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Dated 21/1/37

1836

Not to be folded or roughly handled

No. 539. Read the following Circular from the Government of India, Public Works Department, (Military Works,) dated Simla, 2nd August 1866, No. 65 :—

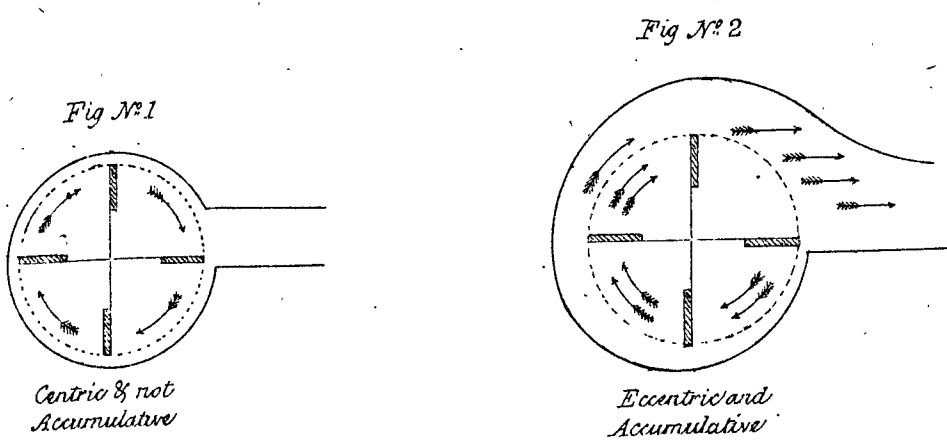
The following Memorandum on Thermantidotes, by Lieutenant-Colonel J. D. Campbell, Superintending Engineer, 2nd Circle, Punjab, and the plan therein referred to, are forwarded to the Local Governments and Administrations noted on the margin, for general information and circulation, as the Memorandum contains many practical hints in regard to the construction of Thermantidotes,

which it is considered will prove generally useful.

(Signed) C. H. DICKENS, Lieut.-Colonel, R. A.,
Secretary to the Government of India.

Memorandum by Lieutenant-Colonel J. D. CAMPBELL, R. E., Superintending Engineer, 2nd Circle, Punjab, on Thermantidotes.

SECTION I. *General form.*—The circular fanner should always move within an eccentric case, which causes accumulation as well as centrifugal force. In the eccentric case, we have continuously the benefit of all the fan-boards : whereas in the case of a circular covering, corresponding in form to the circular fanner, we get only the benefit of one fan-board at a time, and the difference in the quantity of air produced is very great. This has been explained among the first of the Royal Engineer papers, in something like the following diagrams :—



The difference in the supply of such a stream of air is scarcely calculable in figures ; but judging from actual practice, I believe that the number of arrows in this case very fairly expresses the difference in the supply; viz., the eccentric case will furnish about four times the quantity furnished by the centric case.

2. Under the class of eccentric blasts, or thermantidotes, may be mentioned, the "noiseless fan" on Lloyd's principle. It differs from the worst kind of ordinary thermantidotes in having

Fig No 3

Horizontal Section

Fan Board

B

Lloyds Principle

Fig No 4

Fan Board

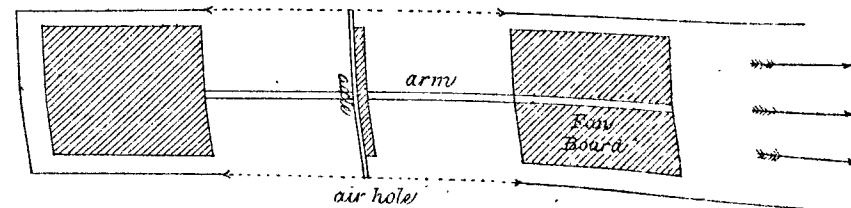
A

A

Ordinary or the Worst Kind

By using only half the fan-board, firmly fixed to an arm from the axis, we not only diminish weight, but we also obtain so much free space round the axle for the accumulation of air previous to its being acted upon by the fanners, retaining the useful part of the fan-board as shown in—

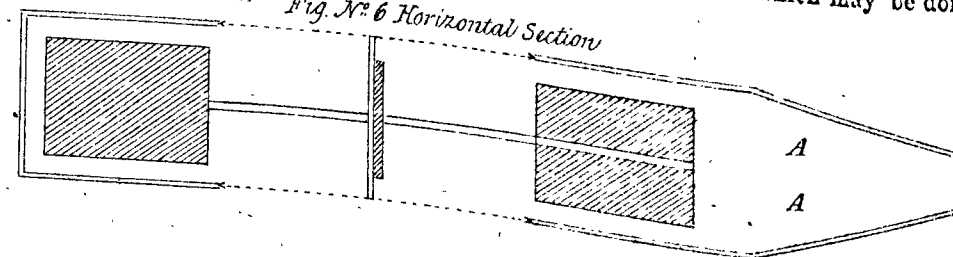
Fig N°5 Horizontal Section



4. In the last figure, the mouth of the thermantidote is shown as in straight continuation of the sides, from which construction it becomes in fact as "noiseless" as Lloyd's principle professes to make it, and the current of air, though better diffused, will not be so sensibly felt, or thrown so far into an empty room. For the purposes of a blast, for transmission through pipes, or to obtain a concentrated blast for any other purpose, some approach to Lloyd's principle must be made without interfering with the rectangular shape of the fan-board, and which may be done, being a compromise, as shown in the following:—

Fig. No. 6. Having

Fig. No 6 Horizontal Section



In fact, all conducting pipes, such as used in the barracks at Agra, should gradually diminish in sectional area to correspond with the diminishing supply, as the distance increases from the thermantidote, otherwise the total distance reached will not be so great.

5. *Eccentric case.*—The vertical section of the eccentric case is a cycloid, and is best produced by the unwinding of a piece of string from the circumference of a circular piece of wood called the *radius vector*; the amount of eccentricity thus produced will, of course, be $3\frac{1}{2}$ times the diameter of the *radius vector*.

diameter of the *radius vector*.
The most effective amount or degree of eccentricity depends directly upon the velocity of the fanners. For the extreme velocities which steam can communicate to fanners of sizes from 1 to 5 feet in diameter, the amount of eccentricity will vary from a half to a whole diameter. On this point, there has not been sufficient practical experience to lay down a more exact scale; but in the case of ordinary thermantidotes in India, moved by coolie power, the maximum velocity is about three revolutions per second, and the proper amount of eccentricity, as proved by experiment, is $\frac{1}{2}$ th the diameter. For fanners of 5 feet diameter or more, the eccentricity must be decreased in proportion to the decreased number of revolutions. Too little eccentricity will prevent accumulation, and too much of it will cause the loss of centrifugal force, although, in the latter case, the quantity of air supplied will be just the same. In some cases, fanners of about 5 feet diameter have been built (half-sunk in masonry, with a large amount of eccentricity equal to a whole diameter; the top of the case being half-way up the roof, when the revolutions of the fanner were about than one per *causecond*. The result was that, with scarcely any perceptible current, the quantity of cooled air supplied was still the same, and gradually filled the room with more general effect than could have been caused by a concentrated current; in these cases the doors and windows were kept closed, and the rooms were square rather than long, so the cooled air had not far to go. The addition of a common punkah hung from the roof made the arrangement still more complete.

SECTION II. *Size*.—The size of thermantidotes must be determined by local circumstances, in which is included the area of the mouth-piece required, with the velocity which we can give, and a consideration of the cost. As a general rule, any excess of size can only be considered as a waste of labour and materials, not only in first construction, but also in subsequent repairs. With regard to cost, it will be found to increase nearly as the cubes of the diameters of fanners (using the same materials) less by 25 per cent. For example, if we know that a fanner of 3 feet diameter, with case and fittings, costs Rs. 25, then the calculation for a fanner 5 feet in diameter with case, &c., complete, will be as follows:—

Let x represent the required cost, less by 25 per cent, then we have—

$3^3 : 25 \text{ Rs.} = 5^3 : x$	Rs.
or $27 : 25 \text{ " } = 125 : x$	115
$x = \frac{25 \times 125}{27} =$	
Deduct 25 per cent	28
Round numbers	87

Actual cost for 5 feet tankers, ...
which is worth remembering.

2. The following sizes of thermantidotes may be recommended, when coolie or bullock-power is used for different purposes:—

For an office table for one person, 3 feet diameter, case of $\frac{1}{2}$ inch mango	Rs.
planks, costing at Meerut	25
For a room 18' x 18'—5 feet diameter, as above, costing at Meerut ...	85
For a room 40' x 20'—6 feet diameter, with $\frac{3}{4}$ inch plank case, costing at Meerut	150

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21st September 1866.*

(Requires two coolies when a multiplying wheel of three diameters is used.)
For a Barrack (Half-Company,) 6 feet diameter of fanner.

For a Barrack (Full-Company,) two thermantidotes at different ends when north and south, east and west would be useless, through pipes, each 6 feet diameter of fanner.

Beyond 5 feet diameter, the thermantidotes require to be half sunk, or raised and inverted to bring the mouth to a convenient level.

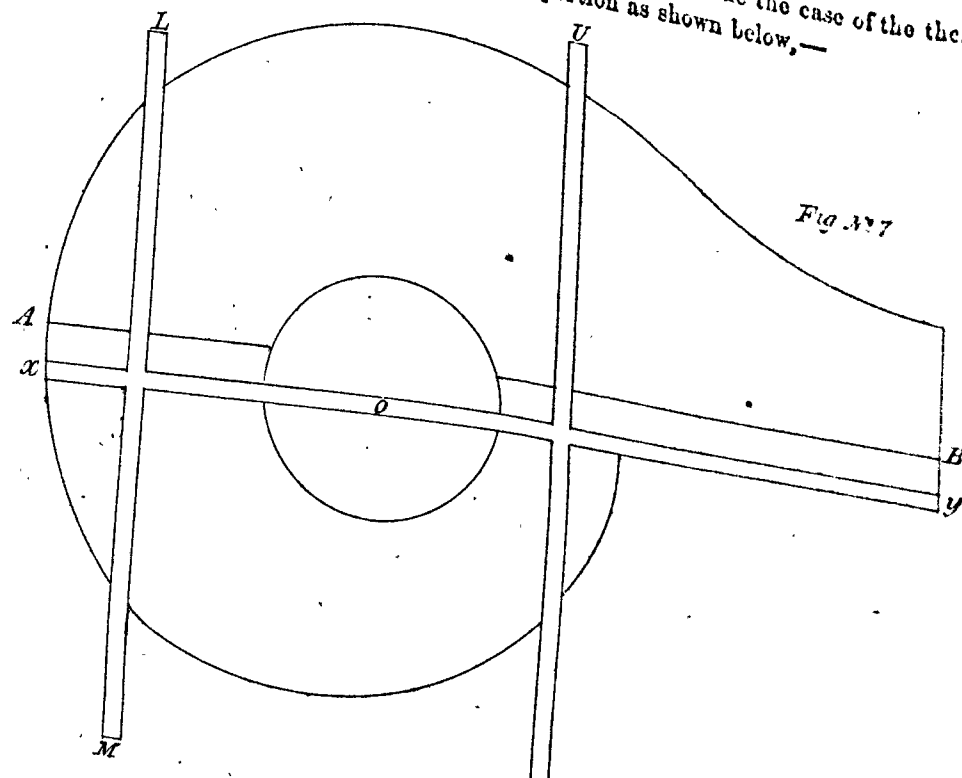
A single thermantidote 10 feet in diameter of fanner, and 4½ feet in width, with double arms, and two rims of hoop iron to steady the fanners, worked by two men, without multiplying wheel, will give (as has been proved) a large supply of air, but the cost will be fully Rs. 725, whether the case be of wood or pukka masonry.

Cheap Thermantidote.—An economical and very cool thermantidote may be constructed of a wooden fanner, in a kutchu-pukka or mud case, roughly completed with any timbers at hand; the case is generally the expensive part, costing more than ¾ of the sum for the fanner and fittings, but mud-walls and roof will be unsightly, not durable beyond the season, and very liable to white-ants. They are, however, the coolest. A little pukka brick-work must be given between the mud-wall and the khuss tattee.

SECTION III. Materials of construction.—Wood and iron are the chief materials for the fanners; wood or brick-work for the case; and brass or iron for the "plummer" blocks carrying the axle.

Sometimes, the fan-boards are made of canvas stretched and painted on wooden frames; but such are objectionable, as the damp, with the constant action, causes the canvas to stretch, and a great deal of flapping noise is soon produced. Attention is necessary to the use of seasoned wood, not on the score of durability only, but also to prevent warping, which causes much trouble. The fanners last for a long time, but the wooden case, generally of mangoe planking, is much subject to dry-rot, and, even with careful painting annually, will not last five seasons. The sal-wood skeleton framing will last a long time. Solid workmanship is essential, as there is a great deal of vibration when the thermantidote is in action. All nails should be carefully avoided, and screws or screws and nuts only used. The planking should all be tongued and grooved to avoid the opening of seams; painting should be particularly avoided; the best preservative is an annual coat of tar and oil, inside and out; ordinary paint soon peels off.

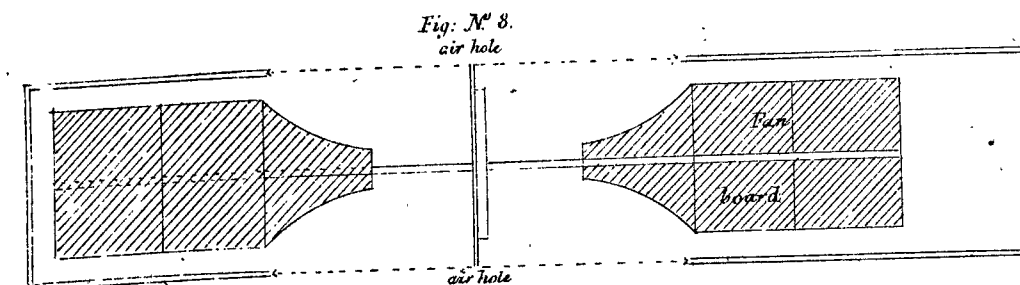
SECTION IV. Details of construction.—It is convenient to make the case of the thermantidote in two pieces, having a distinct upper and lower portion as shown below,—



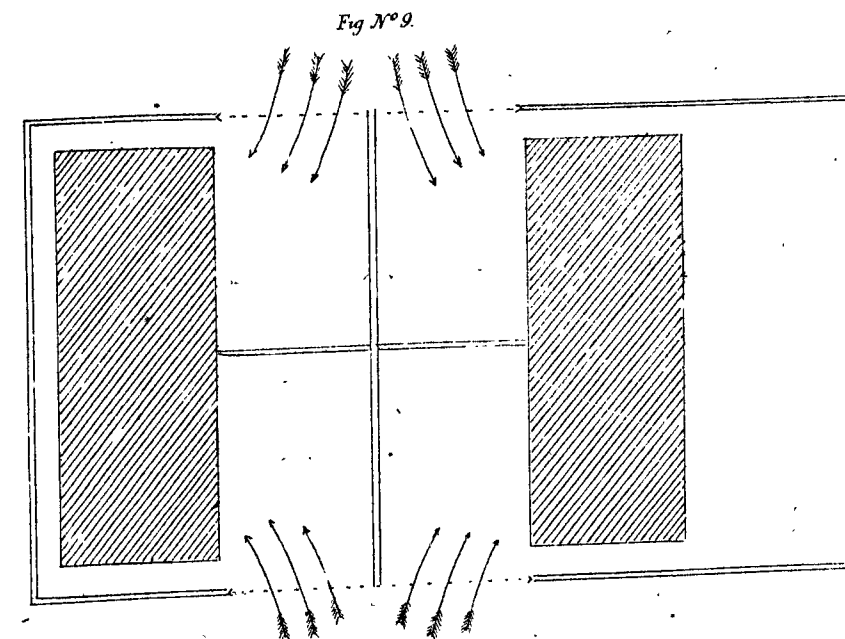
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21st September 1866.*

xy is the beam carrying the axle at o , and AB is the line of division between the upper and lower portions. The process in practice is to build the case as a whole, then a saw is passed from A to B . The upper portions of the timbers LM and UP are made to rest in iron cups and secured by hooks. (In cases of heavy thermantidote, the iron cups are not necessary.) By this arrangement, the removal of the top portion enables workmen to repair or paint the fanner, with this further advantage (no small one), that the thermantidote can be carried in three pieces instead of one unwieldy mass.

2. The horizontal sections of fanners shown in figs. 5 and 6 (Section I.) can be improved by adopting the shape shown below in fig. 8; when the thermantidote does not exceed 3½ feet in width, the construction is stronger, with more area of fan-board, but beyond 3½ feet in width, the triangular (nearly triangular) space is required for air previous to being thrown out.

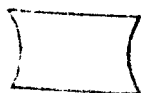


3. *Comparative widths.*—If the case is made very wide in proportion to the diameter of the fanner, the result is that, the air through the air-holes cannot reach the centre of the case, but gets disposed of as shown below, in leaving only a rarified and useless atmosphere all about the centre O .

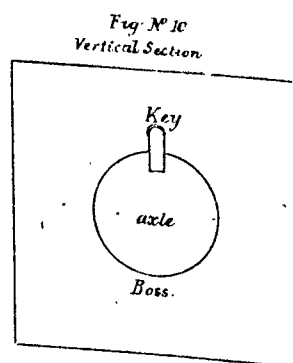


To obtain a *blast*, the width of the case should be half the diameter of the fanner, but as area of effect is also generally an object, the width of case may be to the diameter of the fanner in the proportion of 4 to 5, which is the extreme limit of width to be recommended as a matter of compromise.

4. In all cases, the free space between the fan-boards and the sides of the case should not be less than one inch. Theoretically, the fan-boards should move in an air-tight case (at the sides), but in practice, some allowance must be made for indifferent construction and for warping, otherwise there will be sudden stoppages and constant trouble, of which much may be further saved by making the sides of the fan-boards concave thus

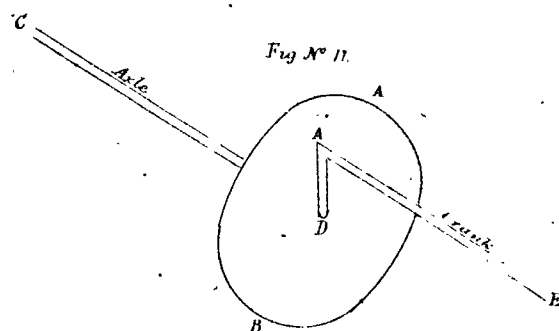


5. *Boss.*—The block of wood or iron from which the arms of the fan-boards spring, is usually called the "boss," and the only true way of fitting this firmly to the axle, is by a *circular* joining, the centre portion of the axle being turned in a lath, as also the orifice in the boss, to correspond, and properly keyed as shown in



There is a groove cut, not only in the boss, but also in the axle and a key (of hard iron about $4\frac{1}{2}$ inches in length, with a turned-up end is firmly hammered in on one or both sides. The usual way with Native artisans is only to cut the groove in the boss, and then drive an old nail in. A glance at the sketch will show that such a process is useless, giving no hold on the axle beyond what is due to friction.

6. *Crank.*—The mode of securing the crank to the axle when there is no driving-wheel, is worth consideration. Work from a European workshop will generally be firm in any shape; but in dealing with Native workmen and materials, the following arrangement is recommended:—



A circular piece of wood A B (solid) is firmly fixed (keyed) to the axle, and the portion A'D of the crank is fixed with screws and nuts to the wooden disc; C E is the handle.

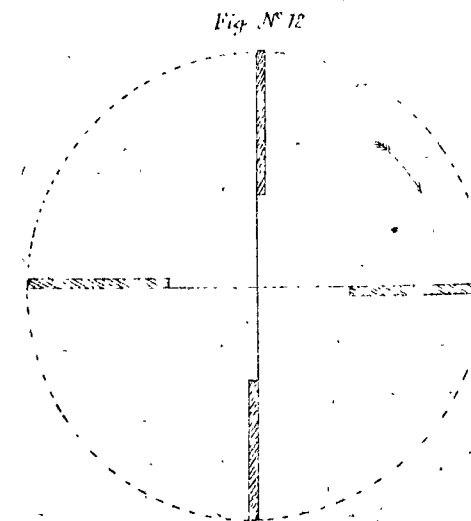
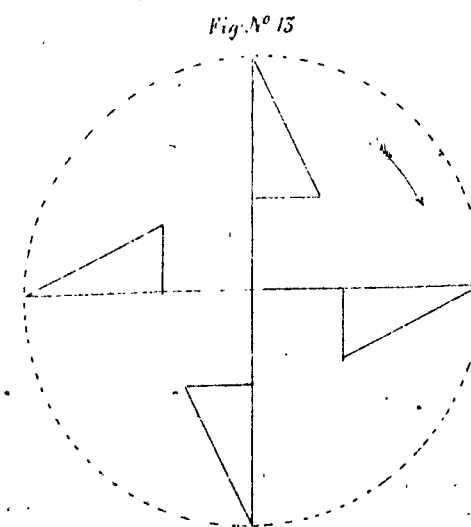
The object of this arrangement is to prevent the portion A'D from bending, so the disc of wood should be thick, not to yield not less than an inch, and (for a Native's arm) the portion A'D should be just 10 inches in length. The inch thickness of wooden disc secures firm fixing to the axle, and this joint also must be *circular* and *keyed*. The circle can be turned truly while there is no certainty in fitting a square or triangle.

7. *Leather under axles.*—The use of half-inch or inch leather under the axle obviates noise without any perceptible increase of friction, but the leather must be oiled daily, when the wear will be less than by working on iron or brass, or any of the softer metals (compounds) now usually preferred. Half an inch of leather will generally last the best part of two seasons in a 5-foot fanner. The same applies to the driving-wheel (when used), but in that case, there must be leather both above and below the axle.

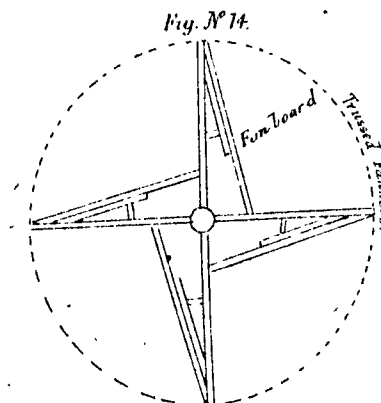
8. The feet on which a thermantidote rests should not be less than 6 inches off the ground, else the accumulation of water will rot the lower planking.

9. All thermantidotes should have 3 or 4 holes bored through the bottom planks, to get rid of accumulated water inside.

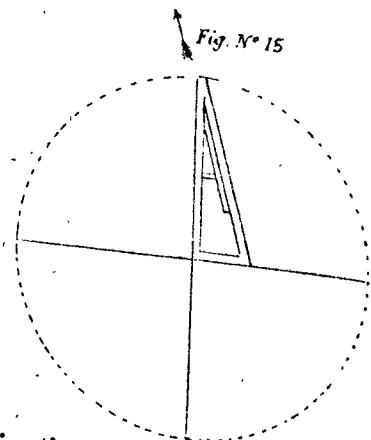
10. *Angle of fanners.*—The angle of the arms to the fan-boards appears to be of no importance whatever. There is no perceptible difference in effect, whether the fan-boards are placed as radii to the axle, as in fig. 12, or at an angle as in fig. 13.



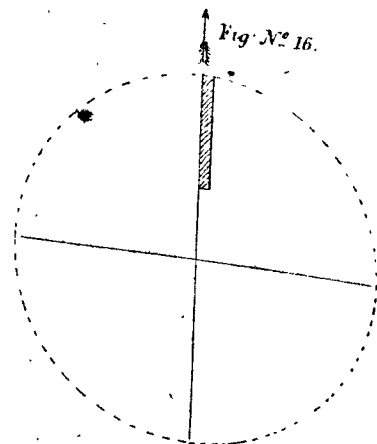
With reference to fig. 13, it will readily be understood that the act of fanning, as in the case of a hand-punkah, does not consist in pushing the fan towards the object to be fanned, but in moving it rapidly *across* the line of the object. This direct effect is obtained in fig. 12, when the fan-board is opposite the mouth; but it is sometimes an object to gain strength by trussing the fanner as sketched in fig. 14, in which case the air is still collected and impelled in consequence of the shape of the case and mouth-piece.



Theoretically, the trussed form does not seem so good, as the current from the fanner is rather in a backward direction (fig. 15)—

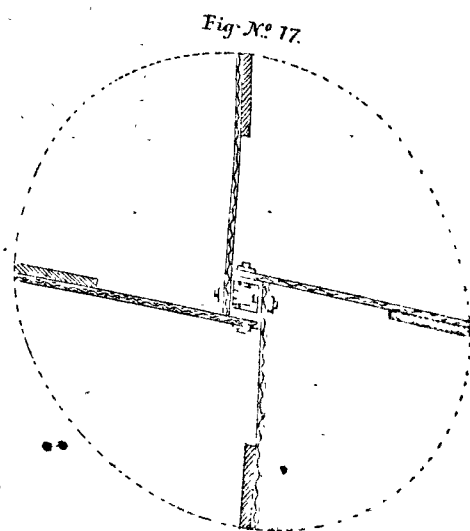


whereas, in the radial form, the direction of the current is radial, but not partially opposed to the general direction of the stream (fig. 16)—



But, as said above, the difference is not practically perceptible within an angle of 10th or 15th (or has not yet been clearly defined to be so). In any case, the span *behind* the fan-board in motion must be quite clear, as it is there that the current of air is generated.

11. The best method of fixing the fan-boards to the axle or boss is simply to dove-tail the handle into a square (or pentagonal, &c.,) sided boss—

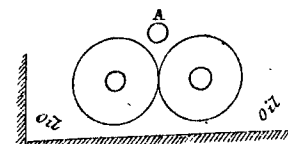


fixed with screws and nuts, and the whole may be further strengthened by a couple of thin circular rims of iron, next to the sides of the case, in the plane shown by the dotted line in the above figure, (or the ends of the radii may be connected and stiffened by straight rods with screws and nuts at the ends).

12. *Nails not admissible.*—Nails are not admissible in work of this kind, only screws or screw and nuts, as each part may require, and the plank of the case, as before mentioned, (when wood is used) should be deeply tongued and grooved, to allow of shrinkage, without open joints being caused).

13. The width of axle bearing should be no more than is needful for strength, and to meet the wear and tear for two or three seasons, as the friction increases with the width. Generally, the weight of the axle, fan-boards, &c., will be sufficient to keep the axle in its place, without any pressure from above, and the upper portion of the plummer-block can be left just free of the axle (to meet any sudden jerks), by which much of the friction is avoided.

Fig N° 18, Section



14. *Friction wheels*—consist of two narrow wheels of hard iron or steel within a wooden or iron box, on which the axle rests at A. The box is filled with oil.

The diameter of the wheels usually varies from an inch to 4½ inches; but they can seldom be made so as to be durable, unless in our workshop at Roorkee, or elsewhere. When used, the larger diameters are of course to be preferred. But they are troublesome things if not made of the best materials and workmanship. The usual mischief is, that some jerk of the axle chips a small portion off one of the wheels, the axle then lies in the chipped portion (continually enlarging the hollow), and the wheel will not turn round. The second wheel usually goes on for some time, but is, of course, liable to the same accident and results. Even a damaged wheel may, however, be considered as a useful shifting bearing, as by filing a fresh indentation on the surface, the axle can be removed to a fresh bearing until that, in its turn, gets worn down to an inconvenient depth. One wheel in motion will keep the oil going. If both have stopped, then the ordinary "lubricator" can be used, i. e., a small endless chain round the axle of the fanner, and hanging in the oil.

15. *Driving wheels*—with straps and with coolie power should not be more than three diameters (compared with the drum or pulley at the end of the axle). If more than three diameters, the leverage is so increased that the drag against the coolie becomes very great. He moves slower in proportion, and nothing is gained in the velocity of the fanner.

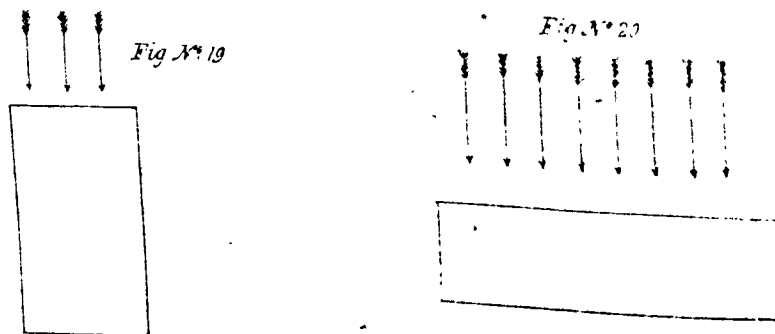
It has to be considered further, that the drum must have a certain amount of friction surface to hold the strap without its being drawn tight (which adds to friction at the axles, and is generally injurious), and generally the best proportions are to make the drum or pulley one foot in diameter, while the driving-wheel is made three feet in diameter. Both wheels have a slightly convex edge which keep the strap (about four inches in width) always working towards the centre, and prevents slipping off.

16. The axles of fanners are sometimes *hung on points* like a lathe, but the points wear rapidly, then noise is produced. Further, the revolving motion of the axle is apt to be communicated to the screw (which is the usual form), either jamming the points too tightly against the cup, or loosening it, as the case may be. The result of jamming will be a squeaking noise, and the result of loosening a rattling noise. The movement of the screws can, however, be prevented by nuts working in opposite directions. If points are used, they should be rather in the shape of a small bullet than needle points, and a double set is necessary, to be changed, and sharpened, or rounded weekly.

17. *Khuss tatties*—obstruct about 1/10th of the air (so found also by experiment). Hence, for maximum effect, the area of the tattie should be nine times the area of the side, or ventilating aperture of the thermantidote. Horizontal layers of khuss will retain water much longer than the usual mode of vertical layers. The best way is to enclose the khuss in horizontal layers between two frames of wood, filled in with wide wire (or split bamboo) netting, the frames being

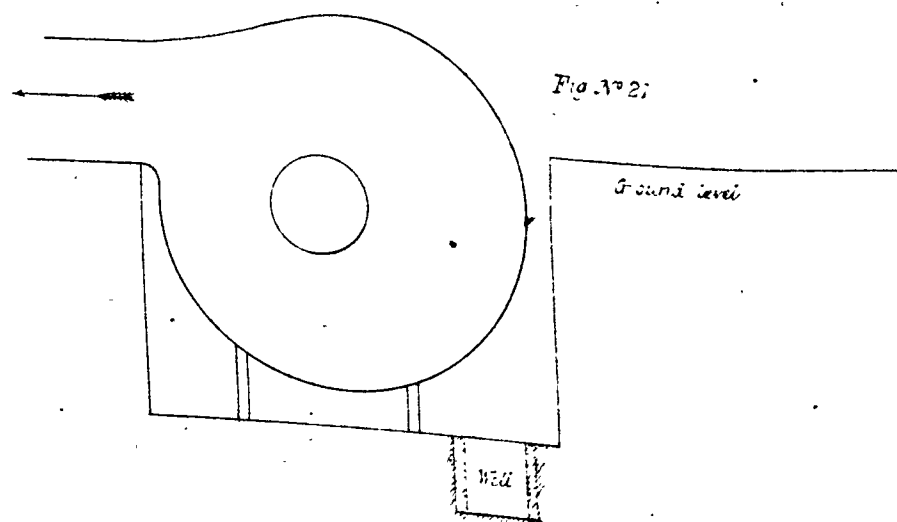
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held together at the corners by screws and nuts, so as to admit of easy replacement of the khuss. Telegraph wire will last longest. It will be evident that a high and narrow tattie-frame (fig. 19) will economize water better than a low and wide one (fig. 20), the area remaining the same.

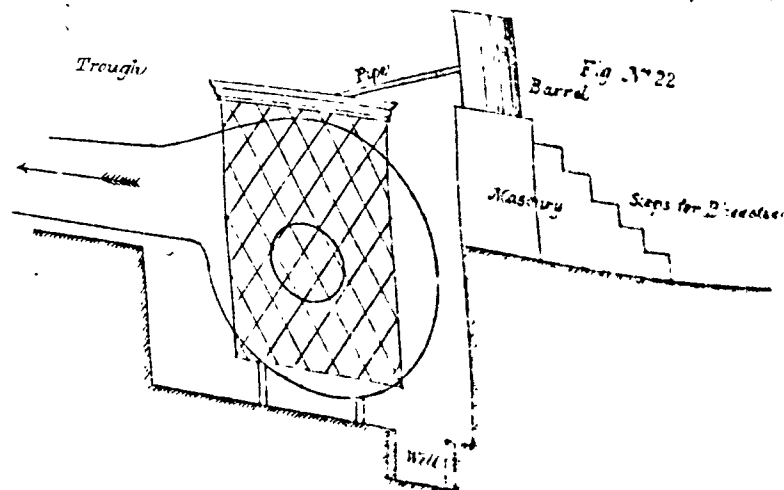


Above, in the one case, the proportion of water consumed is represented by three arrows, while in the other by eight arrows; the exact shape must, however, depend on local circumstances.

18. When a large thermantidote is used, it is convenient to sink half of it below the ground-level, within a square well, lined with masonry of sufficient area to admit of free circulation of air about the tatties and with room also for a couple of small wells within the large well, to drain off the water from the tatties like the section given in—

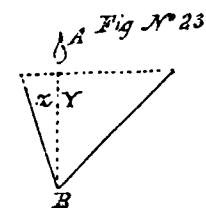


This facilitates the watering of the tatties either by hand or by means of troughs, and a barrel of water raised above the level of the trough, as shown in fig. 22.



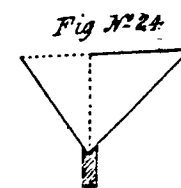
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In the above figure, the barrel is shown in rear of the thermantidote to supply both tatties; but it will generally be more convenient to have a barrel on each side of the thermantidote, and syphons may be used instead of the straight pipe shown in the foregoing figure.



A good trough for the purpose is Grant's Patent Trough (obtainable at Benares). This trough is eccentric in section (fig. 23) suspended at the ends on points on the line A B in equilibrium when empty; but when nearly full, the preponderance of water in Y spills the trough, which returns empty to its original position in equilibrium.

These troughs are apt to sag when more than 4 feet in length; but the sagging may be prevented by using a "fin" (fig. 24), which acts as a stiffener.



19. Thermantidotes in action collect air, whether good or bad, from a considerable distance. This can be practically proved by burning a pan-full of tar, or other strongly-scented substance, within a radius of 50 feet, when a strong scent of the same kind will be experienced within the house. Hence the advisability of avoiding all sources of malaria in the vicinity of thermantidotes, in which may be included vegetation of most kinds, during the night. The water on the tatties is, however, in itself a disinfectant; and positive disinfectants in a liquid form can be spread through the khuss tattie, by pouring a small quantity into the trough. The same may be done in a gaseous form by fumigation of any kind. By the same means, a very small quantity of rose-water (say a wine-glass-full), or other scent in a liquid form, can be easily introduced into any room, so as to be very distinctly perceptible to the senses.

20. Enclosed is a tracing of a thermantidote by General J. T. Boileau, with some modifications in details, since found useful on further experience.

NOTE.—In the foregoing, nothing has been said about bullock-power: but it may be taken for granted that, whatever is gained by the additional power of the bullock, is lost in time by the large circle in which the bullock must move, while it is almost impossible to avoid noise. The only advantage of the bullock is that he is less apt to shirk work than the coolie.

I have tried bullock-power, and had given up the idea as not being generally advisable.

No. 540. ORDER THEREON, 21st September 1866, No. 3,031.

MILITARY WORKS, No. 35.

Communicated to the Military Department and to the Superintending Engineers.

(True Extract.)

(Signed) CHARLES A. ORR, Colonel, R. E.,
Secretary to Government.

To the Military Department,
Superintending Engineers, } With plan.

Exd. S. T. Augustin.

CIRCULAR No. 65 PUBLIC WORKS.
GOVERNMENT OF INDIA.
PUBLIC WORKS DEPARTMENT.
Military Works.

SIMLA, AUGUST 2, 1866.

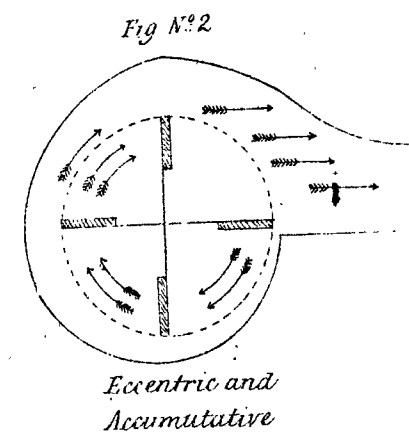
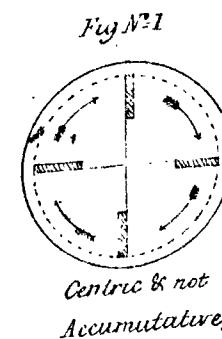
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Secy. to the Govt. of India.

J. D. Campbell
for Under Secy. to the Govt. of India.

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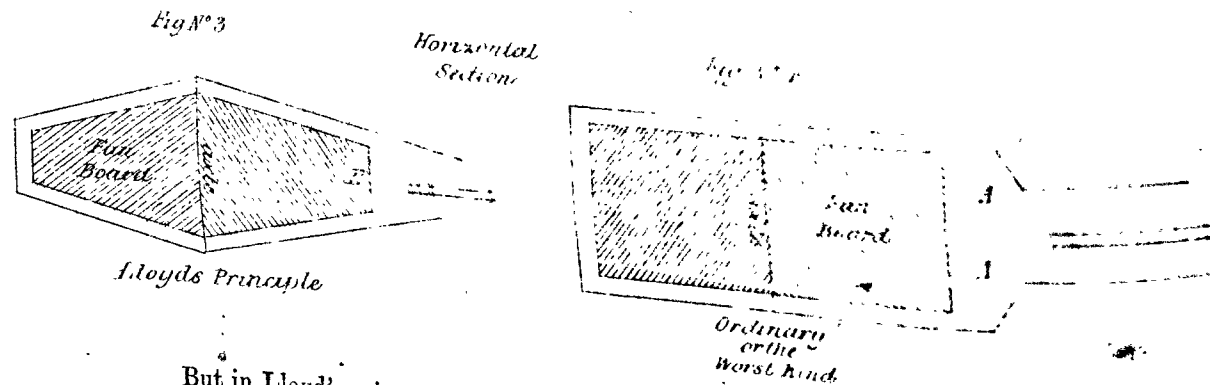


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The Secretary to Govt. of Madras
Public Works Department

expresses the difference in the supply, viz., the eccentric case will furnish about four times the quantity furnished by the centric case.

2. Under the class of eccentric blasts, or thermantidotes, may be mentioned, the "noiseless fan" on Lloyd's principle. It differs from the worst kind of ordinary thermantidotes in having no abrupt angles (A A fig. 4) to create eddies which are the causes of noise, and also to a small degree of waste of power.

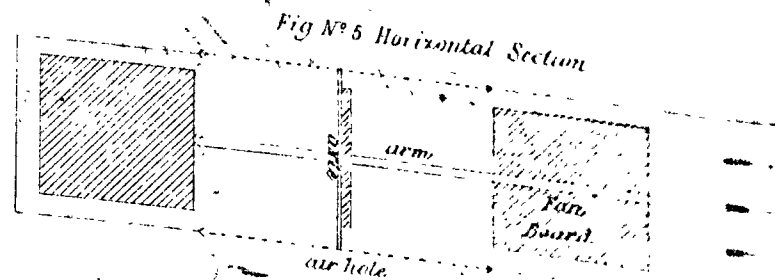


But in Lloyd's principle there is also a positive defect, and a serious one. It is evident that the portion of the fanner B, which is furthest from the axle, must, when in action, have the greatest velocity, and it is on this portion (diminished on Lloyd's fan) that we chiefly depend for the effect.

In Lloyd's blast, as applied to furnaces, this defect escapes notice, and is in some measure compensated by the extreme velocity communicated to fanners of about a foot radius, and only a few inches in width by steam-power; so it answers its special purpose very well.

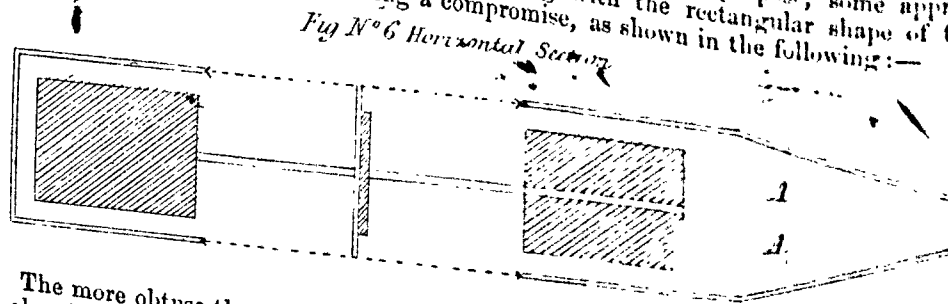
3. It has just been observed that the most effective portion of a fan-board is the portion which is farthest from the axle. The portion next the axle moves in a very small circuit, and, comparatively, so slowly, that the effect is practically nil.

By using only half the fan-board, firmly fixed to an arm from the axis, we not only diminish weight, but we also obtain so much free space round the axle for the accumulation of air previous to its being acted upon by the fanners, retaining the useful part of the fan-board as shown in—



It has been found by repeated experiments, that the maximum effect is produced by giving half the radius to the fan-board, and half to the arm, the air-holes in the outer case (represented by dotted lines) being of corresponding diameter, so as to reach the edge of the fan-board without exposing it to direct view.

4. In the last figure, the mouth of the thermantidote is shown as in straight continuation of the sides, from which construction it becomes in fact as "noiseless" as Lloyd's principle professes to make it, and the current of air, though better diffused, will not be so sensibly felt, or thrown so far into an empty room. For the purpose of a blast, for transmission through pipes, or to obtain a concentrated blast for any other purpose, some approach to Lloyd's principle must be made, without interfering with the rectangular shape of the fan-board, and which may be done, being a compromise, as shown in the following:—



The more obtuse the angle A can be made the better, especially with regard to noise and also, in some measure, with regard to effect. There is, however, a limit to the diminishment

of the mouth, so that the current of air may not be so concentrated as to become obstructive, and half the width of the case is supposed to be that limit in ordinary cases, but for long channels, as when transmitting pipes are used, there is no limit short of closing the pipe, when the air can be impelled no further.

In fact, all conducting pipes, such as used in the barracks at Agra, should gradually diminish in sectional area to correspond with the diminishing supply, as the distance increases from the thermantidote, otherwise the total distance reached will not be so great.

5. *Eccentric case.*—The vertical section of the eccentric case is a cycloid, and is best produced by the unwinding of a piece of string from the circumference of a circular piece of wood called the *radius vector*; the amount of eccentricity thus produced will, of course, be $3\frac{1}{2}$ times the diameter of the *radius vector*.

The most effective amount or degree of eccentricity depends directly upon the velocity of the fanners. For the extreme velocities which steam can communicate to fanners of sizes from 1 to 5 feet in diameter, the amount of eccentricity will vary from a half to a whole diameter. On this point, there has not been sufficient practical experience to lay down a more exact scale; but in the case of ordinary thermantidotes in India, moved by coolie power, the maximum velocity is about three revolutions per second, and the proper amount of eccentricity, as proved by experiment, is $\frac{1}{4}$ th the diameter. For fanners of 5 feet diameter or more, the eccentricity must be decreased in proportion to the decreased number of revolutions. Too little eccentricity will prevent accumulation, and too much of it will cause the loss of centrifugal force, although, in the latter case, the quantity of air supplied will be just the same. In some cases, fanners of about 5 feet diameter have been built (half-sunk) in masonry, with a large amount of eccentricity equal to a whole diameter; the top of the case being half-way up the roof, when the revolutions of the fanner were about one per *causecond*. The result was that, with scarcely any perceptible current, the quantity of cooled air supplied was still the same, and gradually filled the room with more general effect than could have been caused by a concentrated current; in these cases the doors and windows were kept closed, and the rooms were square rather than long, so the cooled air had still more complete.

SECTION II. *Size.*—The size of thermantidotes must be determined by local circumstances, in which is included the area of the mouth-piece required, with the velocity which we can give, and a consideration of the cost. As a general rule, any excess of size can only be considered as a waste of labour and materials, not only in first construction, but also in subsequent repairs. With regard to cost, it will be found to increase nearly as the cubes of the diameters of fanners (using the same materials) less by 25 per cent. For example, if we know that a fanner of 3 feet diameter, with case and fittings, costs Rs. 25, then the calculation for a fanner 5 feet in diameter, with case, &c., complete, will be as follows:—

Let x represent the required cost, less by 25 per cent, then we have—	Rs.
$3^3 : 25 \text{ Rs.} = 5^3 : x$	115
or $27 : 25 = 125 : x$	28
$x = \frac{25 \times 125}{27} = \dots$	87
Deduct 25 per cent $\dots$	
Actual cost for 5 feet fanner, &c., in round numbers $\dots$	87

which is worth remembering.

2. The following sizes of thermantidotes may be recommended, when coolie or bullock power is used, for different purposes:—

For an Office table for one person, 3 feet diameter, case of $\frac{1}{2}$ inch	Rs. 25
mangoe planks, costing at Meerut $\dots$	
For a room 18' x 18'—5 feet diameter, as above, costing at Meerut $\dots$	85
For a room 40' x 20'—6 feet diameter, with $\frac{3}{4}$ inch plank case, costing at Meerut $\dots$	150
(Requires two coolies when a multiplying wheel of three diameters is used.)	
For a Barrack (Half-Company,) 6 feet diameter of fanner.	
For a Barrack (Full-Company), two thermantidotes at different ends when north and south, east and west would be useless, through pipes, each 6 feet diameter of fanner.	

Beyond 5 feet diameter, the thermantidotes require to be half sunk, or raised and inverted to bring the mouth to a convenient level.

A single thermantidote 10 feet in diameter of fanner, and $4\frac{1}{2}$ feet in width, with double arms, and two rims of hoop-iron to steady the fanners, worked by two men, without multiplying

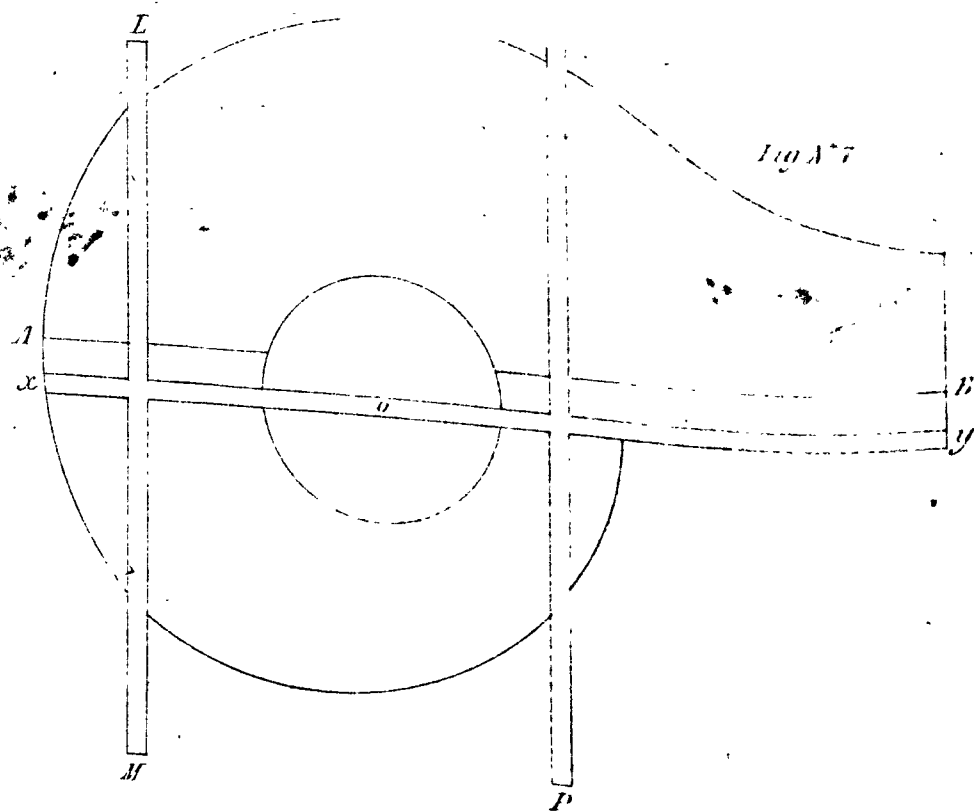
wheel, will give (as has been proved) a large supply of air, but the cost will be fully Rs. 725, whether the case be of wood or pukka masonry.

Cheap thermantidote.—An economical and very cool thermantidote may be constructed of a wooden fanner, in a katcha-pucka or mud case, roughly completed with any timbers at hand; the case is generally the expensive part, costing more than $\frac{1}{3}$ of the sum for the fanner and fittings, but mud-walls and roof will be unsightly, not durable beyond the season, and very liable to white-ants. They are, however, the coolest. A little pukka brick-work must be given between the mud-wall and the khuss tattee.

SECTION III. Materials of construction.—Wood and iron are the chief materials for the fanners; wood or brick-work for the case; and brass or iron for the "plummer" blocks carrying the axle.

Sometimes, the fan-boards are made of canvas stretched and painted on wooden frames; but such are objectionable, as the damp, with the constant action, causes the canvas to stretch, and a great deal of flapping noise is soon produced. Attention is necessary to the use of seasoned wood, not on the score of durability only, but also to prevent warping, which causes much trouble. The fanners last for a long time, but the wooden case, generally of mangoe planking, is much subject to dry-rot, and, even with careful painting annually, will not last five seasons. The sal-wood skeleton framing will last a long time. Solid workmanship is essential, as there is a great deal of vibration when the thermantidote is in action. All nails should be carefully avoided, and screws or screws and nuts only used. The planking should all be tongued and grooved to avoid the opening of seams; painting should be particularly avoided; the best preservative is an annual coat of tar and oil, inside and out; ordinary paint soon peels off.

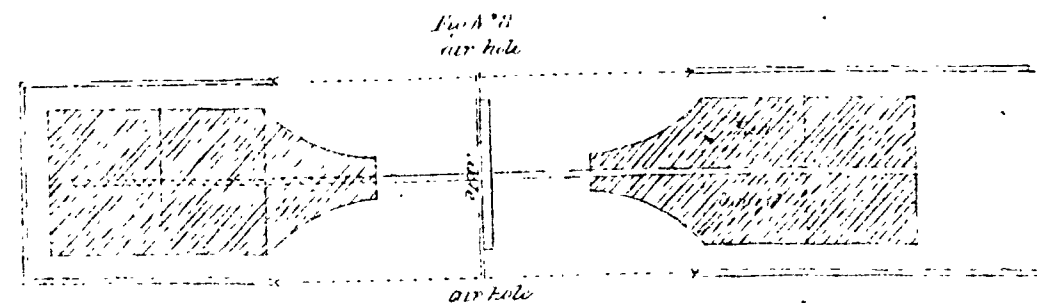
SECTION IV. Details of construction.—It is convenient to make the case of the thermantidote in two pieces, having a distinct upper and lower portion as shewn below,—



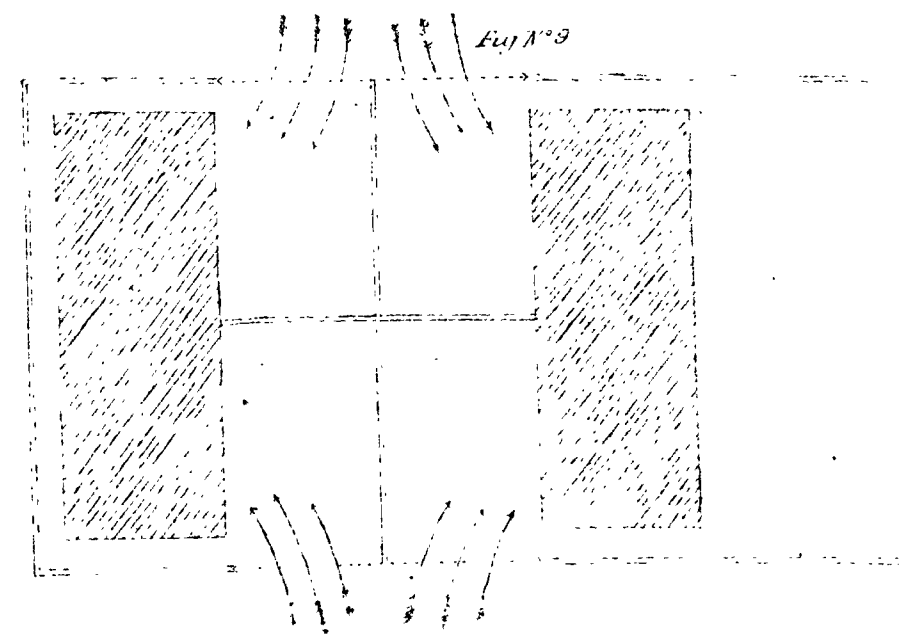
xy is the beam carrying the axle at o, and AB is the line of division between the upper and lower portions. The process in practice is to build the case as a whole, then a saw is passed from A to B. The upper portions of the timbers LM and UP are made to rest in iron cups and secured by hooks. (In cases of heavy thermantidote, the iron cups are not necessary.) By this arrangement, the removal of the top portion enables workmen to repair or paint the fanner,

with this further advantage (no small one), that the thermantidote can be carried in three pieces instead of one unwieldy mass.

2. The horizontal sections of fanners shewn in figs. 5 and 6 (Section I) can be improved by adopting the shape shewn below in fig. 8; when the thermantidote does not exceed $3\frac{1}{2}$ feet in width, the construction is stronger, with more area of fan-board, but beyond $3\frac{1}{2}$ feet in width, the triangular (nearly triangular) space is required for air previous to being thrown out.



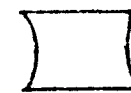
3. *Comparative widths.*—If the case is made very wide in proportion to the diameter of the fanner, the result is that, the air through the air-holes cannot reach the centre of the case, but gets disposed of as shown below, in leaving only a rarified and useless atmosphere all about the centre O.



To obtain a blast, the width of the case should be half the diameter of the fanner, but as area of effect is also generally an object, the width of case may be to the diameter of the fanner in the proportion of 4 to 5, which is the extreme limit of width to be recommended as a matter of compromise.

4. In all cases, the free space between the fan-boards and the sides of the case should not be less than one inch. Theoretically, the fan-boards should move in an air-tight case (at the sides), but in practice, some allowance must be made for indifferent construction and for warping, otherwise there will be sudden stoppages and constant trouble, of which much may

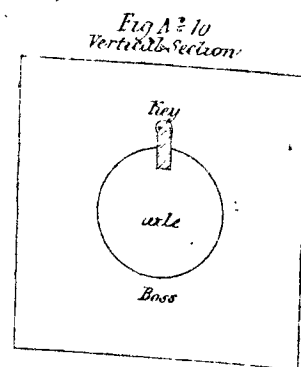
be further saved by making the sides of the fan-boards concave thus



The

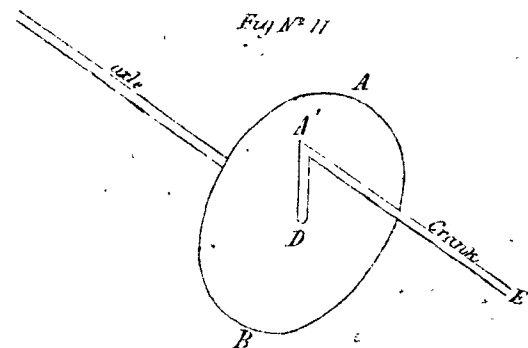
points only will have to be cut away when warping takes place.

5. *Boss*.—The block of wood or iron from which the arms of the fan-boards spring, is usually called the "boss," and the only true way of fitting this firmly to the axle, is by a circular joining, the centre portion of the axle being turned in a lathe, as also the orifice in the boss, to correspond, and properly keyed as shewn in



There is a groove cut, not only in the boss, but also in the axle and a key () of hard iron about $4\frac{1}{2}$ inches in length, with a turned-up end is firmly hammered in on one or both sides. The usual way with Native artisans is only to cut the groove in the boss, and then drive an old nail in. A glance at the sketch will shew that such a process is useless, giving no hold on the axle beyond what is due to friction.

6. *Crank*.—The mode of securing the crank to the axle when there is no driving-wheel, is worth consideration. Work from a European workshop will generally be firm in any shape; but in dealing with Native workmen and materials, the following arrangement is recommended:—



A circular piece of wood A B (solid) is firmly fixed (keyed) to the axle, and the portion A'D of the crank is fixed with screws and nuts to the wooden disc; C E is the handle.

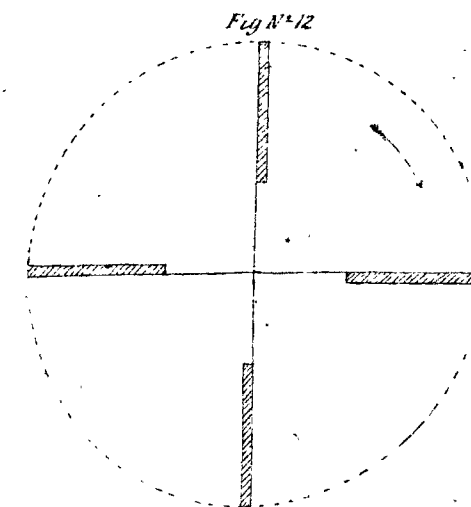
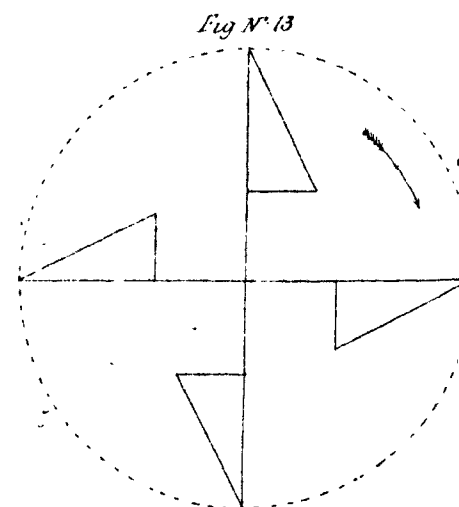
The object of this arrangement is to prevent the portion A'D from bending, so the disc of wood should be thick, not to yield not less than an inch, and (for a Native's arm) the portion A'D should be just 10 inches in length. The inch thickness of wooden disc secures firm fixing to the axle, and this joint also must be circular and keyed. The circle can be turned truly while there is no certainty in fitting a square or triangle.

7. *Leather under axles*.—The use of half-inch or inch leather under the axle obviates noise without any perceptible increase of friction, but the leather must be oiled daily, when the wear will be less than by working on iron or brass, or any of the softer metals (compounds) now usually preferred. Half an inch of leather will generally last the best part of two seasons in a 5-foot fanner. The same applies to the driving-wheel (when used), but in that case, there must be leather both above and below the axle.

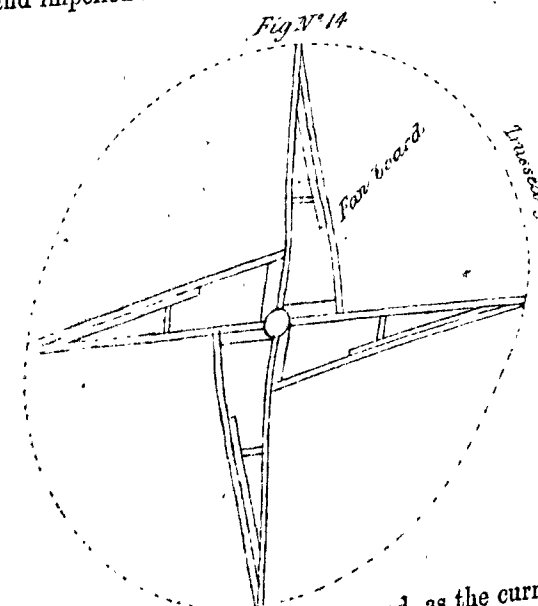
8. The feet on which a thermantidote rests should not be less than 6 inches off the ground, else the accumulation of water will rot the lower planking.

9. All thermantidotes should have 3 or 4 holes bored through the bottom planks, to get rid of accumulated water inside.

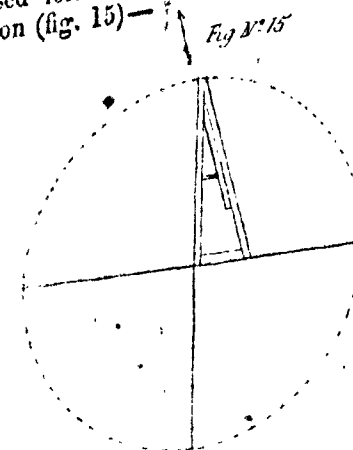
10. *Angle of fanners*.—The angle of the arms to the fan-boards appears to be of no importance whatever. There is no perceptible difference in effect, whether the fan-boards are placed as radii to the axle, as in fig. 12, or at an angle as in fig. 13.



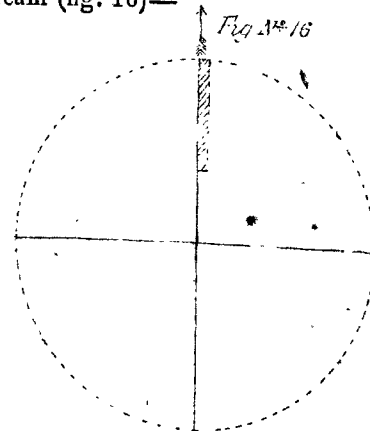
With reference to fig. 13, it will readily be understood that the act of fanning, as in the case of a hand-punkah, does not consist in pushing the fan towards the object to be fanned, but in moving it rapidly across the line of the object. This direct effect is obtained in fig. 12, when the fan-board is opposite the mouth; but it is sometimes an object to gain strength by trussing the fanner as sketched in fig. 14, in which case the air is still collected and impelled in consequence of the shape of the case and mouth-piece.



Theoretically, the trussed form does not seem so good, as the current from the fanner is rather in a backward direction (fig. 15)—



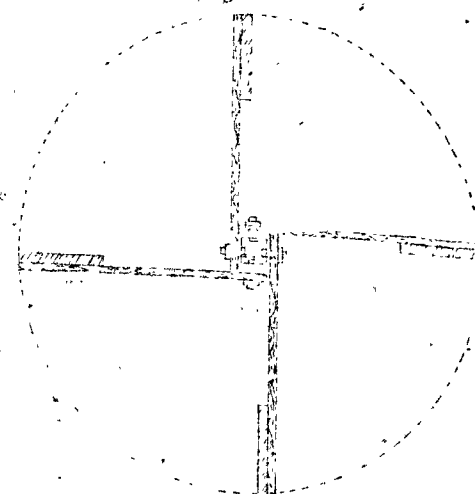
whereas, in the radial form, the direction of the current is radial, but not partially opposed to the general direction of the stream (fig. 16)—



But, as said above, the difference is not practically perceptible within an angle of 10th or 15th (or has not yet been clearly defined to be so). In any case, the span *behind* the fan-board in motion must be quite clear, as it is there that the current of air is generated.

11. The best method of fixing the fan-boards to the axle or boss is simply to dove-tail the handle into a square (or pentagonal, &c.) sided boss—

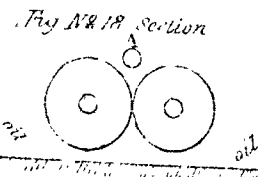
Fig. No. 17



fixed with screws and nuts, and the whole may be further strengthened by a couple of thin circular rims of iron, next to the sides of the case, in the plane shewn by the dotted line in the above figure, (or the ends of the radii may be connected and stiffened by straight rods with screws and nuts at the ends).

12. *Nails not admissible.*—Nails are not admissible in work of this kind, only screws or screw and nuts, as each part may require, and the plank of the case, as before mentioned, (when wood is used) should be deeply tongued and grooved, to allow of shrinkage, without open joints being caused).

13. The width of axle-bearing should be no more than is needful for strength, and to meet the wear and tear for two or three seasons, as the friction increases with the width. Generally, the weight of the axle, fan-boards, &c., will be sufficient to keep the axle in its place, without any pressure from above, and the upper portion of the plunger-block can be left just free of the axle (to meet any sudden jerks), by which much of the friction is avoided.



14. *Friction wheels*—consist of two narrow wheels of hard iron or steel within a wooden or iron-box, on which the axle rests at A. The box is filled with oil.

The diameter of the wheels usually varies from an inch to 4½ inches; but they can seldom be made so as to be durable, unless in our workshop at Roorkee, or elsewhere. When used, the larger diameters are of course to be preferred. But they are troublesome things if not made of the best materials and workmanship. The usual mischief is, that some jerk of the axle chips a small portion off

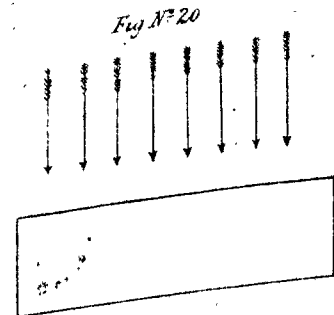
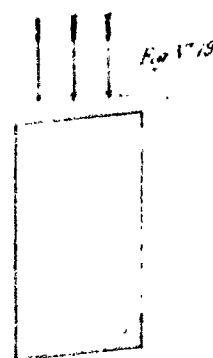
one of the wheels, the axle then lies in the chipped portion (continually enlarging the hollow), and the wheel will not turn round. The second wheel usually goes on for some time, but is, of course, liable to the same accident and results. Even a damaged wheel may, however, be considered as a useful shifting bearing, as by filing a fresh indentation on the surface, the axle can be removed to a fresh bearing until that, in its turn, gets worn down to an inconvenient depth. One wheel in motion will keep the oil going. If both have stopped, then the ordinary "lubricator" can be used, i. e., a small endless chain round the axle of the fanner, and hanging in the oil.

15. *Driving wheels*—with straps and with coolie power should not be more than 3 diameters (compared with the drum or pulley at the end of the axle). If more than three diameters, the leverage is so increased that the drag against the coolie becomes very great. He moves slower in proportion, and nothing is gained in the velocity of the fanner.

It has to be considered further, that the drum must have a certain amount of friction surface to hold the strap without its being drawn tight (which adds to friction at the axles, and is generally injurious), and generally the best proportions are to make the drum or pulley one foot in diameter, while the driving-wheel is made 3 feet in diameter. Both wheels have a slightly convex edge which keep the strap (about 4 inches in width) always working towards the centre, and prevents slipping off.

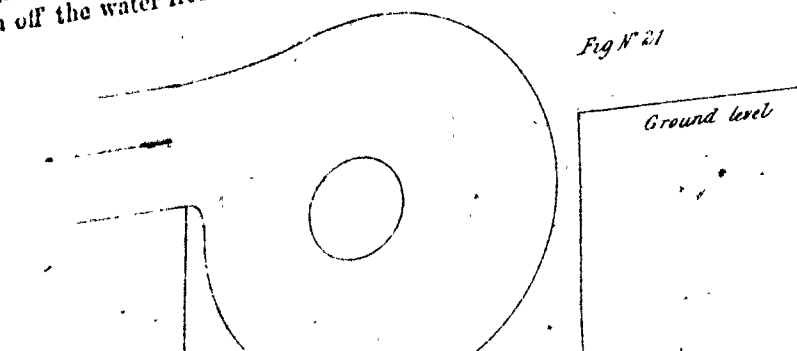
16. The axles of fanners are sometimes *hung on points* like a lathe, but the points wear rapidly, then noise is produced. Further, the revolving motion of the axle is apt to be communicated to the screw (which is the usual form), either jamming the points too tightly against the cup, or loosening it, as the case may be. The result of jamming will be a squeaking noise, and the result of loosening a rattling noise. The movement of the screws can, however, be prevented by nuts working in opposite directions. If points are used, they should be rather in the shape of a small bullet than needle points, and a double set is necessary, to be changed, and sharpened, or rounded weekly.

17. *Khuss tatties*—obstruct about 1/4 th of the air (so found also by experiment). Hence, for maximum effect, the area of the tatties should be nine times the area of the side, or ventilating aperture of the thermantidote. Horizontal layers of khuss will retain water much longer than the usual mode of vertical layers. The best way is to enclose the khuss in horizontal layers between two frames of wood, filled in with wide wire (or split bamboo) netting, the frames being held together at the corners by screws and nuts, so as to admit of easy replacement of the khuss. Telegraph wire will last longest. It will be evident that a high and narrow tattie-frame (fig. 19) will economize water better than a low and wide one (fig. 20), the area remaining the same.

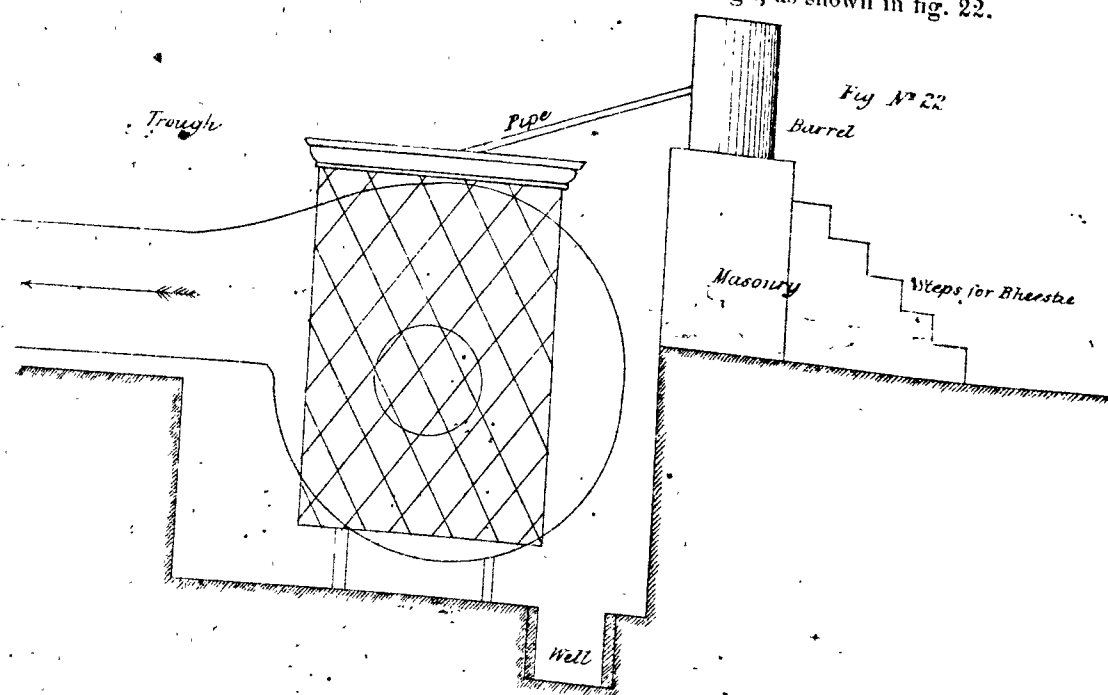


Above, in the one case, the proportion of water consumed is represented by 3 arrows, while in the other by 8 arrows; the exact shape must, however, depend on local circumstances.

18. When a large thermantidote is used, it is convenient to sink half of it below the ground-level, within a square well, lined with masonry of sufficient area to admit of free circulation of air about the tatties, and with room also for a couple of small wells within the large well, to drain off the water from the tatties like the section given in—



This facilitates the watering of the tatties either by hand or by means of troughs, and a barrel of water raised above the level of the trough, as shown in fig. 22.



In the above figure, the barrel is shown in rear of the thermantidote to supply both tatties; but it will generally be more convenient to have a barrel on each side of the thermantidote, and syphons may be used instead of the straight pipe shown in the foregoing figure.

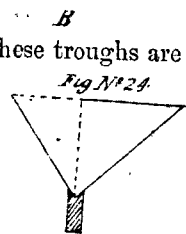
Fig. No. 23

A good trough for the purpose is Grant's Patent Trough (obtainable at Benares). This trough is eccentric in section (fig. 23) suspended at the ends on points on the line A B in equilibrium when empty; but when nearly full the preponderance of water in Y spills the trough, which returns empty to its original position in equilibrium.

B

Fig. No. 24

These troughs are apt to sag when more than 4 feet in length; but the sagging may be prevented by using a "fin" (fig. 24), which acts as a stiffener.



19. Thermantidotes in action collect air, whether good or bad, from a considerable distance. This can be practically proved by burning a pan-full of tar, or other strongly-scented substance, within a radius of 50 feet, when a strong scent of the same kind will be experienced within the house. Hence the advisability of avoiding all sources of malaria in the vicinity of thermantidotes, in which may be included vegetation of most kinds, during the night. The water on the tatties is, however, in itself a disinfectant; and positive disinfectants in a liquid form can be spread through the khuss tattie, by pouring a small quantity into the trough. The same may be done in a gaseous form by fumigation of any kind. By the same means, a very small quantity of rose-water (say a wine-glass-full), or other scent in a liquid form, can be easily introduced into any room, so as to be very distinctly perceptible to the senses.

20. Enclosed is a tracing of a thermantidote by General J. T. Boileau, with some modifications in details, since found useful on further experience.

NOTE.—In the foregoing, nothing has been said about bullock-power: but it may be taken for granted that, whatever is gained by the additional power of the bullock, is lost in time by the large circle in which the bullock must move, while it is almost impossible to avoid noise. The only advantage of the bullock is that he is less apt to shirk work than the coolie.

I have tried bullock-power, and have given up the idea as not being generally advisable.

Calculate

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23

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GOVERNMENT OF INDIA

PUBLIC WORKS DEPARTMENT.

MILITARY WORKS.

To *The Secy. to Govt. P.W.D.*

CIRCULAR No. 65 PUBLIC WORKS.

Dated SIMLA, August 2, 1866.

Received *12th September.*

En. one
1st September
3031

Forwards for general information and circulation
a Memo. by Lieutenant Colonel J. D. Campbell,
and the plan therein referred to, in regard to the
construction of thermantidotes.

en. 3031 - 21st Sept/66

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With an Order

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