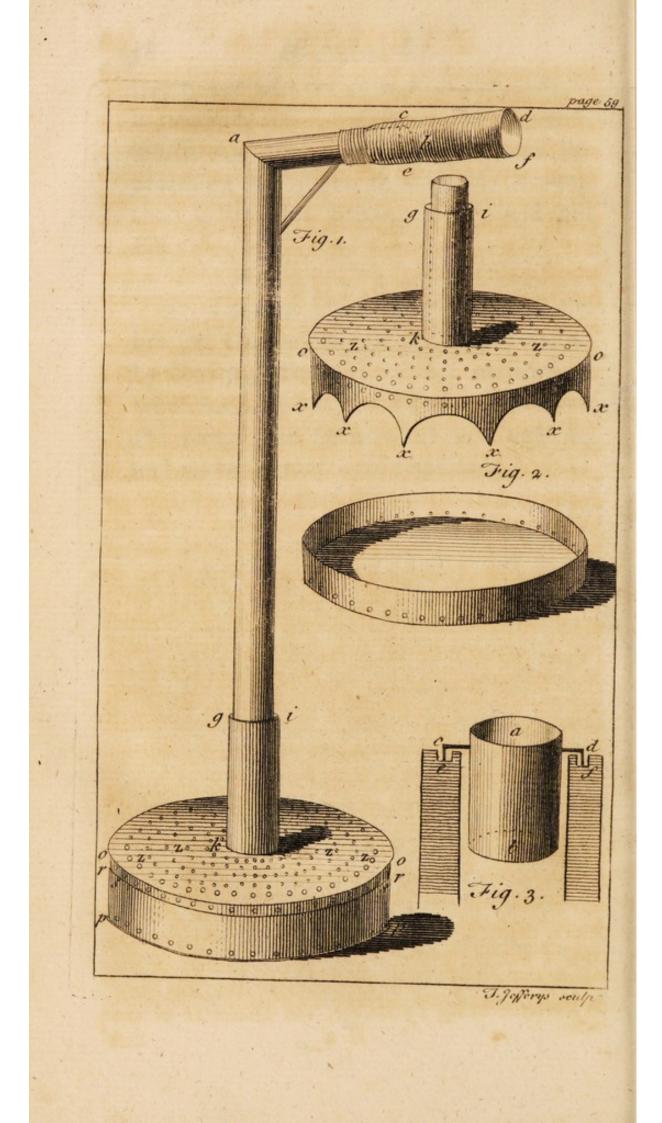
Ill tasted, &c.

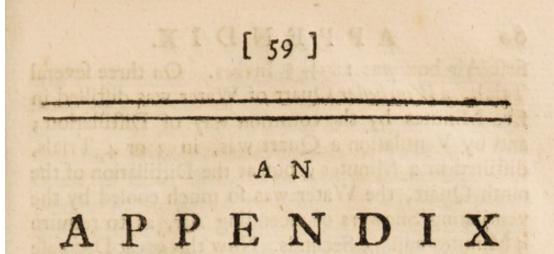
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fweet, but also enrich it with Air, which is neceffary for the Life of Fishes; with which Air they supply their Blood, by breathing the Water, thin spread, between their Gills: But stinking Water will kill Fish.

73. I HAVE found that much of the heating Oil may be got out of Tar-water, by blowing Showers of Air up thro' it when fcalding-hot, for 15 or 30 Minutes, the longer the better; the lefs volatile, and more falutary Acid remaining.







TO THE

TREATISE on distilling SEA-WATER, sweetning MILK, &c. which gives a farther Account how to procure still greater Plenty of FRESH-WATER at Sea, and to sweeten illtasted Milk, Stinking-water, and musty Liquors, &c. by blowing Showers of Air up thro' them.

74. SEVERAL confiderable Improvements having been made on the Subjects of this little Book, fince the Publication of it, I fhall here give a fhort Account of them, hoping they may in feveral Refpects be of Benefit to the World; efpecially the great Improvement in diffilling Plenty of Frefh-water at Sea.

75. In order to bring the Method of procuring Plenty of good Fresh-water at Sea, into practice, feveral previous Trials were made, at the laudable Motion and Defire of Peter Wyche, Esq; in a Still containing 24 Gallions of Water, at Messes. Steel and Stephens's Copper Workhouse, near the Falkon-Stairs, Southwark. The first thing to be done, was to find out the proper Size of the Diameter of the Copper Air-box. The Diameter of the Still, near its Bottom, being 19 Inches, the Diameter of the E 2 first

first Air-box was $18 + \frac{1}{2}$ Inches. On three feveral Trials, a Winchester Quart of Water was distilled in five Minutes by the common way of Diftillation; and by Ventilation a Quart was, in 3 or 4 Trials, diffilled in 2 Minutes; but at the Diffillation of the ninth Quart, the Water was fo much cooled by the ventilating Showers of afcending Air, as to require 5 Minutes and 44 Seconds. Now this great Decrease of the Quantities diffilled, was plainly owing to the too great Breadth of the Air-box, which hindered the Fire from heating and keeping hot the Water which was above it, to fuch a Degree, as to have no Distillation in the common way, for 8 or 10 Minutes after the Ventilations; for the half Inch Circle of Water which was not covered by the Air-box, was The next but one nineteenth Part of the whole. Trial, in the fame Still, was made with an Air-box, whole Diameter was 13 Inches, its Area therefore 127 Iquare Inches; which deducted from 271 Iquare Inches, the whole Area or Breadth of that part of the Still, there remains 144 fquare Inches, for the Area of the three Inch broad annular Circle round the Air-box, viz. 17 fquare Inches more than the Area of the Air-box. The Event was, that in feven Distillations in the common way, a Quart was diffilled in 5 Minutes, fometimes in a little lefs, and fometimes in a longer Time. And by Ventilation 14 different Quarts were diffilled in different Lengths of Time, from a Quart in 2 Minutes and 6 Seconds, to 3 or 4 Minutes,

76. I then repeated the like Trials with my fmall three Gallon Still, diffilling in the common way a Pint in $10 + \frac{1}{2}$ and 9 Minutes; and feven feparate Pints were diffilled by Ventilation in $3 + \frac{1}{2}$ to 4 $+ \frac{1}{2}$ Minutes. Hence we fee that Ventilation has a more fleddy and conftant good Effect where the Air-box is lefs in Proportion to the Still, than it was

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was in the other two Distillations: For in this leffer Still, only 27 out of 99 square Inches were ventilated, 72 square Inches being unventilated. It will therefore probably be advisable to have the Airboxes of other Stills to be nearly in the like Proportion to the respective Stills, the Diameter of this Still being $11 + \frac{1}{2}$ Inches, of its Air-box 6 Inches. 77. As by repeated Trials a Quart of Water was distilled in the common way in five Minutes, in the above-mentioned twenty Gallon Still, fo an 120, or two Tune and 14 Gallons, may be distilled by Hoge Ventilation in twenty Hours.

78. Mr. Wyche, who was prefent at the Trials near the Falcon-Stairs, observing the Water in the upper Part of the Worm-tub to be reeking hot, tho' the Water below it was cool, very rightly propofed to have the hot Water run from the upper part of the Worm-tub, thro' a fmall Copper Pipe, into the upper Part of the Still, as fast as it was diftilled off, the running Quantity of Water to be adjusted by a Turn-cock in the Pipe. This I tried in my little Still, by conveying the upper warm Water of the Worm tub into the Still thro' a small Pipe which paffed thro' a Hole in the Head of the Still, almost down to the Bottom of the Water in the Still: My Reafons for doing of which were, viz. left the lefs hot Water, by running on the Surface of the boiling Water, might confiderably check the Afcent of the rifing Vapours; whereas, being mixed and blended with the lower Water, it will soon acquire a due Heat. Another Reason why I chofe to lead the entering Rill of Water fo flow, was, that it might be intimately mixed with the Chalk, which is there in an agitated State by reason of the Action of the Fire. The Event was as follows, viz. that fix feparate Pints of Water were diffilled by Ventilation during the running in E 3 of

of the warm Water, fome in $3 \pm$ Minutes, others in 4 Minutes, $4 \pm \frac{1}{2}$, and 4 Minutes, 50 Seconds, which was the cafe of the fecond Pint.

79. Hence we fee the great Benefit of this ingenious Improvement of Mr. Wyche's in diftilling Sea-water, where the Still will be filled with the fame Liquor as the Worm-tub; but this Method cannot fo well be put in Practice in other Distillations. The Benefit of thus gently and inceffantly keeping the Still full, will fave about one-fourth of the Time and Fuel, which it would otherwife require to refill with cold Liquor, and bring to a diftilling Heat. This great Advantage, added to that of diffilling about double the Quantity by Ventilation, must needs both together be of fo great Improvement in diffilling three Parts in four more than usual, as will be of the greatest Benefit to Navigation in feveral respects. By this means the Still need be emptied and cleanfed from the Chalk, and very falt Water, only at the end of each daily Distillation.

80. And whereas if all the Chalk requifite for a whole Day's Diffillation were put into the Still at once, it might be fuspected that fuch a Quantity laying at the Bottom of the Still, might hinder the boiling of the Water : I put into a broadly flatbottomed fauce-pan, half an Inch Depth of powdered Chalk, and two Quarts of Water boiled in ten Minutes : The Water mingling freely, especially in the time of boiling, among the thin pappy Chalk, was freely acted on by the Fire. But as in boiling it frothed much, it may be proper to put at first into the Still only as many half Ounces of Chalk as there are Gallons of Water; and afterwards from time to time in proportion to what additional Water shall have run into the Still, at a Hole purposely made in the Head of the Still, taking care to ventilate

APPENDIX.

late while the Chalk is putting in, which will caufe it to mix intimately with the Water, and thereby have the better Effect on it. And perhaps a lefs Proportion of Chalk than half an Ounce to a Gallon of Sea-water may fuffice.

81. The Degree of Fulness or Emptiness of the Still, may be known by putting a small floating metalline Vessel, in at the Chalk Hole, with a long flender Wire to it.

82. Mr. Wyche thought of other Means the better to promote Diftillation, viz. by conveying the Air from the Bellows through a Pipe with feveral fpiral Coiles, thereby in paffing thro' boiling Water in the Still, to make the afcending Showers of the Air the hotter, and fo the lefs refrigerating. Alfo to have the warm Water pafs from the Wormtub, in a Pipe, with feveral the like fpiral Coiles, in the Head of the Still; thereby the more to heat the entering Water. But we find, by the abovementioned Experiments, that there is no occafion for either of them; but if wanted may be ufed.

83. As to the Benefit of Ventilators in preferving the Health and Lives of People in Slave and other Transport Ships, I have received farther Confirmation of their great Benefit, in a Letter from Dr. Demainbray, who has fhewn Courfes of Experimental Philosophy to his Royal Highness the Prince of Wales and Prince Edward, viz. " That in the Year " 1753 Ventilators were put into the Veffels in the " Slave Trade at Bordeaux, and in other Ports of " France; the happy Effect of which was, that in-* ftead of the Lofs of one-fourth of those valuable " Cargoes, in long Paffages from Africa to the " French Plantations, the Lofs feldom exceeded a " twentieth, And fince my Return to England, I E 4 " have

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" have been informed of a French Veffel, which " by this felf-evidently reafonable Precaution, faved " 308 out of 312 Slaves, spite of most tedious " Calms and a long Paffage. And Dr. Garden, in his Letter to me, dated Charles-Town, South-Carolina, March 24th, 1756, fays, viz. " It is indeed « very wonderful, that the Slave Merchants do not " come into the Ufe of Ventilators. There are " few Ships come here from Africa, (even though " they call for fresh Provisions and Water at the " Islands) but have had many of their Cargoe " thrown overboard; fome one-fourth, fome one-" third, fome lofe half; and I have feen fome that " have loft two-thirds of their Slaves. I have of-" ten gone to vifit thefe Veffels on their first Arri-" val, in order to make a Report of their State of " Health to the Governor and Council; but I ne-" ver yet was on board one, that did not fmell " most offensive and noisome. What from Filth. " putrid Air, putrid Dyfenteries (which is their " common Diforder) it is a wonder any escape " with Life."

84. A probable Means lately occurred to my Thoughts, tho' not perfectly to cure, yet much to abate the great Degrees of flinking of the Bilgewater in the Well of Ships, viz. by laying at the Bottom of the Bilge-water, round the Main-maft, Copper Pipes full of very fmall Holes, not one twentieth of an Inch in Diameter; and blowing Showers of Air up thro' them from fmall Blackfmith's Bellows, fixed out of the way, within the Well. Such Bellows may be worked with great Eafe, for one, two, or three quarters of an Hour, in every 24 Hours, more or lefs, as shall be found requifite by Experience : But with this Precaution, that whenever the Water flinks much, first to pump it out of the Ship, and after letting in fweet Water, then

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then to ventilate it a little now and then, as shall be found needful; but care must be taken not to ventilate very flinking Water, becaufe it may increase the Unwholfomeness of the foul Air in Ships. By this means Ships will probably be made fomething lefs unhealthy; for the putrid Vapours which arife from ftinking Water, must needs greatly contribute to increase the Putridness, and confequently the Noxioufnefs of the foul Air in Ships. This Precaution therefore, with Ventilators frequently to convey off the close foul Air, will be effectual Means to make Ships much more healthy; as will the changing the foul Air in Goals, Hofpitals, and fick Rooms, with proper Precautions, make them more wholfome : And it is with pleafure that I obferve, that these falutary Means are coming more in use in Hospitals, &c. either by means of Ventilators, or by admitting fresh Air in small Quantities, and those spread in thin Sheets, so as not to have the entering Air blow directly on, and incommode the Patients. Where it can be had, a thorough Air entering on one fide, and paffing out on the other fide of Wards or Rooms, will be beft; because the Change will be almost constant, and may be as gradual and gentle as we pleafe. I shall give a more particular Account of this in my fecond Volume of Ventilators.

85. As to the curing the ill Taile of Milk from the Food of Cows; and also curing musty Liquors, I made the following Trials, viz. When in the Beginning of *March* the Turnips had made large Shoots, and were thereby become very rancid, two Cows being fed with Turnips only for feven Days, their Milk had a very difagreeable Smell and Tafte. On ventilating it fealding hot, with afcending Showers of Air, at first the ill Smell increased, but in two Minutes that Smell was much abated; and with 66

with five Minutes Ventilation, there was only the common Smell of good Milk; which shows that the rancid Oil of Turnips, which gives the ill Tafte, is very volatile : After ten Minutes Ventilation, there was no ill Tafte or Smell; and it was the fame after 15 and 30 Minutes Ventilation. By this means therefore the ill Tafte of Milk from fome Food of Cows, may eafily be cured. Experience will flow what Degrees of Ventilation will be requifite for larger Quantities of Milk; as alfo for curing the ill Taftes from different Kinds of Food ; as also from the shorter and longer Times of feeding on fuch Foods. It is observeable that the Breath of these Cows was difagreeable; whence we fee how freely contagious Infections may be conveyed through the Lungs, from tainted putrefcent Blood.

86. A Cow having been fed for fixty Hours with a good Quantity of Crow Garlick, mixed with cut Grafs, towards the end of June, the Milk had a very difagreeable Smell and Tafte; which was not cured, though fomething better, after 30 Minutes Ventilation, while fcalding hot. I repeated the fame Ventilations for 15 Minutes, with the two following Evening and Morning Milks of the fame Cow, viz. 12 and 24 Hours after the Cow had left off eating Crow-Garlick ; at which times the ill Tafte and Smell was fenfibly abated before Ventilation, and fomething more after it, yet was far from being cured. Hence we fee that the ill Tafte and Smell of the Crow-Garlick Milk, cannot thus be cured, tho' fomewhat amended. The ill Tafte of this Cow's Milk continued for about five Days after fhe had left off eating of the Crow-Garlick. And perhaps where Cows have eaten but a small Quantity of it, the Abatement of the ill Tafte may be fo confiderable, as to recompence

pence the Trouble of ventilating it. As Opportunities offer, I will make the like Trials, with other ill-tafted Milks, fuch as that from autumnal Leaves, &c. and hope that others will do the like.

87. Cream or Milk Sillabubs may most commodiously and easily be made in Plenty, in a few Minutes, by means of a small Tin Air-box, three Inches in diameter, and three quarters of an Inch deep; the flat Bottom of the Pot, which contains the Cream or Milk, to be but little wider than the Air-box, that the Air from the Box may the better come at it: But the wider and deeper the upper Part of the Pot is, so much the better, for the Froth expands much.

88. Scalding-hot mufty Vinegar was cured by repeated Trials, of near three Gallons in each Trial, by ten Minutes Ventilation. And giving Vinegar a fcalding Heat, does not weaken or damage it, as it does Wine, whofe vinous Spirit is carried off both by Heat and Ventilation; for when fome flrong mufty Raifin Wine was ventilated hot, it was cured in five Minutes : But the vinous Spirit, which ftrongly affected the Nofe in flying off during Ventilation, being gone off, the vapid Wine would not kindle into a Blaze, when thrown into the Fire, as it did to a great Degree before it was heated and ventilated. Neither mufty Wine nor Vinegar were cured, tho' fomething bettered by 30 Minutes Ventilation, when cold.

89. Mr. Jones, a Chemist in Cranbourn-Ally, Leicester-Square, ventilated a Gallon of Proof Malt Spirits 15 Minutes cold, in which time it wasted two Ounces and half; whereas a like Quantity of common cold Water wasted but half an Ounce in 15 Minutes Ventilation, viz. but one-fifth part of what

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what the Spirits did; and the fame Spirits ventilated hot, wafted no lefs than 5 Ounces in 5 Minutes; which Ventilation made them fenfibly better tafted than the unventilated. But the great Wafte flows that these volatile vinous Spirits, ought not to be ventilated, neither hot nor cold. Befides that, the 15 Minutes cold Ventilation had but little Effect in bettering the Spirit.

90. In order to know whether Fish in a Veffel of Water would live the longer for having Showers of Air blown up thro' the Water, May 25, 1756, at feven in the Morning, the Wind N. E. the Mercury in Farenbeit's Thermometer, 50 Degrees, and it continued fo cold, that at one o'clock it role but to 60 Degrees; I put twelve Dace into a Pail Ain two Gallons of fresh Pond Water, thro' which a Stream ran, and twelve more into a Pail B, with the like Quantity of Water; one of which Fishes in B was fick, as appeared by turning its Belly upwards; as were also two Fishes in the Pail A; which was occasioned by being all brought in a Pail above half a Mile from the Thames.

91. At 45 Minutes paft 8, most of the Fish in the Pail B, were turned Belly upwards, and lay as dead; at 30 Minutes past 9 seven of them were dead; at 30 Minutes past 11 all but three were dead; at two o'clock but two Fish remain alive in B; which remained alive, tho' fick, at ten that Night, viz. at the end of 14 Hours.

92. The good Effect of blowing every quarter of an Hour, with 25 Strokes each time with double Bellows, Showers of fresh Air up thro' the Water, was, viz. they all continued well, and the larger of the two fick Fish recovered; but the leffer died at 4 o'clock, viz. at the end of nine Hours; 5 upon upon each Ventilation it turned its Back upwards; but foon after the Ventilations, it conftantly fell precipitate with its Head foremost, to the Bottom, and there turned Belly upwards. After 4 o'clock the ventilated Water frothed with larger Bubbles, this owing to the Slime of the Fish. The last Ventilation was at 10 at Night, when the Fish in the ventilated Water were well, and would probably have long continued fo by the Salutarines of Ventilation; but that being discontinued, they were all found dead the next Morning, except one which had fome fmall Degree of Life.

93. June 7, the Wind S. W. cloudy, the Thermometer at 58 Degrees, 13 live Gudgeons were put into two Gallons of fresh Pond-water in a Pail A; and a like Number into a Pail B, at 10 Minutes before 7 in the Morning. At 50 Minutes past 7, two in B began to be fick; at 8, half of them came up for Air, and showed Uneasines; at 15 Minutes past 8 two are dead; at 30 Minutes past 8, eight more turned Belly upwards; at 8 Minutes past 9, five are dead in B, and five more fick; at 30 Minutes paft 9, feven are dead, and four fick, two well; and 30 Minutes paft 10, eight are dead; at 11 two only alive, and alfo well, though they fhowed fome Uneafinefs by their raifing their Mouth to the Surface, which they continued to do till nine, when they were taken out of the Water. Hence we fee, by this, and the preceding Experiment on Dace, that one or two Fifh may be kept alive many - Hours longer than a greater Number can be, by means of the fmall Portion of fresh Air, that is continually mixing with the Water, on which it preffes.

94. The Water in the Pail A was ventilated from 10 Minutes before 7, to 6 in the Evening, by blowing

blowing every quarter of an Hour Showers of fresh Air up thro' it, with 25 Strokes of the Bellows; by which means the Fish continued all well, laying quiet at the Bottom : At fix we ceafed to ventilate; for an Hour and half after which, there was no Signs of Sickness; after two Hours two of them fhowed Signs of Uneafinefs; and at nine most of the Fishes turned Belly upwards, and lay at the Bottom dead or dying. By comparing this Event with that at eight in the Morning, we fee there is more Air in this ventilated Water than in the Pondwater, as is probable by the Gudgeons living longer in it, without Ventilation, than in the Pond-water. And accordingly the fpecific Gravity of unventilated Pump Well-water, was a very fmall Matter greater, than that of the fame, after being ventilated with 100 Strokes of the Bellows, as I found by the Hydrometer; and there was nearly the fame Difference between the specific Gravity of unventilated and ventilated Table Beer.

95. Tho' from thefe Experiments it is manifelt, that Fifh die for want of conftant Supplies of frefh Air in the Water, yet when taken out of the Water very lively, they foon die, notwithftanding the Surfaces of their Gills are then exposed to the immediate Contact of the Air; which shows that either the Air does not enter from the Gills to the Blood, from the open Air, as it does from the Water; or that the Circulation of the Blood is stopped by exchanging their proper Element, Water, for Air; as the Circulation of the Blood of Land Animals is foon stopped by immersing from Air into Water.

96. Hence we fee the Benefit of frequently replenishing the Water with fresh Air, which we find is necessary not only to preferve the Life of Land

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Land Animals, but also of Fish; as also the Use of their Gills, to spread in thin Sheets fresh Supplies of Water, that they may the better come at the Air in the Water; for which Purpose both Sides of their Gills are furrowed with many fine Furrows, not only thereby to enlarge their Surfaces, but also more minutely to divide the Water, whereby to come at the Air in it.

97. Whence we may reafonably infer, how requifite it is, in order to keep the Blood in a falutary State, to have almost constant Supplies of the Breath of Life, fresh Air, to mix with it: For if the principal Use of the Gills were only to cool, and churn, and comminute the Blood, Water devoid of Air could as well perform that Office, as Water repleat with fresh Air. It must therefore be of Importance for all Animals to have fo necessary a vital Fluid fresh and pure, and not foul and putrid.

98. A Fisherman informing me that the Fish were apt to die in the Well-boats, it occurred to me that it might, in a good measure, be remedied, by fixing upright a Board of a proper Breadth at the Outfide of the Boat, as long as the Well is deep, on that fide of the Well which is next to the Stern, and opening at an Angle of about 45 Degrees towards the Head; which, by checking the Courfe of the Stream of the River near the Boat, will raife the Water a little, and thereby caufe it to run into the Well on that Side, and out on the other Side of the Boat; and the Run of the Water thro' the Well, will be more accelerated, if a like Board is fixed in the fame manner on the other fide of the Boat, at the Side of the Well next to the Head of the Boat, but opening towards the Stern at an Angle of 45 Degrees, by which means the Water 72

Water will be lowered on this, as much as it is raifed on the other Side of the Boat .---- Another Means to have a brifker Current of Water thro' the Well, would be to moor the Boat in a fixed Polition acrofs the Stream when it can conveniently be I am informed that there are Paffages from done. Head to Stern, for the Water to pass freely thro' the Fish-Well of some Vessels. We see, from the Event of the above Experiments, the Importance of frequently changing the Water in the Fish-Well of Ships, especially when there are many Fishes in it. Hence also we fee how falutary it is to Fifh, to have the Surface of the Water agitated into Waves by Winds, whereby Plenty of fresh Air enters, and is blended with the Water.

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