CHAPTER XXIV.

RULES FOR DISCOVERING NEW IMPROVEMENTS; EXEMPLIFIED IN IMPROVING THE ART OF CLEANING AND HULLING RICE, WARMING ROOMS, VENTING SMOKE BY CHIMNEYS, &c.*

The true Path to Inventions.

NECESSITY is called the mother of invention, but, upon inquiry, we shall find that Reason and Experiment bring it forth; for almost all inventions have resulted from such steps as the following:—

I. To investigate the fundamental principles of the theory, and process of the art, or manufacture, we wish to improve.

II. To consider what is the best plan, in theory, that can be deduced from, or founded on, those principles, to produce the effect we desire.

III. To inquire whether the theory be already put in practice to the best advantage; and what are the imperfections or disadvantages of the common process, and what plans are likely to succeed better.

IV. To make experiments in practice, upon any plans that these speculative reasonings may suggest, or lead to. Any ingenious artist, taking the foregoing steps, will probably be led to improvement on his own art: for we see, by daily experience, that every art may be improved. It will, however, be in vain to attempt improvements, unless the mind be freed from prejudice in favour of established plans.

EXAMPLE I.

On the Art of cleaning Grain by Wind.

I. What are the principles on which the art is founded? When bodies fall through resisting mediums, their velo-

* The rules and observations, which formed an appendix to the former editions of this work, contain some suggestions which are worthy of attention. Since they were written, many improvements have been made, in the processes to which they refer; but the path is still open, and perhaps the remarks made by Mr. Evans, may yet lead to useful results; with this hope, they have, with some modifications been retained.

cities are as their specific gravities, and the surface they expose to the medium; consequently, when light and heavy articles are mixed together, the farther they fall, the greater will be their distance apart: on this principle a separation can be effected.

II. What is the best plan in theory? First, make a current of air, as deep as possible, for the grain to fall through; the lightest will then be carried farthest, and the separation be more complete at the end of the fall. Secondly, cause the grain, with the chaff, &c., to fall in a narrow line across the current, that the light parts may meet no obstruction from the heavy, in being carried forward. Thirdly, fix a movable board edgewise to separate between the good clean, and the light grain, &c. Fourthly, cause the same blast to blow the grain several times, and thereby effect a complete separation at one operation.

III. Is this theory in practice already? what are the disadvantages of the common process? We find that the farmers' common fans drop the grain in a line 15 inches wide, to fall through a current of air about 8 inches deep, instead of falling in a line half an inch wide, through a current three feet deep; so that it requires a very strong blast even to blow out the chaff; but garlic, light grains, &c., cannot be thus removed, as they meet so much obstruction from the heavy grains; the grain has, therefore, to undergo two or three such operations, so that the practice appears absurd, when tried by the scale of reason.

IV. The fourth step is to construct a fan to put the theory in practice, by experiment. (See Art. 83.)

EXAMPLE II.

The Art of Distillation.

I. The principles on which this art is founded, are evaporation and condensation. When liquid is heated, the spirit it contains, being more volatile than the watery part, evaporates, before it, into steam, which being condensed again into a liquid, by cold, is obtained in a separate state.

II. The best plan, in theory, for effecting this, appears to be as follows: the fire should be applied to the still, so as to spend the greatest possible part of its heat to heat the liquid. Secondly, the steam should be conveyed into a metallic vessel of any suitable form, and this should be immersed in cold water, to condense the steam; in order to keep the condenser cold, there should be a stream of cold water continually entering the bottom and flowing over the top of the condensing tub; the steam should have no free passage out of the condenser, else the strongest part of the liquor will escape.

III. Is this theory already put in practice, and what are the disadvantages of the common process?—1st, A great part of the heat escapes up the chimney. 2dly, It is almost impossible to keep the grounds from burning in the still. 3dly, The fire cannot be regulated to keep the still from boiling over; we are, therefore, obliged to run the spirit off very slowly; how are we to remedy these disadvantages?—First, to lessen the fuel, apply the fire as much to the surface of the still as possible; enclose the fire by a wall of clay that will not convey the heat away so fast as stone; let in no more air than is necessary to keep the fire burning, for the surplus air carries away the heat of the fire. Secondly, to keep the grounds from burning, immerse the still, with the contained liquor, in a vessel of water, joining their tops together; then, by applying the fire to heat the water in the outside vessel, the grounds will not burn, and by regulating the heat of the outside vessel the still may be kept from boiling over.

IV. A still to be heated through the medium of water, was made, some years ago, by Colonel Alexander Anderson, of Philadelphia, and the experiment tried; but the outside vessel being open, the water in it boiled away, and carried off the heat, and the liquor in the still could not be made to boil—this appeared to defeat the scheme. But, by enclosing the water in a tight vessel, so that the steam could not escape, and that the heat might be increased, it now passed to the liquor in the still, which boiled as well as if the fire had been immediately applied to it. By fixing a valve to be loaded so as to let the steam escape, when it has arrived to such a degree of heat as to require it, all danger of explosion is avoided, and all boiling over prevented.

EXAMPLE III.

The Art of venting Smoke from Rooms by Chimneys.

I. The principles are:—Heat, by repelling the particles of air to a greater distance than when cold, renders it lighter than cold air, and it will rise above it, forming a current upwards, with a velocity proportional to the degree of heat, and the size of the tube or funnel of the chimney, through which it ascends, and with a power proportional to its perpendicular height; which power to ascend will always be equal to the difference of the weight of a column of rarefied air of the size of the smallest part of the chimney, and a column of common air of equal size.

II. What is the best plan, in theory, for venting smoke, that can be founded on these principles?

1st. The size of the chimney must be proportioned to the size and closeness of the room and to the fire; because, if the chimney be immensely large, and the fire small, there will be little current upwards. And again, if the fire be large, and the chimney too small, the smoke cannot be all vented by it: more air being necessary to supply the fire, than can find vent up the chimney, it must spread in the room again, which air, after passing through the fire, is rendered deleterious.

2dly. The narrowest place in the chimney must be next the fire, and in front of it, so that the smoke would have to pass under it to get into the room; the current will there be greatest, and will draw up the smoke briskly.

3dly. The chimney must be perfectly tight, so as to admit no air but at the bottom.

III. The errors in chimneys in common practice, are,

1st. In making them widest at bottom.

2dly. Too large for the size and closeness of the room.

3dly. In not building them high enough, so that the wind, whirling over the tops of houses, blows down them.

4thly. By letting in air any where above the breast, or opening, which destroys the current of it at the bottom.

IV. The cures directed by the principles and theory, are,

1st. If the chimney smoke on account of being too large for the size and closeness of the room, make the chimney less at the bottom—its size at the top may not do much injury, but it will weaken the power of ascent, by giving the smoke time to cool before it leave the chimney; the room may be as tight, and the fire as small as you please, if the chimney be in proportion.

2dly. If it be small at the top and large at the bottom, there is no cure but to lessen it at the bottom.

3dly. If it be too small, which is seldom the case, stop up the chimney and use a stove—it will be large enough to vent all the air that can pass through a two inch hole, which is large enough to sustain the fire in a stove. Chimneys built in accordance with these theories, I believe, are every where found to answer the purpose. (See Franklin's letters on smoky chimneys.)

EXAMPLE IV.

The Art of warming Rooms by Fire.

I. Consider in what way fire operates.

1st. The fire heats and rarefies the air in the room, which gives us the sensation of heat or warmth.

2dly. The warmest part of the air being lightest, rises to the uppermost part of the room, and will ascend through holes (if there be any) to the room above, making it warmer than the one in which the fire is.

3dly. If the chimney be too open, the warm air will fly up it, leaving the room empty; the cold air will then rush in at all crevices to supply its place, which keeps the room cold.

II. Considering these principles, what is the best plan, in theory, for warming rooms?

1st. We must contrive to apply the fire to spend all its heat, to warm the air which comes into the room.

2dly. The warm air must be retained in the room as long as possible.

3dly. Make the fire in a lower room, conducting the heat through the floor into the upper one, and leaving another hole for the cold air to descend to the lower room.

4thly. Make the room so tight as to admit no more cold air, than can be warmed as it comes in.

5thly. By closing the chimney so as to let no warm air escape, but that which is absolutely necessary to sustain the fire—a hole of two square inches will be sufficient for a very large room.

6thly. The fire may be supplied by a current of air brought from without, not using any of the air already warmed. If this theory, which is founded on true principles and reason, be compared with common practice, the errors will appear, and may be avoided.

I had a stove constructed in accordance with these principles, and have found all to answer according to theory.

The operation and effects are as follows; namely :—

1st. It applies the fire to warm the air as it enters the room, and admits a full and fresh supply, rendering the room moderately warm throughout.

2dly. It effectually prevents the cold air from pressing in at the chinks or crevices, but causes a small current to pass outwards.

3dly. It conveys the coldest air out of the room first, consequently,

4thly. It is a complete ventilator, thereby rendering the room healthy.

5thly. The fire may be supplied (in very cold weather) by a current of air from without, that does not communicate with the warm air in the room.

6thly. Warm air may be retained in the room any length of time, at pleasure; circulating through the stove, the coldest entering first, to be warmed over again.

7thly. It will bake, roast, and boil equally well with the common ten plate stove, as it has a capacious oven.

8thly. In consequence of these improvements, it requires not more than half the usual quantity of fuel.

Description of the Philosophical and Ventilating Stove.

It consists of three parts, either cylindrical or square, the greatest surrounding the least. (See fig. 1, Plate X.) S F is a perspective view thereof in a square form, supposed open at one side: the fire is put in at F, into the least part, which communicates with the space next the outside, where the smoke passes to the pipe 1—5. The middle part is about two inches less than the outside part, leaving a large space between it, and above the inner part, for an oven, in which the air is warmed, being brought in by a pipe B D between the joists of the floor, from a hole in the wall at B, it rises under the stove at D, into the space surrounding the oven and the fire, which air is again surrounded by the smoke flue, giving the fire a full action to warm it, whence it ascends into the room by the pipe 2. E brings air from the pipe D B to blow the fire. H is a view of the front end plate, showing the fire and oven doors. I is a view of the back end, the plate being off, the dark square shows the space for the fire, and the light part the air-space surrounding the fire, the dark outside space the smoke surrounding the air; these are drawn on a larger scale. The stove consists of fifteen plates, twelve of which join, by one end, against the front plate H.

To apply this stove to the best advantage, suppose fig. 1, Plate X., to represent a three or four story house, two rooms on a floor—set the stove S F in the partition on the lower floor, half in each room; pass the smoke pipe through all the stories; make the room very close; let no air enter but what comes in by the pipes A B or G C through the wall at A and G, that it may be the more pure, and pass through the stove and be warmed. But to convey it to any room, and take as much heat as possible with it, there must be an air-pipe surrounding the smoke pipe, with a valve to open at every floor. Suppose we wish to warm the rooms No. 3—6, we open the valves, and the warm air enters, ascends to the upper part, depresses the cold air, and if we open the holes a—c, it will descend the pipes, and enter the stove to be warmed again: this may be done in very cold weather. The higher the room above the stove, the more powerfully will the warm air ascend and expel the cold air. But if the room require to be ventilated, the air must be prevented from descending, by shutting the little gate 2 or 5, and drawing 1 or 6, and giving it liberty to ascend and escape at A or G—or up the chimney, letting it in close at the hearth. If the warm air be conveyed under the floor, as between 5—6, and let rise in several places, with a valve at each, it will be extremely convenient and pleasant; if above the floor, as at 4, several persons might set their feet on it to warm. The rooms will be moderately warm throughout—a person will not be sensible of the coldness of the weather.

One large stove of this construction may be made to warm a whole house, ventilate the rooms at pleasure, bake bread, meat, &c.

These principles and improvements ought to be considered and provided for in building.

EXAMPLE V.

Art of Hulling and Cleaning Rice.

STEP I. The principles on which this art may be founded, will appear, by taking a handful of rough rice, and rubbing it hard between the hands—the hulls will be broken off, and, by continuing the operation, the sharp texture of the outside of the hull (which, through a magnifying glass, appears like a sharp, fine file, and, no doubt, is designed by nature for the purpose) will cut off the inside hull, and the chaff being blown out, will leave the rice perfectly clean, without breaking any of the grains.

II. What is the best plan, in theory, for effecting this? (See the plan proposed, represented in Plate X., fig. 2; explained Art. 103.)

EXAMPLE VI.

To save Ships from sinking at Sea.

STEP I. The principle on which ships float, is the difference of their specific gravities from that of the water,—sinking only to displace a quantity of water equal in weight to that of the ship, and its lading; they sink deeper, therefore, in fresh than in salt water. If we can calculate the weight of the cubic feet of water a ship displaces when empty, it will show her weight, and subtracting that from what she displaces when loaded, shows the weight of her load; each cubic foot of fresh water weighing 62,5 lbs. If an empty rum hogshead weigh 62,5 lbs. and measure 15 cubic feet, it will require 875 lbs. to sink it. A vessel of iron, containing air only, and so large as to make its whole bulk lighter than so much water, will float, but if it be filled with water, it will sink. Hence, we may conclude, that a ship loaded with any thing that will float, will not sink if filled with water; but if loaded with any thing specifically heavier than water, it will sink as soon as filled.

II. This appears to be the true theory:—How is it to be applied in case a ship spring a leak, that gains on the pumps?

III. The mariner, who understands well the above principles and theory, will be led to the following steps:

1st. To cast overboard such things as will not float, and carefully to reserve every thing that will float, for by them the ship may at last be buoyed up.

2dly. To empty every cask or thing that can be made water-tight, to put them in the hold, and fasten them down under the water, filling the vacancies between them with billets of wood; even the spars and masts may, in desperate cases, be cut up for this purpose, which will fill the hold with light matter; and as soon as the water inside is level with that outside, no more will enter. If every hogshead buoy up 875 lbs., they will be a great help to buoy up the ship, (but care must be taken not to put the empty casks too low, which would overset the ship,) and she will float, although half the bottom be torn off. Mariners, for want of this knowledge, often leave their ships too soon, taking to their boats, although the ship be much the safest, and do not sink for a long time after being abandoned—not considering that, although the water gain on their pumps at first, they may be able to hold way with it when risen to a certain height in the hold, because the velocity with which it will enter, will be in proportion to the square root of the difference between the level of the water inside and outside—added to this, the fuller the ship the easier the pumps will work, because the water has to be raised to a less height; therefore, they ought not to be too soon discouraged.

Description of the Thrashing Machine, with elastic Flails; invented by James Wardrop, *of Ampthill, Virginia.**

PLATE XXV.

A—the floor on which the flails are fixed.

B—the part of the floor on which the grain is laid, made of wicker-work, through which the grain falls, and is conveyed to the fan or screen below; the pivot of the fan is seen at P, and is turned by a band from the wheel or wallower.

C C C—a thin board raised round the floor to confine the wheat, and made shelving outwards, to render raking off the straw more easy.

D—the wallower or wheel.

E—Crank handle to turn the wheel.

F F—Flails.

G G G—Lifters, with ropes fixed to the flails.

I I I—Catches or teeth to raise the lifters.

K—Post on which the wallower is fixed.

L—Beam on which the lifters rest and are fixed by an iron rod passing through the lifters, and let into this beam.

M—Check-beam to stop the end of the lifters from rising.

N—Keeps in which the lifters work.

O—Beam in which the ends of the flails are mortised.

Q—Fly-ends loaded with lead, not necessary in a horse machine.

R—Showing the lifters and keeps, how fixed.

The machine, to be worked by two men, was made on a scale of a 12 foot flail, having a spring which required a power of 20 lbs. to raise it three feet high at the point:—A spring of this power, and raised three feet high, being found to get out wheat with great effect.

* The flail thrashing machine has been superseded by that with cylindrical beaters and a concave, variously modified. This is now so generally introduced as not to require any description. The flail machine having been originally engraved for this work, has been retained.