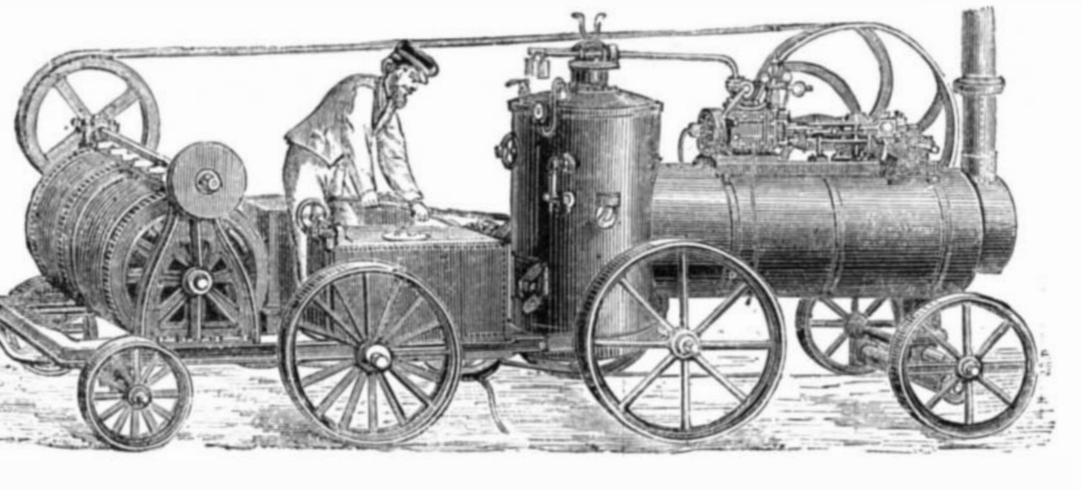
STEAM PLOW WINDLASS TENDER.

OUR engraving shows the Cheneral Windlass Tender exhibited at Paris by Messrs. Howard & Co., in connection with other apparatus for steam plowing. This is considered by the makers as a very simple and effective mechanism for winding the wire cables used in drawing the plows back and forth across the fields.



STEAM PLOW WINDLASS TENDER.

WATER SUPPLY.

By JOSEPH PRESTWICH, F.R.S., Professor of Geology in the University of Oxford.

THE water supply, as it now exists, whether of detached houses, villages, or towns, has been one of purely local growth, and although the sites of most of our older villages and towns have been determined by the presence of an easily accessible water supply, such as may be obtained by shallow wells or from rivers, very little improvement, and that only in the case of our larger towns, has been introduced in the sources of supply, notwithstanding that in the mode of distribution of the supplies in large towns England has distanced all other countries. With the increase of population, the simple contrivances that were originally in use have otherwise in most cases experienced but little change, although our buildings may have become crowded upon one another to an inconvenient extent, and have produced evils of the most serious character. Water-bearing strata—whether consisting of beds of gravel overlying clays, such as the gravel on which London stands, or of the outcropping beds of a deep-seated formation, such as the lower tertiary sands under the London clay, or of hills of permeable strata, such as the chalk or oolite ranges—while they absorb and store the rain water which they deliver again in the form of springs, absorb with equal readiness water from any other sources—consequently, what apparently more convenient in constructing a house than to sink a well in one part of the premises for water and on another part for the house sewage? The works are out of sight; no one thinks of the evil, and few realize it if they see it. But the evil is an accumulative one, and every now and then we are reminded of its existence by disastrous and fatal results. It has grown to such an extent that almost all the shallower of these sources of water supply are contaminated and injured, and our villages and smaller towns are suffering to an extent which it is difficult to estimate, and which few probably, except geologists, can fully realize. Not but that the other sources of supply—our rivers—have been treated with equal disregard of sanitary principles, and they would, but for timely Parliamentary interference, have suffered equally in consequence. The able sixth report of the Rivers Pollution Commission illustrates in a remarkable manner the consequence of this neglect, whether in the case of our wells or of our rivers.

I have prefaced my communication with these few remarks, because, in considering the general question of water supply, it is as indispensable to determine what source should be avoided as it is to see what sources are available, and in what way the mistakes of the past may be avoided for the future. Fortunately natural agencies are constantly operating to counteract the evil consequences of our neglect. The power of oxidation and absorption of the soil on underground waters, and of air and light on surface waters, goes far to remedy the evil and restore our springs and rivers to their original purity. The surface waters have been the subject of successful legislative enactment, and it is to be hoped that some similar measure may be applied to our underground waters, for nothing else, it seems to me, can effect a cure for an evil which is so widespread, and at the same time so entirely withdrawn from observation. The arrangements being all below ground, are unknown in most instances to all except the builder, and the well springs, although often seriously contaminated, yield too often water which is so cool, limpid, and sparkling as to not only give confidence to the resident, but even to inspire him with a belief in its unusual excellence.

In our larger towns, where cesspits are gradually being done away with, the wells may improve if no other source of impurity exists; but in villages and detached houses, where nothing is done, not only do the local underground springs suffer, but it is to be feared the pollution often injures sources having a wider range. Some contrivance for the protection against the contamination of underground waters, used in common by adjacent communities, is as much needed as party walls are as a protection against the spread of one's neighbor's fires.

If this were done many of the underground springs which of old supplied both town and rural population might be again rendered available for their use, and it would not be necessary to look for a supply to more distant and less accessible sources. It must be, however, remembered that none of our several sources of public supply are free from some drawbacks.

The gravitation system is very good where there are large tracts of high ground not under cultivation, but with the decrease of these and the increase of population the difficulties in the use of this plan are yearly increasing. The variability of our rainfall forms also an objection.

Rivers offer a source generally available, as their waters consist of the immediate rainfall, flowing at once from the impermeable portions of each hydrographical basin, and of the springs due to past rainfalls, discharged in the same basin, throughout longer periods of time, from the permeable strata—but for the many contaminations to which they have too frequently been subjected. With the remedies, however, now in operation against river pollution, and the well-known purifying effects of flow and aeration, our rivers still frequently offer convenient and large sources of supply.

Springs afford supplies, generally good in quality, but more limited in quantity. Instead of being absorbed in our rivers, the risks incurred in their channels are avoided when the springs can be at once diverted and stored for use. Where they are sufficient there cannot be a better source.

Deep wells may be either ordinary ones—sunk in an area where the permeable strata extend from the surface to considerable depths, as in the case of our chalk downs or oolite hills—or may be artesian wells, when the same permeable strata pass beneath impermeable strata, and can only be reached by passing through the latter, when the water rises in the bore, or shaft, to its natural level, which may be above the surface, or may be at some depth intermediate between the surface and the imprisoned spring; in any case it may be assumed to rise to a considerable height above its original level.

An impression prevails that, owing to the extent of filtration experienced by the surface waters in passing through a great thickness of such permeable strata, it becomes purified more effectually than it can be by any other means. To a certain extent this is true, but these strata are, nevertheless, exposed to the same dangers as are the river waters, only the sources of contamination fail to make themselves so apparent, nor do they exist to the same amount. They are, nevertheless, there, although from being less conspicuous, they have not attracted so much attention. Thus, in constructing a house on the sand hills of Sussex or the chalk hills of Kent or Surrey, it is the almost invariable practice to dig a shaft more or less deep into which the house sewage and surface waters are directed, and from which they disperse rapidly and disappear in the mass of permeable strata, as in a filter. Neither builder nor tenant may know or inquire what becomes of all this fluid refuse. But it is, of course, not lost. It passes underground, and goes to increase the reservoir of underground water stored away in the body of the hills. The population on these hills is, owing to the depth at which the water lies, usually sparse and scanty, so that the evil is at its minimum. Still it exists, and is increasing, while manufactories, cemeteries, and increasing cultivation contribute their inevitable quota. It is not difficult, therefore, to account for the presence of nitrites and nitrates found in our chalk and oolite waters, although it must be at the same time observed that the extent of filtration breaks up and destroys almost all the original organic matter. Yet so it is in our rivers where the flow (as in the other case the filtration) is of sufficient length.

But there is another and more serious evil to guard against in some underground waters, and this is the consequences to be feared from blind wells communicating with the springs. These wells are formed where the underground spring does not rise to the surface, but stands at a depth of 50, or 100, or more feet. Then any addition made to the spring does not affect the level, or only temporarily, of the water in the well, but goes to feed the volume of the spring. This may go on for years, the impure water passing below ground, and forming a constituent part of the spring. Such wells form natural drains of a most permanent kind, because, as the underground spring cannot rise in the well so long as the other channels of escape by which its surplus waters have been hitherto discharged remain open, every addition to it only increases the volume of the spring. This plan was formerly so largely adopted in Paris that the waters of many wells there were rendered entirely unfit for use. It is to be feared that London and its neighborhood are not free from them. Those with whom it originates are, I imagine, often not aware of the consequences. I have not made this the subject of any special inquiry; but looking at the facilities this plan offers for ready and inexpensive drainage, I have reason to believe that these blind wells may not be uncommon, whether in the chalk or in the lower tertiary sands under the London clay. Incidentally, two cases have come to my knowledge which will serve as illustrations

Some time ago it was in contemplation to construct such a dry well for drainage purposes a few miles from London. I happened to be consulted and pointed out the objections, but whether or not the work was carried out I do not know. The other case is, if rightly reported, a most objectionable one. A cemetery near London stands on a bed of gravel; under the gravel is the London clay, and beneath the London clay are the water-bearing lower tertiary sands which hold the springs supplying the greater number of artesian wells in London. I am informed that, in order to carry off the water from the gravel in which the graves are dug, a dry or blind well was sunk through the London clay into the underlying sands, and that into this well the drainage of the cemetery is diverted. Although the filtration through the sands will remove much, or, if the distance be sufficient, possibly all of the organic matter carried in by such refuse waters, still such a proceeding cannot be otherwise than most objectionable and obnoxious, and serves to show how our wells may be polluted as clearly as in the instances of the more conspicuous pollution of our rivers.

In fact, with our present arrangements, and with the distribution of our population, the purity of our water sources is only a question of degree. Although nature steps in and is incessantly at work in remedying rapidly and effectually much of the evil, there are limits to this self-acting process, and while, on the one hand, the fixity of the rainfall insures that the measure of our future will not exceed those of the present sources, the calls on those sources must steadily increase, and if care be not taken there will, with the increase of population, be a proportionate increase of contamination. But this care, for the reasons before mentioned, cannot be exercised by individual action. Self-interest and incompetency are alike opposed to any such expectation. It can only be done by legislative measures, of which we have had a commencement in the Rivers Pollution Bill. Some similar measure of protection is equally needed for our underground waters and our springs.

Let us now briefly consider how our sources of water supply are derived. There is the rainfall stored in lakes; there is the rainfall stored in hills and at depths beneath the surface; and there is the rainfall carried off by rivers and coming to the surface again as springs from the overcharged hills.

Lakes.—In imitation of these natural reservoirs we have the artificial reservoirs of drainage areas to which we have before alluded. The objections which apply to the latter do not, however, apply to the former. Lakes in this country only exist where the rainfall is exceptionally great, where the land is high, the rocks hard and in great part bare, and where the population is scanty and never likely to be very numerous. Such districts, therefore, possess large, steady, and pure water stores, vastly in excess of the needs of the local population, and offer to the teeming populations of adjacent lower lying districts the most valuable boon of their surplus stores. I consider, therefore, that in a national point of view, for the supply of our manufacturing and large commercial towns, where the population has outrun from its numbers, or overrun with its impurities, the ordinary supplies of the hydrographical basin in which they are situated, the waters of these lakes, if fairly and economically used, and with due local considerations, present legitimate and most valuable sources of water supply.

Wells.—Another source of supply lies in the water stored in our hills and at depths beneath our valleys. The annual surplus escapes as springs, to which I will refer presently. That which remains underground is obtained either by deep and artesian wells or by shallow wells. The deep wells are especially valuable in chalk, oolitic, or triassic districts, where the mass of the strata is great and the water stores proportionately large, and in those districts of England where these formations exist they may often afford excellent sources of supply, though care is required, that as far as possible only the waste and surplus quantity is taken, as otherwise the neighboring springs and wells must unavoidably suffer.

Artesian Wells can often be used with great advantage. As the outcrop of the strata supplying them is sometimes at a very considerable distance from the towns they supply, they may conduct water from districts where it can be spared to others where there is a deficiency. At the same time, the extent of strata through which the underground water passes, and the depth beneath the surface, insure the most perfect filtration and uniformity of temperature. The Chalk where it extends under London acts in this way. But as the water does not pass with great facility, and the drain on it is excessive, the level of the underground water diminishes, as is well known, from year to year, and stands now many feet below its normal level. In such a case as this there is a risk to the quality of the water, for under the original normal conditions the surplus underground water due to the annual rainfall escapes through various channels at the lowest levels, especially in beds of rivers or the sea shore; but when the water line falls, through artificial interference, beneath these surface levels, the pressure is reversed, and an inflow is established which inevitably carries in the outer waters (before the receiving medium) to supply the deficiency, and if those waters be impure, the springs must suffer. In all these cases the original natural balance cannot be disturbed without introducing complications which are difficult to foresee.

The Oolites and the Triassic rocks of the midland counties, where they pass under impermeable strata, also lend themselves to the formation of Artesian wells, as do likewise beds of sand when sufficiently thick. On a small scale, the Lower Tertiary sands have for some years past been made available for this purpose; but their dimensions are very limited, and the demand on them too large. There exists, however, at greater depths beneath the Chalk, the Lower Greensand, which, as I have long pointed out,* would in all probability, as it does at Paris, be found to contain large stores of water. There is, however, the possible contingency of iron being present; for although most of the Greensand water, both in wells† and at its outcrop, is of excellent quality, there are other wells where the water is slightly ferruginous. This can only be determined by experiment. The anticipation first formed of the continuation underground of the Lower Greensand from Kent and Surrey to Buckinghamshire, proved incorrect, as it was found to be interrupted by an underground ridge of Palæozoic rocks. But the boring recently made at Messrs. Meux & Co.'s brewery has shown this formation to extend northward as far as that point, so that in the area between South London and the Chalk hills of Kent and Surrey, the Greensand, which varies between these points from 60 to 500 feet thick, would, no doubt, be found in sufficient development to yield a large quantity of water, and might prove to be a source of considerable value for public metropolitan purposes. But whatever the quantity, both quantity and quality must inevitably suffer if the source be open to unrestricted use. For whether with the waters stored in our hills or at depths beneath the surface, it must be borne in mind that all the surplus quantity (which is that due to the annual rainfall) escapes naturally in the form of surface springs, except the very small proportion that escapes below the high water mark, in our estuaries, and on our shores, where the permeable strata run out to sea. At a distance from the coast this action is reduced to a vanishing point. How far, therefore, these underground waters can be drawn on without injury, depends on local conditions of population, surplus quantities, etc., which must be determined separately for each case, but it is necessary to observe that while you may depend on the quantity yielded by the annual rain-supply, you can no more overdraw the water-capital of these hills without a resulting deficiency in the course of years, than you could expect to maintain income while drawing annually on capital. Both must end in bankruptcy.

I have already mentioned that these sources of supply are not, any more than rivers, altogether free from pollution, but

* "The Water-bearing Strata around London." Van Voorst.

† The two deep Artesian wells at Paris yield water of great purity, and valuable as an auxiliary source of supply.

the extent of filtration where the permeable strata are thick, as in the Chalk, the Lower Greensand, the Oolites, and Trias, reduces the mischief to its minimum. It becomes more objectionable when the strata pass at depths beneath the surface, and the water can only escape by artificial means, and, therefore, in much smaller quantities. Still, as a rule, these waters are good and wholesome, and where the underground reservoirs are so extensive that their use does not interfere with local supplies, or with the permanence of streams, they offer convenient sources of supply, which, if moderate in quantity compared to lakes and rivers, are often available when the latter are not.

Shallow Wells, 10 to 20 feet deep, are very general in thin permeable strata overlying beds of clay. These, from their small dimensions, contain only limited quantities of water, and are affected, therefore, by a less quantity of impure admixture. But from the circumstance of being of easy attainment, inexpensive, and at every door, they are in more general use than any other source for private supply, where the quantity of water required for each house is small. For the same reason such sites were early selected, and have been in use for ages. Shallow wells consequently exist everywhere where beds of gravel or thin beds of sand overlie clays, that is to say, in places all over England, on high grounds and on low grounds, as well as in valleys where the line of water level is, from other causes, within easy reach of the surface. It is this facility of obtaining water on the one hand, and of drainage on the other, in shallow water-bearing strata, that has led to the pollution of the water I have before pointed out.

While every house or every village has found in the permeable stratum its ready water supply, each one has also found its convenient pit for the drainage of all house sewage. Graveyards, manufactories, and other sources of organic impurities in the same way drain into the common spring underground, and contribute to the general mischief. It is only surprising that the consequences are not more serious. Few houses, whatever their character and importance, are, under these geological conditions of water-supply, free from this lurking and insidious evil, which is, probably, more than any other the frequent cause of illness and disease (though often in a form not to attract attention for years), in towns and villages which would and should otherwise, from their position and build, be chosen for healthiness and cleanliness. For this reason good surface springs, or some good selected source for common supply, would prove of much importance to our smaller town and villages. For detached houses it is difficult to see what remedial measures can be applied, except better knowledge on the part of builders or adherence to obligatory rules.

Springs.—If left to itself, all the surplus rain supply stored in the hills escapes as springs; and these, although small compared with rivers and lakes, form very valuable supplies where the strata are of sufficient dimensions to afford extensive filtration, and maintain a permanent and large delivery. They have the advantage over wells in that they are natural water channels, enlarged by time, and from which all the more readily soluble matter has been removed by long wear. When, therefore, such sources of supply are available, they are among the best and most desirable that can be adopted, although their volume is generally such as to limit their use to villages, or to towns of moderate size. As an illustration of this source of supply, there are the fine springs of the Oolite hills in the upper part of the Thames basin, which I have pointed out for the water supply of Oxford,* or which might, together with the great Chalk springs of the lower part of the same valley, be made available, as a potable water, for the use of London.

The value of a pure water supply is so inestimable that, except on the score of cost and inconvenience, I see no reason why a separate supply of potable water from this or other sources should not be introduced into our large towns, as has been already proposed for London, where the water requirement for ordinary purposes is so vast, and the difficulty of filtration so great, and becoming year by year more unmanageable. Springs of moderate volume exist in most parts of the country. The chief of these in the Oolite and Chalk districts of the Thames valley will be seen on the hydrogeological map I prepared some years since, with contour lines furnished by the late Sir Henry James, to accompany the report of the Water Commission, but which, though printed, has never been published. An inspection of this map will show how numerous are these springs in the Thames basin, while the sections across the same basin show how large the volume of water stored in the hills is, and what portion of it goes to form the perennial springs, or may be drawn upon by deep wells. It will be noticed that one set of springs is dependent upon a lesser head of water than others, and that from the geological structure of the country, it is not difficult to determine to which order any spring may belong. The villages and towns which might be supplied by these means are many, and no better supply could be desired, even if it were limited only to the supply of drinking water.

Rivers.—With respect to this more ordinary mode of public supply, it is a sound principle laid down by the Water Commission of 1869, that each river catchment basin should supply, as far as possible, its own population. There are cases, however, where the population of one basin being much under its amount of water supply, no inconvenience could arise in diverting a portion of the surplus supply from any source to places in adjoining basins, where the population is in excess. So long, however, as this does not happen, and the river waters are maintained in a state of sufficient purity, so long should the towns in each catchment basin look to the rivers and springs in that basin for their sources of supply. Under the improved system now inaugurated, it is to be hoped that many, if not most, of our rivers may be rendered (if they are not so already) available for the water supply of the towns on their banks. This subject is so fully treated in the report of that Commission, on which I had the honor to serve, that I need say no more about it. Nor do I think it necessary to go into the question of hard or soft water which the Commission also fully discussed. The conclusion I drew was, that it was really a matter of very minor importance, compared to the great importance of freedom from organic matter. Both waters, avoiding extremes, are perfectly wholesome, and as a question of preference, it seems to be very much one of use and custom. Pure lake waters do not seem, as a question of health, to be better than pure chalk waters, or pure river waters.

Rivers subject to floods should store a portion of their flood waters, and so better regulate their delivery during dry seasons. Their volume, however, depends not only on the rainfall, but on the geological character of their catchment basins, a subject which will also be found fully investigated with respect to the Thames and the Severn in the report of the same Commission. As an admirable instance of the study of the *régime* of rivers and of water supply to towns, I would refer to the late M. Belgrand's hydrological and geological map of the catchment basin of the Seine, with its accompanying tables and report.

In the foregoing remarks, I have merely attempted to give general outlines of where our towns and villages may look for their water supplies, and to point out, also generally, the risks run of organic contamination in the different sources of supply. A careful selection of the one, and the application of proper restrictions to the other, cannot but be a matter of the highest importance, requiring the most careful consideration. It is not possible, in a communication of this kind, to go into the details of particular districts. Each one must be the subject of special inquiry, with respect to various conditions, of which that of geological structure is one of the most essential, whether as regard the sources that should be chosen as well as those which should be avoided. The existing evils arising from contamination are so serious that the probability of this has, in each case, to be considered, and a remedy, where needed, applied. This is a matter of considerable difficulty, as without some knowledge of geology and chemistry, it is not easy for those whom it is intended to relieve to see or understand the necessity for change, especially where the polluted waters are, as is so often the case, cool, sparkling, and pleasant, and where, further, the change involves cost and trouble. Authority is needed in such instances to effect changes which are indispensable, or to carry out a combined plan of public supply from new sources for the general benefit of the community. Much information on the subject is already furnished in the map of the geographical survey, in the Reports of Royal and Parliamentary Committees, in special works and papers, in scientific periodicals, and in the Reports to the British Association.—*Journal of the Society of Arts.*

* "On the Water Supply to Houses and Towns, with Special Reference to the Town of Oxford." Parker & Co.

A SINGULARLY FATAL OCCUPATION.

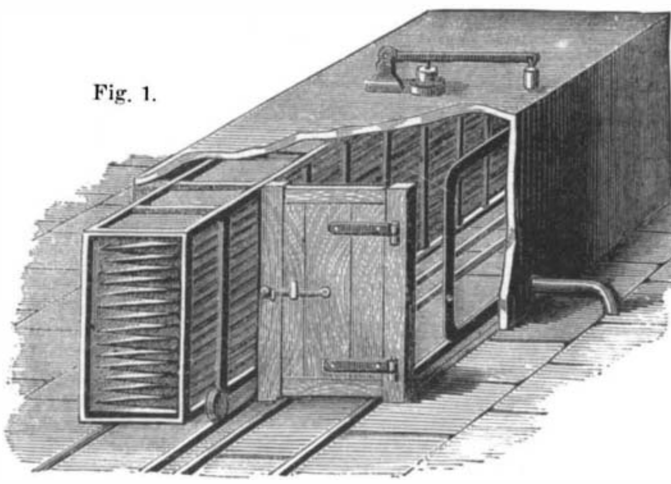
THE statement has been made by a Sheffield (England) physician, that the fork grinders' employment is probably more fatal to human life than any other pursuit in England. According to this authority there are generally from eight to ten individuals at work in the room in which this industry is carried on; and the dust which is created, composed of fine particles of stone and metal—the grinding being always performed on dry stone—rises in clouds, and pervades the atmosphere to which the operatives are confined. The dust, which is thus every moment inhaled, gradually undermines the vigor of the constitution, and produces permanent disease of the lungs, accompanied by difficulty of breathing, cough, and a wasting of the animal frame, often at the early age of twenty-five; and the average longevity of fork grinders is found not to exceed thirty years.

THE man who was put in sudden possession of $2,500,000 by the discovery of petroleum on his otherwise almost worthless Pennsylvania farm, only to become poor again through wild extravagance, is now a station agent on the Atlantic and Great Western Railroad.

STEAMING PRINTED TEXTILES.

THE Industrial Society of Rouen recently offered a prize "For the best work on the steaming of printed textile fabrics, especially cotton, comprising the historical part of the question, the study of the part which vaporization plays in the fixing of the colors, the description with drawings of the apparatus used, and an indication of the progress to be attained." The committee appointed to examine the pamphlets submitted, selected one which, they say, although it did not fulfill all the conditions and expressed theories not commonly received, nevertheless contained such merits in its descriptive parts that the author was fairly entitled to the reward offered. As the committee was composed of men whose opinions and experience carry considerable weight, we translate that part of the pamphlet which was commended, and which treats of the different appliances in use for steaming textile fabrics.

Fig. 1.



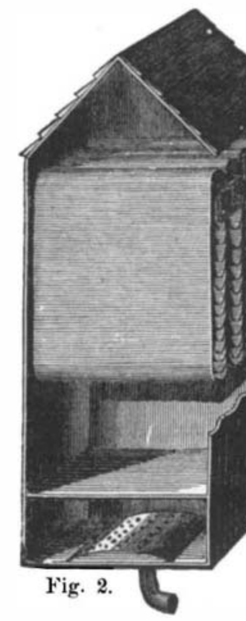
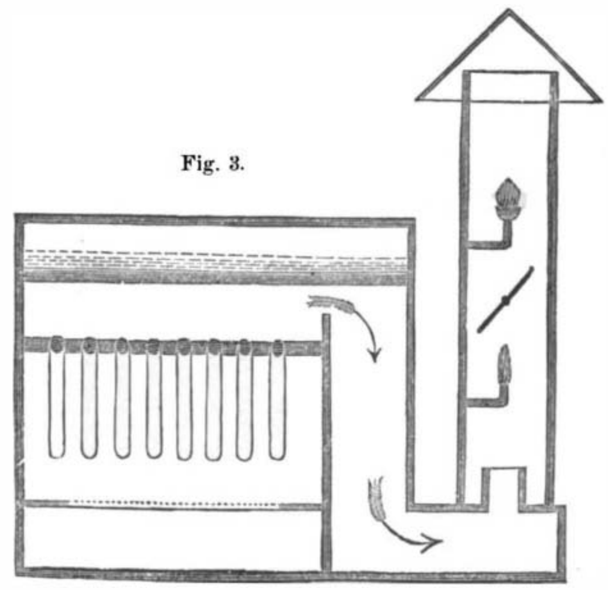


Fig. 2.

Fig. 3.



STEAMING APPARATUS FOR PRINTED TEXTILES.

En passant, we may remark that this mode of fixing printed colors is of comparatively recent date, and, consequently, of more interest than other methods. As is well known, the colors are printed upon tissues or yarn in the ordinary way, and the color thus applied "fixed" by the application of steam; the points to be observed in practice being three, viz., to fix the colors with the greatest possible fastness, to accomplish this economically, and with the least consumption of time.

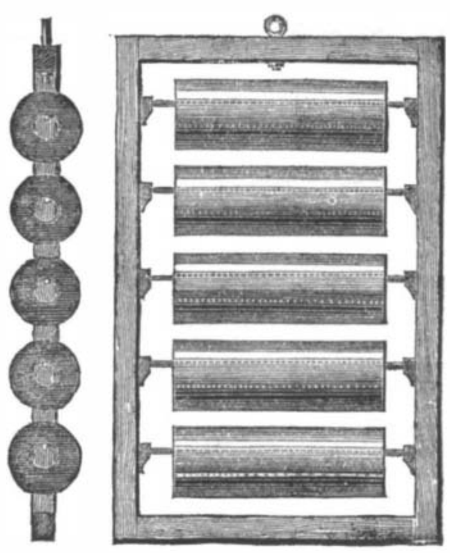


Fig. 4.

The first contrivances in use for the purpose of steaming fabrics consisted of a chamber into which the printed pieces were hung upon rollers, and subsequently of a perforated steam-pipe, upon which the cloth was rolled with a blanket; these, however, have long since been abandoned as being too tedious, and not accurate enough for the present perfected state of the printer's business.

The first apparatus introduced of any value is a chamber containing frames, as represented in Fig. 1. It has a length of about 4 yards, a width of 3 yards, and is closed at one end by a pair of doors, through which the frames are admitted. These frames run in upon wheels and rails; they are of a size to fit the interior of the chamber, and the cloth is stretched upon them by being hooked on with its selvages, so as to get the greatest possible length into the space: thus, a chamber of the dimensions given will contain from 600 to 650 yards of cloth. In order to distribute the steam evenly it is introduced by two pipes, closed at their extremities, but containing a number of very small holes. As the space in the interior of the chamber is large, and condensation of the steam might take place, which, if not provided against, through the dropping of the water, would spoil the goods, it is necessary to cover the frames with a hood of cloth, which is an effectual protection from the dripping water.

One of the most usual methods of steaming is to suspend the cloth in a chamber, as shown in Fig. 2. This plan admits of a great many modifications. The chamber consists of a rectangular room or box made of wood, iron, or cemented bricks, but in each case perfectly tight; on the bottom are placed pipes perforated with small holes, which give access to the steam. The chamber is generally two or three yards long, the same height, a yard or a yard and a half wide; the inner walls are lined with coarse linen or cotton cloth, and to prevent the water carried by the steam from injuring the pieces to be steamed, there is a false bottom of cloth (linen, cotton, or wool), which dries the steam. The pieces to be steamed are rolled with a blanket to prevent creasing, and then suspended from a hollow roller resting upon an iron bar which is fixed to a rail on each side of the