

chromate and bichromate of potash, chrome yellow, chalk, etc.

Cocoa and Chocolate.—All the parts of the cocoa bean are found in small fragments in the paste. Fig. 10 shows the microscopical appearance of genuine Trinidad cocoa. At *a* we recognize fragments of the cellular tissue of the bean; at *b*, portions of the rind; at *c*, fragments of the germ; and at *d* and *e*, isolated granules of the peculiar starch of the seed.

As regards chocolate, the processes employed in corrupting the manufacture are described as "diabolical." "It is often mixed with brick dust to the amount of ten per cent., and peroxide of iron twenty-two per cent., and animal fats of the worst description." In England, cocoa is sold under the names of flake, rock, granulated, soluble, dietetic, homœopathic, etc. Such names are evidently employed to disguise the fact that the articles are compounded of sugar, starch, and other substances. Other adulterants are flour, potato starch, cocoa nut oil, lard, and tallow, and, to give weight, chalk and plaster of Paris, and for color, red earth or Venetian red. Fig. 11 shows one of these mixtures as seen under the microscope. It is sold under the name of "Homœopathic Cocoa." At *aaa* are seen granules and cells of cocoa; at *bbb*, granules of canna starch; and at *c*, granules of tapioca starch.

Flour.—Starch almost constantly occurs in the vegetable kingdom in the form of organized corpuscles, the characters of which frequently vary greatly in different plants. These differences are often so great that, with the aid of the microscope, they afford information of a highly valuable character, and allow the observer to distinguish many flours from each other. Wheat flour is frequently adulterated with various substances, such as potato starch, bean flour, Indian meal, rye flour, and rice flour, and with alum, chalk, bone dust, and plaster of Paris. In the detection of such adulterations, the microscope, together with a slight knowledge of the action of chemical reagents, lends important assistance. "It enables us to judge of the size, shape, and markings of the starch grains, and thereby to distinguish the granules of one meal from those of another. In some cases, the microscopic examination is aided by an application of potash. Thus, we may readily detect the mixture of wheat flour with potato starch, or meal of the pea or bean, by the addition of a little water to a small quantity of the flour; then, by adding a few drops of a solution of potash

The adulteration of wheat flour with alum and "stuff" is practiced with a twofold object, viz.: "First, to render flour of bad color and inferior quality white and equal, in appearance only, to flour of superior quality; and secondly, to enable the flour to retain a larger proportion of water, by which the loaf is made to weigh heavier. By dissolving out the alum in water, and then recrystallizing it under the microscope, this adulteration is readily detected."

The starch granules of rye flour, which is sometimes used to adulterate wheat flour, are shown in Fig. 13. For the sake of comparison, we present in Fig. 15 the starch granules of sago, a fecula obtained from the *Sagus Rumphii*, a palm growing in the Moluccas, and those of the arrowroot, a fecula derived from the *Maranta arundinacea*, growing in the West Indies. It is very rare that sago reaches us in the state of purity here shown. And an imitation of the article is sometimes prepared in Europe from potato starch. This imitation, however, when examined under the microscope, exhibits larger granules, which are also

they give the examples and cases which prove to their minds the truth of such belief. But the cases cited as proofs are generally defective, and do not exclude the possibility of infection from a preceding case. Take for example the four instances given by Dr. R. W. Hutchinson, of Queens County, N. Y., published as late as October 9, 1886, in the *Medical and Surgical Reporter*.

I will not occupy your time by criticising all these cases, but will select the fourth, which seems to be the strongest, as follows:

"IV. In the last part of August, 1885, a party of young folks, numbering some fifteen, started out to spend the day at the banks of a creek near East Rockaway. They carried no water with them, but relied on securing a supply from a sunken barrel near the creek, that had been used for that purpose for a number of years. On this occasion it was noticed that the water smelled and tasted bad, so much so that some of the party refused to drink it. Exactly one week from the day of the picnic most of them who had drunk the water, some nine in number, were stricken down abruptly with typhoid fever. I regret very much that I did not have the opportunity of examining the barrel, with its contents, immediately after the picnic, as I am now left in doubt as to the cause of the decomposition in the water. Shortly after the outbreak of the fever some person, fearing that others might drink, pulled up the barrel and destroyed the well. But from a number of reasons I can positively say that there was no possibility of the water being contaminated with the fecal matter of a patient suffering from typhoid fever, which is the recognized way of communicating the disease; and if the germs of the disease did not originate *de novo* in the well water, I ask the question, Where did they come from?"

You see he gives no reason why the well could not be contaminated with typhoid fever, though he says he has a number of them; yet he says he had no opportunity of examining the barrel, nor its contents, but he *heard* some of the party say that the water tasted and smelled bad. Notice that in less than seven days most of the party of nine who drank the water were suddenly stricken down. This fact, in itself, might occasion some doubt of the fever being a true typhoid, as the incubation period of typhoid fever is usually longer, though there are instances on record which would have a tendency to show that ty-

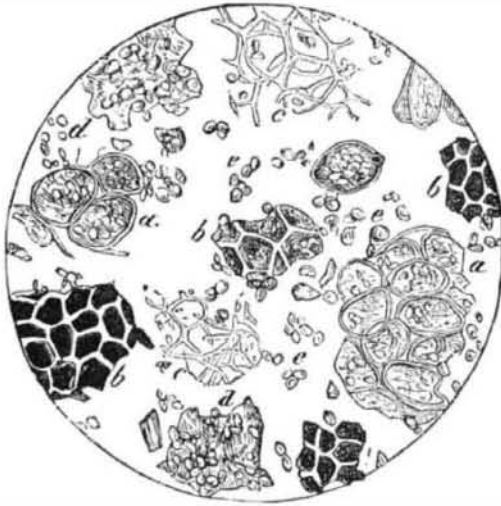


FIG. 10.—GENUINE TRINIDAD COCOA.

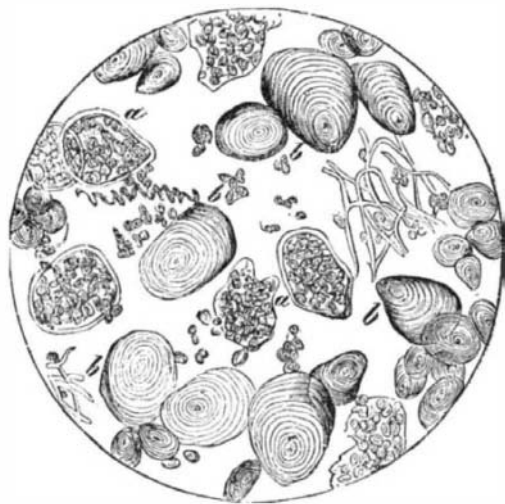


FIG. 11.—ADULTERATED COCOA.

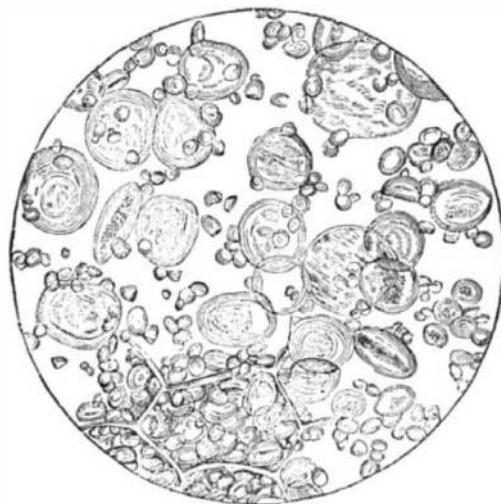


FIG. 12.—STARCH GRANULES OF WHEAT STARCH, AND CHARACTERS OF THE CELLULOSE.

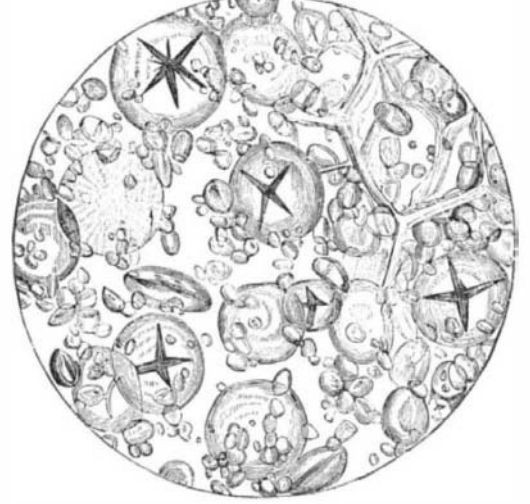


FIG. 13.—STARCH GRANULES OF RYE FLOUR.

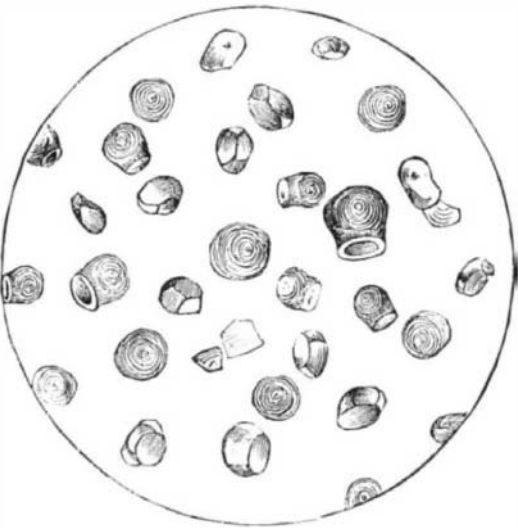


FIG. 14.—GRANULES OF POTATO STARCH.



FIG. 15.—SAGO.

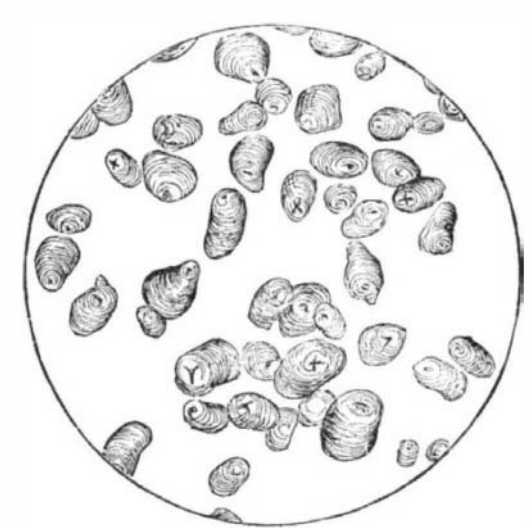


FIG. 16.—ARROWROOT.

(made of the strength of one part liquid potash to three parts of water), the granules of the potato starch (Fig. 14) will immediately swell up and acquire three or four times their natural size, while those of the wheat starch (Fig. 12) are scarcely affected. If adulterated with pea or bean meal, the hexagonal tissue of the seed is at the same time rendered very obvious under the microscope. Polarized light will be of use as an additional aid. Wheat starch presents a faint black cross proceeding from the central hilum, whereas the starch of the oat shows nothing of the kind."

"Adulteration of bread with boiled and mashed potatoes, next to that with alum, is, perhaps, the one which is most commonly resorted to. The great objection to the use of potatoes is that they are made to take the place of an article very much more nutritious. The cells which contain the starch corpuscles are, in the potato, very large (Fig. 14); in the raw potato, they are adherent to each other, and form a reticulated structure, in the meshes of which the well defined starch granules are clearly seen; in the boiled potato, however, the cells separate readily from each other, each forming a distinct article. The starch corpuscles are less distinct and of an altered form."

more regularly oval or ovate, smoother, less broken, and more distinctly marked with the annular rugæ than those of sago. Arrowroot is often adulterated with common or potato starch, but the sophistication may, as in the preceding case, be easily detected with the microscope.

THE RELATION BETWEEN DRINKING WATER AND TYPHOID FEVER.*

By DOWLING BENJAMIN, M.D., Camden, N. J.

TYPHOID fever is caused by a peculiar and specific poison. I do not know that this is denied to-day by any one competent, from careful study and thorough investigation, to give trustworthy information on this subject. Does it arise *de novo*? All the investigations that I have made have proved to my mind that the poison which produces typhoid fever cannot be generated spontaneously, but must come from another source. I am aware that there are some gentlemen who even now believe that it originates *de novo*, and

typhoid fever may occur with a shorter incubation period than two weeks. Two weeks, however, is about the usual time.

What a blessing it might have been if the doctor had only told us the precious little secret of how he knew that no one had been in that vicinity, that his fecal matter might have affected the well!

Then take the cases cited by the illustrious Morchison, who has done so much for the thermometry of typhoid fever, but who has, perhaps, led astray more students of the origin of the poison than any other man. None of his cases is in my opinion conclusive, and this opinion is sustained, also, by the opinion of Dr. J. H. Hutchinson, of Pennsylvania, who says, in an article on this subject, that the cases referred to are by no means convincing (see p. 256, "System of Medicine by American Authors," just published).

A case put forward by the advocates of the spontaneous origin theory as one of their strongest is that reported by R. Bruce Lowe, Medical Officer of Health, Holmesley, Yorkshire, published in the *British Medical Journal* in 1880. "It occurred," he says, "in a lad who had not been away from home for months. No stranger had visited the house, and there was no fever

* Read at the twelfth annual meeting of the New Jersey Sanitary Association, Saturday, November 20, 1886.

in the district." But Mr. Lowe admits there was a case before, only eight months past, and only eight miles distant, and he does not prove there was no possibility of infection, either by domestic animals or by streams of water. It is a well-known fact that, when the great forests of *pine* are cut off the land in the northern part of the United States, there comes up a thick growth of *oak* timber immediately succeeding; and the common opinion of people who notice this strange phenomenon is, that the little *oak plants* originate spontaneously in the soil. I think you will hardly believe this correct; but the same agencies that sowed the original oak seeds in the forest, it must be admitted, are fully competent to sow the seeds of typhoid fever in unexpected places occasionally. The man who starts out, in this present age of scientific research, to prove that typhoid fever originates *de novo* assumes a greater task than Hercules.

No combination, either of filth, fecal matter, or sewer gas, has ever yet been discovered that will produce the disease.

What are the physical characteristics of the virus of typhoid fever? Is this virus a liquid, a solid, or a gas? Evidently it is matter of some kind. Inorganic matter may be either solid, liquid, or gas; organized matter is never liquid, never gas. We conclude it is not a gas for the following reasons:

First, the gas has not been isolated. Second, it would be more apt to go through the air than otherwise, which is not the case with this virus.

Third, all known gases that affect the system profoundly, if they affect it at all, do so at once or in a few minutes after their reception into the system.

Can a dose of carbonic acid gas, ammonia gas, illuminating gas, or any other poisonous gas, be taken and lie in the system for from two to six weeks, and then begin to develop a train of trouble, a uniform succession of symptoms, like typhoid fever, or small-pox, or any other of the zymotic diseases? Never. Is it a liquid, this virus? The same objections apply to this theory that apply to the theory of its being a gas. Is it composed of solid particles? If so, these particles must be of nearly the same specific gravity as water. There is no evidence to the contrary, at any rate, and these solid particles must be very small indeed, for water known to contain typhoid fever poison is often apparently clear and bright. Filters do not seem capable of sieving out these particles, these poisonous particles and this matter. At least water has been filtered through ten and even one hundred feet of sand and earth, coming out clear, but still bearing poison in sufficient quantities to produce fever and cause death. So far as is at present known, the poison has not been filtered out of the water by any kind of filter. This would lead us to think it was really dissolved in the water, but for the fact that a system of very fine filtration has not been tried upon suspected water, and then the water given to persons to drink, to see if the disease would be produced by it. There is no case on record of any person ever having taken the disease from water that has been boiled, thus showing that, as far as known, the boiling temperature destroys the poison.

The theory that the poison of typhoid is an organized poison, or germ, or bacillus, seems to explain its action more completely than any other. This phase of the subject was carefully discussed, and its progress given at length, by me in an essay written in 1876, and published in *The Country Practitioner*, vol. ii., Nos 6 and 7. Whatever may be considered the nature of this virus, the fact that water is its principal distributor is certain. Indeed, a careful study of the cases and statistics that I have examined seems conclusive that at least ninety-five per cent. of the cases of typhoid fever come directly from the water. The poison which produces this disease does not go through the air. All physicians now permit people to go into the sick room where this disease exists. Visitors, and those who wait on the patients, do not take the disease. The washer-woman has been known, in rare instances, to take the disease from the water containing the soiled linen, which has infected her hands and gotten into the mouth and absorbents. The infected wash water is very often thrown on the ground near a well, or into the sewer, with the more poisonous dejecta. I have seen two cases that occurred among sailors who drank water from the Delaware River, opposite the Philadelphia sewers.

There is one instance * where it has also been shown that cattle have been afflicted with this disease. But in tracing the disease still further back, it was found that the cattle caught the disease from drinking infected water, and thus the milk supply has also been known to become affected. So the more we investigate the subject, the more strikingly the fact stands out that water is the main habitat of the poison. Several facts show, also, that when water contains a little organic matter, the virus will be active for at least a year, in still water, and very probably for a number of years, as some of these cases cited prove.

Recent investigations show the intimate relations of this disease to drinking water to be so close and so constant that it is hardly ever worth while to think of any other source of the contagion.

One of the most remarkably clear examples of this relation of drinking water to typhoid fever occurred at Plymouth, a small city in Luzerne County, Pa.; and for the invaluable lessons taught by this epidemic we owe much to the committee sent by the mayor of Philadelphia to investigate the subject, and it is a plain and perfect explanation of the case. The explanation is as follows:

"The mountain stream is a small one, running down over a rocky bed, and on a declivity not eighty feet from its bed a dwelling is situated, wherein, during January, February, and March, was located a case of typhoid fever that is only now convalescent, the worst period of the case being about the 30th of March. The attending nurse was in the habit, during each night, of carrying the excreta from the patient and depositing it on the ground toward the stream. The ground during all this time was frozen and covered with snow, until the thaw and rain already alluded to occurred. The poisonous character of the dejecta is not destroyed by freezing, but is only kept in a state of hibernation.

"A great part of the three months' accumulation of dejecta was suddenly swept into the rapidly running

stream, and reached the lower reservoir as quickly as a man walking fast could have arrived there.

"In fifteen days from this time the epidemic began, fifty cases occurring daily between the 10th and 20th of April. Up to the present, twelve hundred have been sick and one hundred have died out of a population of eight thousand. For the first three weeks the few people in the town who used well water exclusively escaped the disease. The period of incubation varies between ten and twenty days, or longer, and therefore no other conclusion can be arrived at than that the infective poison existed in the mountain water and originated from the one case of fever in the house on the side of the stream."

This entire and comprehensive report is on file in the mayor's office, Philadelphia, and is also published in the "Proceedings of the County Medical Society," May 13, 1885. The committee consisted of M. S. French, A. M., M. D., Surgeon of the Police Department of Philadelphia, and E. O. Shakespeare, A. M., M. D., Pathologist of the Philadelphia Hospital.

Last October a severe epidemic of typhoid was in progress in Inlaystown, N. J., about forty miles from Camden, and I went out there to investigate it, and was greatly assisted in so doing by the kindness of Dr. H. G. Norton.

I found that a brook about four feet wide runs through the village. A street runs parallel with the stream, about one hundred feet from it. A row of houses is situated between the brook and the street, and the back yards extend to the brook, about forty feet distant. Between the brook and the houses is situated a row of privies, and a row of wells for drinking water. The privies are situated on the bank of the brook, so that the fecal matter from them has to run only a distance of three or four feet to get into the stream. The wells are between the stream and dwelling houses, and about thirty or forty feet from the brook. The somewhat impervious stratum has a slight dip toward the well, and underlies the locality. On measuring, it was found that the floor or bottom of the wells was not more than a few inches below the floor of the brook, and when the water was high in the brook it was also high in the wells, and that there was porous ground between the brook and the wells of the privies.

Beginning up the stream, and designating the houses, which are but a few feet apart—not over fifty feet—and numbering from 1 to 3, I will give you the following explanation:

In 1893 a family came to No. 2 suffering with "typhoid malarial fever and diarrhoea." The children had fever and bowel trouble, with diarrhoea, lasting for months, until the spring of 1885. On August 14, 1885, a young lady was taken with typhoid fever in this same house. On August 28, another young lady was taken with the disease in No. 2, the next house below—down the stream. August 27, patient at No. 3 took the disease. September 12, another patient took the disease in No. 3. In September a relative of the family in No. 2 visited the town, drank the water, and died in a few weeks afterward of typhoid fever. September 30, a patient opposite to No. 2 took the disease. In the spring of 1886 the family had moved out of No. 2; the well had been kept closed, and had not been cleaned out. A new family moved into No. 2 in April or May, 1886. The boys drank the well water, in spite of protests, and took the disease in June, 1886. One of the brothers died. The girls, who would not drink the water, escaped the disease.

An analysis of this water from the wells, by Professor H. B. Cornwall, of Princeton College, showed the water to be thoroughly contaminated with fecal matter. Evidently the virus had remained in one of these wells; a year had passed, and yet the winter had not been able to kill it.

The length of time that the virus will remain active has not been ascertained, but it is known to be years, in water that is not much disturbed.

I have cited these examples because they are so recent and so near at hand. Hundreds of instances might be cited, and the evidence piled up almost *ad libitum*; but, if further examples would not be superfluous in this paper, the time—twenty minutes—alotted to me would preclude my citing them here, and I might say now that much of the data upon which my remarks have been based are not included in this paper for the same reasons.

In the face of what is already known, I do not think that any student of sanitary science can deny that the poison of typhoid may be carried by the water supply. I do not know that any do; but the extent to which it is carried by water and the preventability of the same are the great points that do not seem to be sufficiently appreciated by us, and scarcely appreciated at all by the people in general.

If the people can be made to understand that almost all the cases of typhoid fever come from the water supply, and that there is no disease more easily prevented than this, we shall have accomplished the first great step toward the annihilation of one of the worst destroyers of mankind.

Look at the dreadful suffering caused in Philadelphia and Camden to-day by ignorance or indifference to these facts. Only a few days ago a noble wife and young mother died in our city of this dread disease, thus blighting the prospects of a happy family; and as I stood by her bedside, I could but regret that another life had been needlessly sacrificed.

The disease cannot occur without the virus to produce it, and the virus can be kept out of the drinking water, and it should be kept out at any cost. It would pay at any price. Every death that is preventable is needless, and is a reproach to the community. Dr. E. O. Shakespeare, an eminent investigator of contagious diseases, who has been sent abroad by the highest executive authority of the United States, to investigate the nature and causes of cholera, says, in the *New York Medical Journal*, January, 1885, that "epidemics of typhoid fever are absolutely preventable and controllable, and neglect to employ proper means to this end should be regarded as inexcusable."

Great reforms and revolutions have taken place within our own recollection; and the student of science dares to indulge the hope that, even during his short life, he may have the pleasure of seeing the death rate from typhoid fever reduced more than ninety per cent.—*Medical Record*.

THE Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, \$5 a year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, \$2.50 stitched in paper, or \$3.50 bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, \$7.00.

A liberal discount to booksellers, news agents, and canvassers.

MUNN & CO., Publishers,

361 Broadway, New York, N. Y.

TABLE OF CONTENTS.

	PAGE
I. ARMS OF WAR.—Magazine Rifles.—The different types of military magazine rifles described.—8 illustrations	9538
II. CHEMISTRY AND METALLURGY.—Aluminum	9529
Cellulose	9530
Determination of Nitrogen in Commercial Fertilizers	9531
Nutritive Value of Fungi	9529
Plant that Destroys the Taste of Sugar.—An examination of the leaves of <i>Gymnema sylvestre</i>	9530
Resin Gas for Iron Making	9531
III. GEOLOGY.—The Artesian Wells of the Oued Rir.—A remarkable artesian basin and its phenomena described from the geological and topographical outlook.—1 illustration	9537
IV. HYGIENE AND SANITATION.—Adulterations in Food and Drink.—The microscopic examination of foods, tea, milk, spices, and other food products.—16 illustrations	9540
The Relation between Drinking Water and Typhoid Fever.—By DOWLING BENJAMIN, M.D.—An elaborate examination of the causation of typhoid fever.—The agency of drinking water in disseminating the disease	9541
V. MISCELLANEOUS.—The American Exhibition in London.—The originators of the great enterprise.—The director-general and United States director.—"Buffalo Bill"—3 portraits	9528
The Manchester Royal Jubilee Exhibition.—Description of the buildings of the exhibition and their features of construction.—3 illustrations	9527
VI. NAVAL ENGINEERING.—The Steam Yacht Chemcheck.—A new yacht designed for cruising in the Bosphorus and Mediterranean.—3 illustrations	9537
VII. PHYSICS.—Apparatus for Investigating Terrestrial Magnetism.—A reflecting magnetometer for giving at one observation the deflection and declination.—1 illustration	9539
VIII. TECHNOLOGY.—A New Method of Manufacturing Cylindrical Glass Objects.—An ingenious mechanism for this work, dispensing with blowing.—3 illustrations	9531
Causes and Prevention of Stoppages in Burner Tips.—The effect of bisulphide of carbon on gas burners discussed.—1 illustration	9536
Locked Coil and Stranded Wire Ropes.—A new and ingenious form of cable; the use of wires of special section producing cables of true cylindrical contour.—3 illustrations	9536
Wrought Iron.—By J. STARRIE GARDNER.—The manufacture and manipulation of the metal, with special reference to the production of ornamental forgings.—6 illustrations	9532

PATENTS.

In connection with the *Scientific American*, Messrs. MUNN & Co. are solicitors of American and Foreign Patents, have had 42 years' experience, and now have the largest establishment in the world. Patents are obtained on the best terms.

A special notice is made in the *Scientific American* of all inventions patented through this Agency, with the name and residence of the Patentee. By the immense circulation thus given, public attention is directed to the merits of the new patent, and sales or introduction often easily effected.

Any person who has made a new discovery or invention can ascertain, free of charge, whether a patent can probably be obtained, by writing to MUNN & Co.

We also send free our Hand Book about the Patent Laws, Patents, Caveats, Trade Marks, their costs, and how procured. Address

Munn & Co., 361 Broadway, New York.

Branch Office, 622 and 624 F St., Washington, D. C.

THE SCIENTIFIC AMERICAN Architects and Builders Edition.

\$2.50 a Year. Single Copies, 25 Cents.

This is a Special Edition of THE SCIENTIFIC AMERICAN, issued monthly on the first day of the month. Each number contains about forty large quarto pages, equal to about two hundred ordinary book pages, forming, practically, a large and splendid Magazine of Architecture, richly adorned with elegant plates in colors and with fine engravings, illustrating the most interesting examples of modern Architectural Construction and allied subjects.

A special feature is the presentation in each number of a variety of the latest and best plans for private residences, city and country, including those of very moderate cost as well as the more expensive. Drawings in perspective and in color are given, together with full Plans, Specifications, Costs, Bills of Estimate, and Sheets of Details.

No other building paper contains so many plans, details, and specifications regularly presented as the SCIENTIFIC AMERICAN. Hundreds of dwellings have already been erected on the various plans we have issued during the past year, and many others are in process of construction. Architects, Builders, and Owners will find this work valuable in furnishing fresh and useful suggestions. All who contemplate building or improving homes, or erecting structures of any kind, have before them in this work an almost endless series of the latest and best examples from which to make selections, thus saving time and money.

Many other subjects, including Sewerage, Piping, Lighting, Warming, Ventilating, Decorating, Laying out of grounds, etc., are illustrated. An extensive Compendium of Manufacturers' Announcements is also given, in which the most reliable and approved Building Materials, Goods, Machines, Tools, and Appliances are described and illustrated, with addresses of the makers, etc.

The fullness, richness, cheapness, and convenience of this work have won for it the largest Circulation of any Architectural publication in the world.

MUNN & CO., Publishers, 361 Broadway, New York.

A Catalogue of valuable books on Architecture, Building, Carpentry, Masonry, Heating, Warming, Lighting, Ventilation, and all branches of industry pertaining to the art of Building, is supplied free of charge, sent to any address.

BUILDING PLANS and SPECIFICATIONS.

In connection with the publication of the BUILDING EDITION of the SCIENTIFIC AMERICAN, Messrs. MUNN & Co. furnish plans and specifications for buildings of every kind, including Churches, Schools, Stores, Dwellings, Carriage Houses, Barns, etc.

In this work they are assisted by able and experienced architects. Full plans, details, and specifications for the various buildings illustrated in this paper can be supplied.

Those who contemplate building, or who wish to alter, improve, extend, or add to existing buildings, whether wings, porches, bay windows, or attic rooms, are invited to communicate with the undersigned. Our work extends to all parts of the country. Estimates, plans, and drawings promptly prepared. Terms moderate. Address

MUNN & CO., 361 Broadway, New York.

* Closter, Germany, 1878; Berlin. klin. Wochenschrift.