ments made thus far prove that this new machine will drag on ordinary roads, or on rails, a train four times as heavy as the ordinary trains; the cost of this augmented train will not, it is said, vary materially from that of the ordinary machines with the usual trains when used on equal grades; but the increased adhering power of the new locomotive will permit of the employment of a lighter built machine for the usual trains, as well as the power to surmount steeper grades than are usual on the railways of the present construction.

This new system of M. Fortin-Hermann enlarges very greatly the capacities of all locomotives for any roads, and will allow of passing through ground where roads have not been constructed, and up grades of one foot in ten.

Scientific American.

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Contents.

(Illustrated articles are marked with an asterisk.)

Air, compressing (34)........ 172
Alizarin, artificial........ 161
Answers to correspondents........ 171
Ants, to destroy (40)........ 172
Balloon, a hot air (9)........ 171
Balloon, a vacuum (1)........ 171
Battery poles (10)........ 171
Bell, repairing the Independence* 164
Bleaching cotton prints, etc. (38). 172
Bleaching shellac (4)........ 171
Bleaching tobacco (11)........ 171
Bleaching wax (12)........ 171
Boracic acid, fused........ 167
Boring bits*........ 165
Bricks, Japanese........ 169
Business and personal........ 171
Carbonic acid and dioxide (33)... 172
Carbonic acid as motive power.... 166
Cells, Traube's artificial........ 161
Cement for glass and lead (18)... 171
Centennial horticultural building* 159
Chloral as an anæsthetic........ 169
Chronometer, a solar*........ 159
Cleaning tin, copper, etc., (24)... 171
Clouds, altitude of, ascertaining... 164
Cochliostema Jacobianum*........ 167
Collodion, old, using (3)........ 171
Cooking chamber, improved*........ 166
Cooling apparatus (16)........ 172
Copper adhering to glass........ 169
Copper and tin, weights of (4)........ 171
Copper sulphide, dissolving (5)... 171
Cylinder, measuring a (4)........ 171
Donkey, the steam........ 159
Dyeing thread (20)........ 171
Earth's interior, theories of the.. 168
Electric phenomenon, recent........ 165
Electromotive force (39)........ 172
Electroplating with tin (6)........ 171
Fire engines, floating*........ 162
Fuel, economy in use of........ 163
Gas, the Keely........ 165
Hen houses, purifying........ 165
Hights of mountains, etc. (30).... 172
Ink, black (32)........ 172
Insects, excommunicated........ 166
Magnetism, terrestrial*........ 164
Mesembryanthemums*........ 167
Metal glass........ 166
Metals, prices of........ 169
Molding machine, improved*........ 166
Moon and the weather, the (31)... 172
Oils, fatty, adulterations of........ 161
Oils, heating (14)........ 171
Optical delusions, two (29)........ 171
Oxuvitic acid........ 171
Paper, to keep (35)........ 172
Paper, making lace (19)........ 171
Paraffin varnish (26)........ 171
Patent decisions, recent........ 169
Patents, American and foreign... 169
Patents, list of Canadian........ 172
Patents, official list of........ 172
Pencils, copying........ 168
Permutations, etc., calculating (27) 171
Perpetual motion (2)........ 171
Picric acid in beer........ 161
Picric acid, source of........ 167
Pneumatic tubes in London........ 163
Pneumatic tubes in Paris........ 167
Quartz crystals, making (8)........ 171
Rapid transit, progress of........ 160
Recipes, useful........ 169
Screw propellers, pitch, etc. (41). 172
Sea's level, the, etc. (28)........ 171
Sight, the education of........ 160
Silver from the nitrate (39)........ 172
Skippers in meat, etc. (15)........ 171
Sounding the Gulf of Mexico........ 166
Star, a south polar (30)........ 172
Starch, making (22)........ 171
Stealing brains........ 161
Steam yacht Hermione, the........ 168
Stereopticons and screens (7)........ 171
Swimming the English Channel... 165
Telegraph cable, the direct........ 163
Tiles, pictorial........ 168
Tools, heavy vs. light........ 163
Tunnel in Algiers, Roman........ 165
Volcano revelations, new........ 160
Water a spent substance (25)........ 171
Waterproofing fish lines (21)........ 171
Wax, etching, for zinc (23)........ 171
Wheels on a curve, slip of (17).... 171
Wood and the sun's heat (37)........ 172

THE EDUCATION OF SIGHT.

As the reader's eyes rest upon this page of the SCIENTIFIC AMERICAN, a very complex impression is conveyed to his mind. He perceives a contrast of light and shade, the white paper and the black ink. The dark portions exhibit various forms, which stand in definite positions with reference to each other and to the reader. The paper lies at a recognized distance from the reader's eye. It has form and size, a certain degree of smoothness, and certain roughnesses indicating lines of print on the reverse side. Further looking will discover a succession of black forms—letters, words, etc.—conveying the ideas now in the writer's mind.

How much of all this is strictly speaking, seen? How much is the result of ulterior processes?

Paradoxical as it may seem, the reader's eyes report only the first mentioned contrasts of light and shade: all the rest is extravisual. In other words, when we look at a complex object, say a landscape, the eye distinguishes light and shade only: the situation, direction, distance, form, size, etc., of the several objects which produce lights and shades, we have to determine by other means, for the discovery of which we are indebted to the patients of Cheselden, Home, Wardrop, Franz, and others, who were born blind and given the power of vision in later years by a surgical operation.

In all these cases, we believe, the cure consisted in the removal of an overlying growth which eclipsed the otherwise perfect organ of vision. In each case the patient was sufficiently mature to report the exact nature of the sensation aroused by the act of sight on the part of a perfect but uneducated eye—uneducated, that is, in respect to motion, and unaided by any knowledge acquired by the other senses. Their experiences, therefore, clearly demonstrate the scope of pure vision in all persons, and also the origin of the ideas of form, size, distance, etc., which seem to arise in our minds through simple seeing.

Of the earliest patient, Cheselden's, it is recorded that "he knew not the shape of anything, nor any one thing from another, however different in shape or magnitude," and the same is substantially true of all the others.

Ten minutes after his eyes were opened, Home's patient was shown a round piece of card, and was asked the shape of it. He could not tell till he had touched it. The next moment a square card was shown him, and he said it was round like the other. He said the same of a three-cornered card. He was then asked if he could find a corner on the square card. It was only by much thinking that he decided that the card had a corner, after which he readily recognized the other three corners.

An exceedingly instructive subject was a lady operated on by Wardrop: she could merely distinguish a very light from a very dark room, so complete was her blindness. At first she saw only patches of light and shade; by degrees she learned the names of colors and was able to distinguish them, though unable to interpret the chaos of color impressions she received. On the seventh day after the operation, she was seen to examine some tea cups and saucers. She thought them queer, but could not tell what they were till she touched them. Similarly she saw but failed to recognize an orange. On the eighteenth day, a key and a pencil case, with which she was perfectly familiar by touch, were placed side by side on a table before her: she could not tell which was the pencil case, which the key. At the end of three weeks, she saw a grassplot simply as a large and beautiful patch of green in her field of vision. How far it might be from her she had no idea. Usually in cases of this sort, the patient imagines at first that all that he sees touches his eyes, just as objects felt touch the skin.

On the twenty-fifth day, Wardrop's patient was taken out in a carriage, and inquired continually as to the meanings of her visual sensations. A person on horseback was vaguely a large object. She asked: What is that? of a soldier; and of some ladies wearing red shawls she inquired: "What is that on the pavement, red?"

At the end of six weeks it was found that she had acquired a pretty accurate knowledge of colors and their shades and names, but was unable to judge of distances or of forms, and the sight of all new objects was still very confusing. Neither was she able, without considerable difficulty and numerous fruitless trials, to direct her eyes to any object: when she attempted to look at anything, she turned her head in various directions until her eye caught the object she was in search of.

That our power of "seeing" solids is also extravisual was clearly shown in the case of Franz's patient. Among the observations reported of this patient, the following applies here: A solid cube and a sphere, each of four inches diameter, were placed before him, three feet off and at the level of his eye. After attentively examining these bodies, he said he saw a quadrangular and a circular figure, and after some consideration he pronounced the one a square and the other a disk. His eye was then closed, the cube taken away, and a disk put in its place. On opening his eye, he observed no difference in these objects, but regarded them both as disks. The cube was now placed in a somewhat oblique position before the eye, and close beside it a figure cut out of pasteboard, representing a plain outline prospect of the cube when in this position: both objects he took to be somewhat like a flat quadrate. A pyramid placed before him, with one of its sides turned toward his eye, he saw as a plain triangle. Placed so as to present two of its sides to view, the pyramid was a puzzle. After considering it a long time, he said it was a very extraordinary figure. It was neither a triangle nor a quadrangle, nor a circle; he had no idea of it and could not describe it. When he took the sphere, cube, and pyramid into his hand, he was astonished that he had not recognized them as such by sight, being well acquainted with them by touch.

What these patients had to learn in later life, more fortunate individuals born with unclouded eyes learn in infancy, but so forget the process that the acquirement seems to be innate, a simple function of the unaided eye. The mechanism involved in the process is described in every good treatise on human physiology: the metaphysics of the case are cleverly discussed in Taine's treatise "On Intelligence." Those of our readers who have taken issue with our remarks with reference to sight will find both aspects of the subject well worth pursuing in those works, to greater length than is possible in our limited space. The facts given are sufficient to sustain the position taken by us on this point in previous articles.

SOME NEW VOLCANO REVELATIONS.

The theory that our earth was successively a vaporous, a fluid, and a plastic mass, which, by cooling during billions of centuries, finally obtained a solid crust, in connection with the fact that during all this time she rotated round the sun and received on her equator solar heat (of which the poles were nearly deprived), leads necessarily to the conclusion that, in the neighborhood of the poles, the slowly forming solid crust must have become thicker than it is around the equator, because the solar heat was able to retard this cooling longer at the equator than at the poles. Such a crust is of course more easily perforated, by interior pressure acting outwardly, where it is thinnest; and volcanoes, which are the result of such perforation, must therefore be more numerous in the thinner places, such as around the equator, and scarce near the poles. This is confirmed by observation. Active volcanoes are not frequent around the poles; the only one near the north pole is in Iceland, while between the tropics such volcanoes are found in considerable numbers.

Another interesting consideration is that the amount of material ejected by volcanoes is enormous. The estimates to the volume of the lava ejected by Vesuvius, Etna, and especially by the volcanoes of Iceland are appalling figures; and all these masses necessarily come from the interior of the earth, and must create in the neighborhood of the volcanoes (which may be considered as safety valves) empty spaces, which are filled up by a sinking of the crust. This logical conclusion has been verified by the observation that every active volcano is situated in the center of a region of depression, and never in one of upheaval, unless the material ejected by the volcano itself be so considered.

But a still more remarkable fact has been revealed by the calculations of astronomers making observations at different points of the earth's surface. It is that there are two points of depression, extending even over the ocean's surface, forming a kind of flattened poles, one the exact antipodes of the other. These points are the Antilles, in the West Indies, and the Sunda Islands (Java and its surroundings), in the East Indian Ocean. Each region contains a greater number of active volcanoes in a smaller surface than can probably be found anywhere else on the earth. But the reason why the ocean's surface partakes of this depression, at these two volcanic centers, is as yet a problem. Modern observations have already proved many irregularities in the form of the ocean's mean level, making the ocean's surface to be far from a perfect spheroid. As this surface must, according to the laws of hydrostatics, be always at right angles to the direction of gravitation, it proves that, at various points of the earth's surface, the lines of gravitation do not pass through the same central point, even on places of the same latitude. As gravitation is a general property of matter, depending on its mass, it proves that the mass in the interior of the earth is not homogeneous nor of uniform density, and that it is unequally distributed. As the interior is liquid, this distribution may be affected by cosmic influences, as for instance the relative position of the moon and planets; and any change effected in this distribution may react on the direction of gravitation on the earth's surface, and so on the form of the ocean, and thus slowly produce changes in its level, which may, in some cases, cause an apparent rising or depression of the land.

PROGRESS OF RAPID CITY TRANSIT.

The new Commissioners of Rapid Transit in this city are daily holding their sessions, and day by day their perplexities increase, if the published newspaper reports of their proceedings are correct. They are unable to agree either upon the plan of construction or upon the proper route. The original assumption that the Commissioners were committed to the election of some form of cheap elevated railway resulted in the production of a multitude of plans of that order: and the promoters of some of these plans are backed by influence which is not without effect upon the minds of the Commissioners.

The indications at present are that, if any plan of rapid transit is adopted now, it will be one comprising some form of cheap elevated structure to meet an immediate want, with little reference to ultimate economy. Not what is really best and cheapest, but what is least expensive at first, seems likely to win. The question, therefore, is not so much which of the temporary devices to adopt, as where the road shall be put.

All but two of the plans for elevated roads, laid before the Commissioners, propose to take possession of the public streets. Their projectors are no doubt able to demonstrate to their own satisfaction that such an occupation of the sidewalk or the roadway would be of signal advantage to any street which should be chosen as the route of their road: but can the occupants and property owners of any street be made to believe it?

If we are to have an extension of elevated rapid transit, which now seems quite probable, the public ought to insist that the new roads be put where they will do least injury to property and business, that is, *between the streets*, not over them.

The worst fallacy connected with this whole matter is the assumption that economy dictates a temporary structure of small capacity—a cheap affair to meet a pressing present need. The city of New York is in its infancy. Much as it needs rapid transit, and scarce as money is now, the metropolis of the country cannot afford to begin ill-advisedly, however cheaply, in a matter which must largely determine its future prosperity and growth.

The example and experience of the great city of London would be a very safe one for New York to follow. Rapid transit is chiefly effected in London by underground railways, which ramify in all directions; but as they are placed below the level of the streets, out of sight, their operation disturbs no one, while their advantage to the public is so great that every year witnesses their extension.

Sir Edmund Watkin, a member of Parliament and President of the Metropolitan (London) Underground Railway, and of the London and Great Eastern Railway, is now in this country; and a few days ago, at the request of the New York Rapid Transit Commissioners, he addressed them, giving a number of interesting particulars concerning the present status and operation of the rapid transit railway system of London.

The London Underground Railroad Company, he said, already had about sixteen miles of road in operation, and in a few months they would have twenty miles of completed road. They were negotiating for a still further extension of their routes, and would in time burrow under the whole city of London. These roads had proved to be a greater convenience to the poorer classes than to wealthy persons. The average fare collected was five cents, and the rate per mile was reduced by a system of commutation to one penny. Last year these roads carried 70,000,000 passengers. Heavy locomotives were used, and 1,000 trains per day, each having a carrying capacity for 1,000 persons, were run over them. The rate of speed was thirty miles per hour, or twenty miles including stoppages. The cost was $5,000,000 per mile, of which about four fifths was due to damages to real estate caused by cutting through blocks of buildings and tunneling under houses. In some places the roads ran under graveyards without disturbing the graves and the vaults above.

According to this statement, the cost of building and equipment of the London underground roads has been one million dollars per mile, and the expenses for right of way and land damages four millions dollars per mile. This enormous cost for land would be wholly saved in New York, because here the railway lines would be longitudinal with and run directly under the main streets, without invading private property. But in London, owing to the formation of the city, the underground roads pass athwart the streets and cut through private property in all directions. The citizens of London have ascertained by practical experience that the underground system is the best, have invested in it upwards of eighty millions of dollars, and are annually increasing the investment and extending the works.

Sir Edmund answered a large number of questions put to him by our Commissioners, and corrected several erroneous impressions prevalent here concerning the underground railways of London. He explained the construction of those railroads, and described at considerable length the difficulties encountered in building and running them. He said that 93 per cent of the passengers on the London underground roads traveled only short distances, and only 7 per cent of them were carried to the end of the various routes. This fact was regarded as very important, because it showed that, in selecting a plan of rapid transit, the convenience and facility of those who wish to ride for short distances only ought to be considered.

STEALING BRAINS.

Professor Weisbach, in the preface to the further edition of his "Treatise on Mechanics," makes the following remarks: "As I consider my reputation as an author of much more importance than any mere pecuniary advantage, it is always a pleasure to me to find my 'Mechanics' made use of in works of a similar character; but when writers avail themselves of it without the slightest acknowledgment, I can only appeal to the judgment of the public." What the distinguished author has so clearly laid down is generally recognized as a leading principle by writers and editors. Most writers, for example, are glad to have the widest publicity given to their productions, provided they receive credit for the same; and there are few reputable editors or publishers who neglect this courtesy in copying from books and other periodicals. Still more rarely do writers who are compelled from the nature of their subjects to draw material from all sources omit to state this fact, and give due credit to all from whom they derive information. Recently, however, a very flagrant instance of neglect of this most ordinary courtesy has come to our notice, in a work entitled "Handbook of Land and Marine Engines, by Stephen Roper, Engineer." No reference is made, in the preface of this book, to any authorities who have been consulted; and throughout the text, all credit for data and remarks is, with very few exceptions, omitted. Some illustrative examples are given below; and in every instance mentioned, for anything that the author says, it might fairly be inferred that the matter is original

1. On page 81 is a stroke table, which is an exact reproduction of the original calculated by Mr. Auchincloss, to be found in "Link and Valve Motions," page 59.

2. On page 39 is a table of the properties of saturated steam, which originally appeared in the eighth edition of the *Encyclopædia Britannica*, and was copied, with due credit, in Wilson's "Treatise on Steam Boilers," and possibly in other works.

3. On pages 82, 84, and 88 are three tables from "Link and Valve Motions," which were original with the author of that work.

4. On pages 197, 216, 219, 220, and 285 are statements, illustrations, and examples, which were originally given in the "Cadet Engineer," on pages 156, 133, 136, and 24, respectively,

5. On page 227, we recognize a remark in regard to practical men, which originally appeared in the SCIENTIFIC AMERICAN, page 17, volume XXX. Other quotations from the SCIENTIFIC AMERICAN occur as follows: Page 258, the opening remarks of an article on page 305 of our volume XXXII; page 279, the entire article on "The Measurement of a Screw Propeller," which was published for the first time on page 240 of our volume XXXI; page 473, table and example from an article on "Feed Water Heaters," pnblished on page 288 of our volume XXXI.

These are a few of the instances which we have marked. We could fill several columns with similar illustrations; but those already given, selected at random through the book, tell the whole story. In fact, we have never seen a more decided case of wholesale plagiarism, if we except an incident which occurred in our younger days, when the dullest boy in school mounted the platform and attempted to pass off one of Lord Bacon's most profound dissertations as an essay of his own composition. Happily, such instances of literary robbery are very rare, and we are inclined to think that Mr. Roper has sinned rather through ignorance than design. If so, he can even yet make some amends, tardy though they be, by publishing a supplement to his work, in which due credit is given to all authorities which have been used. By doing this, he will both increase the value of his work, and the respect in which he will be held by his fellow men.

TRAUBE'S ARTIFICIAL CELLS.

In the early days of modern chemistry it used to be taught that the compounds produced under the influence of life were different in kind from those of the chemist's laboratory, and subject to different laws. A characteristic of "vitality," indeed, was thought to be its power to reverse or transcend the laws of "dead" matter, death being the surrender of the organism to the forces of inorganic chemistry. It was commonly and confidently predicted that the chemist, however skillful, would never be able to construct the magic compounds formed by the creative power of life: it was even declared impious to attempt it. But chemists were not to be deterred by such objections. They persevered. They built up from inorganic materials first one, then another, then thousands of the so-called organic compounds, and the old theory of vitality was for ever shelved.

A corresponding mechanical theory of life is still held by most physiologists. The mechanism of organic growth is declared to be something quite unlike anything that occurs in the domain of lifeless matter, something utterly beyond the skill and power of man to imitate. Even the lowest of organized structures, it is said, exhibits a power of choice in the selection of food, and an individual mode of development; which combinations of inert matter can never rival. Life is assumed to be something unique, something superior to the crude forces of dead matter; hence the structural forms built up through its agency must be unique; hence it is impossible for man to produce anything like them. The whole chain hangs upon the first assumption, for which proof is lacking.

Seeing that the physiology of growth hinges on the life history of the cell—all organized bodies consisting simply of a more or less simple aggregation of these organic elements—the success which Traube has had in imitating with dead matter the characteristics of living cells shows that it is altogether too early to dogmatize touching man's present or future inability to rival the physics as he has the chemistry of life.

The behavior of those groups of compounds denominated colloids and crystalloids by Graham, when their solutions are separated by thin membranes from each other or from solutions of crystalline substances, needs no description here. The established fact that dissolved colloids cannot pass through colloidal membranes formed the starting point of Traube's investigations. He was aware of the additional fact that the precipitates of colloidal substances are themselves usually colloidal. It followed, as a natural consequence, that a drop of one colloid, if placed in the solution of another suitable colloid, would be converted into a closed cell by the precipitate formed by the mutual action of the two colloids at their surface of meeting. For example, a drop of concentrated solution of gelatin plunged into a solution of tannic acid is immediately surrounded by a pellicle of gelatin tannate, the thickness of which depends upon the relative densities of the two solutions. This colloidal pellicle is impervious to the colloid solutions, while it allows water to pass through freely. Hereupon most significant phenomena arise. The gelatin within the cell is more concentrated than the solution of tannic acid in which it is immersed; it has in consequence a stronger attraction for water, and absorbs a portion from the weaker solution. To make room for the increased contents of the cell, the pellicle stretches, separating its molecules to such an extent that the outer and inner solutions come in contact, and a fresh precipitate of gelatin tannate is formed between the original molecules. Through the enlarged pellicle, water continues to penetrate, and the process of growth in the cell wall goes on so long as a difference in density exists between the contents of the cell and the surrounding liquid. A firmer pellicle is formed when a little lead acetate or copper sulphate is added to the gelatin. That the growth observed is not a mere stretching of the pellicle occasioned by endosmose is proved by replacing the outside solution by water, whereupon the growth ceases, the formation of new molecules of precipitate being prevented. It will be remembered that the natural growth of living cell walls is by the same process of intussception, or the deposition of new matter between the molecules already existing.

While the cell wall is growing, changes also go on in the interior. So long as a nucleus of undissolved gelatin remains, the artificial cell is spherical. When the enclosed gelatin is all dissolved, the contents become diluted by the inflowing water, the density being least at the top, the heavier solution settling to the bottom of the cell. When sufficiently dilute, the cell contents begin to dissolve the cell-wall at the top; the pellicle of that part becomes thinner and more extensible; as it yields, new matter is precipitated between its molecules; in short the cell grows upward, and often protuberances directed outward are formed, in imitation of living cell growth. Still more remarkable is the behavior of the pellicle of copper ferrocyanide precipitated round a drop of a concentrated solution of copper chloride in a solution of potassium ferrocyanide: or, better yet, according to Sachs, around a small piece of solid copper chloride in the ferrocyanide solution. In the latter case a green drop is immediately formed at the expense of the solution, the precipitated pellicle of which encloses the solid nucleus which is gradually dissolved by the permeating water. Cells so formed manifest active growth and a variety of differences not easy to explain. Some have very thin pellicles, are roundish, and exhibit a slight tendency to grow upward; they usually form a number of small wart-like outgrowths, and attain very considerable dimensions—from 0·4 to 0·8 of an inch in diameter. Others have thick reddish brown pellicles, grow quickly upwards in the form of irregular cylinders, rarely branch, and attain a diameter of from 0·08 to 0·16 of an inch, and often several times that measurement in hight. Sometimes combinations of these two kinds form a sort of horizontal tuberous rhizome-like structure, from which long stalk-like outgrowths arise upward and root-like protuberances downward.

Sachs insists that these pellicles of copper ferrocyanide do not always grow entirely by intussception, as Traube supposed, but sometimes by eruption, as he terms it. In such cases a brown pellicle is formed round the green drop; water penetrates quickly through the pellicle to the enclosed copper chloride, stretches the pellicle rapidly, and at length ruptures it. The green solution immediately escapes through the fissure, but becomes at once coated with precipitate which appears either as an intercalated piece of the previous pellicle, or as an excrescence or branch of it, a process which is repeated as long as any copper chloride remains inside the cell. Besides these solutions already named, Traube experimented also with mixtures of tannic acid with copper and lead acetates, and soluble glass with the same substances, or with copper chloride, etc., and came to the conclusion that every precipitate, the molecular interstices of which are smaller than the molecules of its components, must assume the form of a pellicle when the solutions of its components come in contact.

These pellicle precipitates are peculiarly well adapted for the study of endosmotic processes. They behave very differently from other membranes, being often impermeable to the most diffusible substances, while allowing other compounds to pass through them; and every kind of pellicle has in this respect its own peculiarities. For instance, the gelatin tannate employed by Traube in most of his experiments is impermeable to potassium ferrocyanide but permeable to ammonium chloride and barium nitrate. The pellicle of copper ferrocyanide of the other experiments mentioned is impermeable to barium chloride, calcium chloride, potassium sulphate, and barium nitrate, but permeable to potassium chloride. Again, if a small quantity of ammonium sulphate is added to the solution of gelatin, and a small quantity of barium chloride to the tannic acid, the pellicle formed by their admixture is composed of calcium tannate with barium sulphate deposited upon it, diminishing its permeability: the two solutions can no longer diffuse, but the encrusted pellicle is still permeable to the smaller molecules of ammonium chloride and water. From facts of this sort Traube infers that, in the permeability of pellicle precipitates, we have a means of determining the size of the molecules of different solutions, since only those molecules can pass through a pellicle which are smaller than its molecular interstices, and therefore smaller than the molecules of the solutions which produce the pellicle.

SCIENTIFIC AND PRACTICAL INFORMATION.

OXUVITIC ACID.

MM. A. Oppenheim and S. Pfaff announce the discovery of a new acid named as above, and having the formula $C_6 H_2 (CH_3, OH, COOH, COOH)$. It results from the action of chloroform on acetic sodic ether.

MANUFACTURE OF ARTIFICIAL ALIZARIN.

The process of manufacture of this substance, as practised in Frankfort, Germany, consists in heating for 3 hours, in earthen vessels, anthracene having its fusing point between 404° and 410° Fah. with one fourth its weight of bichromate of potash and 12 parts nitric acid of a density of 15·04. Anthraquinone is thus formed, and the crude resulting product is dissolved in 6 parts boiling nitric acid, of density 1·5. The dissolving of the anthraquinone is continued until, on cooling, no residue of that substance is precipitated. The solution then contains anthraquinone in a mononitrated state, which is precipitated by water; and on the solution becoming clear, the precipitate is dissolved in from 9 to 12 parts of a solution of caustic soda of specific weight 1·3 to 1·4, heated to about 382° Fah. When the precipitate is no longer augmented by the addition of hydrochloric acid, the heating is arrested. The mass is allowed to cool, dissolved in boiling water, and filtered, and the coloring matter precipitated in the hot solution by means of an acid. The yellow brown deposit is then ready, after washing, to be used for dyeing. The residue on the filter is principally anthraquinone, which is re-used. The manufacture of artificial alizarin is constantly increasing. The German production is estimated at some 1,198,000 lbs. per year.

NEW METHOD OF DETECTING ADULTERATION OF FATTY OILS.

M. Roth employs, as a re-agent for the above, sulphuric acid at 46° B. saturated with nitrous vapors by causing nitric acid to act upon large pieces of iron. At the end of six or eight days, the solution acquires a fine bluish green color, indicative of complete saturation. This re-agent solidifies either partially or entirely the olein of non-siccative oils. The purity of the oil may thus be determined by noting the time which it occupies in solidifying.

DETECTION OF PICRIC ACID IN BEER.

For this purpose, Brunner recommends acidulating the beer with hydrochloric acid, and plunging therein a fragment of woolen thread, and digesting the same in a *bain marie*. After the thread is removed, it is heated with a solution of ammonia. The latter is filtered, evaporated in a *bain marie* to small volume, and a few drops of cyanide of potassium are added. The presence of 0·015 grain of picric acid in a pint of beer is determined by a red color being produced, due to the formation of isopurpurate of potash.