

Specimina Ichthyographica :

OR, A BRIEF

NARRATIVE

Of several new

INVENTIONS,

AND

EXPERIMENTS;

PARTICULARLY,

The Navigating a Ship in a Calm,

The Improvement of the Engine to raise Water by Fire,

A new Method of drying Malt, &c.

For all which his MAJESTY has lately been most graciously
pleas'd to grant his *Letters Patent* to

JOHN ALLEN, M. D.

LONDON:

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Fig. 1.

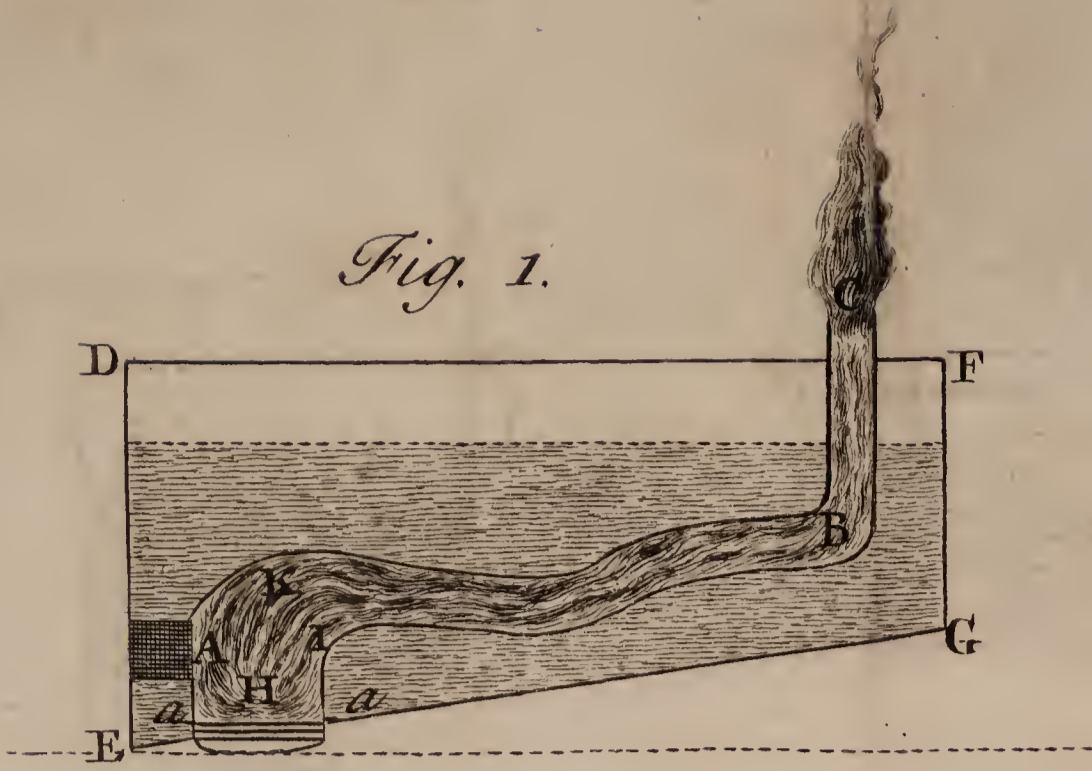


Fig. 2.

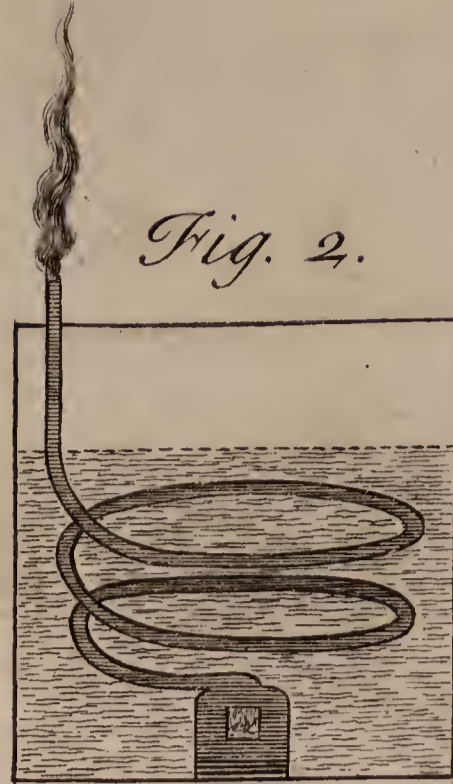


Fig. 4.

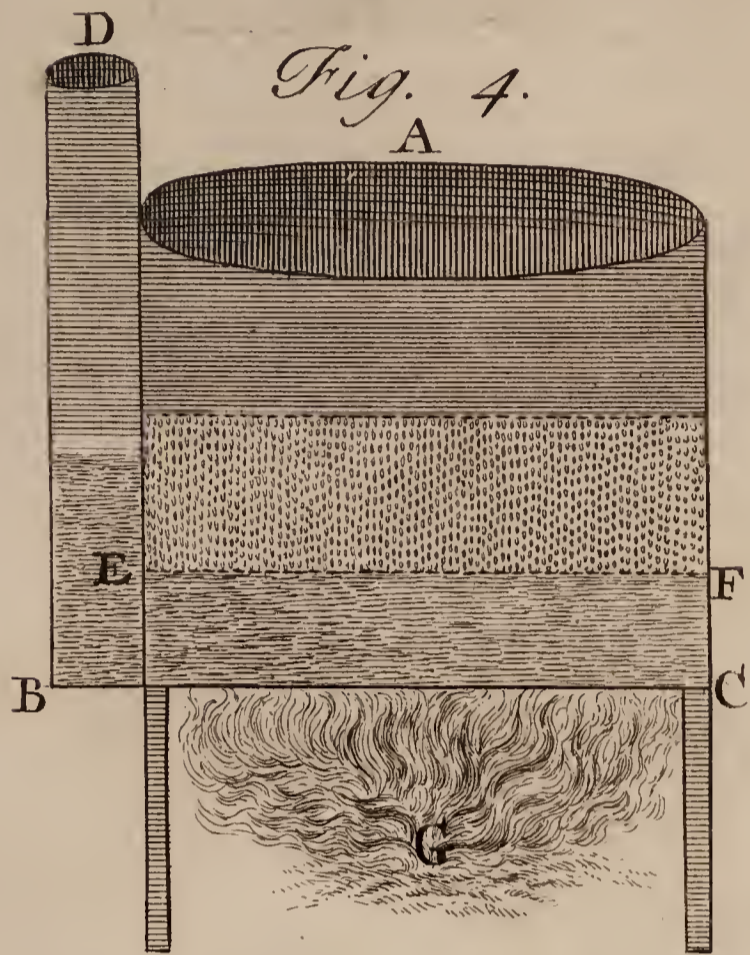
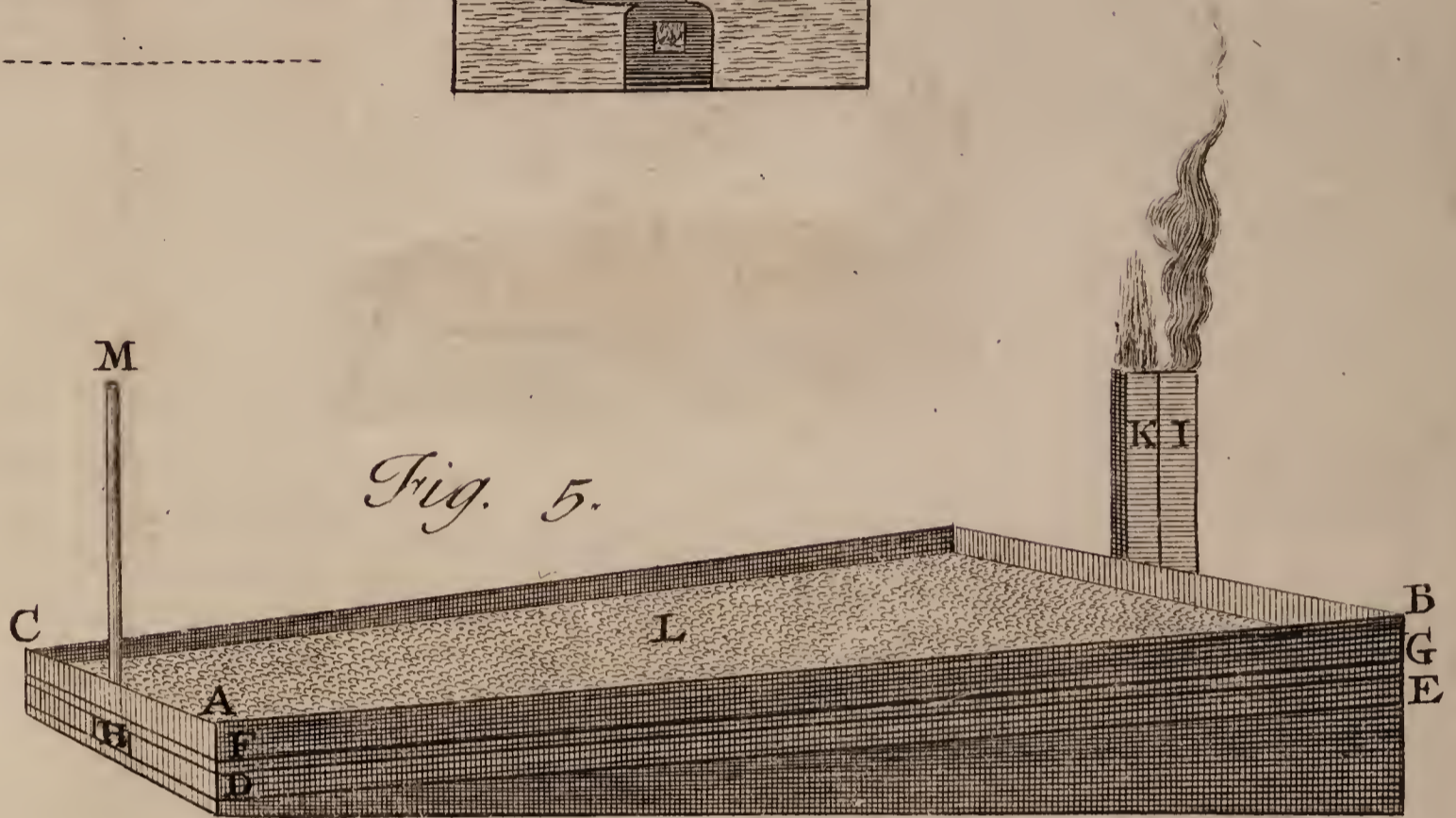


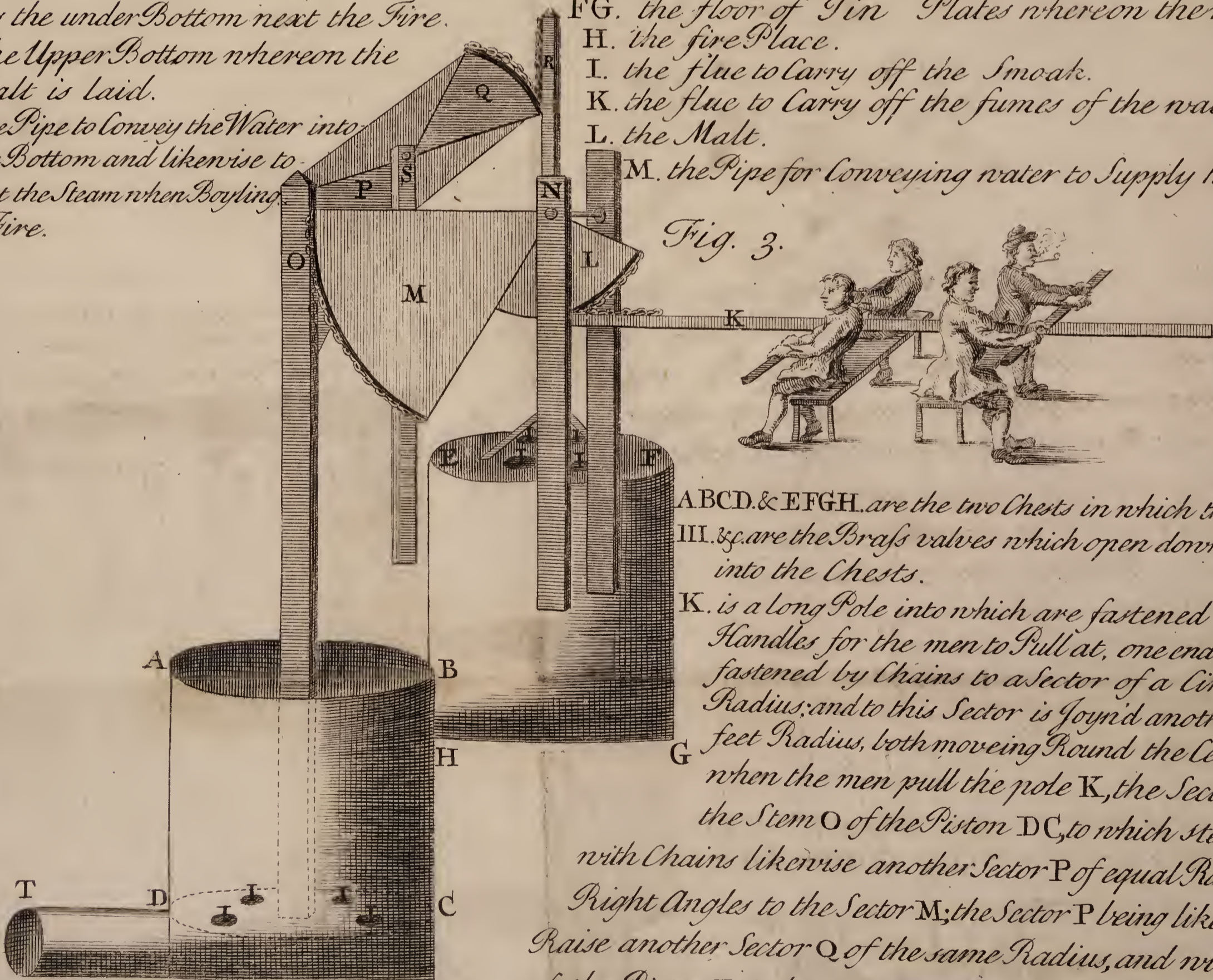
Fig. 5.



BC. is the under Bottom next the Fire.
 EF. the Upper Bottom whereon the Malt is laid.
 DB. the Pipe to convey the Water into the Bottom and likewise to let out the Steam when Boiling.
 G. the Fire.

AB. the Length of the Kiln.
 AC. the Breadth.
 DE. the Copper Brass or Iron bottom with its sides turnid up as to FG.
 FG. the floor of Tin Plates whereon the Malt is laid.
 H. the fire Place.
 I. the flue to carry off the Smoak.
 K. the flue to carry off the fumes of the water.
 L. the Malt.
 M. the Pipe for conveying water to Supply the Evaporation.

Fig. 3.



ABCD. & EFGH. are the two Chests in which the Pistons work.
 III. &c. are the Brass valves which open downwards to let Air into the Chests.
 K. is a long Pole into which are fastened Cross peices or Handles for the men to Pull at, one end of which Pole is fastened by Chains to a Sector of a Circle L of three feet Radius; and to this Sector is Joynid another Sector M of Six feet Radius, both moving Round the Center N; so that when the men pull the pole K, the Sector M will depress the Stem O of the Piston DC, to which stem is fastened with Chains likewise another Sector P of equal Radius, but placd at Right Angles to the Sector M; the Sector P being likewise depressd will Raise another Sector Q of the same Radius, and with it the Stem R of the Piston EF, they moving On the Center S in the same manner as the Sectors L, M do upon the Center N; so that when the Piston DC is depressd EF will be Raised, & vice versa, and so they strike their Strokes alternately.

DT is a Large Tube thro' which the Air is forc'd out of the Chest into the Sea. The Chest EFGH has its Tube likewise for the same Purpose.

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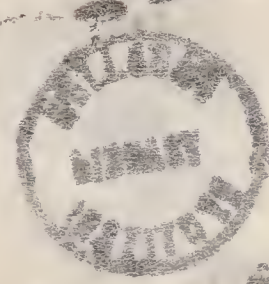
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THE UNIVERSITY OF CHICAGO

PHYSICS DEPARTMENT



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5720 S. UNIVERSITY AVE.
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TO THE
KING'S most Excellent Majesty,
THESE
DISQUISITIONS

ARE
Most humbly Dedicated

BY
His MAJESTY'S
Most Dutiful,
and most Obedient
Subject and Servant,

JOHN ALLEN.



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Specimina Ichnographica.

DISSERTATION I.

A new Invention for Heating and Boiling Water or other Liquors, with far less Expence of Fuel, than by the common Methods now in Use.

ART. I. **T**HE common Method of boiling Water and other Liquors (since the Invention of setting Furnaces in Brick-work) is by the Application of Fire under the Bottom, and round the Sides of the Furnace or Boiler, wherein the Water is to be boiled. In this Way (notwithstanding how much soever it may exceed the boiling of Water in a Kettle over an open Fire) it is evident, that well nigh half of the Heat or Effect of the Fire, is employ'd in heating the Walls of the Fire-place, and consequently so much of it is in great measure lost. Besides, in the best contrived Furnaces that ever I saw, the Current of Flame and Heat, after having fetch'd
one

one single Compass by a Flue round the Furnace, makes its Exit presently into the Tunnel, where the greatest Force of the Heat is immediately sent up into the Air, and any farther Benefit and Advantage of it entirely lost.

ART. 2. Moreover, when there is a great Quantity of Water to be heated, as in large Boilers containing 30 or 40 Hogsheads, the Body or Bulk of it is so large, that the Contact of the Fire on the Outside of the Boiler must be every where at the Distance of 4 or 5 Foot from some Parts of the Water, which renders the Operation exceedingly slow before it boils, and also is the Occasion that it requires much more Fuel to keep it boiling, than if Matters were otherwise order'd, as will be seen by and by.

ART. 3. It will be needless to set forth here the various Experiments I have made Use of, with Relation to the Article of saving the Expence of Fuel in boiling Water; since it will be sufficient if I describe the new Method I propose, and explain the Construction of a large Boiler; for instance, one about the Size of that employ'd at *York-Buildings*, for working the famous Engine for raising Water by Fire, which is the noblest Invention that any Age has produced, and is of far more extensive Use than has hitherto been thought of, and especially it will be so, when it has received the Improvement of being wrought with one half of the Fuel now consumed.

ART. 4. In the Method I am speaking of, the Fire
is

is not to be made on the Outside of the Boiler, as in the usual Way, but in the Center or Midst of the Water to be boil'd, in a Furnace of Copper, Brass or Iron, &c. of a peculiar Form and Figure; and the Water to be contain'd *undequaque* on the Outsides of it, in a Vessel made of Wood, Lead, or any other Material that will hold Water, by which Means the whole Force and Energy of the Fire will be employ'd solely in heating the Water, the Fire here is closely confin'd, and the Heat not so soon discharg'd in the open Air, the Surface of Contact of the Fire against the Water will be larger, the Distances the Fire is to penetrate much less, the Superficies of the Water for emitting Steams greater; and consequently far less Expence of Fuel will be required, &c.

A Description of the new Boiler, Fig. 1.

ART. 5. The whole Figure is a Section of it lengthways through the Middle. A B C is the Copper, Brass or Iron Vessel, or Fire-place, included in a large external Vessel D E F G, two thirds full of Water, supported in its proper Situation by Iron Bars from the Bottom Plank E G, and firmly screw'd down to the said Plank by means of a Planchet or Border *aa* on the Outside, round the Part, where the Fire is to be made on the Grate H, in such manner that no Water may issue out.

This Copper Vessel, at the Place where the Fire is
made,

made, is to be in Breadth from A to I about 21 Inches, and in Height about 3 Foot from H to K, and in Breadth the other Way on the Flat (not visible in this Figure) 4 Foot: and then from I to B, where it turns up, it is to be of one uniform Depth and Breadth, *viz.* a Foot deep and 4 Foot broad. Lastly, from B to C the Tunnel where the Smoak is discharged, it may be made tapering from 4 Foot to 2 Foot, or a Foot and half, and from 12 Inches to 10 or 9, as will best serve the Occasion, and carried up by a Tin Shaft to any Height. So much for the Copper or Fire-place.

The large Vessel D E F G, containing the boiling Water, is to be made after the following Manner: The Top and Bottom each to consist of three good substantial Planks 5 or 6 Inches thick, 2 Foot broad, and 14 Foot long, well fitted together, and the Joints or Seams calked within and without with Oakham. This Top and Bottom are to be kept asunder at their proper Distance with a Frame of Wood or Iron Bars placed in the Inside, *viz.* at the End D E at 7 Foot Distance, and at the other End F G 5 Foot. This being done, the Sides are to be made of good substantial Sheet Lead, firmly nail'd all round to the Edges of the Top and Bottom Plank; and this would complete it, was it not, that there will be a Necessity to take it abroad sometimes to mend the Copper within, when defective; therefore it must be made to take asunder in the Middle, which may be thus contrived. The
Lead

Lead must be disposed of in two Sheets, one of them nail'd to the upper Plank, and the other to the bottom one, as before mentioned ; and at the Middle, where they are to meet, they must be allow'd broad enough to turn off square outwards, about 3 Fingers Breadth, so that they may lie flat one on the other, and being thus placed, thin Plates of Iron clap'd on each Side, and screw'd together with Screw-Pins thro' Lead and all, will so pinch the Foldings together, that the Joint will be secured from leaking ; or if this Method should not be thought sufficient, the Edges may be folder'd together, the Expence being not very great. If the Sides of this Boiler, being of Lead, should not be supposed to be strong enough to sustain the Weight of the Water within, and the Force of the Steam, &c. it will be very easy to strengthen the Outside with a Frame of Timber-work screw'd together, that may be taken abroad at Pleasure. And thus this Boiler may be open'd at any Time to repair the Copper within, which also may be taken out without much Trouble, only by unscrewing it from the Bottom Plank at the Grate. Lastly, a Case of Boards may be fitted all round the Boiler, fill'd with Sand to keep in the Heat, the Sand may be perhaps 8 or 9 Inches thick or more, as will be found best to answer the End.

ART. 6. The better to discover the Preference of this Boiler to the common Furnaces, it will not be amiss to make a Comparison between them. The Capacity of the Boiler of the Engine to raise Water by

B

Fire

Fire at *York-Buildings*, is nearly the same with this here described. I suppose the Diameter of that Furnace to be about 8 Foot and a half, and its Depth about 8 Foot; if so, its Contents will be about 453 cubical Feet, which is about 53 Hogsheads, after the Rate of 8 Foot and a half to the Hogshead, which is a little more than Wine Measure; be that as it will, to reckon by cubical Feet will be the most commodious for the present Calculation.

ART. 7. The Comparison.

The Boiler at York-Buildings.

Suppose we then, the total Capacity of the Boiler at *York-Buildings* to be in cubical Feet 453.

Two thirds of this Boiler to be filled with Water; and one third for the Reception of Steam.

The Contact of the Fire against this Boiler may be supposed to be all over the Bottom, and about 18 Inches up the Sides, which is in square Feet about 95.

Water kept boiling (as I have experienced with great Exactness) evaporates after the Rate of an Inch and half in Depth per Hour:
Therefore

The New Boiler.

The Dimensions here being 14 Foot long, 6 broad, and, at a Medium, 5 deep, the whole Cavity would contain 504 cubical Feet; out of which the Space the Copper or Fire-place takes up (about 50 Foot) being deducted, what remains will be in cubical Feet 454.

The same in this.

The Contact of the Fire in this, reckoning the least of it, is more than 10 Foot *per* 12, 120, exceeding the other 25 Foot. The Contact of the Fire, I say, is in superficial square Feet 120.

The

Therefore the larger the Surface, cæteris paribus, the greater the Evaporation or Production of Steam,

The Superficies of the Water in this Boiler is in Square Feet 56.71.

The Water therefore evaporated in an Hour in this will be in cubical Feet 7, about 52 Gallons.

The Water in this Boiler lies together in a vast bulky Body, 8 or 9 Foot Diameter, and about 5 or 6 Foot deep; so that the Fire on the Outside does not reach the middle and upper Part of it within, by 4 or 5 Foot.

Lastly, in this, as in all other common Furnaces, the Force of the Fire is hurried away with great Impetuosity from the Fire-place, through the Flues up the Tunnel, without imparting its greatest Efficacy to the Water it is to heat.

The Superficies of the Water in this Boiler (the Dimensions being 14 *per* 6) is in cubical Feet 84.

The Water evaporated in this therefore will be one third more than in the *York-Buildings* Boiler, which will consequently generate one third more Steam, *viz.* every Hour in cubical Feet 10.5 about 78 Gallons.

In the new Boiler (which is a very considerable Advantage in this Invention) the Fire is hardly any where much more than at a Foot's Distance from any Part of the Water, as is apparent from the Construction of it.

In the new Boiler the Fire is so contrived, that it burns in a Reverberatory Furnace, which affords the strongest Heat that culinary Fire is capable of producing by any Art we know of, and that Heat is retained and improved to the utmost, before it is dismissed at the Tunnel.

The Comparison between these two Boilers here set forth, being considered, and the several Advantages of the one above the other duly weighed, will without doubt sufficiently recommend this new Method to

be put in Practice, and therefore it will be needless to add any thing more in Vindication of it.

ART. 8. However there may be contrived another Sort of Boiler, the Construction of which is somewhat different from this now described, tho' in the main deduced from the same Principles; but I cannot say whether much preferable to it or not, having not made Trial of it; it is as follows:

The external or containing Vessel here is a Cylinder, Fig. 2. whose Diameter is to be 9 Foot, and its Altitude 8 Foot and a half, the Top and Bottom of firm Plank, and the Sides of Lead, hooped with Iron Hoops, or perhaps it may be all of Wood, if so large a Cask can be made.

From the Fire-place (of the same Dimensions with the other) is to be continued a large Copper-worm about 15 Inches Diameter, and about 40 Foot in Length, as is visible in the Figure. By which Contrivance the Flame, heated Air, and Smoak are retained more than three Times as long as in the other, which is a very singular Privilege and Advantage in this Form; the Contact of the Copper against the Water to be heated is far more extensive, than in the other; all other Things relating to it are pretty much the same. If this should not be found to have Draught enough of Air barely by the Admission of it at the Grate, a large Pair of Bellows may be made use of to force the Fire, as may be found necessary.

ART. 9. It is a Thing well known, that in boiling
of

of Water in a cylindrical Vessel over a Fire, there is a constant Flux of the bottom Part of the Water, as it heats, to the top; and also a reciprocal Flux of that at the Top, which is colder, down towards the Bottom, occasioned from the Difference of the Specific Gravity in the Parts of the Water at the Top and Bottom of the Boiler, the Heat communicating itself to that Part of it, which is next to the Fire, rarifies it, and makes it lighter, and causes it to ascend; and consequently that, which is colder, descends.

ART. 10. From this Theory, which is Matter of Fact, it is evident that this Boiler is contrived very advantageously, for that the upper Part of the Water receiveth the strongest Heat, and boils most furiously, whilst the lower Part has also a moderate Share of the Benefit of the Fire, so as to prepare it to ascend, as Occasion requires, to answer the Evaporation; for which Reason I should advise the Supply of fresh Water to be made at the Bottom of the Boiler, not at the Top, as it is usually done in the Fire-Engine from the large Cylinder or Steam-Barrel; I mean, that the warm Water descending from thence should be conveyed into the Boiler near the Bottom of it, not at the Top; because the coming of it in there damps the boiling, and hinders the Ascent of the Steam.

ART. 11. This Boiler would exceed the other in point of saving Fuel; but then the Construction of it may be look'd upon somewhat more difficult, and the repairing and amending of it, when Need requires, perhaps

perhaps not quite so easy; tho' even this is not to be look'd upon as impracticable.

ART. 12. It is now more than 30 Years since the Engine for raising Water by Fire was at first invented by the famous Captain *Savery*, and upwards of 20 Years that it received its great Improvement by my good Friend the ever-memorable Mr. *Newcomen*, whose Death I very much regret; and that it has not been more frequently made use of, and employed also to other Purposes, as well as almost solely the draining of Coal-mines, seems to be owing to the great Expence of Coals that is required for the working of it, it being at present so very expensive on that Account in some Parts of *England*, especially where Coals are at an excessive Price, that in many Copper and Lead-Mines it cannot be set up.

ART. 13. For the working the Engine at *York-Buildings*, the Article of Coals is at least 1000 Pounds a Year, and proportionably as much in all others, where Coals are as dear as they are in *London*, according to the Largeness of the Engine. Now if this Engine can be wrought at half the Expence of Coals, or even at two Thirds of the Expence, there will be great Encouragement, not only for the setting it up in many Places, where at the present it cannot be afforded, but also of applying it to many other Uses in Mill-Work, and particularly for draining large Levels of low Lands, to which Purpose I greatly admire that it has never been as yet applied, when a whole River
might

might be lifted with it 4 or 5 Foot high or more, as Occasion should require.

ART. 14. One considerable Advantage of this new Boiler, that has not hitherto been mention'd, is, that it is capable of being removed and shifted with great Ease from one Place to another, which cannot be so readily done in Furnaces that are set in Brick-work. By this means it may without great Trouble be adapted to this or that Shaft of a Mine, as Occasion may require. It may also be put on Board to navigate a Ship, as will be shewn in the Sequel of this Tract, which the Fire-Engine now in Use is altogether incapable of, on account of its Brick-work Furnace.

DISSERTATION II.

New Inventions for the Application of Powers (never before made use of for such Purposes) to give Motion to Engines, whereby a Ship may be navigated in a Calm, and some other great Works perform'd, where much Force is required.

ART. I. **T**HE ancient *Greeks* and *Romans*, for ought we read in History, contented themselves with giving their Ships a Motion in calm Weather

ther by rowing them with Oars, much after the same Manner as the Gallies are rowed now-a-days. Several Attempts have been made in our modern Times to navigate a Ship in a Calm, after a more expeditious Manner, and in a less laborious Way, than can be effected by the Means of common Oars; but these Attempts have hitherto all of 'em proved unsuccessful, their Contrivances having been (by all that I could hear or learn of 'em) by some kind of Machinery working without the Ship, having a Motion communicated to them from within from the Capstan or otherwise, something analogous to Oars, Paddles, or by the Revolution of Wheels, or the like, which have ever been found incommodious, and consequently not practicable.

ART. 2. The Method, that I propose for navigating a Ship, is altogether of another Nature, and very different from any Thing that has been ever yet attempted, no Part of its Machinery or *Apparatus* being without the Ship. In short, the Principle of giving Motion to the Ship, in my Way, is by forcing Water or some other Fluid through the Stern or hinder part of it into the Sea by a proper Engine or Engines placed within the Ship for that Purpose.

ART. 3. This is an Operation consentaneous to Nature, agreeable to what the Author of it has shewn us in the Swimming of Fishes, who proceed in their progressive Motion, not by any Vibration of their Fins, as Oars, but by Protrusion with their Tails. So
likewise

likewise Ducks and other Water Fowls swim forward by paddling with their Feet behind their Bodies. Nor is it dissonant to some Productions of Art; witness the Sky-rockets ascending in the Air by Virtue of a Stream of fired Gun-powder forceably bursting out at the lower End of it, and the Recoiling of a Canon when it is fired off, &c.

ART. 4. I got a Tin Machine, or Sort of Boat, to be made 11 Inches long, 5 Inches broad, and about 6 deep. I put it into a Vessel of stagnant Water, and loaded it in such manner, that it sunk in the Water exactly 3 Inches and three quarters in Depth, and in such Case 18.75 square Inches would be the Surface of it presenting to the Water, which we call the Surface of Resistance immersed in the Water, which Surface of 18.75 Inches, was equal to 300 times the Aperture in the Pipe or Tube of a quarter of an Inch square, by and by to be mentioned. In this Tin-Boat was placed a cylindrical Vessel 6 Inches high, and almost 3 Inches Diameter filled with Water, and at the Bottom of it in a horizontal Position, was a small Pipe or Tube a quarter of an Inch square, carried quite through the Stern of the Boat, about an Inch and half under the Surface of the Water in which the Boat floated, where it had its Aperture of a quarter of an Inch square. Things being thus prepared, I stopt the Aperture, at the End of the Tube, under Water, with my Finger; and then, when the Boat was in a steady Position, and the Water calm, I gently drew it away, and leaving the Boat

C

at.

at Liberty, the Water beginning to run out at the End of the Tube, gave Motion to it as I expected; which Motion, as nearly as I could observe upon many Trials, was 3 Foot in 10 or 11 Seconds of Time, which is after the Rate of 1056 in an Hour, or one fifth of a Mile. The Column of Water being 6 Inches high, we may suppose the Pressure of it at a Medium to be equal to 3 Inches in Height. The Motion of the Boat at the first was very slow, but increasing gradually towards the last it was more swift, and could it have been continued longer, it would doubtless have acquired still a somewhat greater Celerity.

ART. 5. Let us in this Experiment suppose the resisting Surface to be augmented to 500 square Feet, which is much about the Size of a cross Section at the main Breadth of a 70 Gun Ship; then in proportion the Diameter of the Aperture of the Tube must be enlarged to about 20 Inches square; then it is plain, that the Pressure of a Column of Water of 20 Inches square and 3 Inches high, would move the Ship after the Rate of 1056 Feet, or one fifth of a Mile in an Hour. The Weight of a Column of Water 20 Inches square and 3 Inches high, will be found to be 25 Pound and .3328 in Decimals, at the Rate of a cubical Foot of Water (being Salt-water) weighing 64 Pound.

ART. 6. It has been abundantly demonstrated, or at least presumed to have been demonstrated, that the Resistance of Fluids is as the Squares of the Velocities
of

of solid Bodies moving in them, and the moving Powers are always equal to the Resistances. Hence in the Case before us, as the Square of the Velocity of one fifth of a Mile in a given Time, *viz.* an Hour, is to the Square of the Velocity of 2 Miles; so is 25.3328 to a fourth proportional, which by working will be found to be 2533.2 *&c.* Pound Weight, which is equal to the Force required to navigate a Ship, whose Surface of Resistance contains 500 Foot, at the Rate of two Mile an Hour, according to this Way of Reckoning. This, how random a Computation soever it may seem to be, will notwithstanding be found not very distant from other more accurate Calculations, or from the Truth itself in Fact.

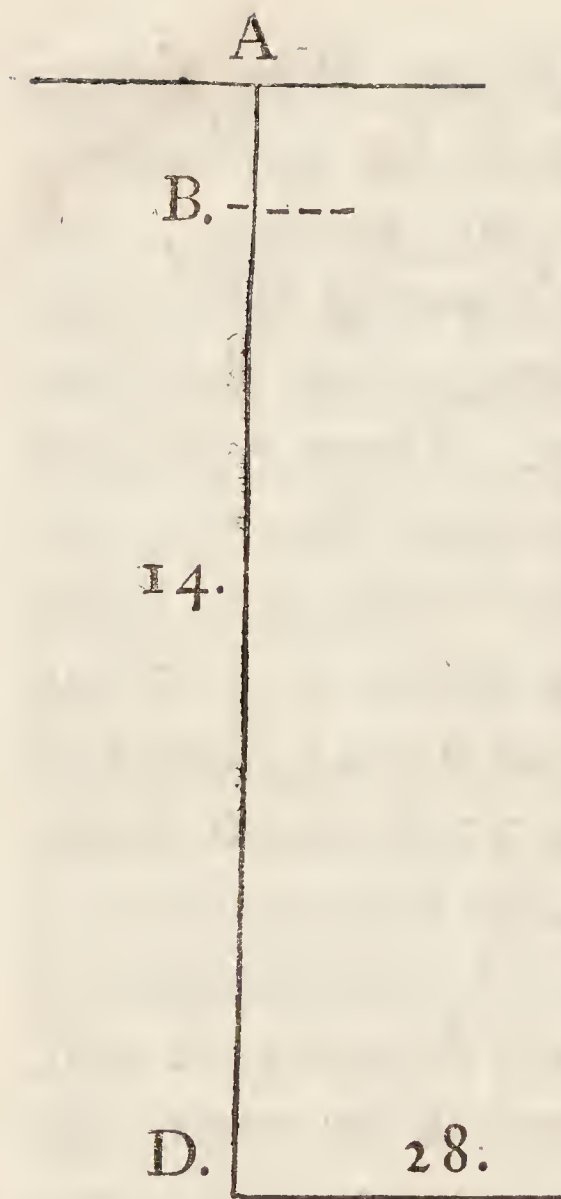
ART. 7. Some Things very well worth remarking to the Purpose in Hand, may be observed from the Rowing of the Gallies in the *Mediterranean* Sea. A Galley, whose Surface at a cross Section at the main Breadth presenting to the Water is 80 Foot, having 52 Oars, and 3 Men at an Oar, (156 Men) proceeds ordinarily in a Calm at the Rate of about 3 Mile and two thirds in an Hour. At that Rate of Rowing, the Weight of Water against the Galley is 2240 Pounds, according to M. *de la Hire*, *Memoir des Scien. Anno 1702. p. 370.* allowing it so (tho' it is no more than 1606) that Weight being equally divided among the 156 Men, each Rower impels towards navigating it no more than 14 Pound and 6 Ounces or thereabouts, which they unitedly contribute to give it that Motion.

But then it is to be considered, that at least two thirds of their Force is lost in wielding the Oars being 36 Foot long, which must be moved upwards and downwards, as well as backwards and forwards; and in giving it this last Motion the Rowers are obliged to run backwards and forwards, he that is the farthest from the *Fulcrum* no less than 6 Foot, and the rest proportionably; add to this, that they sometimes meet with Opposition of Water in fetching their Stroke, and sometimes quite miss their Stroke; besides they wrest the Galley from Side to Side, and disturb its direct Motion, one Side of the Rowers happening almost always to out-row, or pull stronger than the other, which is unavoidable; this makes the Galley move in a crooked Line from Side to Side; but this you will say is to be help'd by the Steerage, right; but then so much as it is rectified by the Rudder, so much of the Motion is abated and retarded. There is also yet another Thing, which in some measure impedes the progressive Motion, which is the Dancing of the Galley upwards and downwards, occasioned by the lifting up and plunging down the Oars in the Sea. It is farther to be observed, that they strike no more than 24 Strokes in a Minute, and one third of that Time only is applicable to give Motion to the Galley, the rest being imployed in wielding the Oars, &c. as before noted. By Reason of these Impediments it cannot be supposed, that more than one third of the Rower's Strength exerts
itself

itself in forwarding the Galley. In my Way therefore of Navigating, herein after to be explained, wherein all these Inconveniencies are avoided, less than half of the Number of Hands would suffice for Rowing a Galley of that Dimensions, after the Rate of 3 Miles and two thirds an Hour. There are some Galleys that are larger, and have greater Numbers of Hands on Board, but then the same Proportion holds good in all. They have usually from 25 to 30 Benches of Oars on each Side, and 4 or 5 Slaves to each Bench; they are from 20 to 22 Fathom long, 3 broad, and 1 deep; and they are said to Row 5 Miles an Hour, but then they have a vast Number of Hands. Let their Rate of Rowing be what it will, the same is to be performed in my Way with half the Number of Men, which certainly is Encouragement enough for those that make Use of Galleys, to put this Method in Practice, whatsoever the Wisdom of this Nation may think fit to do.

ART. 8. *Philosophical Transactions*, N^o 169. A cubical Foot of Pump Water, by Experiment is found to weigh 62 Pound and 8 Ounces; but Salt-water may weigh about a twenty-ninth or a twenty-eighth more than common Water; which Allowance being made, a cubical Foot of Sea Water at the most can weigh no more than 64 Pound, which I make the Standard in my future Calculations.

ART.



ART. 9. Water falling from a Reservoir 14 Foot high, from A to D, acquires the Velocity of 28 Foot in a Second, as has been found by very nice Experiments.

From whence a general Rule for Calculation in all Cases may be established, (Resistances of Fluids being as the Squares of the Velocities of Bodies moving in them) as thus:

As 784 (the Square of 28, the Velocity in D) is to the Square of the Velocity in B, (which is to be found by Experiment, it being the Velocity of the Current, or the

Velocity you would have the Ship to sail at in a Second of Time, or the Height of the Reservoir from A to B, which are all the same Thing; for Example, supposing the Current to move after the Rate of one Mile an Hour, *viz.* 5280 Foot, then it would move 1.4666 &c. in a Second, the Square of which is, 2.1508.) so is AD, 14 to a fourth Term, which fourth Term is the Length of the Line from A to B, and is to be multiplied by 64, the Pounds in a cubical Foot of Water, (*vid. Art. præced.*) and this Rule will hold univervally. See the Operation following;

$$\begin{array}{r}
2.1508 \\
14. \\
\hline
86032 \\
21508 \\
\hline
784. \left. \begin{array}{l} 30.1112 \\ 23.52 \end{array} \right) \left(\begin{array}{l} .0384 \\ 64. \end{array} \right. \\
\hline
6.591 \quad 1536 \\
6.272 \quad 2304 \\
\hline
.3192 \quad 2.4576 \\
.3136 \\
\hline
\dots 56
\end{array}$$

= to the Weight of Water against one Foot, at the rate of one Mile an Hour.

For A B, the Height of the Reservoir being determined from the given Celerity, and the Proportions being as above mentioned, it will be easy to discover the Resistance of the Water in all Cases whatsoever, and the Powers able to overcome it in any single Foot of Water; and from thence the cross Section of a Ship, which is the Surface of Resistance, being given in square Feet, the Power to navigate it in still Water may be known by multiplying the Weight of Resistance of that square Foot, into the Number of square Feet contained in the Ship's Surface of Resistance. So also the Force required to navigate a Ship or Boat against any determined Current may be found out, if we add the Celerity of the Current to the Resistance of dead Water, and proceed in the Manner spoken of.

After

After this Manner may be found the Force required to navigate a Ship of any Burthen, after the Rate of 1, 2, 3, 4, &c. Miles an Hour, by the same Method of Proceeding.

ART. 10. A 70 Gun Ship may be about 38 Foot Beam, and may draw 16 Foot Water, not including the Keel; a Section then at the main Breadth will contain about 500 Foot, which is the Surface of Resistance. And if it be required to know what Force is sufficient to navigate it in a Calm, for Example after the Rate of two Miles an Hour, we had need only to multiply 9.8, the Weight of Water against one Foot, by 500, the whole Surface of Resistance, and the Product will be 4900 Pounds equal to the Force required; and if we would have it to sail after the Rate of 3 Mile an Hour, it would require somewhat more than double the Force to effect it, as the Method of Calculation, here laid down, would shew.

And this Method of Calculation would undoubtedly obtain, if the Form of a Ship was an exact Parallelepiped, at each End flat and square; but the Figure and Shape of it is so artfully contrived to facilitate its Passage thro' the Water, that it very much alters the Case, as the Experiment underneath will demonstrate.

ART. 11. It is a Proposition self-evident, *That a Force or Power, whatsoever it be, that is sufficient to hold a Boat or Vessel against a Current of a known Velocity, the same Force or Power would draw it with an equal Degree of Velocity in a still Water, I mean*
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with the same Swiftness as such a Current runs at. In consequence of this Proposition I made the following Experiment.

ART. 12. In the River *Parret* at *Bridgwater*, I procured a small Vessel about 50 Ton, whose cross Section at the main Breadth was 15 Foot, and being about 3 fourths loaden, it sunk to the Depth of 6 Foot and a half, or drew so much Water, as 'tis called, not including the Keel, so that the Surface of Resistance might be about 85 Foot. From a Cable fasten'd cross the River, in the Middle of it we had a Line fixed; at the Distance of about 20 or 30 Yards from the Cable was the Vessel with a Block lashed to the middle part of the Bowsprit, over this Block was brought the Line, to which was fasten'd a Scale to receive such Weight, as we should want from a Boat attending underneath to make a Counterpoise against the Stream. Soon after the Tide began to ebb we tried the Experiment, what Weight it would bear, and found it to be hardly half a hundred; after a while we added more Weight, as the Tide of ebb ran stronger, and at length it sustained 325 Pound *Averdupoize*, Weights, Scale and all. At the same time when the Current was at that Strength, we threw into the River a roundish Block of Deal Timber, which we had prepared for the Purpose, about 6 or 7 Inches Diameter, and 10 Inches long, with a sufficient Quantity of Lead nailed to the Bottom of it to make it swim upright, about 2 Inches of it appearing above Water; and at the

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same time we also threw in an old Hoop about a Foot and a half Diameter, for half a Mile or more they kept Pace pretty well together, after that the Block happening to come near the Shore, its Motion was retarded, and at length it lodged on the Side of the Bank; but the Hoop all the while went on in very good Order, and we attended it whilst it floated along a full measured Mile, which it did in 26 Minutes, as we observed by our Watches: So that the Current ran at the rate of a Mile in 26 Minutes, or 2 Mile and 3 tenths in an Hour.

ART. 13. This Experiment was made with great Care and pretty good Exactness, so that we may adventure to deduce Rules for Calculation from it. The first fundamental Proposition will stand incontestibly thus; *That the Force Weight or Power of 325 Pound will navigate a Ship, whose Surface of Resistance contains 85 square Feet, at the rate of 1 Mile in 26 Minutes, or 2 Mile and 3 tenths in an Hour.* However, that a sufficient Allowance may be made for the Friction of the Block, the Stiffness of the Rope, &c. we will suppose, that the Ship would have suspended 15 Pound more, viz. in all 340 Pound, which 340 Pound being divided by 85, the superficial square Feet in the Ship's Section, the Quotient will be 4 Pound to each Foot: Then as the Square of the Velocity of 2.3 Miles an Hour is to the Square of the Velocity of 2 Miles an Hour, so is 4 Pound to a fourth proportional, which by working will be found to be 3 Pound, and a trifle more,

more, which is inconsiderable, after the great Allowance just now mentioned. Therefore 3 Pound to the Foot will be amply sufficient to navigate a Ship after the rate of 2 Miles an Hour, and consequently be admitted as a standing Rule for all future Calculations.

Thus much may suffice for an Enquiry, what Force and Power is necessarily required to navigate a Ship in a Calm, which I have deduced, partly from the Speculation of rowing the Gallies, and from other Mens Writings and Observations; but chiefly from several of mine own Experiments; by which, I apprehend, I am come to a great Degree of Certainty.

In the next Place then I am to explain my own Method, which, as I have hinted above, is by forcing Water, or some other Fluid, through the Stern or hinder Part of the Ship into the Sea, by a proper Engine or Engines placed within the Ship for that Purpose. The other Fluids besides Water that I am to make Use of for this Purpose, are Air and Fire, as I have declared in the Specification of my Patent.

ART. 14. I got a Sort of Force Pump fitted in thro' the Bottom of a large Cock-Boat, with a Valve on the lower End of it opening upwards, so as to let in the Water into the Pump-Barrel from under the Boat, and prevent its Return that Way; a little higher up was a Spout about 3 Foot long fixed into the Barrel of the Pump horizontally, and the End of it went thro' the Stern of the Boat, about half a Foot under Water; the Barrel of the Pump was about 5 Inches

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Diameter,

Diameter, and the Bore of the Spout, where it delivered the Water, somewhat less than 2 Inches. Things being thus prepared, and the Boat in a Mill-pond River, where there was no Current, the Pump was set to work, and it moved on the Boat after the Rate of about a Mile and half an Hour. The Boat was loaded, so as to sink to a Depth, a Section of which I computed to be equal to 4 square Feet; the Weight upon each Foot, after the Rate of a Mile and half an Hour, is one Pound and 6875 in Decimals, or 6 Pound three quarters on the 4 Foot, the Double of which is 13 Pound and a half, (the Reason for doubling it will be seen hereafter) which, besides the Friction of the Force Pump (which was not a very good one) was all the Force required to give it a Motion of half a League an Hour.

Some preliminary Suppositions in order for a Description of a Pneumatick Engine to navigate a Seventy Gun Ship in a Calm.

ART. 15. In the first Place, let there be supposed to be prepared two large Chests which may be called the Air Chests, of thick Deal Plank 12 Foot square, and about 7 or 8 Foot deep, made to the greatest Truth and Exactness, and the Joints all tight and well secured, or they may be made of a cylindrical Figure. These are to be supposed to be set Side by Side in some convenient Place, towards the Stern of the Ship, at
such

such an Height, that their Bottoms may be about 7 or 8 Foot under the Water-Mark. Each of these Air-Chests is to have a Piston fitted to it, and leather'd all round in a good Workman-like Manner. These Pistons are to be furnished each of 'em with 3 or 4 Brass Valves two Foot diameter, opening into the Cavity of the Chests, and to be provided with Springs to shut them, as Occasion shall require.

ART. 16. Before I describe the Method of working these Pistons, it may not be amiss to take a Survey of the Power and Effect they would have to move a Ship, according to the known Laws of Motion and Rules of mechanical Operations, for the present taking it for granted, that we can find an adequate Power to work such an Engine. This is a matter of great Importance, and will deserve to be examined with the utmost Strictness and Impartiality; for if I am mistaken herein, I must own it a fundamental Error, and I must come infinitely short of what I pretend to. And first perhaps it will be objected, that Air being so light a Body, so tenuious and yielding, as also so compressible and elastick, I shall be able to make little or no Impression with it against the Water, which is a Fluid of so superior a Gravity and Density. This indeed looks like an Objection to vulgar Apprehensions; but I hope for better Quarter from the Learned and skilful in Mechanics; they will agree with me, that an Impulse made on a Body of Air in a confined Place will communi-
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cate the same Degree of Motion to any other Body, whether fluid or solid, by a Shove it will give it, a small Allowance only being made on account of its Compressibility, which is not to be look'd upon to be very great neither: For in the Case before us, in a Column of Air 12 Foot square, it would require more than 30000 Pound Weight to compress the Column, so as to shorten it 3 Inches; therefore, when a great Weight or Force comes upon it, it will not be squeezed together, but it must go *quà data porta*, with a Celerity correspondent to the Weight incumbent, or Force, from whence it receives the Impulse, and the Diameters of the *Foramen* or *Foramina*, where it makes its Escape.

ART. 17. If such a Column of Air as we are speaking of 12 Foot square was supposed to be carried out against the Sea Water horizontally in its full Dimensions at the Stern of the Ship; supposing, I say, the Make of a Ship would admit of such a Thing, in such case the Shove or Impulse the Air would make against the Water would be equal to the Impression it received at the Top of the Column by the Piston; this granted, we will suppose farther the Velocity of the Motion of the Piston to be 2 Yards in 2 Seconds in each Chest, which, added together, would make as it were a continued Stream of Air issuing out with the Celerity of 2 Yards in every Second of Time, which is more than 4 Miles an Hour, equal in Weight to 1728 Pound and upwards. Now the Resistances of
Fluids

Fluids to Bodies moving in them being as the Squares of their Velocities, half this Power will be expended in shoving the Ship forward, or (which is the same Thing) in making its Effort against the Water afore the Ship; and the other half in shoving back or spurning against the Water behind the Ship. We may justly enough compare it to the Explosion of Gunpowder in the Barrel of a Cannon, half of whose Force is employed in sending forward the Ball, and the other half in making the Cannon to recoil; tho' it be not exactly so, it matters not, it serves to illustrate the Notion; or it is like driving a Wedge, which presses as much on one Side of the Block to be cloven, where the Crack or Cleaving is, as on the other. According to this Computation, the Ship would have the Weight of 864 Pound impressed on it to forward its Motion, which in a 70 Gun Ship, whose Surface of Resistance is 500 square Feet, being divided by that Sum, the Quotient will be one Pound .72 C° in Decimals on each Foot, sufficient to navigate such a Ship more than half a League an Hour; and would require no more than 70 Men to work it, (was it possible to do it in this manner) as will appear hereafter. Thus far Things are plain, and we are involved in no Obscurity.

ART. 18. To render this Engine practicable for Navigation, it is necessary that the Conveyances of the Air thro' the Stern of the Ship into the Sea be lessened, and it would be expedient to have the Air-Chests also,

so, as much as conveniently may be, diminished, that they may not be too cumbersome in the Ship. It is visible, that every where I entirely depend on the Truth of the Proposition, *That the Resistances of Fluids are as the Squares of the Velocities.* I am not ignorant however, that it has been disputed; but believe, tho' I am not Master enough of the Mathematics to demonstrate it, that it will be allow'd me, that it is extreamly near so, and near enough for Practice, which is all I contend for. If the Air-Chests, or Cylinders, if they be made round, or Pump-Barrels, let 'em be called what any one pleases, be made no more than 7 Foot Diameter, with Pistons fitted to them, and their Trunks or Tubes to convey the Air into the Sea 2 Foot square, and the Strokes be made as before observed; then will the Stream issuing from them move with a Velocity of 48 Miles an Hour, operating upon a Volume of Water 2 Foot square, or of 4 square Feet; the Effect of it will be, that it will impress a Force of 6912 Pound, which being divided by 500, the square Feet of Resistance in a 70 Gun Ship, the Quotient will be 13 Pound and eight tenths on every Foot, which being halved is 6.9, more than sufficient to navigate such a Ship after the Rate of 3 Mile an Hour, and the Number of Men for that Work would be 276. If the Square of the Air-Chests be lessen'd to 5 Foot, and the Tubes to convey the Air into the Sea to 18 Inches, then will the Stream issuing from them move with a Velocity 44 Miles an Hour, operating upon a Volume
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of Water 18 Inches square, or of 2 square Feet and a quarter, and the Effect will be, that it will impress a Force of 1452 Pound, which being divided, as above, by 500, the Quotient will be 2 Pound and 9 tenths, which being halved is 1.45, within a trifle enough to navigate such a Ship after the rate of half a League an Hour, and will require no more than 58 Men. These two Examples may be sufficient, since there is an infinite Variety, which any one may try at Pleasure.

The Description of a Water Engine to navigate a small Ship, for Example, about 200 Ton. Such a Vessel at the main Beam may measure about 22 Foot, and may draw about 11 Foot Water, not including the Keel.

ART. 19. For the accomplishing this Design, a little Portion of the Ship abaft must be divided off by a very strong and firm Partition, such as may be Proof against the Sea. Into this Room, as I may call it, the Water may be permitted to come in the Intervals of the Strokes of the Piston, thro' several Inlets or Openings from the Bottom of the Ship by Valves opening inwards; so that the Water may come as high in that Room, as it is in the Sea without side the Ship. In this Room is to be placed a Cylinder or a Tube of 6 Foot square, and about 7 Foot long, open at the Bottom, with a Piston fitted to it. The whole Room must be closely sealed down with good strong Planks every where, except over the Opening of the Tube, where

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the Piston works. When the Piston works, it forces the Water in the Room into the Sea thro' 2 Tubes, each a little more than a Foot square, one on each Side of the Stern-post opening into the Sea, where they are to deliver their Water ; these are to be placed in a level Line parallel with the Keel, and are to be of a convenient Length, they are not to be contiguous to the Cylinder, or Pump-Barrel. The Strokes here being but once in 2 Seconds, the Piston moves 3 Foot in a Second, which is somewhat more than 2 Mile an Hour, the Water will issue out thro' the Tubes into the Sea after the rate of 16 Mile an Hour, operating upon a Volume of Water 18 Inches square, or of 2 square Feet and a quarter, and the Effect will be, that it will impress a Force equal to 786 Pound Weight, which being divided by 200, the square Feet of Resistance, the Quotient will be 3 Pound and 9 Tenths, which being halved, is 1.95 Pound upon each Foot, which is almost enough to navigate the Ship after the rate of a Mile and 3 Fourths an Hour, and requires about 15 or 16 Men to do it by Hand. This also may be varied according to the Bigness of the Ship, and other Circumstances *pro re nata*.

ART. 20. Having proceeded thus far in an untrod-den Path, it will be now incumbent upon me to shew in what Manner the Engines are to be wrought, how and by what Powers and Force the Pistons are to be moved, in order to communicate a Motion to the Ship, &c. The Powers to be made use of are either the Strength of Men, or the Application of the Fire-Engine,

gine, and, upon some very extraordinary Occasions, the Explosion of Gun-powder. The Manner of working the Pistons is to be by Wheels and Chains, which is the very best Way of all, being the most simple, and liable to the least Friction of any. First then for doing it by Hand. The Stroke of the Piston, as has been noted above, being to be about 6 Foot, and the Reach of a Man, as he is to sit in a rowing Posture, being not much more than 3 Foot, the *Radius*, that moves the Piston, must be double to that by which the Men pull at. A very few Men can work the Piston in any Ship, but then if they are few, the Strokes will not be quick enough, and the Motion of the Ship very slow; the more Hands are employ'd, the quicker the Strokes will be, and the Ship will receive the greater Impulse. The Men may be ranged along between Decks at a great Length, and may work it by means of a long Pole, with small cross Bars or Handles to pull by, as will be found most commodious for the Purpose. There are two Pistons in the pneumatick Engine to be wrought alternately, of which Mention was made above. This is effected by seating one half of the Men with their Faces towards the Prow, and the other half towards the Stern, and the making use of two Wheels or Sectors of Circles, which is explained in the Draught, *Fig. 3.* but could be made much more intelligible by a Model, than by any Draught or Scheme. The Strokes of the Pistons are alternate, as I have said, so that between the two they create a perpetual Stream, incessantly

stantly pouring forth from 10 to 150 Miles an Hour, if one pleases (let it not be thought incredible, when Mr. *Newsham's* Engine spouts Water after the rate of upwards of 230 Miles an Hour, as any one, who will be at the pains to calculate, may find; and a Bullet out of a Cannon moves after the rate of above 430 Mile an Hour.) The Resistance of the Sea Water against so very rapid a Stream, especially because it is thrown out at such a Distance under the Surface, is very considerable, as may be calculated by the Rules laid down; and tho' it presses upon but a small Volume of Water, yet by its prodigious Celerity an ample Amends is made, as it is easy to compute, and will be made good in Experience. *N. B.* A 70 Gun Ship may be about 1000 Ton, carrying about 430 Men.

The Manner of applying the Engine for raising Water by Fire to navigate a Ship in a Calm.

ART. 21. I must suppose my Reader to understand the Construction and Method of working of Engines to raise Water by the impellent Force of Fire, as now in Practice at *York-Buildings*, and at several other Places in *England* for draining Mines: He must also attend to the Alteration, I have proposed to make in it, *Dissert. I. Art. 5, &c.* for when it is modelled after the Manner there proposed, it may be put on Board, and made use of to navigate a Ship; but then the Steam-Barrel must be set down almost upon the Level
with

with the Boiler, which may be done by means of a crooked Pipe of Conveyance for the Steam into the great Cylinder; for the Steam may be made to descend as well as ascend into the Cylinder or Steam-Barrel. If it was not contrived after this Manner, the Leaver or Beam would rise too high in the Ship above the Deck. This Inconvenience being thus prevented, let us suppose a Fire-Engine with its Furniture (tho' it is not needful, that it be made to work itself, since 4 or 5 Men, there being enough in the Ship, can supply it by Hand) to be placed in a 70 Gun Ship, having on board the pneumatick Engine above described, with two 7 Foot Cylinders, and their Pistons accordingly fitted, &c. Only here it is to be observed, that the two Pistons are to be made so as to strike together, the Fire-Engine being powerful enough to work both of them at once. The Engine, as it is well known, strikes about 12 Strokes in a Minute, one every 5 Seconds, which Stroke in the large Engine is computed at about 5 Ton, so that an Impulse of a Weight equal to one Ton every Second is communicated, half of which goes towards forwarding the Ship (as has been before observed) that half therefore equal to 1000 Weight being divided by 500, the Feet of Resistance gives in the Quote 2 Pound, which is almost sufficient to navigate such a Ship after the rate of 1 Mile in 3 quarters of an Hour, which, if done by Hand, would require between 90 and 100 Men; so that the Engine performs
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the Work of such a Number of Hands. The Fire-Engine is capable of being well adapted for this Purpose, because it strikes a Stroke of 6 or 7 Foot in Length. And I am persuaded, that it will perform to a greater Degree, than what I here have mention'd, on account of the prodigious Celerity of its Strokes, although they do not follow one another so quick, as one could wish: Infomuch, that I think there is no manner of Doubt, that if a Couple of 'em were apply'd to a Ship of 12 or 14 hundred Ton, they would impel it at the rate of three Knots an Hour.

ART. 22. It remains now that I should give some Account of what Helps are to be had from the Explo- sion of Gunpowder for the giving Motion to a Ship on some extraordinary Occasions, as in Sea-Engagements, in great Dangers of Shipwreck, or the like: But this is a Thing of such a Nature and Consequence, 'that it must not be published to the World over-hastily, without mature Deliberation, as well as great Caution; for I have had some Doubtings with myself, whether some bad Uses might not be made of it, to the great Detri- ment and Prejudice of Mankind. Moreover, there are also some other Engines, besides what relate to Shipping, which, to their great Improvement, may be brought to receive Motion from this same powerful Agent. Wherefore, upon the present View of Things, I can- not judge it to be so convenient at the present to un- fold this great Mystery of the Use of Gunpowder in these Respects, and to explain the Methods of applying
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it to the various Purposes it is capable of; but rather choose to reserve it for a future Treatise, if it shall please God to grant me Life and Health to go on with my Experiments, and to perfect my Speculations in that Affair, wherein, when I am upon the Subject of Gunpowder, I shall explain a new Invention of a Piece of Ordnance about 4 Foot and a half long, consisting but of half the Weight of Metal of a common Cannon, and requiring no more than one sixth Part of Gunpowder for the Charge, yet will do the same Execution with the other. It is obvious enough at the first Hearing, how advantageous Guns of this Make would be on Ship-board, and how commodious and portable by Land.

ART. 23. Now I am discoursing on Maritime Affairs, I hope my kind Reader will be so good to indulge me a little, whilst I just mention the Circumstances of an Invention (I am in some measure entitled unto) which, I believe, has not unto this Day received its full Improvement. In the Year 1716, the last Day of *May*, I communicated to the Royal Society an Invention of mine, which I called the *Perpetual Log*, or *Marine Hodometer*, shewing the Way of a Ship by Inspection, by an Index on a Dial-plate. A Model of which Invention was produced, and an Account of its Use in Writing delivered at the same Time; and received with an Approbation of it in Theory by the said honourable Society; and the Model laid up in their Repository, and the Writing committed to their Register, &c. Soon after this, upon Application made to the Admiralty, an Order was
given

given by the Commissioners for its being tried at Sea, and in Order thereunto the Machine was performed from the aforesaid Model by the famous Mr. *Rowley*, and was put on Board Capt. *Chandler*, who sailed for the *West-Indies*, but he dying in the Voyage, I never heard any Thing more of the Experiment, until 2 or 3 Years after; when I was informed, that one Mr. *Henry de Saumarez*, a *Guernsey* Man, was reviving it, under the Title of *the Marine Surveyor*; and indeed, as may be seen by the several Accounts printed in the Transactions of the Royal Society, he had taken a great deal of Pains in the Thing, and perhaps in some degree improved the first Contrivance, and I heartily wish he had lived to have brought it to it to its greatest Perfection; all that I claim in it is the Invention of it at first. At the same Time I acquainted the Admiralty, or at least some of the honourable Commissioners, that I knew of a Method of finding the Influence of Currents, and Lee-way of the Ship, without stirring out of it; but I do not understand, that now after 14 Years, any Body has as yet hit of that Notion. After so many Pretences, there have been offered to the World to secure Ships from the Worm in the *West-Indies*, perhaps it would be esteemed a very great Presumption in me, who am of a very obscure Character, should I say, I can so prepare Plank for the building of Ships, at a very small Expence, that the Worm will never touch it: but this at the present I mention here only as a Problem.

DISSERTATION III.

A new Method of drying Malt, in such a manner that no Smoak of the Fuel affects it; and the Beer brew'd therewith is render'd more wholesome and pleasant.

ART. I. **I**N the common Way of drying Malt, the gross Fumes or *Halitus* of the Fire pass through the Malt to exhale the Humidity of it; these Fumes communicate an ill smoaky Taste to the Malt, different according to the Nature of the Fuel made Use of in the drying. Hence it is, that the Drinkers of Beer brew'd with Coal-dry'd Malt condemn the Wood or Straw-dry'd, alledging it has a smoaky Taste, gives them the Heart-burning, &c. The Drinkers of the Wood or Straw-dry'd say the same of the Coal-dry'd; and indeed both of them affirm it with great Truth, only Use and Custom in the Drinkers of each Sort have familiarized the Flavour of one and the other to themselves; whereas in Reality all Sorts of it have a smoaky Taste, more or less according to the Kind and Nature of the Fuel wherewith it is dried.

ART. 2. To remedy this Inconvenience, and to render Malt Drink the more pleasant and wholesome; I have discover'd a new Method of drying Malt with any

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Sort

Sort of Fuel whatsoever, after such a Manner, that no Smoak at all comes at the Malt.

This is to be done in a very easy, simple and natural Way, *viz.* By laying the Malt to dry on a *Stratum* of boiling Water, included in a thin flat Boiler, artfully placed in a proper Kiln for that Purpose; so that by the Intervention of the Water between the Fire and the Malt, the Malt is dry'd in a very gentle and uniform manner, without Danger of being burnt or smoak'd.

ART. 3. The Experiment I at first try'd, was as follows; I caus'd a Tin Vessel to be made, about 10 Inches Diameter, and 8 or 9 Inches deep, with a double Bottom, as in the Figure ABCD, Fig. 4. The Cavity between the two Bottoms being about 2 Inches deep was fill'd with Water at the Top of the Pipe D, about 2 Inches Diameter; and the Vessel being placed on a small Fire of Wood Coals, the Water was soon made to boil and bubble up at the Pipe D; and a very small Fire would keep it boiling. Then the Malt was laid in the Cavity above on the upper Bottom to dry, and being laid on 3 Inches thick, it was 12 Hours in drying, and at 4 Inches thick it required 18 Hours. With Malt dried in this manner I brew'd some Beer, which was of a fine delicious Flavour, without the least smoaky Taste.

ART. 4. For the Purpose then; in order to dry large Quantities of Malt in this Way, a Kiln may be prepared, as I projected it more than a Year and half since
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(and should have built it if some very great Misfortune had not happen'd in my Family) after the following manner; see Fig. 5. first a large Copper, Brass or Iron Bottom must be made, suppose about 6 Foot broad, and 20 or 25 Foot in Length, or more, according to the Largeness of the Kiln intended, the Sides to be turn'd up about 4 or 5 Inches, in order to have a Floor of Tin Plates well solder'd together placed all over it, at about 3 Inches Distance above the Copper Bottom; which Floor of Tin Plates may be supported from the said Copper-Bottom with thin Strips of Wood, or the like Contrivance; this Vessel, thus fitly compacted together, I call the Boiler, which may conveniently enough perhaps be made all of Iron both Top and Bottom, as the Salt-Pans are made, or the upper Side, where the Malt is to be laid on, may be made of Lead, if Lead will not be thought to communicate an Unwholsomness to the Malt. This Boiler must be set in a Kiln of Brick-work made to receive it, and the Bottom of it to be 6 or 8 Inches above the Brick Floor. The End where the Fire is to be made, must be laid about 2 Foot lower than the upper End, where the Flues are to carry off the Smoak of the Fire, and Fumes of the Water.

ART. 5. The Boiler thus placed must be fill'd with Water at the upper End, where it must be turn'd up about a Foot high, and left open for discharging the Fumes occasion'd by the boiling of the Water; and the Supply of Water to answer that Evaporation, may

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most commodiously be furnish'd by a Pipe near the lower End over the Fire-place, where the Heat may be supposed to be the strongest.

The Malt is to be laid on this Boiler about 4 Inches thick, which will contain (the Dimensions being as before spoken) about 20 or 25 Bushels. It must be turn'd pretty often, as is usually done in other Ways of Drying; and it will be dry'd in about 18 Hours.

ART. 6. By all the Experiments I have been hitherto able to make, I do not find that this Method will take more Fuel, or require longer Time for the drying, than the common Way: And any sort of Coals, Turff or Peat, Furze, Hearth, Straw, or any other combustible Matter whatsoever, that will but heat Water, may be used to as good Purpose as charred-Coals, or the finest and choicest cleft Wood.

F I N I S



