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(Illustrated articles are marked with an asterisk.)

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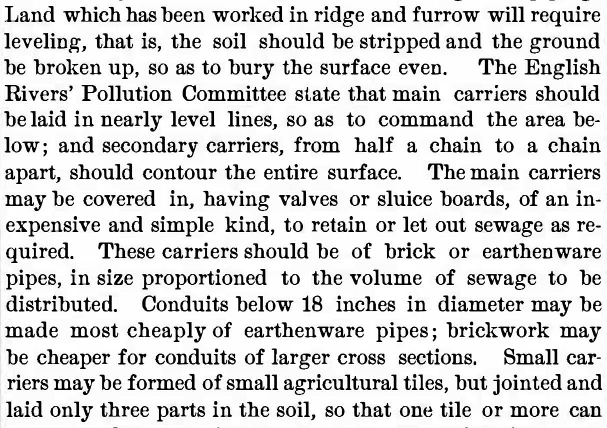
THE SCIENTIFIC AMERICAN SUPPLEMENT,
No. 75,
For the Week ending June 9, 1877.

SEWAGE IRRIGATION ON A SMALL SCALE.

It is now generally conceded that the application of sewage to purposes of irrigation is the only process which fully meets all the requirements attaching to the disposal of that material. It is the only one which, while it purifies the sewage, efficiently realizes the highest profits, and may be carried on without creating any nuisance or detriment to the health of the neighboring inhabitants. This is the opinion expressed by Dr. Wilson in his recent admirable work on "Hygiene," and it is fully corroborated by the very extensive review of the whole subject of the disposal of sewage which is embodied in that model official document, the Report of the State Board of Health of Massachusetts for 1876. The conditions under which the sewage of a village may thus be turned to agricultural profit, and at the same time the pollution of streams be prevented and a public source of disease removed, are by no means complicated; while the advantages which actual experiment has shown to be secured are so great as to render the matter one which may be strongly commended to the careful attention of village authorities and farmers throughout the country.

The simpler the details of the work, the better; and in this view it is recommended that for villages the application should be by surface carriers, in lieu of underground piping. Land which has been worked in ridge and furrow will require leveling, that is, the soil should be stripped and the ground be broken up, so as to bury the surface even. The English Rivers' Pollution Committee state that main carriers should be laid in nearly level lines, so as to command the area below; and secondary carriers, from half a chain to a chain apart, should contour the entire surface. The main carriers may be covered in, having valves or sluice boards, of an inexpensive and simple kind, to retain or let out sewage as required. These carriers should be of brick or earthenware pipes, in size proportioned to the volume of sewage to be distributed. Conduits below 18 inches in diameter may be made most cheaply of earthenware pipes; brickwork may be cheaper for conduits of larger cross sections. Small carriers may be formed of small agricultural tiles, but jointed and laid only three parts in the soil, so that one tile or more can be removed temporarily at any point to allow of surface overflowing. All ordinary conduits may be open trenches, readily formed by hand labor or by the plow.

In the first place, the land must be prepared so that the beds shall have a slope varying from 1 in 50 to 1 in 150. If not loose and porous, the ground must be underdrained. The sewage must be delivered (by pumping if necessary) at the highest point on the irrigated area, whence it is distributed by gravitation. The annexed diagram exhibits the



arrangement usually adopted where only the main carrier is of brickwork or pipe and the branching carriers mere trenches. A is the main conduit, dammed at various points by gates, as shown at F. By opening the gates, G, any trench, B, C, etc., may be made to distribute the sewage over any part of the field; and the flow is limited by placing the dam, D, at any desired point. The sewage flows uniformly over the surface of the land, each plot being irrigated for a few hours at a time, and once in every three to twelve days, as is necessary: grass, for instance, may be treated much oftener than vegetables.

The amount of land necessary depends somewhat upon the character of the soil and the climate. The English Rivers' Pollution Committee prefer one acre for the sewage of every 150 people. The Earl of Warwick, however, who has one of the most successful sewage farms in England, has one acre of land for every 50 people. In England, Scotland, and France, no difficulty has been found in irrigating through the winter. In our northern climate, where the ground often freezes to considerable depth, the results, it might be expected, would not be so uniformly successful; but judging from experiments made at Berlin, where the soil sometimes freezes to a depth of three feet, there is reason to believe that irrigation is well accomplished the year round.

The effluent water from sewage farms is often so pure as not to reveal any evidence of contamination to the chemist; and it has been freely used for drinking purposes without bad effects. The following data relative to the utilization of the sewage of the Augusta (Maine) State Asylum will serve to show how the system may be put in practice on a small scale, and the results it secures. In this case, the sewage passes by gravitation into large tanks where it is mixed with a quantity of absorbents (straw, leaves, muck, etc.). The solid parts are from time to time carted on to the land, and the liquid passes off, often quite clear and sparkling, to be used on the land for irrigation. A portion flows over a few acres, from which three crops of fine hay were cut in 1875. Another part is used for hose irrigation of the vegetable garden, care being taken not to sprinkle the leaves. A third part is carried to different sections of the farm and distributed from a vehicle which acts on the principle of an ordinary street watering cart, though different in principle. Seven thousand gallons of sewage are disposed of in this way daily, and the results are as follows: What was formerly a nuisance has become inoffensive. The hay crop on the land irrigated by gravitation had increased sixfold, and increase is also noted in other crops. The system pays for itself through the greater value of the crops raised (labor, however, being that of patients, costs nothing); and irrigation was efficiently carried on during the coldest weather. In such cases as the above, and generally in all where the sewage of a comparatively small number of people is to be disposed of, the subsoil method of irrigation may likewise be advantageously used. By this system the sewage is carried to a safe distance from the houses in tight pipes, and is then distributed in open jointed pipes about one foot below the surface of the ground. Subsoil drains are placed at a depth of four feet to carry off the purified liquids. Colonel G. E. Waring some time ago described in the *Atlantic Monthly* his application of this system to the removal and utilization of a country house as follows: "The house drainage is discharged into a tightly connected and thoroughly ventilated tank. Its outlet pipe, starting from a point one foot below the surface of the water, and about two feet below the capstone, passes out near the surface of the ground, and is continued by a cemented vitrified pipe to a point about 25 feet further away. Here it connects with a system of open jointed drain tiles, consisting of one main 50 feet long and eight lateral drains, six feet (the writer has since stated that half this distance is better) apart, and each about 20 feet long. These drains underlie a part of the lawn and are only about 10 inches below the surface." The slope from one extreme of the system to the other is only 15 inches. The pipes require cleaning about once a year.

PREVALENT MANIAS.

The blue glass mania has had its day. The bar rooms are removing their signs of "cocktails in blue glass," and the cerulean goblets, wherein those seductive and presumably sun-strengthened beverages were dispensed, may be purchased for small sums from the cheap china vendors on our sidewalks. We notice a diminution in the sheets of blue glass hung in windows of private dwellings, "signs," some one calls them, "to inform the public of the gullibility of the inmates;" and in fact the only evidence at hand which exhibits any vitality of the now rapidly collapsing blue glass mania is the production of a cheap variety of note paper, called the "Pleasonton," because the pasteboard box in which it is contained has a blue glass lid. The General can doubtless explain the efficacy of the glass in this connection. Blue glass, therefore, has had its run, its inventor has earned his notoriety, and also the thanks of the glass dealers, who have reaped a fine pecuniary harvest.

Two new manias are at hand, to wit, the celery cure and metallo-therapy. "Celery is the greatest food in the world for the nerves," says one of our contemporaries; and the information is traveling the length and breadth of the land. It is fashionable nowadays to call every ailment that flesh is heir to a nervous disease; and where our ancestors would have resorted to such homely remedies as a hot drink and simple cathartics, the present practice demands chloral, and bromides, and quinine, and strychnine, and phosphates, and rare chemicals without number. Of course celery is pleasanter to take than most drugs; and now that it is brought forward as a new nervine, plenty of people will use it. As it can do no harm, and, indeed, may actually work good by checking the too prevalent consumption of "nervous specifics," the mania is rather a benefit than otherwise, and should be encouraged. Wild celery or smallage is known to possess some narcotic effect, and is reputed as unhealthy. As regards the medicinal properties of cultivated celery, there are no utilizations of them in the United States Pharmacopœia; but as celery (*apium graveolens*) belongs to the same family as the parsley (*apium petroselinum*), it is probable that it would yield apiin and apiol, as such substances are obtained from the latter. Apiol acts as a tonic, similar in its effects upon the system to quinia.

The other mania, metallo-therapy, to which we have already briefly alluded, is perfectly harmless, and at present is confined to France. *Les Mondes*, of recent date, reports another "astonishing cure"—a child four years old this time, almost dead with meningitis. The metallo-therapy inventor enveloped the infant—there is no Children's Protective Society in France—in plates of iron and copper from head to foot. Half of the body was covered with one metal, half with the other, in order "that both metals might have an equal chance of doing good." In eight hours, the child revived; in six days, it was out of danger; in a month, it was well. Manufacturers of iron and copper plate may now consult with blue glass makers as to how to advertise this.

SAFETY VALVE TESTS.

In September, 1875, a Special Committee of the United States Board of Supervising Inspectors of Steam Vessels made a series of experiments to determine the proper proportions for safety valves and to test the relative merits of such valves as were furnished by manufacturers. Their report has just been published by the Government; and as it contains considerable information that will not be generally accessible, we propose to furnish a synopsis to our readers that shall embody the most important points determined by the Committee. As nearly all the prominent safety valves in the market were submitted to test, this report is useful in showing what is still required to produce the ideal safety valve. It is scarcely necessary to say that a perfect safety valve is one which will rise as soon as the pressure at which it is set is attained, will prevent the pressure increasing if the boiler is forced to its utmost extent, and will close promptly as soon as the pressure commences to fall. It may well be doubted, in the light of experience, whether it is possible to design a valve possessing all the above features; but they can be closely approximated, as will appear.

The boiler which was used for making the experiments was cylindrical, with internal furnaces, of the modern marine form, and was capable of evaporating about 1,900 lbs. of water an hour on an average, at a pressure of 20 lbs. by gauge. Before experimenting with the competing valves, the committee made a number of experiments with common safety valves of different sizes, the valves being carefully constructed, with knife-edge points of support for the lever and valve stem, as shown in Fig. 1. These experiments fully confirm the opinion, held by many experienced engineers, that the common safety valve, when made of sufficient size, is about as effective in relieving a boiler and closing promptly as the best special forms that have been devised. It is a matter of regret that the Committee's experiments did not include a test of what is sometimes called the "positive safety valve," in which the weight is suspended directly from the valve stem and acts without the aid of levers or springs, the valve being spherical and thus exposing a greatly increased area when opened, as these features are very meritorious, at least in a theoretical point of view. The experiments with these ordinary safety valves enabled the Committee to give rules for general practice which agree well with those determined by other experimenters. The Committee recommend the following rules for determining the evaporation in lbs. per hour of stationary and marine boilers: 112×square feet of grate surface, for natural draught; 168×square feet of grate surface, for forced draught.

It was found, when experimenting with the common safety valves, that the lift decreased as the pressure at which the valve was set was increased; and by observing the areas of openings, the Committee derive the following rule for calculating the area of opening, in square inches, required to discharge a given weight of steam per hour: Multiply the number of lbs. of water evaporated per hour by 0·0011, if the valve is set to blow off at 10 lbs.; by 0·0010, if at 20 lbs.; by 0·0009, for 30 lbs.; by 0·0008, for 40 lbs.; by 0·0007, for 50 lbs.; by 0·0006, for 60 lbs.; by 0·0005, for 70 lbs.; by 0·0004, for 80 lbs.; by 0·0003, for 90 lbs.; by 0·0002, for 100 lbs.

By observing the lifts of the ordinary valves when discharging at different pressures, the Committee obtain the following rule for calculating the area of valve that will give the required area of opening for any particular case: Multiply the number of lbs. of water evaporated per hour by 0·005; the product will be the area of the valve in square inches. This rule gives a smaller area than the similar formula proposed by the late Professor Rankine, in which the multiplier is 0·006. It is to be remembered that the valves used by the Committee were constructed especially for the experiments, and may have acted more effectively than the average; so that the multiplier given by Professor Rankine will probably be safer for general use. It may be added that rules of this form are the only safe ones for general use, the ordinary formulas giving very discrepant results, as shown by the following example in the report: The area of safety valve required for the boiler on which the experiments were made, at a pressure of 70 lbs., would be: For the rule of U. S. Board of Supervisors, 37 square inches; for that of the English Board of Trade, 11·8; for that of the French Government, 6·75; for that given by Molesworth, 18·88; for the 1st rule given by Professor Thurston, 8·3; for the 2d, 29; for that given by Rankine, 12; for that proposed by Committee, 10. Attention has been directed to the discrepancies of these rules on several occasions; and in spite of the distinguished authority on which they rest, it is reasonable to hope that all but the last two will speedily find the oblivion they so justly deserve.

The Committee observe that, when very large valves of the common form is used, their action is not satisfactory, as at high pressure the lift is scarcely noticeable, the pressure being relieved by a kind of tilting of the valve; and they fix the limit at valves having an area of 10 square inches, recommending that two or more valves be used, when a greater area than 10 inches is required.

TESTS OF COMPETING VALVES.

Valves of special form were sent by 27 makers, and tested

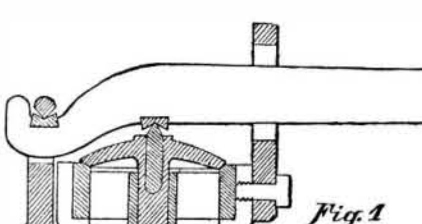


Fig. 1

by the Committee. The general object of all of these valves was to give an increased lift as soon as the valve was opened. The valves are divided by the Committee into 6 classes, according to their construction:

1. Reactionary safety valves, in which the escape of the steam is opposed by a lip or stricture with the idea that the reaction will force the valve further from its seat. One form of this class is shown in Fig. 2.

2. Disk safety valves, in which a disk is secured to the valve having a greater area than the valve, so as to force the

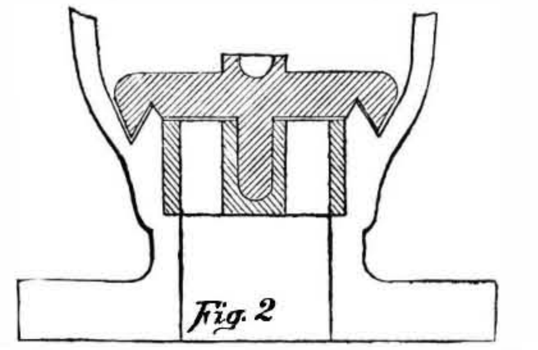


Fig. 2

valve further from its seat, when it opens. Fig. 3 is an example of this class.

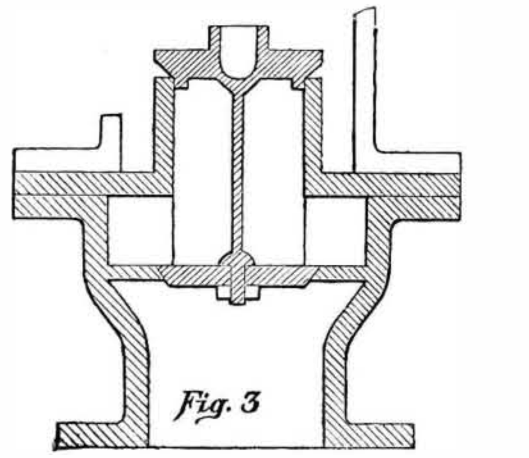


Fig. 3

3. Annular safety valves, with two seats upon an annular opening (as shown in Fig. 4), with a view of obtaining a greater area of opening for a given lift.

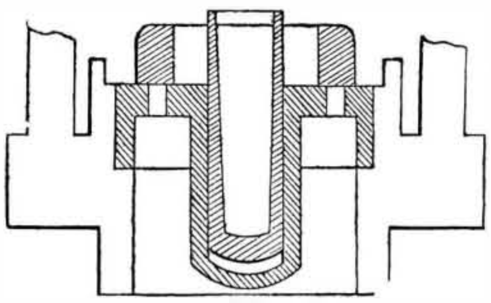


Fig. 4

4. Double seated safety valves, of the same general form as the double puppet valve, the upper and lower parts being of different areas, so that they move easily and expose large areas of opening. The practical difficulties of construction, however, will probably prevent the adoption of this plan. The Committee report that they "can say nothing favorable of any of this construction that were tested."

5. Combination safety valves, which are assisted in their operation by small auxiliary valves or a combination of levers. One of this class is shown in Fig. 5, the valve being held down by a spring balance attached to the lever, and being assisted to rise, when opened, by the action of the rod and bell-crank lever, the other end of the spring balance being attached to the long arm of the latter.

6. Piston safety valves (see Fig. 6 for an example of this class), in which a piston connected with the valve assists it to rise. A uniform method of test was adopted for all these valves. Each was attached, in turn, to the boiler, was set to blow off at 30 lbs., and was allowed to operate for 10 minutes, with a strong fire in the boiler, was then set to 70 lbs. pressure, and the experiment was repeated. The following table gives a summary of the results obtained with 12 of the competing valves, and 2 of the common valves constructed by order of the Committee. The table in the report contains results of the list of 22 valves, but the data were only complete in the case of 12, as the area of opening was not observed for the others, or they were tested at different pressures. The different valves are distinguished by numbers in the table given below. Several of the valves tested gave such unsatisfactory results that they were not included in the Committee's table.

			SET TO OPEN AT 30 LBS.				SET TO OPEN AT 70 LBS.			
No. of valve.	Area of valve in sq. in.	Class of valve.	No. of trials.	Greatest and least excess of pressure.	Greatest and least area of opening.	Greatest and least closing pressure.	No. of trials.	Greatest and least excess of pressure.	Greatest and least area of opening.	Greatest and least closing pressure.
					sq. in.				sq. in.	
1	5	Reactionary.	..	....	....	....	2	0	1·231	65½, 67¼
2	5	"	5	5¼, 2½	1·257	26½, 29	5	4, 3	·729, ·628	64, 68¼
3	5	"	2	7, 6¾	1·580	27¼, 28	1	9¼	·92	67½
4	5	"	2	6, 0	2·934	20¼, 26	2	0	1·427	55½, 56
5	5	"	1	16	·457	30	1	4	·284	61
6	5	"	5	7, ¼	·869, 1·455	27½, 29½	3	3¾, 1¼	·691	66¼, 68
7	7	Combination.	2	2, 0	1·11	17, 26	4	4, 1	·574	60, 67½
8	5	"	3	1¼, ½	1·171	27¼, 29	4	½, 0	1·171	64¼, 70
9	5	Disk.	2	0	1·82	27	2	¼	1·18	67¾, 68½
10	5	"	2	4½, 1½	1·11	26½, 29	5	0	·555	65, 69¾
11	6	Annular.	1	0	1·42	27	3	0	·84	59½, 69½
12	5	Piston.	3	1¼, ¾	1·231	25½, 28½	5	4, 3	1·231	60½, 66
13	5	Committee's	2	7¼, 4½	·929	28	1	5¼	·633	68
14	10	valves.	..	.....	....	....	1	2	·725	68¾

It will be observed that some of the special forms of valves, with considerably larger areas of openings than the common valves, allowed the pressure to increase as much or

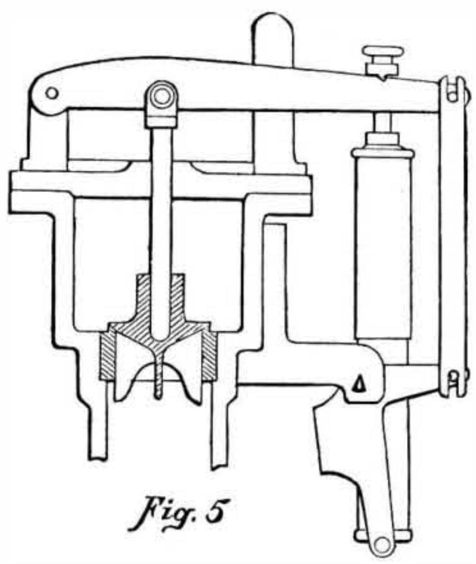


Fig. 5

more. This is probably due to the fact that the very form by which the greater lift was obtained made it more difficult for the steam to escape, and thus rendered a larger opening necessary to discharge the same quantity of steam. In

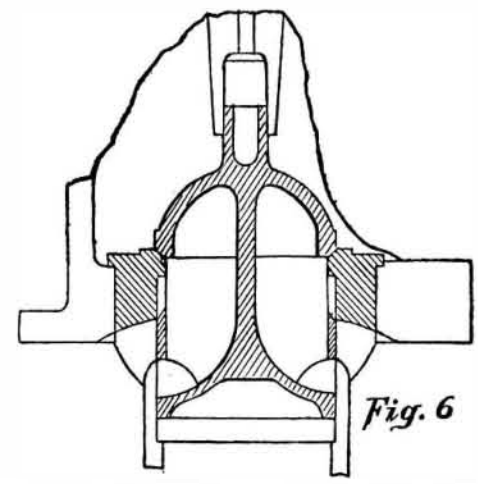


Fig. 6

the case of several experiments with the same valve, where the table shows considerable differences in the results, these were generally due to lack of adjustment, so that the best results represent the action of the valve when properly adjusted. This remark applies both to the common and special forms of valves. There is one peculiarity, quite an important one, which the table does not show, but is noted in the records given in the case of each experiment.

With the common valves, when the valve opened, the pressure gradually increased to the maximum, when the boiler was forced, and, when the pressure was allowed to fall, it closed at the points indicated. With nearly all the other valves, however, after the valve opened, the pressure fell below the opening point, the valve sometimes closing several times, and the pressure falling below the opening point several times, in the course of a 10 minutes' trial, and sometimes the pressure fell at once and the valve blew off at a less pressure than that at which it was set, during the whole trial. It is evident that this is not a desirable feature in a safety valve, if safety can be secured without this loss; and the records of the trial seem fully to confirm the opinion previously stated that the common valve, represented in Fig. 1, is not excelled in any important particular by its competitors—at least for stationary purposes. For use upon locomotives, and steamers in rough water, some of the special forms may be advantageously employed, and the Committee especially recommend three, constructed on the reactionary principle, viz: Ashcroft's, Crosby's, and Richardson's (Nos. 1, 2, and 6 in the preceding table). It is believed that these recommendations are justified by experience. The Committee state that there are objectionable features in the other forms of valves presented to their consideration, which may possibly be removed, and think the instruments should be further perfected before their adoption for steamer use can be recommended.