



XIII. Description of a cheap and efficacious ventilator for preserving corn on ship-board

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pulleys G, G, are brought round, and their ends, having hooks for that purpose, are hitched into staples fixed to the front of the cart or other carriage: within these ropes the load H is placed on a common pulley I, which forms an inclined plane, up which, by the turning of the winch, the ropes are wound upon the barrels, and the load raised into the carriage.

K K, the frame, intended to represent the part of the cart, or other carriage, on which the machine is occasionally to be placed.

The whole of the barrels and cogged wheels are contained in an iron box L, the sides of which are represented in the figure as taken off, that the construction of the several parts may be shewn.

*XIII. Description of a cheap and efficacious Ventilator for preserving Corn on Ship-board. By THOMAS SOUTH, Esq. **

THE importation of grain is a precarious traffic. The produce of distant countries, or even of those near home, when long in collecting, or long detained on ship-board, is subject to heat, soon becomes fetid, and is often so far spoiled and depreciated in its value as to sell for less than the original cost. Hence the merchant, overwhelmed with losses, regrets his patriotism, grows shy of importation, and, unless invited by a certainty of gain, drops the trade, even whilst the nation stands in need of supplies.

The remedy here proposed is a simple, cheap, and, I trust, efficacious method of ventilating grain whilst confined on ship-board; sufficient, I presume, to keep it sweet and marketable after sustaining a tedious voyage.

Description of the Ventilator, with References to the Figures thereof. (See Plate VII.)

Fig. 1. is a cylindrical air-vessel or forcing-pump, of lead,

* From the *Letters and Papers of the Bath and W. of-England Society for the Encouragement of Agriculture, &c.*

tin, or other cheap metal; its internal diameter being ten inches, and its length three feet; having a crutch-handled piston to work with, and an iron nosse, *viz.* a hollow inverted cone, two feet long, to condense the air, and increase its power in its passage downwards. This cylinder should be riveted or screwed, by means of an iron collar or straps, to the deck it passes through, both above and below, as at *aa*; and should be farther secured by some hold-fast near *b*, to keep it steady in working.

Fig. 2. is a bottom of wood, four inches and a half thick, with a projecting rim at its base, for the metal cylinder to rest on, when cemented and screwed to the wood. The centre of this bottom is excavated, for the reception of the crown of the nosse. In the same figure the nosse is represented with its crown like a bowl-dish, to condense the air gradually, without resistance, in its advance to the more contracted base of the inverted cone, *i. e.* the top or entrance of the nosse. About two-thirds down this nosse may be fixed a male screw, as *cc*, for the purpose hereafter mentioned.

N. B. The forcing-pump should be cased in wood, to protect it from outward bruises, which would prevent the working of the piston, and ruin its effects. The leather round the embolus should be greased when used.

Fig. 3. is a crutch-handle, fastened to the embolus A by its iron legs B, B. A is a cylinder of wood, cased with leather, so as to fit well, but glide smoothly in the metal cylinder; having an opening as large as its strength will permit, for the free access of atmospheric air. C is a valve, well leathered on its top, and yielding downwards to the pressure of the air when the piston is raised up. D is a cross bar of iron, to confine the valve, so that it may close instantly on the return of the piston downwards.

Fig. 4. is a tin pipe or tube, of less than four inches diameter, and of such length as, when fixed to the base of the cylinder, Fig. 1, shall admit the nosse *d*, Fig. 2, to within half an inch of the valve E, at the bottom of the wooden cylinder F, in Fig. 4; which valve E will then yield to the pressure of air condensed in its passage through the nosse, and deliver it into the pipes below. This valve must be well leathered

leathered on its upper surface, and fastened with an hinge of leather to the cylinder it is meant to close: affixed to its bottom is the spindle G, passing through a spiral spring H, which, being compressed on the descent of the valve, will, by its elasticity, cause it to rise again, close the aperture above, and retain the air delivered beneath it. On connecting this cylinder with the upper end of the nose, at *ee*, Fig. 2, we must carefully prevent any lapse of air that way, by a bandage of oakum smeared with wax, on which to screw the cylinder, like the joints of a flute, air-tight. I is a bar of iron, having a rising in its centre, wide enough for the spindle to play through, but at the same time sufficiently contracted to prevent the passage of the spiral spring.

Fig. 5. is an assemblage of tin pipes, of any lengths, shaped suitably and conveniently to their situation in the ship, to the form of which, when shut into one another, they must be adapted; observing only, that the neck be straight for a length sufficient to admit the lower end of the cylinder, Fig. 4. as high as the letter F, or higher.

Fig. 6. To the middle pipe, which runs along the bottom, should be fixed a perpendicular one, fully perforated, to convey the air more readily into the centre of the heap; and this may have a conical top, as represented in the plate, perforated with a smaller punch to prevent the air from escaping too hastily. In large cargoes, two or three of these perpendiculars may be necessary; and each should be well secured by an iron bar *g*, screwed down, to prevent their being injured by the shifting of the cargo in stormy weather or a rolling sea. The top of the conical cap of these pipes may reach two-thirds up the cargo.

Fig. 7. is a valve of the same construction as that represented in Fig. 4, but inclosed in a tube of brass, having a female screw at *ff*, adapted to the male screw *ee*, on the nose Fig. 2, and may then be inserted into the head of the pipe Fig. 5. This will add to the expence; but, in a large apparatus, is to be preferred, as a more certain security from lapse of air, than the junction of the tube Fig. 4, to the neck *ee* in Fig. 2.

N. B. *ee* is a neck of wood, making a part of the bottom

Fig. 2, whereon to secure the tube Fig. 4, when applied to the nozzle. The joints of the pipes, when put together for use, should be made air-tight, by means of bees-wax or some stronger cement, till they reach the bottom of the vessel, when there is no farther need of this precaution. The horizontal pipes should run by the side of the keelson the whole length of the hold. The tin plates of which K is made, should be punched in holes, like the rose of a watering-pot, in two or three lines only at most, and then formed into a tube, with the rough side outwards. L may have four or five lines of the like perforations. M, and the rest, should gradually increase in their number as they advance towards the middle of the hold, and continue fully perforated to the last pipe, which should be closed at its end to prevent the ingress of the corn. It is the centre of the cargo which most requires ventilating, yet air should pervade the whole. Like the trade-winds, it will direct its course to the part most heated, and, having effected its salutary purpose there, will disperse itself to refresh the mass,

Where the hatches are close-caulked, to prevent the influx of water, vent-holes may be bored in convenient parts of the deck, to be bunged up, and opened occasionally, from whence the state of the corn may be known by the effluvia which ascend when the ventilator is working.

The power of the ventilator is determined by the square of its diameter multiplied into the length of the stroke, and that again by the number of strokes in any given time.

To find the area of a circle, and the solidity of a cylinder raised on that circle, Archimedes gives the following proportion:—

As 1 is to .785398 decimal parts, so is the square of the diameter to the area of the circle.

And, as 1 is to .785398, so is the square of the diameter, multiplied by the height, to the solidity of the cylinder.

The cubical contents, both of cylinders and tubes, are found in the same manner; their difference consisting not in shape, but solidity, the latter being hollow.

Then, to find the contents of a cylindrical vessel whose internal diameter is ten inches, multiply that into itself, and the

the square thus obtained, multiplied by .7854, will give the contents of the circle in cubic inches; which, multiplied again by twenty-four inches or lengths of the stroke, being the proportion of the barrel filled with air, gives in cubic inches the amount of each discharge on the descent of the piston. As thus :

	Inches.
Internal diameter of the pump or tube	10
	× 10
	—
	= 100, or square of the diameter ;
which, multiplied by .7854, to bring the contents of the square	— to the contents of the circle.
Which, multiplied by the } length of the stroke,	78,5400 Contents of the area of the circle.
	24 inches, produces 1884 cubic inches.
	—
	3141600
	1570800
	—
	18849600

which, divided by 231, 1884.9600 (8.1600 gallons, which is $\frac{1}{100}$ ths	
<i>viz.</i> the number of cubic inches —	more than 8 gallons at a
in a wine gallon, quotes 8 galls. 369	stroke; allow these deci-
—	mals for waste of air in
1386	each stroke; and 60 strokes
—	to be made in a minute.

Then - - - - - 8 gallons discharged at a stroke,
multiplied by 60 the number of strokes

amounts to 480 gallons <i>per</i> minute ;	
which multiplied by - - 60, the minutes in an hour, produces 28800	gallons in that time ;
	—

and that, divided by 252) 28800 (114.3 tons.	
(the number of	—
gallons in a	,360
ton, both wine	—
and ship mea-	1080
sure) quotes 114	—
tons in an hour,	.720
	—

Then, suppose the area of the hold of a ship to be = 120 tons, and, when freighted, the interstices between the grains, together with the area between the surface of the corn and the

the underfide of the deck = 5 tons = to the quantity of mephitic air confined ; fuch being the lighteft fluid, the major part of it would, foon after the commencement of the operation, be forced, by the atmofpheric air, to vent itfelf at the holes provided for that purpofe ; and the remainder of the hour being employed in the like ventilation, five tons of frefh air would pafs above twenty times repeatedly amidft the grains, to cool, refrefh, and fweeten the cargo. A purification thus adminiftered once in eight-and-forty hours, would, I conceive, be amply fufficient to preferve the corn from taint or injury, be the voyage ever fo tedious ; and unlefs it fhould by neglect have overheated and grown together, or fettled too clofe, the labour would be that of a boy only ; for the dairy-girl at her churn works harder than he otherwife need to do at this.

My air-veffel is, for the fake of cheapnefs, confined to the narrow diameter of ten inches ; but, as the contents of circles are proportionate to the fquare of their diameters, by enlarging that, you increafe their power accordingly ; wherefore, by extending the diameter to fourteen inches, the contents will be nearly doubled ; and, by adding ten inches more to the length of the ftroke, you almoft treble the difcharge of No. 1, and obtain a power capable of ventilating a cargo of 400 tons within the hour. But the air-veffel muft be lengthened ; the pipes at the fame time enlarged ; the metal of which the whole is conftituted be in fubftance proportionable ; and the labour be that of a man, or perhaps two upon occafion.

A ventilator, on the plan and dimenfions here propofed, would come within the compafs, I fhould think, of five or fix guineas. One on the larger fcale, caufed by the increafed fubftance of the metal, and the extra fize and length of the pipes, might amount to twenty ; which, in either, is under fourpence *per* quarter on the firft cargo ; and as they will laft many years if well painted, and, when not in ufe, taken to pieces and put carefully by, I flatter myfelf it is an experiment well worth trial ; particularly if a premium be offered to the fhip-owner, who, by means of fuch machine, imports his corn pure and untainted from a diftant land.

Objections

Objections made to the supposed Effect of the Ventilator, over-ruled, it is hoped, by the Considerations which follow them.

First, The holes pierced in the tin tubes which are to lie under the corn, seem capable of issuing (especially if an effort be made upon them) a much larger quantity of air than the forcing-pump will supply in a given time. Consequently, a given quantity of these holes, under a given pressure, will be capable of issuing the whole supply of air, without any assistance from the remainder.

Secondly, If these positions are just, it must happen, that if a cargo of corn be unequally circumstanced in relation to its permeability, the whole of the air discharged by the pump will issue through the *more* permeable parts of it, without affecting, in any degree, the *less* permeable ones.

Thirdly, In cargoes heated in any degree, and in those infected by that worm which fastens grains together by a web, the parts most affected become much more close and densely packed together than the rest, either by the swelling of the heated grains, or by the web and dung of the worms which occupy the intervals between the grains.

If so, the parts of a cargo which require the most ventilation will receive the least; but, in all cases, it seems likely that the air discharged will not regularly permeate the whole of the cargo, but will pass through the parts where the grain lies lightest, and leave untouched those parts where it is most closely packed together.

Answer to the preceding Objections.

Though the holes appear numerous, they must be small, lest the corn gain admission; and many (especially of the uppermost) will be nearly, if not totally, stopped by the pressure of the grains upon them. Besides, the pipes which convey the air towards the centre are not meant to be so fully perforated as those at and beyond it; and all may be still less so, if in practice found necessary. But as the quantity of air delivered by the forcing-pump within five seconds

of time is equal to the contents of sixty * feet of four-inch pipe within the first minute, the air (notwithstanding the manifold perforations; obstructed as it is in meandering through a mass so nearly compacted as the bottom of the cargo must necessarily be by the pressure of the heap above) will undoubtedly reach to the end of the pipes, and consequently affect the cargo even there.

Be it farther observed, that the flux of air compressed into an half-inch stream, in its passage through the nozzle, to enable it to overcome the resistance of the spiral spring H, no sooner passes the valve E, than it expands itself to the compass of the pipe; by which expansion, and extension (at the

* Thus calculated :

	Inches.
60 feet	4
× 12 inches	× 4
-----	-----
Produces 720 inches	16 the square of the diameter of the
as a multiplier.	× ,7854 pipe.

	= 12,5664 or area of the circle.
	× 720 length of the pipe in inches.

Which, divided by 231)9047,8080(39,1679 gallons and decimal parts,
the whole capacity
of 60 feet of pipe.

$$\begin{array}{r}
 2117 \\
 \hline
 ..388 \\
 \hline
 1570 \\
 \hline
 1848 \\
 \hline
 221, \&c. \\
 \hline
 \end{array}$$

Then, a single discharge of the forcing-pump being eight gallons, five feet discharges amount to 40 gallons, which is more than equal to the contents of 6 feet of four-inch pipe.

And as on the larger scale of ventilators the pipes need not exceed the same diameter, the power of the air injected, when its egress is stopt, will increase sufficiently to force its way through webs, mats, and other obstructions, though impervious to the atmospheric fluid, unassisted by such mechanic aid.

same

same time) forwards, its power becomes so weakened, that small egress only will be made, till the pipes are filled with a fluid more dense than atmospheric air, which will then, as is justly noticed, issue where it finds the least obstruction, unless attracted to the spot most heated.

Many circumstances may cause one part of the cargo to be less permeable than the rest; should it prove so, the means readily offer for airing and purifying even this.

Suppose the hatches to be caulked down, and the hold made impervious to water; in such case, the lapse of air, under the obstructions met with in its passage, could by no means keep pace with the influx from the forcing-pump; consequently, if the holes in the deck, designed for its exit, be kept close-stopped till the pumper feels resistance, all the intervals of the cargo, be they ever so minute or irregular, must be occupied by fresh air; which, when permitted to escape, will carry off impurities with it. And thus, by stopping and opening such vents repeatedly, no part of the cargo could miss of purification. and this perhaps may be the best mode of administering it.

Prevention is better than a cure.

In a vessel equipped with the apparatus described, the attention must be great, if the corn be suffered to sustain any injury at all. By an early use of it, perspiration and damps will presently be dried away; heating of course will be prevented; and even the production of the pernicious grub alluded to: for, be the nidus of its eggs ever so productive, their embryos will not vivify, without moisture to sustain them. Wherefore, it should seem that the corn-merchant in future will have little to fear, save the influx of sea-water; and even this (if in small quantities) will, by the frequent use of the ventilator, gradually dry away.