(third image of Fig. 34); at this instant the velocity of the carpal joint is about seven meters (23 feet nearly) per second.

The analysis of the chrono-photographs of the bird reveals many curious details. But I must stop. By confining your attention for so long a period to the different applications of chrono-photography, I have wished to make you the judges of the scope of this method and the promise of its future.

Science only exists by precision; it has perpetual need of exact measurements. These measurements have attained a high degree of perfection in all that refers to the geometric properties of bodies; with great exactitude also are determined the static value of the forces of nature, such as weight, electric state, and temperature. Certain dynamic phenomena are also susceptible of exact measurements, when they have attained a uniform dimension; it is thus with the velocity of a stream of water, the intensity of an electric current, the work absorbed by a machine, etc. In all these cases, a common character pervades the

into a higher state of oxidation at the expense of the free oxygen in the water, or of that taken up from the air after the passage of the water through the iron and gravel mixture. I will not attempt to determine the precise nature of the purifying action, but the fact remains that iron is first dissolved in the water to the extent of about one-tenth of a grain to the gallon, and that during this process and the subsequent deposition a powerful effect is produced on organic matters held in solution.

Professor Bischof's system was for some time in operation on a large scale at the Antwerp Water Works, and left nothing to be desired so far as the cleansing effect on the water was concerned. But the river Nethe, from which the supply is taken, is a greatly polluted stream. The iron, therefore, had an abnormal amount of work to do, and in consequence the upper layers of the iron and gravel mixture got choked comparatively quickly with the dissolved impurities separated from the water.

It was curious to note the appearance of the iron

FIG. 33.—Eleven successive attitudes of a flying gull. In this series of images, traced from the originals, the distances representing the positions of the bird in space are exaggerated to avoid confusion.

methods—the dimension to be measured is compared with another of known value.

But when the dimension to be measured is subject to ceaseless change, when the velocity and complexity of its variations defy the most attentive observation, science is brought to a halt. Then a free scope is given to hypotheses; opinions come in conflict, and endless discussions prevail. The imprudent being who risks building his calculations on uncertain grounds obtains absurd results. But when a new method appears which enables us to measure rigorously that which escapes the observation of our senses, science resumes her certain march and progress.

The invention of registering apparatus has made appreciable the variations of all forces that can move a stylus making a trace upon a rotating cylinder. The applications of this graphic method have given an extreme degree of precision to certain branches of physics and of physiology.

But if the body whose rapid changes of position or of form we wish to know is inaccessible to us, its movements cannot be mechanically traced. The physiologist who studies the complex acts of man's or of animals' locomotion should, like the astronomer, determine exactly the position of bodies which he observes at perfectly measured intervals of time. Like him he should determine trajectories, velocities, accelerations, but under the special difficulty that these determinations should be made at extremely short intervals of time.

FIG. 34.—Successive images of a flying gull, showing the flexure of the carpal joint as the wing rises.

You have seen that chrono-photography answers to all needs. If some improvements in apparatus are effected, and if some additional efforts are made to extend the application of the method, the knowledge of motion in the physical world, and in the world of animated beings, will, I hope, attain all desired perfection.

ON THE PURIFICATION OF WATER BY AGITATION WITH IRON AND BY SAND FILTRATION.*

By W. ANDERSON, M. Inst. C. E.

THE fact that iron possesses the property of removing from impure waters coloring matter and organic contamination has been known for these thirty years. In 1857, Dr. Medlock took out a patent, according to which water was to be purified by suspending iron in the tanks containing it; but no practical results followed till some eighteen years ago, when Professor G. Bischof took the matter up, and contrived the domestic filter, which now enjoys a deservedly high reputation. In these filters, the water, after a rough preliminary filtration, passes through a layer of iron in a coarsely granular condition, then through a stratum of native peroxide of manganese, and finally through a layer of filtering sand.

In applying iron to the purification of water upon a large scale, Professor Bischof adopts a different arrangement. The water first passes through a layer of ordinary filter sand, by which the mechanical impurities are separated, then through a layer composed of a mixture of three parts, by measure, of coarse gravel to one part of the granular iron, and, finally, the water is made to flow through an ordinary sand filter. In the layer of gravel and iron a chemical reaction takes place. The iron is slowly dissolved by the water through the combined agency of the free oxygen and carbonic acid which are always present, in variable quantities, in natural waters. The carbonate of iron and low hydrated oxides of the metal which are formed afterward pass

filters. All that could be seen from above, when the water had been drawn off, was the ordinary surface of a sand filter, which had to be cleaned in the usual way about every fortnight. On digging through the sand no change could be detected till the spade arrived within a couple of inches of the iron mixture, when discoloration became apparent, and this continued to increase till the layer of iron was reached. For six or eight inches the gravel and iron particles were thickly coated and mixed with a reddish, slimy substance, the product of the chemical action of the iron.

Deeper down the mixture was of an intense black, and had apparently remained unchanged during the four years that the filters had worked. The upper six inches of the iron mixture had to be removed and washed about every six months, but no difficulty was experienced from any concreting together of the mass. There is very little doubt but that, with purer water, the inconvenience and expense caused by the great deposition of slimy matter would have been less severely felt, and I believe that, in the case of domestic supplies and moderate sized installations, Professor Bischof's system is the best yet introduced. The behavior of the filters at Antwerp demonstrates conclusively that a true chemical action takes place, because the water, before it reached the iron, had undergone twelve hours' subsidence and ordinary filtration through two feet deep of sand, and must, therefore, have been deprived of all mechanically suspended impurities which sand was capable of taking from it; and yet the remaining impurities, when acted on by the iron, were sufficient to cause the clogging up of a very open mixture of gravel and iron, much too coarse to act as a filter, and which, as a matter of fact, permitted the water to issue on to the sand filters in the muddy condition which it must have acquired in passing through.

The rate of filtration was not nearly so rapid as was expected from preliminary experiments. It was thought that the water could be purified at the rate of 150 gallons per square foot per twenty-four hours. In reality, however, the rate did not exceed half that amount. For small installations and with fairly clean water it would be safe, I think, to make the iron and sand filters each have an area of such extent as to filter at the rate of eighty gallons per square foot per twenty-four hours.

The water, as it comes from the iron filters, should be allowed to fall in a shallow cascade or a balloon jet into the sand filter, so as to bring as large a surface as possible into contact with the air. With some kinds of water it is very difficult to remove a faint marshy taste and smell. In such cases, the blowing of a considerable volume of air through the water after treatment with iron, by means of perforated pipes, has been found beneficial, and the same method is efficacious in hastening the deposit of iron where there is not sufficient space to allow time for natural aeration. The depth over the sand should be such as to allow about four hours before the inflowing water reaches the sand. Thus, if the filtration be at the rate of 6 inches deep per hour, or 74½ gallons per square foot per twenty-four hours, the water over the sand should not be less than two feet deep.

Over the filters the water assumes a reddish hue, and a slimy deposit is left on the surface of the sand. This has to be removed from time to time in the usual manner, the frequency depending on the purity of the water to be treated, and generally also on the season of the year. When a filter begins to run sluggishly, its life may be increased by about per 25 cent, by trailing a light chain over the surface of the sand, and by that means breaking up the slimy deposit.

After four years' working, the demand for water by the city of Antwerp had increased to an extent which rendered it imperative that the means of purification should be extended. To double the existing arrangements would have involved the employment of 900 tons more iron and extension of space which would have led to immense expenditure. Under these circumstances, I determined to try a suggestion first made to me by Sir Frederick Abel, of treating the water by agitation with iron instead of by filtration through it. Sir Frederick had pointed out that the action of the iron was of a chemical nature, and that it was desirable to present it continually to the water in the cleanest condition possible, and at the same time to cause the clean metal surfaces to come into contact with fresh quantities of the water under treatment; and that these conditions could be best secured by causing the iron particles to tumble about in a cylinder through which the water was caused to flow very slowly. The difficulty in the way of adopting Sir Frederick Abel's suggestion arose from the idea which prevailed, though not with him, that very prolonged contact, as much as three-quarters of an hour, between the water and the iron was indispensable. Hence the scheme seemed almost impracticable for large volumes of water. Not-

withstanding this prejudice, however, an experimental revolving cylinder was at last made, and it was very soon proved that even the impure waters of the Nethe could be perfectly dealt with by agitation with clean iron, with a contact of 3½ minutes only. In working out this process, I have been greatly indebted to Mr. G. H. Ogston, who had been associated with me from the first, who had made all the analyses, and who had previously tested and condemned many other plans for attaining the object in view. The "revolver," as the purifying apparatus is called, consists of an iron cylinder arranged to revolve on its long axis on hollow trunnions secured to each end. The trunnions are fitted with pipes, connected to them by means of ordinary stuffing boxes and glands, so that the pipes remain stationary while the trunnions revolve watertight round them.

The trunnions are supported on ordinary pedestals, and a slow rotatory motion is given to the cylinder by means of a spurring secured round one end and driven by a pinion actuated by a suitable train of wheelwork. The inlet pipe opens into the cylinder against a disk which forces the water to spread evenly in a radial direction, and the outlet pipe commences in the cylinder in the form of an inverted funnel, up which the water streams so slowly that none but the finest particles of iron are carried away. The inside of the revolver is fitted with curved shelves or ledges arranged in sets to hit and miss each other; these serve to scoop up the iron and shower it down again almost continuously through the water. One-tenth of the volume of the cylinder is filled with coarsely subdivided iron, either Professor Bischof's granular, so called, spongy material, or iron cast into small bullets, or iron granulated by being poured into water, or by ordinary coarse cast iron turnings or borings from engineers' shops. The last form of iron is found, so far, to be the most efficient. The motion of the cylinders is very slow. The Antwerp revolvers, which are 5 feet diameter and 15 feet long, with 10 inch inlet and outlet pipes, capable of purifying 500 gallons a minute, revolve once a minute, and require about ½ horse power to drive them.

In March, 1885, three of these revolvers were started at Antwerp, and the original iron and gravel beds were converted into ordinary sand filters; by this change the capacity of the works was at once doubled. The total weight of iron in use at one time was reduced from 900 tons to 3½ tons, and all the expenses connected with digging over and washing the purifying materials were done away with.

When pure water is passed through a revolver, a certain amount of iron is dissolved, and then the water flows out a light gray color. After two or three hours, the color changes to a reddish brown, and a deposit of rust takes place at the bottom of the vessel. If filtered at once, on escaping from the revolver, the liquid will generally be clear at first, but after a time it will sometimes get cloudy and the deposit of rust will take place, showing that the iron existed in the first instance in solution, and was afterward precipitated by the action of atmospheric oxygen. If the water be impure, colored and charged with dissolved organic matter, it will issue from the revolver of a dark gray color, and this will increase to an inky black in the case of very bad water. So that it is possible to judge of the quality of the water by the color assumed during its treatment. If the impurities are not more than the iron can deal with, the liquid, on standing for some three or four hours, becomes lighter and lighter in color, a black precipitate forms, and sinks very slowly to the bottom, the color becomes a dirty gray, and then the water will filter quite clear and bright. If the impurities overpower the iron, or are of a nature which the iron cannot effectually attack, a purplish color remains, and the liquid will not filter colorless. As in the case of the Bischof filter, the time of repose and exposure to the air before filtration is obtained by providing a sufficient depth of water over the sand of the filter beds.

In addition to its chemical action, iron possesses the property of causing the very finely divided particles of matter, which cause opalescence and cloudiness, to coagulate to such an extent that they can be removed by filtration. The waters of the Nile, for example, which will not subside clear in any reasonable time, and which cannot be filtered bright by sand filters, yield a beautiful clear water if agitated with iron before filtration through sand.

From the nature of the case, the system described is absolutely permanent and constant in its action. The surfaces of the particles of iron are necessarily preserved bright and effective, and the slow waste being made good by periodic additions of fresh iron, the revolver, once set to work, will go on acting in the same manner for an indefinite time.

In a recent paper, read before the Institution of Civil Engineers, Dr. Percy Frankland* described certain results which he had obtained by agitation of water with various finely divided solid substances, including the so-called spongy iron of Professor Bischof, and his results led him to the conclusion that the simple process of agitation could accomplish "a most remarkable purification," but that its efficiency "cannot at present be relied upon, owing to the uncertainty of its success."

This conclusion may be correct with respect to such materials as chalk, charcoal, and coke, with which Dr. Frankland experimented, and which might have the effect of removing organized matter "by mere contact," to which he appears mainly to ascribe the results obtained by him, and the uncertainty success of the treatment. But it is impossible to understand how the classification of finely divided iron with these materials, "in regard to the dependence of its efficiency upon mere contact, and, therefore, to the uncertainty of success of an agitating process in which finely divided iron is the agent used," can be reconciled by the author with his statement of results obtained by him in the employment of iron as a filtering agent. Dr. Percy Frankland justly considered it of great interest to ascertain the character of the purifying results obtained by Clark's process upon the large scale. It is therefore to be regretted that he did not also examine into results which the treatment—by agitation of water with finely divided iron—was furnishing upon a large scale, and thus eliminate the uncertain, and the consequently

* A recent lecture before the Society of Arts, London.

* Proceedings of the Institution of Civil Engineers, session 1885-86. Vol. 85.

fallacious, nature of the results of his small-scale laboratory experiments in this direction.

The effects of the treatment of water by iron may be classed under three heads:

1. The invariable result is that the organic matter is altered in its chemical nature, and the albuminoid ammonia is reduced to from one-half to one-fifth of its original amount.

2. A reaction analogous to that in Clark's softening process appears in many cases to go on. The iron oxide which is produced by combining with some of the carbonic acid which holds the carbonates of lime and magnesia in solution in the water, causes some precipitation of these to take place, and hence an appreciable amount of softening generally results. Thus, at Antwerp, the boilers of the pumping station were originally fed with untreated water; a hard scale was consequently formed in them; but when the arrangements were altered, and the treated and filtered water was supplied, the scale was greatly reduced in quantity, and became of a very open, friable character, which does not adhere to the boiler plates. In the same way, when water contains much iron in solution, the treatment with iron causes a deposition of the metal, on account of the removal of the free carbonic acid, so that the waters of the Nethe have less iron in them after treatment than before. It is very remarkable how completely the iron is deposited from solution in this process; the merest trace only remains, an amount not greater than the Kent Company's water, for example, contains. An idea prevails that, because iron is used in purification, the water resulting must necessarily be unfit for many purposes, such as washing linen, paper making, and so on. I have not been able to find any grounds for this prejudice. Fish live and thrive in the water; it is used exclusively by the famous Zoological Gardens at Antwerp; aquaria are supplied with it; and no complaints about its injurious effect on linen have ever been received.

3. Treatment with iron appears to destroy or remove much of the infusorial life. According to Dr. Frankland, Bischof, Voelcker, G. H. Ogston, and others, who have experimented in the laboratory, the treatment with iron prevents the development of that kind of microscopic life which is the cause of putrefaction of animal substances; and Mr. Ogston's experiments with sterilized infusions placed in sterilized chambers, and also with Dr. Koch's method, prove that the microbes causing fermentation and putrefaction are destroyed or removed.

At Antwerp, during the autumn of last year, the unusual drought, coupled with the great influx of visitors in consequence of the International Exhibition, made so severe a demand upon the purifying arrangements of the water company that it proved impossible to remove entirely the marshy taste in the water. This caused considerable alarm, because the cholera was raging in Spain, and great fears were entertained lest it should travel eastward; the town council, therefore, appointed a commission of five distinguished Belgian chemists to report on the condition of the water. The commission made a very exhaustive examination, and reported that there was nothing deleterious in the water, that it was absolutely sterile to Koch's gelatine test, although life was developed by cultivation on potato slices. I do not venture to pronounce any opinion as to whether it is desirable or not to remove all infusorial life from water. There is no proof whatever, as yet, that it would be any advantage to do so, while there is evidence that microscopic life has the effect of naturally purifying water; and analogy would lead us to suspect that, just as small birds keep down insect pests, so some kinds of microbes, harmless in themselves, may be of great use in destroying dangerous germs.

It is well known that iron is inimical to vegetable and animal life. The presence of salts of iron in the soil produces sterility. Iron must not be used in the construction of aquaria, or of the pipes and pumps connected with them, for even creatures as hardy as eel fry show such strong repugnance to the water as it issues from the revolvers that they make the most persevering efforts to crawl out of it, even up the vertical sides of the iron tank in which the water flows. It is not surprising, therefore, that it should prove inimical to microscopic life. It has been suggested that the presence of iron deprives the water of its free oxygen, and thus snatches animal life, and again it is thought that the slimy precipitate which is formed carries down and entangles the infusoria, and prevents them getting through the sand filters. However that may be, this property of iron is undoubtedly established, and would lead to the inference that, supposing dangerous as well as harmless germs to be destroyed, the worst water treated by iron is safer for dietetic purposes than the best natural supplies, because protection from contamination of water artificially purified is under the complete control of the establishment supplying it, for it can be kept in covered reservoirs and pipes beyond all risk of pollution. Whereas, the best natural supplies, used in their natural condition, those from deep wells not excepted, are more or less open to contamination. Witness the number of wells that have had to be abandoned in the outskirts of London, and the obvious ways in which springs and water courses can be defiled.

The adoption of iron purification by water works deriving their supplies from rivers liable to periodic mudiness and discoloration from floods would obviate the necessity of having large intake reservoirs for the purpose of storing up water when the source is in a good condition, for use when it is too discolored and polluted to be drawn upon. Not only would such a course save a vast amount of valuable space, but it would remove the danger which must accompany the exposure of a vast surface of water to the contaminating influence of the atmosphere of large towns, and who can tell how fatal this may be on the outbreak of epidemic disease? The practice adopted largely in London, for example, is to convert running streams into stagnant ponds situated in the midst of a dense population and surrounded by factories, and make such ponds the real source of supply.

The system which I have had the honor of bringing before you is now in operation on the large scale at Antwerp, at Gouda, and Dordrecht, in Holland, and at the great iron works of Messrs. Cail & Co., in Paris, where the waters of the Seine, considerably polluted by sewage and by the floating wash houses, are taken from opposite the factory on the Quai Grenelle, and

purified for the supply of the factory and the workmen's cottages. In addition, experimental apparatus of large size is in operation in Berlin and at Ostende. In the case of the latter town, the object is to determine whether an abundant supply of good water, which the town stands much in need of, can be obtained at Jabbeke from a canal, the water in which, usually about the same quality as that of the Nethe, from which the Antwerp supply is derived, is subject to periodical pollution by the Esplanade, a stream which drains a large manufacturing district. The apparatus has been at work since last spring, and has given very satisfactory results, the purified canal water being superior to any at present in use in the town.

A table of analysis, showing the degree of purification attained, is appended:

EFFECT OF PURIFICATION BY IRON.

	Organic matter.		Ammonia.			
			Albuminoid.		Free.	
	Before.	After.	Before.	After.	Before.	After.
Antwerp	77	31	0.27	0.08	0.40	—
Dordrecht.....	34	14	0.14	0.05	0.12	—
Gouda.....	151	85	0.41	0.23	0.05	0.03
Ostende (single purification).....	135	76	0.58	0.22	1.30	0.12
Ostende (double purification).....	—	40	—	0.19	—	0.23
Paris	51	25	0.16	0.06	0.40	—

The distinguished Antwerp chemist, Mr. Kemna, has found that in the case of bad waters a double purification is possible, the water being twice passed through the revolver and twice sand-filtered. The results, in the case of Ostende, are given in the table. In his capacity as consulting chemist to the Antwerp Water Works, Mr. Kemna has devoted much time and research to the process, and to him as well as to Mr. Devonshire, the resident engineer, I am much indebted for many useful investigations and suggestions.

I will conclude this paper by exhibiting a laboratory apparatus, wherein the process which I have been describing is in actual operation.

The revolver before you is made of cast iron, and has a capacity of 1½ liters. It is charged with one-tenth of its volume, or 150 c. c., of coarse cast iron borings, and is caused to revolve by means of a train of wheel-work driven through the agency of a band by a small electric motor, the power required being about 2½ watts. The water to be purified is placed in the glass vessel, above the revolver, and is siphoned over into it through the hollow trunnions by means of a glass tube and India rubber pipe fitted with a pinch cock. The water is delivered from the revolver into a series of four tall jars connected together by glass siphons, so arranged that the contents of one jar are drawn from its bottom into the top of the next in the series. This arrangement is adopted merely to avoid the inconvenience of a single jar four feet deep. The last jar delivers, by means of a siphon, into a sand filter, arranged in a large glass beaker, the filtered water being siphoned over into a Winchester quart bottle. Beside this filter is a second one, in which, by way of contrast, the water being purified is filtered direct without the intervention of the iron treatment.

The fluid being operated on consists of Kent Company's water, contaminated by the addition of 4 per cent. of a strong infusion of leather cuttings, which give it a strong yellow color, and the like amount of house sewage of a very pronounced odor.

The apparatus was started three hours before this meeting commenced, and was stopped as soon as the glass jars were full, in order to give the time necessary for the chemical action to take place, and restarted when the meeting commenced. You will, probably, be able to notice the difference in shade of each succeeding jar, the black deposit at the bottom of each, and the same on the surface of the sand in the filter. The dirty yellow water you see has been changed into a colorless fluid, while the same water, merely filtered through sand, retains nearly all its color, though it has become somewhat clearer.

I place in beakers a sample of the water supplied by the water company to this house, a sample of the water you have seen purified, and another of the same water unpurified, but filtered through sand only. I add to each beaker an equal quantity of a weak solution of permanganate of potash, and you will see, in a few moments, that the purified water does not yield much in color to the water company's supply, while the original water has hardly changed color at all, the permanganate having been reduced by the impurities.

The cost of applying this method of purification depends, of course, upon local circumstances, and the quality of the water to be treated. But the capital outlay, where filters exist already, may be taken as £1,000 per million gallons per 24 hours, while the working expenses are merely nominal, the revolvers running without any attention beyond regular oiling and the addition, once a week, of a fresh supply of iron. The cost of the water at Antwerp, delivered into the town main under a pressure of 280 feet, does not exceed three-quarters of a penny per thousand gallons in working expenses of all kinds. Where filter beds exist, as at Dordrecht, and Gouda, in Holland, the revolving purifiers can be added without any substantial alteration, and the filter beds can generally be worked at a greater rate than when the untreated water is to be made reasonably fit for use.*

CERIOD.—According to the *Moniteur Scientifique* *Quesneville*, the fatty matter extracted from wool may be transformed into a substance, to which the above name has been given, possessing the consistency and several properties of wax.

* Further information may be obtained by reference to the "Proceedings of the Institution of Civil Engineers," vol. lxxii., p. 24, vol. lxxxi., pp. 279 and 287. "Journal of the Royal Agricultural Society," vol. xx., part ii., 1884, p. 681. "Rapport sur la qualité de l'eau de la ville d'Anvers pendant l'été de 1885." In the library of Institution of Civil Engineers.

STANDARD PIPE AND PIPE THREADS.

THE adoption, or rather the readoption, by the wrought iron pipe manufacturers of the United States of the Briggs standard of gauges insures the important feature of a general conformity, and it practically solves the problem of interchangeability of pipe and pipe threads.

Of course, it is important that the several manufacturers shall be certain that every gauge to which they work accurately represents the Briggs standard. The taper in the Briggs standard is 1 in 32 each side, or ¼ inch per foot in diameter, up to and including 8 inch pipe. The length of that part of the thread which is perfect at top and bottom (the angle of thread being 60 degrees), and which is termed the "complete thread," is expressed generally by the formula—

Complete thread = $(4.8 + 0.8 D) \div P$, D being the outside diameter of the pipe, and P the pitch of thread, equal to $\frac{1}{N}$, N being the number of threads per inch.

The length of perfect thread expressed by the formula is followed by two threads imperfect at the top, the bottom only being complete, and finally the remaining four threads, which are imperfect at both top and bottom, vanish at the surface of the pipe at this point.

The following table gives the values of complete thread deduced from the above formula, with length of the additional two threads:

Nominal size of pipe.	Actual inside diameter.	Actual outside diameter.	Length of complete thread.	Length of complete thread plus 2 threads.	Pitch of Thread $\frac{1}{N}$.
Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
½	0.270	0.405	0.19	0.264	27
¾	0.364	0.540	0.29	0.402	18
1	0.494	0.675	0.30	0.408	18
1 ¼	0.623	0.840	0.39	0.534	14
1 ½	0.824	1.050	0.40	0.546	14
2	1.048	1.315	0.51	0.688	11½
2 ¼	1.380	1.660	0.54	0.707	11½
2 ½	1.611	1.900	0.55	0.724	11½
3	2.067	2.375	0.58	0.757	11½
3 ½	2.468	2.875	0.89	1.138	8
4	3.067	3.500	0.95	1.200	8
4 ½	3.548	4.000	1.00	1.250	8
5	4.026	4.500	1.05	1.300	8
5 ½	4.508	5.000	1.10	1.350	8
6	5.045	5.563	1.16	1.406	8
6 ½	5.065	6.625	1.26	1.513	8

SCOURING AND BLEACHING PROCESSES.

MARION'S PROCESS.

C. MARION immerses the textile, whether cotton or flax, for two hours in a boiling solution of the caustic soda of commerce, having a specific gravity of 1.060. Lifted from the vat the fiber is set to drain, then transferred to the hydro-extractor, and the alkaline solution which is driven out collected. Water is then freely showered like rain upon the rotating textile, until the discharged liquid is neutral to test paper.

In order to avoid waste of the soda used, by rendering it again fit for employment in scouring, the collected alkaline liquors containing the extracted substances are evaporated in an iron boiler and the residue heated to fusion to burn out the organic matter.

During the operation of scouring, any fibers gummed or otherwise united together become detached. The quantity of solution used should be six times that of the textile acted on.

When the fiber is to be bleached, it—upon being removed from the hydro-extractor—is thrown into acidulated water, containing, say, a half of one per cent. of acid, and allowed to remain for one hour. It is now returned to the hydro-extractor and washed as before until the rinsings are neutral.

In a wooden vat, having a capacity of 2,000 liters, make a solution of 1,200 liters hypochlorite of soda at 12° B., heat to 45° C., enter 700 kilos textile, and let it soak for an hour and a half. On being lifted, it will be found perfectly white. Drain, rinse as before, and return to hydro-extractor, and remove the last traces of soap by passing into a cold bath slightly acidulated with hydrochloric acid.

The bath for mordanting is prepared with:

Water	2,000 liters.
Acetic acid	10 "
Tannic acid	2 kilos.

Enter 200 kilos of fiber, and work for six hours. Without rinsing dry in the centrifugal, and collect the drainings for subsequent addition to the tannic solution. The solution may serve many times, if, for every 100 kilos of the textile, 200 grammes gallotannic acid be added.

Remove fiber from the centrifugal, and enter in bath containing:

Water	2,000 liters.
Acetate of alumina, free from iron,	1 kilo.
Glycerin	2 kilos.
Tartar emetic	1 kilo.

Soak textile for an hour, drain off liquid in centrifugal, preventing waste by collecting the draining, and without rinsing, dry.

TAPPAN'S PROCESS.

The compound for bleaching consists, in certain proportions, of one or more of the products of petroleum, preferably paraffin, a sulphur oil, that of mustard, and an alkali. The latter is used in order to furnish a soapy matter. The compound is dissolved in water, and the matter to be bleached is put in a bleaching vat containing the solution. Heat is applied, the temperature raised to ebullition, and maintained at that point for two or three hours. The stronger the solution, the less the time necessary to finish this stage of the process. After the boiling, the textile is lifted and clean water forced through it. When thoroughly rinsed, it is transferred to a solution of chlorinated lime, and the bleaching completed.—*Textile Record*.