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WAR BALLOONS.

EACH corps of the French army is now provided with a captive balloon made of Chinese silk rendered impermeable by varnish. The equipage includes a transportable hydrogen gas apparatus (in which the gas is produced through the decomposition of water by iron and sulphuric acid) and a steam engine that actuates the windlass used in making ascensions. The car, which is suspended from the balloon in such a way that it shall always hang vertically, is of sufficient capacity to accommodate two officers. An ascent can be made to a height of 1,600 feet, whence the observer's eye may, in fair weather, take in an immense horizon. Communication between the aeronauts and the officers on the earth is had by means of a telephone, whose conducting wire is wound around the hemp cable of the balloon. The car is provided with the photographic apparatus necessary for taking panoramic views or views in detail.

The present establishment at Chalais is the center for the study of war ballooning. At the time of the last great maneuvers of the French army, the experiments with war balloons, performed under the direction of Commander Renard in the vicinity of Montereau, were thoroughly successful, and showed what services may be expected from these ships of the air.

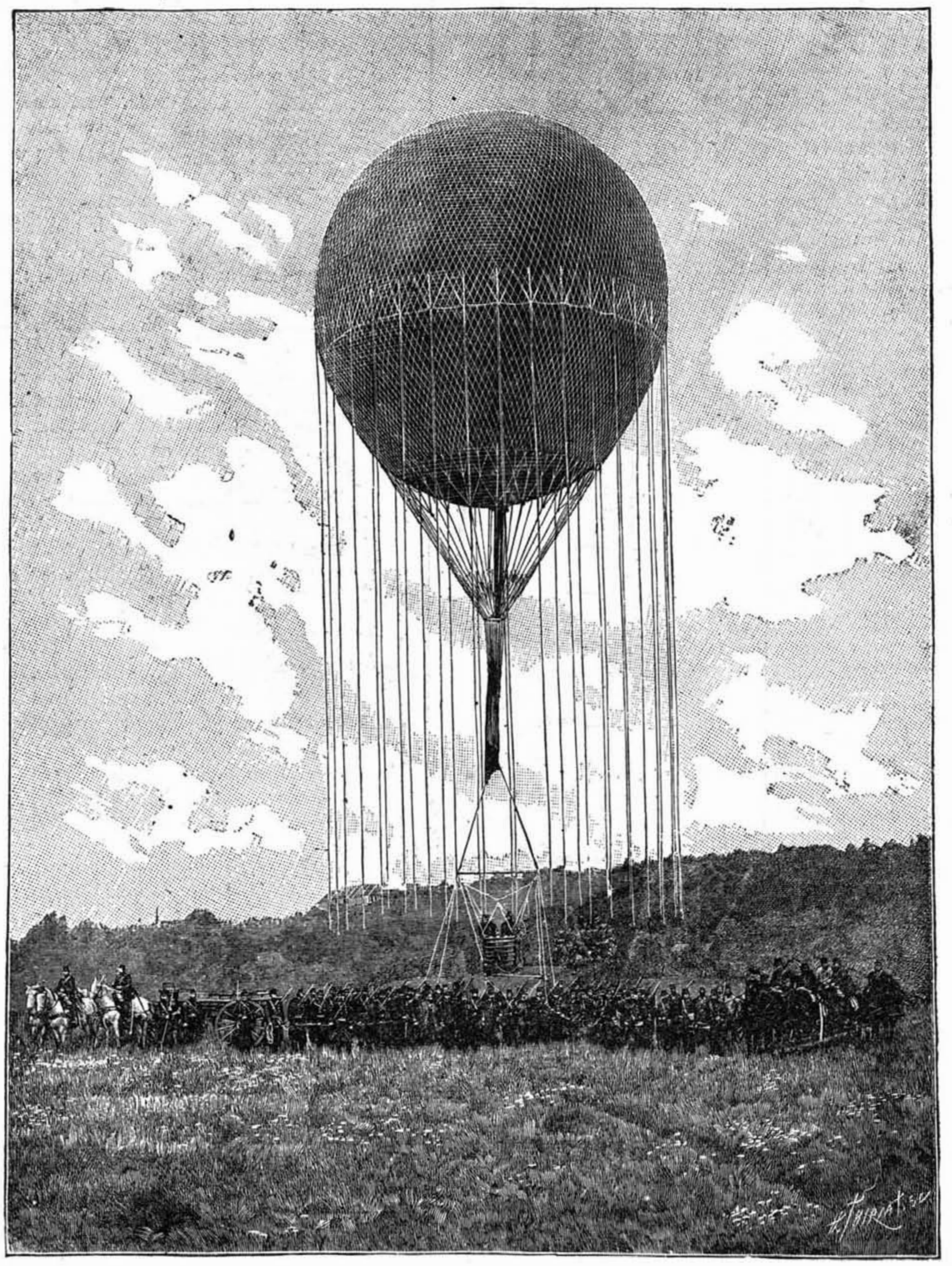
Italy and Russia have adopted war balloons, and the Czar was himself a spectator, last October, of the maneuvers of a party of his military aeronauts. The Russian Government has likewise ordered from Mr. Gabriel Yon a dirigible balloon, which is now being constructed at the works on Suffren Avenue. Mr. Yon has built a vast shed for the purpose, and is hard at work on this screw balloon, which will be fully 195 feet in length, and will be propelled by a petroleum engine. Mr. Yon is studying a very powerful motor of an entirely new type, and the balloon is to have a speed of 21 miles per hour. The preliminary trial of this magnificent aerial ship will probably be made at Paris about the middle of this year.

England has an aeronautic station at Chatham, where the balloons are constructed by the officers themselves. The English have adopted a system of transportable reservoirs containing compressed hydrogen for inflating their war balloons.

Germany is also studying the subject, but it seems that the government has not as yet definitely adopted the use of captive balloons in all of its army corps. The staff office is especially engaged in studying the means of attacking both free and captive balloons, and we know from a reliable source that special artillery apparatus have been constructed at Berlin for throwing projectiles to a great height, in order to reach them in space.

The Dutch and Belgian governments have recently ordered from Mr. Lachambre hydrogen balloons provided with windlasses actuated by manual power, and experiments with the Belgian *materiel* have been tried at Anvers, under the direction of Mr. Lhoste.

Austria also is actively working on the problem, as is also Denmark, one of whose engineers recently visited Paris for this special study.—*La Nature.*



FRENCH WAR BALLOON.

THE USE OF MACHINE GUNS IN THE FIELD, IN COMBINATION WITH INFANTRY.

A PAPER on this subject was lately read at the Royal United Service Institution by Major A. D. Anderson, R.H.A. In the course of his lecture Major Anderson said: While these weapons have been struggling through their stages of early existence, undergoing changes, alterations, and improvements, time has been given us to study and consider the innumerable ideas and suggestions that have been put forward as to their use in the field; advocates are forthcoming for forming machine gun corps, or for attaching them to artillery, cavalry, or infantry, but the consensus of opinion has undoubtedly arrived at the sound view, viz., that they be attached to infantry, and fire the same ammunition. It is not necessary here to discuss why they should not become part of the artillery or cavalry, or be formed into separate corps, though for exceptional purposes they might do any of these; but a little thought will lead to the conviction that machine gun fire should be a multiple of infantry fire, and that as a rule it must be worked in the closest combination and connection with it. The points to be decided toward carrying this into effect are: (*a*) The transport of the gun; (*b*) the number, allotment, and working of them. (*a*) The transport of the gun. The guns should not be on wheels, and must not be moved by manual labor, and this suggests to us that they must be worked on tripods and carried on packs. A machine gun with spare pieces, implements, etc., would form the load for a mule, while a second carried ammunition, and the whole would thus be capable of being taken up and down the steepest hills, over the roughest ground, through narrow lanes, and practically everywhere that a battalion of infantry could go, at the same pace, and without fear of being left behind. Mule transport offers no difficulty in packing and unpacking the loads, and one of the men (probably three or four per piece) told off to attend to the gun would lead and look after the animals. (*b*) The number, allotment, and working of them.

DECENTRALIZATION VERSUS CENTRALIZATION.

Opinions here will probably differ; some advocate their retention under the commanding officer, and entire control by him, but all tends to prove that here, as in many other cases, "decentralization" is the sound theory; place them with the different companies to the extent of one apiece, to be managed and manned by them, and worked as company commanders deem necessary, the battalion commander having, as in all other points, the power of utilizing them or directing their use as he deems requisite. We thus insure all the companies in the regiment taking an interest in their own gun, and training men for work with it; it is ready to the hand of the captain of the company, not requiring to be sent for, or applied for, in the numerous instances when a company detached or in want of assistance would be thankful for its support, and very valuable would be the aid it would afford in nine cases out of ten, if worked by properly instructed men, pushed forward, and, if necessary, used and exposed as freely and boldly as a section of the company; while at any moment the battalion, brigade, or divisional commander would be in a position to order the whole or a portion of them to mass on some suitable spot in support of an advance, an attack, or threatened point. As regards the class of gun, Gardner, Gatling, Nordenfelt, or Hotchkiss, we would leave that to those who have best tried all and each of them, while probably three or four selected men per company would be found equal to working them and attending to the mules, the company officers looking after and controlling their own piece; and should the eight per battalion be called for by the commanding officer, one of the majors or a senior officer should be placed in command, the supply of ammunition, beyond the one mule load per gun, being as for the remainder of the battalion, but on an increased scale.

THE ADVANTAGES OF MACHINE GUN FIRE.

The advantages hoped for from the addition of machine gun fire to that of the weapons now in use are: (*a*) A murderously powerful fire. (*b*) Relief to the infantry, in furnishing for them a powerful support, and one admitting of their withholding their fire till the last moment. (*c*) Increase of volume of fire. Given equal conditions, the commander who spares his infantry, and brings them without firing and fresh close up to the enemy, before launching them forth for the attack, and then opens fire from every possible rifle, will fight under immeasurably more favorable conditions than one who commences firing at long ranges and continues it throughout the advance. Long-range fire is at the same time a very necessary portion of a battle. Your enemy cannot be permitted unmolested to concentrate the whole of his rifle fire on your advancing infantry, and to harass him and endeavor to keep his fire under you must do one of three things: I. Devote one-half of your infantry to long range rifle fire. II. Open fire with your infantry at 1,200 or 1,000 yards, and keep it up throughout the advance. III. Use machine guns for long-range firing, and of these three the last, if efficiently performed, has all and everything to recommend it, for it admits of the whole of the infantry going forward complete, in the formations most suited to the locality, without firing a shot, devoting their whole attention to rapid advances, and gaining cover until within say 500 yards of the enemy.

WHO SHOULD USE THE MACHINE GUN.

All important in the utilization of machine guns is that they be placed in the hands of intelligent men, who have been given sufficient opportunities of knowing and practicing with their weapons, in order to derive full value from them and save reckless waste of ammunition; the three or more men proposed for each piece should therefore be largely composed of non-commissioned officers, the senior of whom should be a sergeant. Beyond this no special provision seems neces-

sary or desirable, and if introduced would only lead to needless expense. Twenty-four men might be added to the strength of battalions or drawn from the present establishment for this purpose as considered desirable, and a very much larger number would of course be instructed for employment if required. As it is proposed that each machine gun should become portion of a company, and in the majority of instances be at the disposal of the company officers, no increase of officers is requisite, while if withdrawn by the commanding officer or higher authority for the purpose of being massed, a field officer or other competent officer should be detached to command them and return them to their companies on the completion of the duty. If after trial it be found that more officers are required with them, an increase of two subalterns per battalion should meet the case, attached to the two flank companies, with which they would remain until the machine guns were ordered to mass, fall out with them and each undertake the charge of four, under the guidance of the officer detailed to command them. Regiments of infantry are not one officer too strong for service, and could not afford to give them from present strength, should they be required. A little practice would require to be devoted to some simple system of maneuvering the mules, in order to guard against confusion when brought together in masses. Probably sections of four guns (eight mules), worked much on the mountain battery drill principle, and only for movements of the simplest description, would be all that would be requisite, while during maneuvers they would join their own companies.

JUSTICE SHOULD BE DONE TO THE WEAPON.

That the fire of a body of infantry would be immensely increased by the addition of one machine gun per company does not admit of doubt, for by detaching three men to attend to the gun the equivalent of the fire of at least fifty men is obtained, leaving out of the calculation the value to the battalion of being able to maneuver up to a certain point without firing. Machine guns can as yet scarcely be said to have had a thoroughly impartial trial; from 50 to 100 picked shots are pitted against a machine gun in the hands of men who have had it a few days or weeks, and who will certainly have fired very few shots from it. The result is, in the hurry a jam occurs, or the gun never gets on the target at all. The trial also should not be confined to the results from one gun, but from those of eight or, if possible, a larger number. We feel convinced that if justice be done to the weapon, the results must be very startling and convincing.

HOW TO TEST THESE PROPOSALS.

The correctness or otherwise of these proposals could with ease be tested by experiment on screens representing a battalion formed for defense, upon which an attack should be delivered by a battalion advancing in every way under regulation conditions, opening fire from the first, and also an attack by the same body supported by eight machine guns, who, occupying a position between 1,200 and 800 yards from the enemy, allowed their own infantry to approach to within 500 yards of the position, and then deliver its attack with combined machine gun and rifle fire. The result of the fire trial cannot be doubted if the machine guns are properly handled, while opportunities for their use by company commanders in detached positions, or working in any way independently, will occur in almost every phase of action; the one danger they have to avoid is artillery fire, and this, considering the mobility that would be attained by mule transport, and the fact that the weapons range up to 2,000 yards, thus offering a large selection of position, ought not to prove in any way an insurmountable difficulty. Once in position and massed, machine guns may be depended on to defend their front against all but artillery as certainly as would masses of guns; while, if searched out, and suffering from artillery fire, their mobility is ample to admit of their being promptly moved over any country to a safer position. It is with a firm conviction that the case is not being overstated when we urge that "the nation which neglects to make use of machine guns in the field will not only incur a heavy responsibility, but will undoubtedly suffer severely if opposed to them."

SUSTAINING WALLS.

IN the present article we propose to study the question of sustaining walls provided with arches and arch buttresses. The use of this system of walls is not recent. As long ago as the last century, Engineer Gauthey made an application of it in the construction of the wharf at Chalon-sur-Saone, and in this way effected a saving of one-third in the cubage of the masonry. The wall here was from 16 to 19 ft. in height, 2 ft. thick at the top, 3¾ ft. thick at the base, and had a batter of 1/8 on the exterior. The buttresses and arches were located on the land side. The former were 3¼ ft. in width, and were spaced 17 ft. from axis to axis. They were connected by three tiers of arches, 5¼ ft. in height under the key.

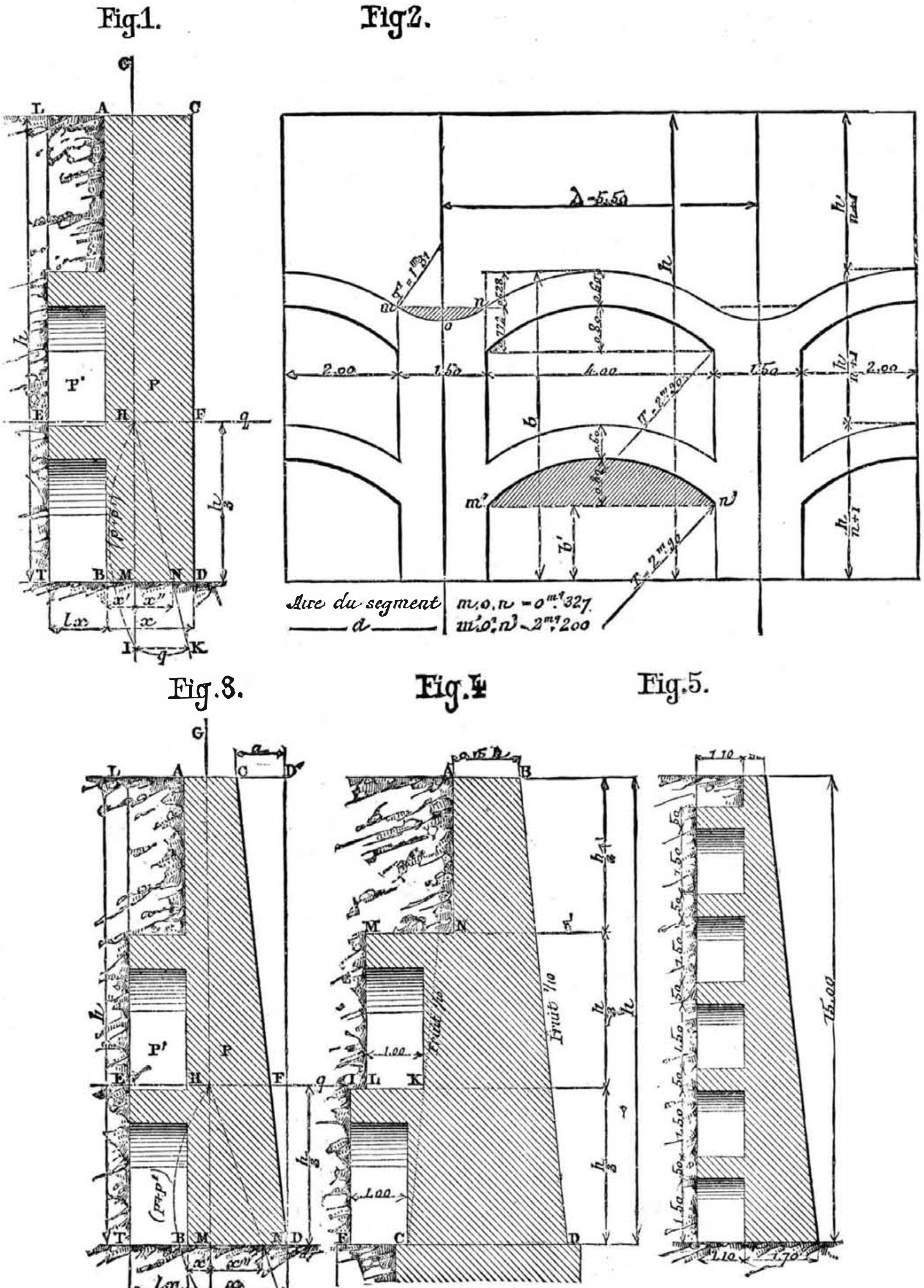
The Gauthey system has been adopted for some of the wharf walls of Paris. One of these is provided with buttresses 5 ft. in width, which are spaced 19½ ft. apart, and are connected by a single row of arches that support the footway of the wharf.

At the time of the construction of the railway from Paris to Auteuil, Engineer Flachat applied the Gauthey system to all the walls and arch buttresses of the bridges and tunnels on that line.

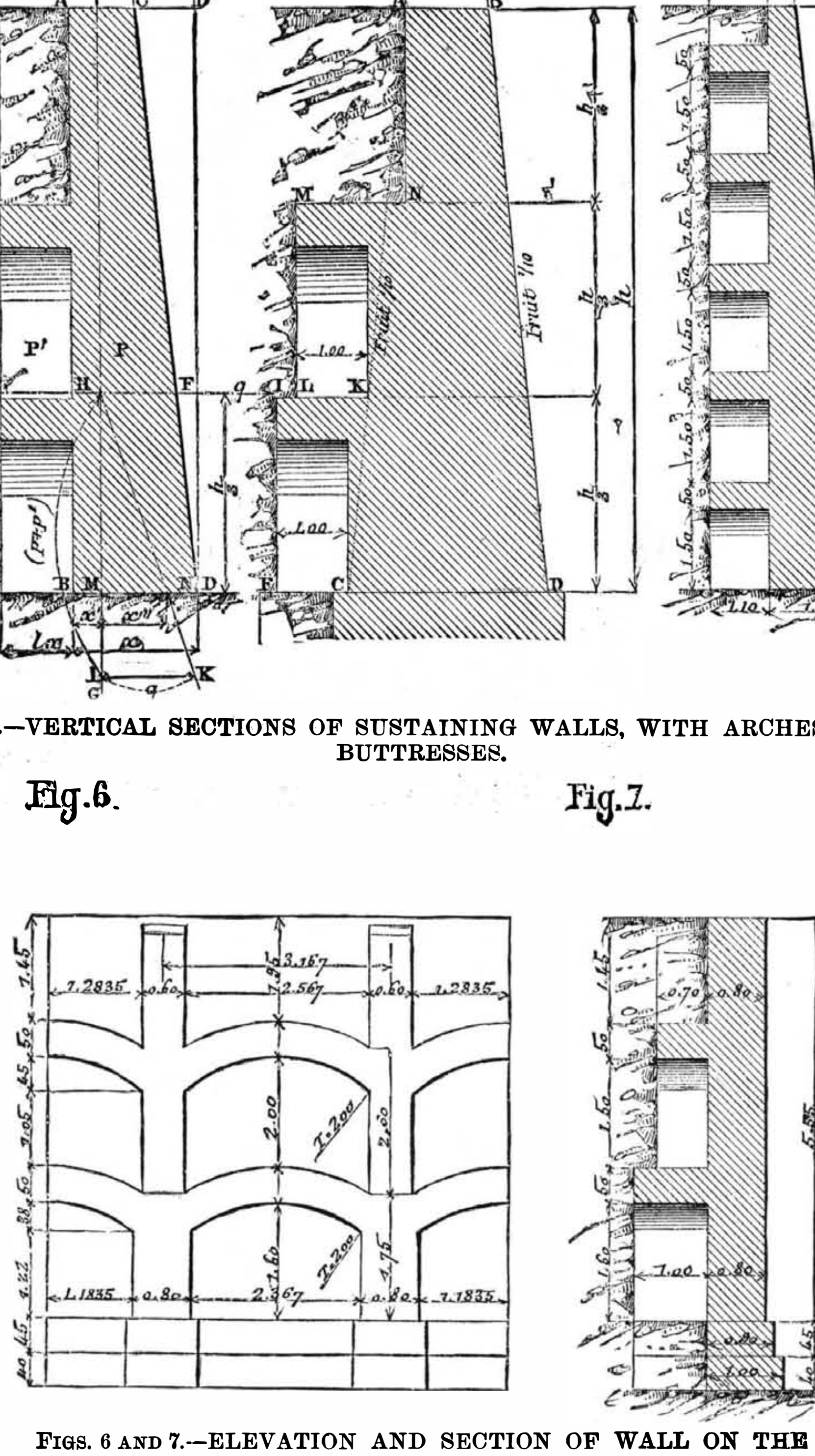
Figs. 6 and 7 give an elevation and vertical section of one of these walls on the inner side. The height does not exceed nineteen feet. The spacing of the arch buttresses varies, according to the length of the various works, beween ten and fifteen feet. The buttresses are, as a general thing, connected by two tiers of arches, and are 2½ ft. in width between the foundations and first row of arches. Such width is reduced to 2 ft. between this row and the summit of the wall. As for the projection of the buttresses, that is 3¼ ft. up to the first arch, and 2¼ ft. to the top of the wall. The arches have a uniform thickness of 1½ ft., and the intrados arch is traced with a constant radius of 6½ ft., which, on account of the span of the arches, gives it a variable pitch.

As for the wall properly so called, that has a uniform thickness of 2½ ft.

To complete these data concerning the walls of the Auteuil line, we may state that the earth that they have to sustain is a calcareous or marly tufa that forms a compact and relatively hard mass, so that the types of wall which we illustrate possess sufficient resistance despite their seeming lightness. When, in 1885, the tracks of the St. Lazare station were being repaired between that point and the Batignolles station, and Rome street was being opened at the same time, it became necessary to construct an immense retaining wall in order to separate the railway from the houses that border this street, and especially in order to compensate for the great difference in level that separates the roadbed of the street from that of the railway, and which is not less than 56 ft. at the culminating point. The earth to be sustained was not bad, for it was a compact marly tufa belonging to the gypseous formation that



FIGS. 1 TO 5.—VERTICAL SECTIONS OF SUSTAINING WALLS, WITH ARCHES AND ARCH BUTTRESSES.



FIGS. 6 AND 7.—ELEVATION AND SECTION OF WALL ON THE PARIS AND AUTEUIL RAILWAY.

SUSTAINING WALLS.

FIG. 8.

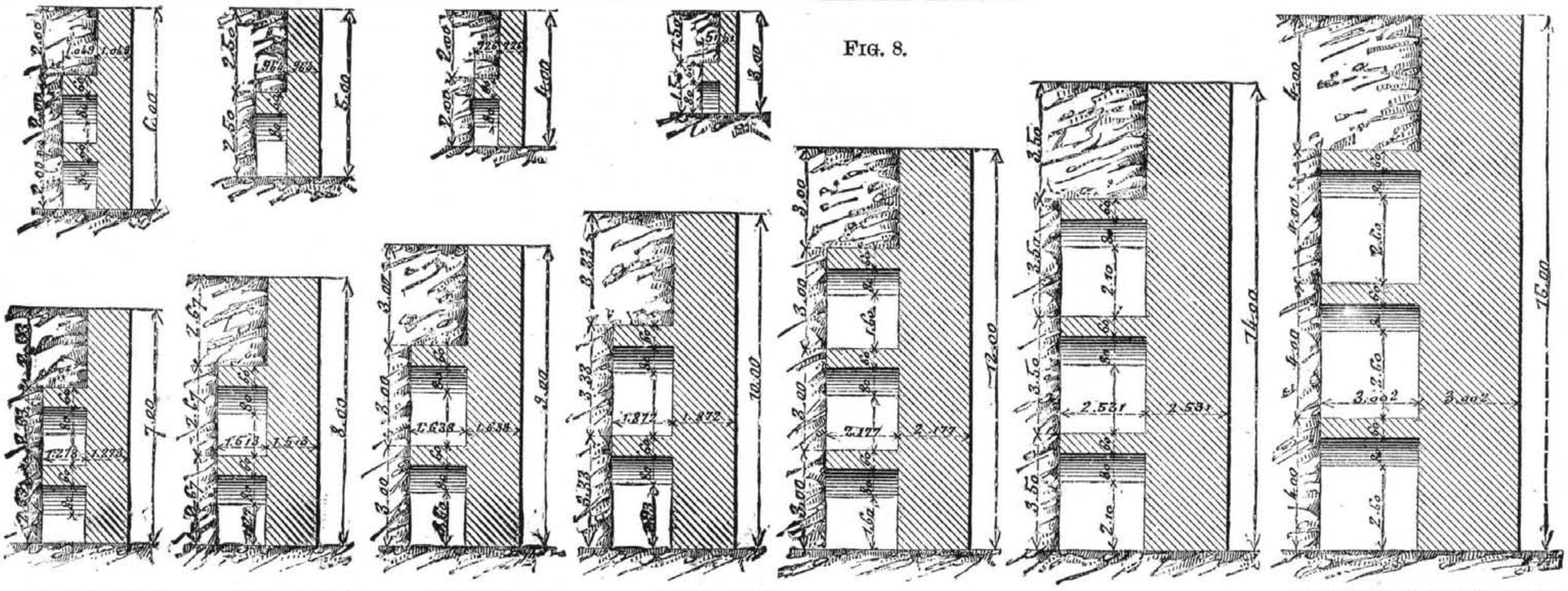
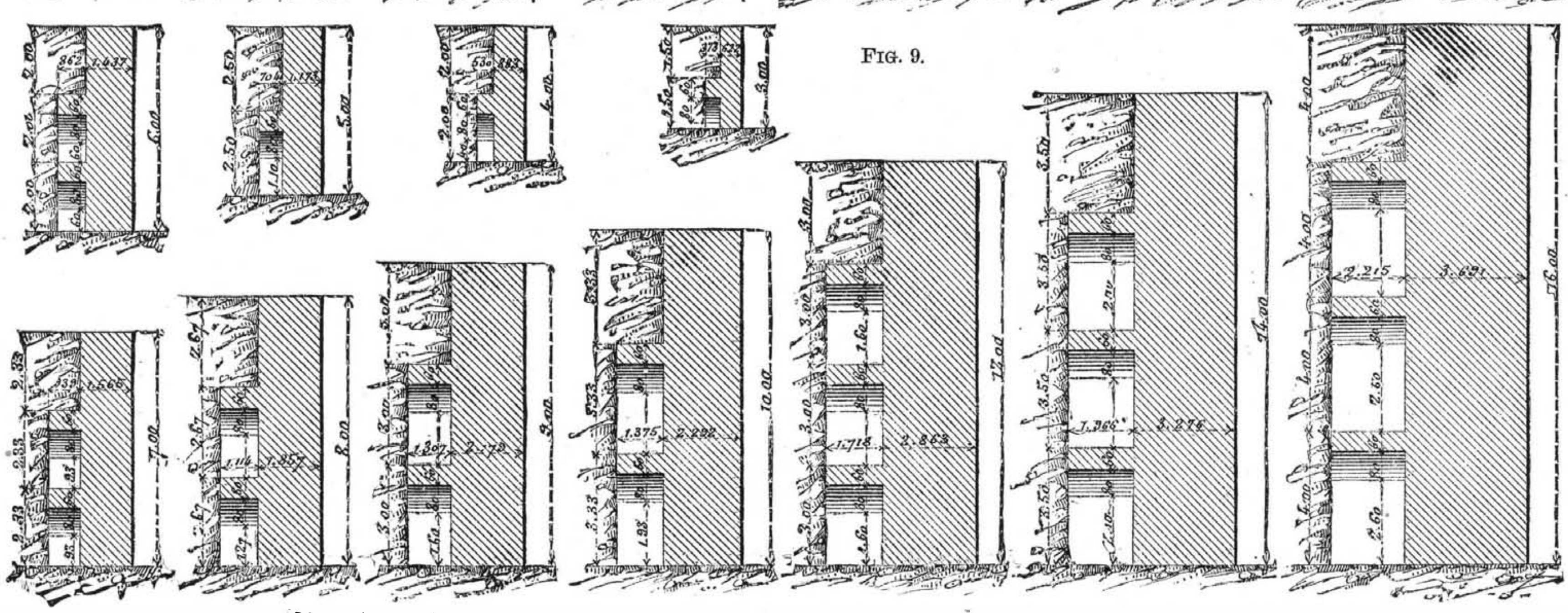


FIG. 9.



FIGS. 8 AND 9.—WALLS WITH ARCHES, BUT NO BATTER. (Natural talus of the earth $\frac{3}{2}$.)

FIG. 10

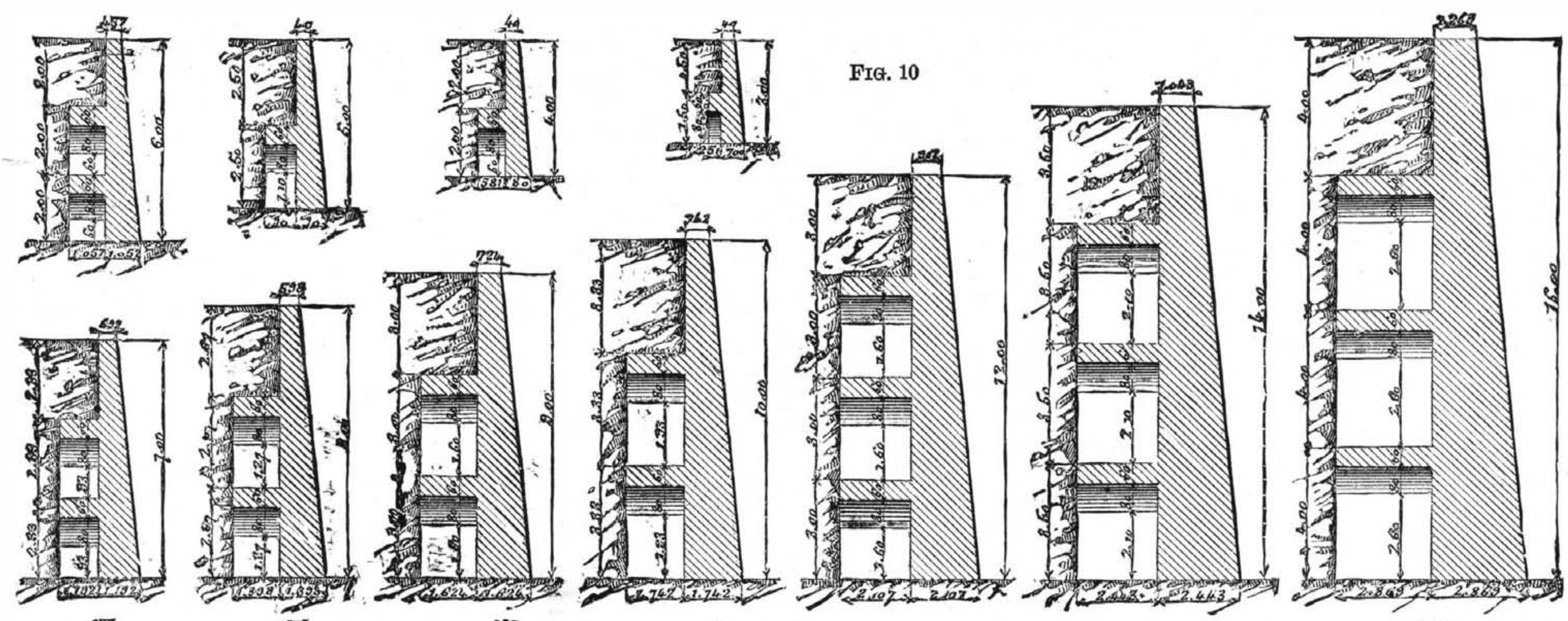
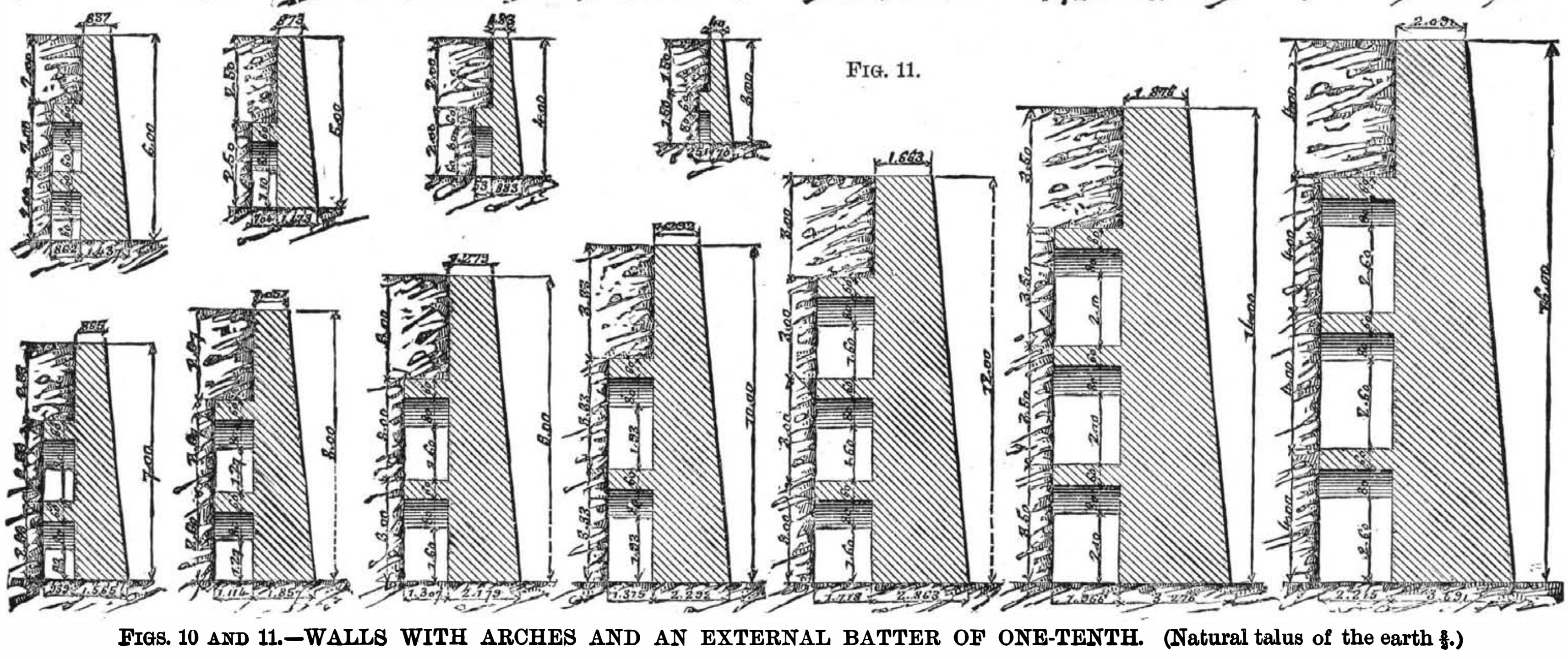


FIG. 11.



FIGS. 10 AND 11.—WALLS WITH ARCHES AND AN EXTERNAL BATTER OF ONE-TENTH. (Natural talus of the earth $\frac{3}{2}$.)

SUSTAINING WALLS.

covers the northern part of Paris. If there had been nothing but this earth to sustain, it would have sufficed to give the wall a relatively slight thickness; but the new houses that were to be built between the top of the wall and Rome Street, at but a few yards from the wall, would, when completed, have exerted upon this newly dug up and disturbed earth pressures of various natures that might have resulted in strong horizontal thrusts on the projected sustaining wall.

On another hand, the great water reservoir that the wants of the station had rendered it necessary to construct at the culminating point of Rome street, between the latter and the wall, would have exerted a strong pressure upon the upper part of the wall. Here, then, was a grave danger that it was necessary to avoid. Moreover, when it becomes necessary to establish a work of this nature, and of this importance, in a city which, like Paris, is subject to continuous changes, it is necessary to foresee even the unforeseen. It is therefore necessary to so build it that it will be capable of defying not only known actions, but also the eventualities of the future.

It was in this spirit of wise foresight that Mr. Clerc, then engineer in chief, and now director of the works of the Western Railways, formed the profile of the wall under consideration, a part of which extends from the Place de l'Europe bridge to the Batignolles tunnel, and another part of which extends from the latter to Batignolles station.

Figs. 2 and 4 represent a section and partial elevation of this wall on the side toward the earth. It will be seen that it has a batter of $\frac{1}{10}$ on the external side, and that it has two tiers of arches on the inner that divide its height into three equal parts. The profile is traced as follows:

The thickness, A B, at the top of the wall is always equal to $\frac{15}{100}$ of its height.

The straight line, B D, traced with a batter of $\frac{1}{10}$, represents the front face. The dotted line, A C, traced with the same batter, is an imaginary one designed for the determination of the profile of the inner face. The width, C F, equal to 3¼ feet, indicates the projection of the lower arch. From F, the vertical, F I, is carried up to a third of the height, and from I, a horizontal, I K, is extended till it meets the imaginary line, A C. We afterward take a width, K L, equal to 3¼ feet, and representing the projection of the upper arch. Then, from L, we carry a vertical, L M, up to two-thirds of the height, and from M, a horizontal, M N, as far as to the vertical of the point, A.

The arch buttresses have a width of 5 feet, and a projection of 3¼ feet from the lower part of the masonry. They do not extend to the top of the wall, but terminate at the level of the upper arch. They are spaced 18 feet from axis to axis. The arches are 2 feet in thickness, and have a pitch of 2½ feet. The radius of the intrados is 9½ feet.

This profile has the triple advantage of giving the wall a broad base, of causing the weight of the earth resting on the two tiers of arches to contribute to its stability, and of giving each of the arches a talus that reduces its projection.

However strong this wall appears, it nowhere represents (whatever be the height) a thickness reduced to more than $\frac{27}{100}$ of its height, although, as a general thing, we give $\frac{33}{100}$, that is to say, a thickness equal to a third of the height. It will be seen from this that Mr. Clerc, while taking future eventualities into consideration, has, at the same time, taken into account the relative consistency of the earth to be sustained.

A few years later on, in 1876, the Paris Gas Company erected at Clichy a large gas works, upon an extensive piece of ground which it became necessary to fill in on account of the subsoil being impregnated with water that infiltered from the Seine. It became necessary to sustain this filling in a line with the streets that bordered the works. The sustaining wall that was built for this purpose was given a batter on the outer face, and the inner face was provided with a series of buttresses connected by several tiers of arches. As a measure of precaution against future thrusts due to a soil that had not fully settled, a thorough connection was made between the wall properly so called and the buttresses by means of bolts horizontally arranged and embedded in the masonry.

We might cite numerous other examples of sustaining walls provided with arch buttresses and arches on the inner side, but it seems to us superfluous to expatiate *ad infinitum* on this subject.

On a close examination of this style of wall, we find that it can be divided into two types:

(1.) Walls that possess no batter on the external side

(2.) Walls that possess a batter on the external side.

Whichever of these types be the one adopted, it gives rise to the following considerations and rules:

The action of the arches and buttresses consists solely in removing the vertical that passes through the center of gravity of the wall from the lower edge of the same, and thus increasing its moment of resistance to overturning. From this it is clear that such action will be so much the more efficacious in proportion as the weight of the arches, buttresses, and the superposed earth is greater.

It results from this observation that, theoretically, it would always be more advantageous to give the buttresses and arches considerable of a projection; but other considerations put an insuperable limit to the latter. In fact, the greater the projection is, the more the thickness of the wall must be diminished for the same resistance and there necessarily comes a point where the wall comprised between two buttresses would no longer have thickness enough to resist, of itself, the stresses of flexion, etc., produced by the thrust.

On another hand, too great a projection would immeasurably develop the surfaces of contact between the earth on the one hand and the buttresses and arches on the other. From this would result strong adhesions, that would, after a manner, retain these projections prisoners in the ground, so that the wall, under the thrust of the earth, might separate from the arches and buttresses. This effect might especially be produced if these latter were attached to the wall by too small a section, or if they were too far apart.

From these considerations, it will be seen that we are practically led to observe a certain proportion between the thickness of the wall proper, the projection, and the thickness and spacing of the arches and buttresses. Absolutely exact rules cannot be formulated in regard to this; but, generally speaking, it may be said that it is always advantageous to give the walls a thickness that shall permit of spacing the buttresses from 4 to 6 yards from axis to axis, and of giving them, as well as the arches, considerable thickness, so as to make it possible to obtain a firm connection between the wall proper and the projecting masonry. The importance of such connection is very great, and it cannot be too carefully looked after. The joints that connect the wall with the projections should be composed of stones or ashlar of large size placed on each side of the joint and laid in cement.—*Annales Industrielles.*

TORPEDO BOAT CATCHERS.

THE question of how the attack of fast unarmored torpedo vessels on a fleet should be met was brought forward more than ten years ago by the late Director of Naval Construction, at a meeting of the Institution of Naval Architects. Speaking of the effect of torpedoes on the bottom of a ship, Sir N. Barnaby then said: "The assailants ought to be brought to bay before they could get within striking distance of the ironclad by consorts armed like the attacking vessels with the ram and the torpedo, which may take, like them, the chances of being sunk. Each costly ironclad ought to be a division defended against the ram and the torpedo by numerous smaller, but less important, parts of the general forces." At that time it was not considered likely that torpedo boats would be met on the high seas, but retained for harbor and coast defense. Hence, Sir Nathaniel's words apply more to the larger torpedo vessels, which are rapidly being added to most European navies. When, however, it was found that the increased dimensions of torpedo boats would enable them to accompany ironclads and take part in an action, in addition to the danger to which a blockading squadron would be subject from their attacks, it became evident that what are now termed torpedo boat catchers or destroyers must form an essential part of future fleets.

Before denoting the qualities which should be embodied in such craft, it is necessary clearly to define their functions. In an action between two fleets their task would be to destroy the enemy's torpedo boats before the latter could get within range of the ironclads. During a blockade they would cruise inside the blockading squadron for the same purpose, and give warning of all movements by the enemy. When cruising with a fleet, they would act as scouts in conjunction with larger dispatch vessels, and be a means of communication with detached squadrons or single ships. To perform these duties efficiently, they should be able to keep the sea independently in all weathers, and maintain a speed of 20 knots against a moderate breeze. Their turning circle should be small. Their armament should consist of quick-firing guns, and a powerful electric light is indispensable. Protection should be limited to what can be given by coal and inch-steel plating. The supply of coal should be sufficient to carry them a thousand miles at a speed of 18 knots. To prevent them falling an easy prey to more powerful vessels, and also to enable them to be utilized for torpedo attack, they should be fitted with a submerged tube in the stem and one on each side above water. The displacement should not exceed 500 tons.

France, as usual, has taken the lead in this branch of construction. While we were deliberating and endeavoring to reconcile the conflicting opinions of constructors and naval officers, the Bombe had been launched and seven more of the same class commenced. With a displacement of about 320 tons the Bombe has attained a speed of over 19 knots. Her armament is to comprise two light guns and three Hotchkiss revolving cannon. She has also a torpedo tube on each side above water. One important feature is the light draught, which at normal sea trim will not much exceed 6 ft. She will thus to a great extent escape the liability of being herself destroyed by a torpedo. These missiles are usually arranged for the depth most destructive to the bottom of an ironclad, and moreover do not readily maintain a course near the surface. If, on the other hand, the dimensions and draught of the torpedo boat catcher are materially increased, she becomes herself worthy of attack, and a fair mark, both in length and depth, for the torpedo boat. In such a small vesssel as the Bombe the armament must be exceedingly limited, and therefore it would seem desirable to have one description of gun, the most suitable for destroying a torpedo boat or engaging another vessel of her own species. Under these circumstances, it would be difficult to find a weapon superior to the quick-firing gun with 3 lb. projectile. As regards torpedo equipment, the French are wise in restricting the number of positions; but we are surprised that the submerged tube has not been adopted. In this system the torpedo and all its appliances are well protected up to the moment of discharge, and it leaves the ship uninfluenced by the action of the sea. It was stated by Commander Gallwey, in a lecture at the United Service Institution, that very successful practice had been carried out from the bow tube of the Polyphemus up to a speed of 18 knots. As, however, we are dealing now more with the question of how torpedo attacks should be frustrated, we will leave the subject of torpedo equipment for a future occasion; but there is no doubt that should the seaworthy qualities of the Bombe prove satisfactory, she and her consorts will be valuable adjuncts to a fleet. We are now preparing four vessels of somewhat similar description, but intended to be superior to these French ships. These are the Grasshopper, Rattlesnake, Spider, and Sandfly, and more inappropriate names it would be difficult to select. They are to have a displacement of 450 tons and 2,700 horse power, with which it is expected a speed of 20 knots will be realized. Their armament is to consist of one 4 in. breech-loading gun forward, and several quick-firing guns. Four above-water torpedo tubes will be fitted; one in the stem, another right aft above the keel, and one on each broadside. The draught of water is to be 8 ft. It is thus evident that these vessels are larger and more powerful than the Bombe class, so that they ought to be able to maintain their speed better in moderately rough weather. We should be inclined to dispense with the stern torpedo tube, as little reliance can be placed in the accuracy of the torpedo discharged into the disturbed water of the wake. It can, however, easily be removed if unsuccessful. The general opinion seems to be that each large ironclad should be attended by one—if not two—of these craft, and therefore it is a pity we have not more than four preparing. The number should be completed to twelve as soon as possible.

Spain has shown much enterprise of late in naval matters. She has secured an excellent specimen of a torpedo boat catcher in the vessel just built by Messrs. Thomson, of the Clyde. With a displacement of 350 tons, the Destructor has realized a speed of over 22 knots. The armament is intended to comprise one 9 cm. gun, four 6 lb. quick-firing guns, and two 37 mm. Hotchkiss cannon. She is also to have five torpedo tubes. The coal capacity of her bunkers is sufficient to carry her 700 knots at full speed. Fair protection is given by the fuel and subdivision into compartments. We cannot commend the intention to have three descriptions of guns, involving different ammunition, and three torpedo tubes would be ample. There is always a tendency to place in ships more than they can conveniently carry or work, and weights are added which seriously affect the speed when the vessel is completed for service.

A smaller class of torpedo boat catcher is one built by Mr. White, of Cowes, and purchased by our government. She is 150 ft. long, and with a displacement of about 130 tons has realized a speed of twenty knots. One great advantage she possesses—that of turning with remarkable quickness—is due to the peculiar construction of the after-body, originated by Mr. White, and now familiarly known as the "turnabout" system. It is only surpassed by boats on the Mallory principle, in which the rudder is dispensed with, its work being done by moving the propeller to either side by means of a small engine in the stern. The effect is almost instantaneous in altering the boat's direction. The chief disadvantage is that when the main engines are stopped, control over the boat ceases. For torpedo service also the auxiliary engine is much exposed, and therefore, in this country at least, the system has not been adopted. Although Mr. White's latest production has several valuable qualities, we doubt if she is sufficiently large for a torpedo boat catcher; but we see no reason why his turnabout system should not be applied to a vessel of 350 tons.

In Russia this type of construction is represented by the Ilyin, which has lately been tried outside Cronstadt in the presence of the Minister of Marine. The Ilyin is somewhat larger than our own vessels, having a displacement of 600 tons, and her equipment in guns and torpedoes is of a more extensive nature. She is to be armed with eight 47 mm. and six 37 mm. Hotchkiss guns, in addition to seven torpedo tubes. A steel projective deck runs throughout her length. A curious feature is that her twin propellers are carried beyond the rudder in order to give increased speed. In some of the earlier torpedo boats this system was adopted, but the rudder exerts a greater turning power when abaft the propeller. The length of the Ilyin is 228 ft., beam 24 ft., and draught of water 9 ft. With a pair of triple expansion engines developing 3,500 horse power, a speed of 20 knots has been obtained. Comparing this vessel with the Grasshopper, we find that she is 28 ft. longer, with 1 ft. more beam and draught. In the Russian vessel the length is 9·5 times the beam, whereas in the English ship it is 8·7 times, so that the latter, though smaller, ought to prove steadier in a sea. We must regard the Ilyin more in the light of a torpedo vessel than a catcher, as evidenced by the number of torpedo positions it is stated she will have, though the intention is evidently to combine both functions. Taking all things into consideration, we cannot admit that the additional 150 tons, with the increased armament it permits, sufficiently compensates for the disadvantages of greater length, draught, and cost, more especially as regards the ability of dealing with a number of hostile torpedo boats.

It is only natural that Italy, who in maritime affairs has for the last fifteen years shown so much energy and originality, should not neglect small swift vessels while preparing such leviathans as the Italia and Lepanto. Seven years ago she launched the Marcantonio Colonna, a 16 knot vessel, with a displacement of 660 tons, but whose usefulness was impaired by not having twin screws. Four vessels are now preparing of 750 tons, which, with a horse power of 3,600 and twin propellers, should give them a speed of 20 knots.

We thus find that all the principal nations are alive to the importance of these swift auxiliaries, and to this country especially is it essential to possess an adequate number of them. In any future naval operations undertaken by our fleet it must be prepared for determined attacks by torpedo boats, against which nets and the most perfect subdivision into compartments would offer an insufficient protection, unless supplemented by numerous small craft fulfilling the conditions indicated at the beginning of this article.—*The Engineer.*

EMPLOYMENT OF ACETIC OR FORMIC ACID IN BLEACHING.

ACCORDING to the *Wochenschrift für Spinnerei und Weberei*, Dr. Lunge, of Zurich, has obtained a patent for producing an increased effect of the solution of chloride of lime in the bleaching of vegetable tissues, by the employment of acetic acid or formic acid in small quantity. This process is free from various disadvantages attending the application of other agents intended to fortify such solutions. The relatively small quantity of acid used by Dr. Lunge's process does not render its cost an element of serious consideration. The combination of acetic acid with the chloride of lime first produces free chloride acid and acetate of lime. In the bleaching process, the former gives off its oxygen and becomes muriatic acid, which, with the acetate of lime, makes chloride of calcium and free acetic acid. The latter again acts on the chloride of lime, and so on. A minimum of acetic acid, therefore, suffices to separate the whole of the chloride of lime into chloride of calcium and active oxygen. The muriatic acid produced is never in a free condition, as it immediately acts upon the acetate of lime. This is an important fact, as, moreover, acetic acid does not attack the fibers in the same manner as muriatic acid. As no insoluble salts of lime are present, the operation of acidification after bleaching can be dispensed with. In this way, not only is there an economy of acid and of washing, but the danger is averted of small quantities of acid remaining in the tissues (particularly if they are thick), with the result of injury to the material and inconvenience in subsequent dyeing operations. The addition

of acetic acid or analogous weak organic acids can be made to the chloride of lime before use, or to the water in which the tissues are washed after the treatment with chloride of lime. The exact form of application must of necessity be determined by the nature of the tissue under treatment, but in any case the result is a saving in chloride of lime and a diminished pollution of the adjacent watercourses. When the tissues retain alkali from the preceding bucking, or if the water is hard, or if the solution of chloride of lime contains an important proportion of caustic lime, it would be necessary to use a relatively large quantity of acetic acid for the neutralization of the bases before the chloride acid can be liberated. In such cases a portion of the acetic acid may be replaced by muriatic acid or sulphuric acid, yet only to such an extent that there may not be any free mineral acid present, but only free acetic acid. This can easily be controlled by keeping the reaction constantly weakly acid against litmus paper.

LA NATURE.

WE give this week several interesting illustrations from *La Nature*, as follows: A New Metallic Thermometer, The Gyroscope Collimator, The Capillarity and Density of Liquids, The Electric Waltzers.

FLEURIAIS' GYROSCOPE COLLIMATOR.

AS well known, the exact position of a vessel at sea is obtained through an observation, by means of a sextant, of the height of one or more stars above the horizontal plane passing through the eye. A meridian height, for example, furnishes the latitude, and a height at any other instant permits of calculating the hour on board, and this, combined with Paris time, as given by a chronometer, gives the longitude. On land, the horizontal plane is accurately determined by a level or, better still, by a bath of mercury, but on a vessel the rolling and pitching preclude the use of such instruments, and the mariner is obliged to take the line of demarkation between the sky and earth as the basis of his observations.

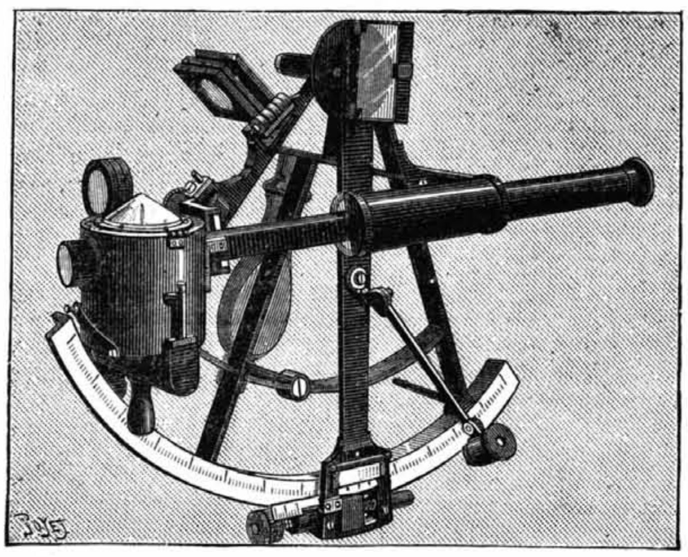


FIG. 1.—THE GYROSCOPE COLLIMATOR.

This line, unfortunately, is very often rendered invisible or diffuse through darkness or the presence of a bank of fog, and the ship has to be steered according to the relatively crude data given by the compass and log. It would prove of great importance, then, especially now that the common use of steam has given rise to high speeds on the sea, to have some process that would permit of dispensing with a view of the horizon of the ocean. The question is of such interest that a very large number of arrangements, some of which date back to the last century, have been successively proposed, but none of them has proved sufficiently accurate.

Capt. Fleuriais, of the navy, who is well known through his scientific expeditions, has just brought out a very simple instrument, which the Academy crowned at its recent annual session as giving that solution of the problem which has for so long been sought.

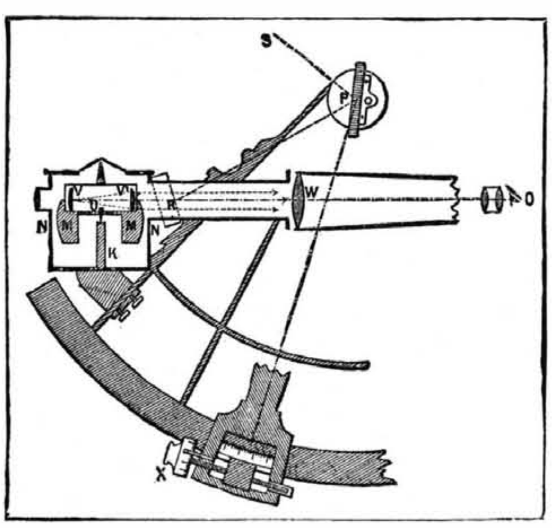


FIG. 2.—DETAILS OF THE INSTRUMENT.

We shall briefly define the principle and arrangement of this apparatus, which is one that is destined to largely increase the safety of high speed navigation. Every one is acquainted with the common top. The axis of this, while in rapid rotation, describes circular cones around the vertical, instead of falling. This conical motion, which is called precession, is uniform and regular in case the point of support is immovable. Now, the oscillations of a ship are, it is true, of a nature to alter the regularity of the cone described; but if the duration of the motion of precession is very slow with respect to the rhythm of the ship's rocking (if, for example, it reaches two minutes, a result easily obtained by giving the top a great velocity and properly reducing the distance from the center of gravity to the point of the top), the disturbances produced will be compensated for, and the mean radius of the circle of precession will not be influenced, since two successive rollings in opposite directions find the axis in very approximate positions.

Such is the principle of the instrument which we figure herewith. The apparatus consists essentially of a top, M M (Fig. 2), inclosed in a box, N N, which hooks on to the sextant back of the small mirror. The pivot consists of a fine steel point, D, resting in a cavity at the extremity of a support, K.

Before observation, the rotary motion is given through the action of a double current of air produced by a small bellows. These currents are directed tangentially to the periphery of the top's center, through two channels located diametrically along the inner sides of the box, on a level with the pivot. The top carries at the extremities of the same diameter two plano-convex lenses, V V', of the same focus. A black line engraved upon each of these at its optical center serves as a datum point.

As the distance, V V', is precisely equal to the focal length, the rays that start from each of the lines make a parallel exit through the opposite lens. Consequently, if the top revolves rapidly, the eye placed at the telescope will see a continuous line that appears to it to come from infinity. This line naturally represents at every instant the line of the plane extended through the center, W, of the telescope objective at right angles with the axis of the top. As this axis has a conical precessional motion, the datum mark rises and descends, and inclines now in one direction and now in another, with respect to the position that it would have were the axis immovable in a vertical direction.

But every time that the axis of the top passes in the vertical plane parallel with that of the sextant (and this occurs from instant to instant), the datum mark reaches a final position, at which it is for a moment immovable and horizontal, and, besides, as has been said, such positions are symmetrical with respect to the ideal line of the true horizon.

But while the luminous rays that start from the top are traversing the left side of the telescope, those that emanate from the star whose height is to be measured enter the right side in the direction, S P R O, and form an image on the side on which the datum mark exists. After this, if the observer, acting upon the graduated head, X, of the alidade screw, keeps the two images in coincidence and notes the graduation at the instant of every renewal of the screw's motion, he has nothing to do but obtain an average of the extreme readings in order to get the value of the true height.

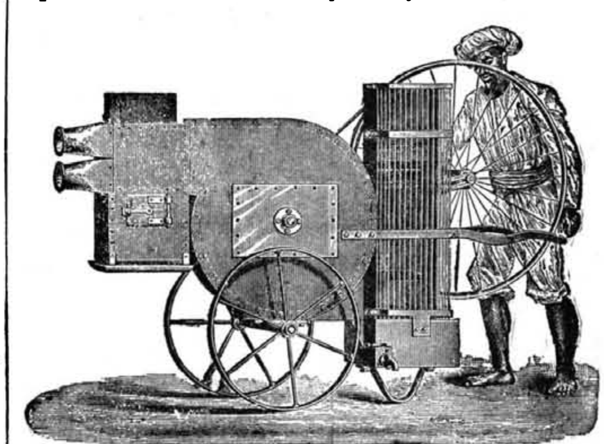
Theoretically, two readings are sufficient, but in practice, on account of the progressive righting of the axis of the top produced by the friction of the pivot, it is well to make three—two maxima and one minimum.

Three models of the instrument have been constructed, and experiments with two of these have shown no errors exceeding 3' at a maximum, even in bad weather.

TEA WITHERING APPARATUS.

IT consists of one of Mr. Gibbs' fans fitted in an iron casing mounted on a pair of wheels, and having a small coke fire in a box in front of it. A handwheel is provided for driving the fan, and a couple of handles for moving the machine about, barrow fashion. There is, of course, an air inlet in the rear of the fan, and there are two outlets in front of the fire box. Into each of these latter when the machine is in use is fixed a light flexible hose about 4 in. in diameter, for the distribution of the air from the fan. The work of turning the fan is very slight, and here Mr. Gibbs has met the requirements of Eastern labor, for after the fan has been once started the slightest touch of the handle at each revolution will keep it going, as the friction is reduced to a minimum. The turning of the handle draws the air into the fan, and it is expelled on the other side, but on its way to the delivery outlet it is made to pass through a chamber which is placed over the fire, and by which means the air is raised to the desired temperature. It will thus be seen that two streams of warm dry air, one on either side, can be delivered through the hose on to the tea which is laid out for withering. With regard to the range of temperature, we may observe that on the occasion of our inspection the thermometer stood at 63° Fahr. at the inlet of the fan and at 87° at the outlet, thus giving a range of 24°.

We have stated that the injurious effects of moist air on the tea can be prevented by Mr. Gibbs' apparatus, and we will now explain how it acts in the case of a hygrometric atmosphere. To meet this case, a cage is fixed in front of the air inlet to the fan. In this cage are placed roughly broken fragments of chloride of calcium, and through this mass the air has to pass on its way to the fan. The chloride of calcium abstracts the moisture from the air, which enters the fan perfectly dry, and is expelled from it in the same condition, the fire not being used if the temperature of the atmosphere be sufficiently high. The machine is perfectly portable, weighing only 1½ cwt., and measuring only about 7 feet in length by 4 feet in height and 2 feet in width over all. Of course, chloride of calcium, being a deliquescent salt, becomes dissolved as it absorbs moisture. It is, however, caught in a pan placed beneath the cage, and is afterward restored to its normal condition by evaporation. It is thus used over and over again, none being wasted, and, therefore, no expense is incurred in this respect beyond the first cost.



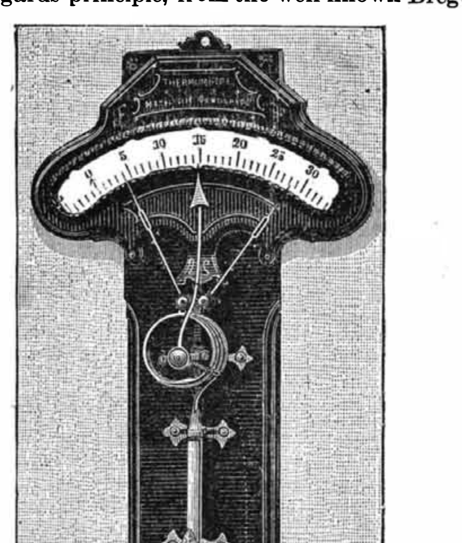
TEA WITHERING APPARATUS.

Although the cost of this machine is far from excessive when taken in connection with the serious loss it may be the means of preventing, Mr. Gibbs has produced the tea witherer in a cheaper and simpler but equally efficient form. The traveling wheels and one nozzle are dispensed with, and by making it somewhat smaller it is still perfectly portable, and can easily be moved about from place to place by two coolies.

The principle of the tea witherer has been applied, or rather added, by Mr. Gibbs to the tea-drying cylinder which he devised for drying the tea as it comes from the rolling mill, and which was described by us about a year ago. This machine consists of a revolving cylinder through which the tea is gradually passed, being exposed during its passage to the desiccating influence of a stream of heated air. In this case the air may have a temperature of some 450 degrees on entering the cylinder, and on leaving it will still be sufficiently warm to be serviceable in withering tea. The air, however, leaves the cylinder laden with the moisture which it has absorbed from the tea, and in this respect is, of course, quite unsuited for withering. But by placing a cage of chloride of calcium at the exit end of the drying cylinder and a small fan beyond it, the air is drawn through the chloride, in which it leaves all its moisture, and is delivered by the fan perfectly dry and of a temperature suitable for withering, as was demonstrated on our visit. These machines are so constructed as to combine strength and economy, and are provided with shelves placed at such an angle as just suffices to move the leaves gently without lifting or bruising them. The ingenious and simple method of obtaining dry air at moderate temperatures devised by Mr. Gibbs being applicable in many cases where heat alone would be injurious, we shall expect, as time goes on and its advantages are realized, to hear of its adoption in connection with many industrial processes.—*Iron.*

A NEW THERMOMETER.

THE apparatus shown in the figure is entirely different, as regards principle, from the well known Breguet



FERMIS' THERMOMETER.

metallic thermometers, and from similar apparatus based upon the difference in effects of the linear expansion of two or more superposed metals. It is based upon the principle of the Bourdon pressure gauge and of the expansion of liquids, and consists of a tube of very thin, hard-hammered copper wound spirally, filled with poppy oil, and entirely exhausted of air. This

tube is stationary, and the extremity of the spiral, through a lever, actuates a needle that moves over a dial.

Under the influence of heat, the oil expands and untwists the spiral; but if, on the contrary, the temperature falls, the liquid diminishes in bulk, and the copper spiral contracts and twists up tighter through the shrinkage of the oil and thinness of the metal.

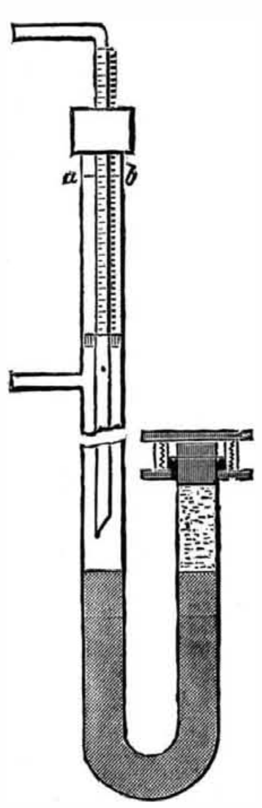
This thermometer is very sensitive, and the degrees are equal. It permits of measuring very different temperatures. As the sizes of the degrees depend upon the proportions of the lever arms, thermometers of very wide or limited graduation can be easily constructed, especially if there be added the influence of a reservoir of a size proportioned to the effect that it is desired to obtain.

The great advantage of this thermometer is that it can be very easily converted into an electrical temperature indicator by the addition of contacts properly connected with a bell and pile. The contact needles likewise play the part of maximum and minimum indicators.

The applications of this apparatus are therefore quite varied, since it at the same time performs the role of a maximum and minimum thermometer and that of an ordinary thermometer, and can be converted into an electric fire or temperature indicator for sick rooms, hospitals, cafes, workshops, stores, etc., and may even be made a light indicator by placing it near a luminous source obtained through combustion. The fall in temperature that occurs in the headlight of a locomotive, for example, might be very easily signaled to a distance.

A NEW GAS THERMO-REGULATOR.

A NEW form of thermo-regulator has recently been devised by Mr. George W. A. Kahlbaum, of Basle, which appears to possess many advantages over the existing kinds of thermostats and thermo-regulators in common use. It is a modification of a form devised many years ago by Andrece, and depends on the gradual cutting off of the supply of coal gas by the expansion of mercury. The part containing the mercury is put in the bath whose temperature is required to be kept constant, and the gas-burner used for heating the apparatus has its supply controlled by connection with the thermo-regulator, so that an increase in the temperature of the bath will cause a diminution in the size of the gas flame, thus tending to keep the temperature constant. It will be seen from the figure that it consists of a U tube of glass, open at both ends, and having limbs of unequal length. At the side of the longer of the two limbs a short piece of thinner glass tubing is sealed on, forming a T piece, by which the gas escapes from the apparatus. This limb is closed by a metal cap, through which passes a bent piece of thin glass tubing, which serves as the gas inlet. The vertical part of this tube contains a scale of regular equal divisions, and a mark, *a b*, at the upper extremity of the longer limb of the wide tube, enables the position of this smaller tube to be regulated. This is effected by a rack attached to it and worked by a small thumb wheel and pinion fixed in the brass cap, but not shown in our illustration. Immediately beneath the lower end of the rack, a cork is fixed on the small tube, which fits air tight in the large one. Below this, the small tube is pierced by a hole, so that when the lower end, which is cut obliquely, is entirely below the surface of the liquid, the supply of gas is not altogether shut off. The shorter limb is closed by a well-fitting caoutchouc stopper, which can be kept in position by a screw cap as shown in the figure, or by binding it with wire to the glass tube. To fill the apparatus, the cork in this shorter limb is removed, and mercury is introduced until the level is about 4 cm. from the top; a second liquid is then poured on to the surface of the mercury, and the cork pressed in and made fast in the way described. Such a regulator can be used for all temperatures between the melting and boiling points of mercury, and is found to be capable of keeping large volumes of liquid at a constant temperature within 0·1° C. For high temperatures, some other substance than caoutchouc must be used for closing the end of the shorter limb. The alteration of barometric pressure has obviously no influence upon the accurate working of this form of thermostat.—*Industries.*



THE LACTOCRITE.

A NEW METHOD OF ASCERTAINING THE AMOUNT OF FAT IN MILK.*

By H. Faber.

AN apparatus which would render possible an easy, quick, and exact determination of the amount of butter fat in milk has for many years been a desideratum, but all attempts to construct such an apparatus have till quite recently proved unsuccessful.

The simplest way of estimating the amount of fat, which nature itself seems to suggest, is to let the cream rise and notice its volume. This method, which is extensively used by practical men, is, however, very unreliable, as there is no constant relation between the volume of cream thrown and the percentage of pure fat. An attempt has been made to improve this method by dissolving the fat in ether, as in the Marchand's lactobutyrometer, but sufficient accuracy can hardly be obtained in this way. The best apparatus, so far as accuracy is concerned, is undoubtedly Professor Soxhlet's aerometrical apparatus, by which the specific gravity of an ethereal solution of the fat is taken, the solution being made according to a given method and the gravity taken at a fixed temperature. A certain specific gravity then corresponds to a certain amount of fat in the milk, but it may reasonably be objected to this method that it is rather costly, and that such a delicate instrument could not well be worked by a practical dairyman.

As far back as 1859, experiments were made by Professor C. J. Fuchs, at Carlsruhe, with the view of obtaining a more complete and uniform rising of the fat globules by employing centrifugal force instead of the force of gravitation, as in the ordinary creamometer, but he failed to produce a sufficiently strong and rapidly revolving machine. In 1881 Professor N. J. Fjord, of Copenhagen, constructed his "control centrifuge," especially intended for, and by him mostly used for, examining separated milk, for which purpose it worked to great satisfaction. It was never intended to be used by others besides his staff, for which reason he never published any directions for its use. It was not intended for, nor did he claim that it could be used for, analyzing whole milk. Nevertheless, it has been taken up, exhibited, and at many places used for analyzing whole milk.

On account of its favorable reception he has lately altered his apparatus, which is now intended for controlling the supply of milk and enabling dairy factories to pay for it according to the amount of butter fat it contains. The apparatus in its new shape contains fifty-four cylindrical tubes, to hold fifty-four samples of milk. The cream is made to rise in the tubes by making the apparatus revolve about 60,000 times in the Danish centrifuge, which takes about three-quarters of an hour. The thickness of the cream is thus then measured.

There is one objection to be made to this apparatus, viz., that it indicates the *amount of cream* and not of *butter fat*, and although undoubtedly the completeness of the rising of the cream and its uniformity is much greater in this case than in the ordinary creamometer, still this apparatus must only be considered as one step further toward the ideal, which is to have *the pure butter fat* isolated by mechanical separation. This is the goal after which Dr. De Laval, of Stockholm, has been striving, and which he has at length attained in his new machine, the lactocrite.

In order to get the fat globules in the milk to unite to one clear mass of fat, it is necessary to render the casein more completely dissolved than it is in the milk in its natural state. There has been, and probably is still, a difference of opinion as to whether the fat globules are coated with a membrane or not, but all agree upon the fact that for some reason or other they do not unite as readily as might be expected. The truth seems to be that by a molecular attraction the casein forms a condensed layer, but not a real membrane, around the fat globules. To dissolve the casein Dr. De Laval at first tried an admixture of alkali, which proved of little avail. He therefore took the opposite course, and succeeded in dissolving the casein completely by boiling the milk with acetic acid. As is well known, small quantities of free acetic acid will precipitate the casein, while a large excess will redissolve it. By the proposed treatment the serum of the milk is transformed into a perfectly clear and thin fluid, and the fat is apparently not affected.

The apparatus itself consists of a strong round steel disk on a spindle, like that of the separator bowl, and test boxes of platina-plated brass with graduated glass tubes. The *modus operandi* is as follows: 10 c. c. of the sample of milk to be tested are run into a small test glass; afterward 10 c. c. of glacial acetic acid, containing five per cent. by volume of concentrated sulphuric acid, are run into the same glass, which is then closed with a perforated cork stopper, in which is inserted a piece of glass tube. This serves to prevent a concentration of the contents of the test glass during the boiling. In a water bath, arranged to hold twelve test glasses, these are heated by steam or gas for seven or eight minutes, after which time the casein has been completely dissolved, while the liquid has acquired a slight violet tinge.

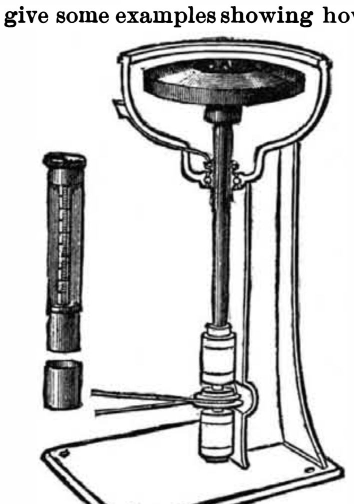
The next step is to charge the test boxes. These consist of a cup in which a perforated stopper fits tightly. The stopper holds the graduated glass tube. As the fat in the milk after boiling with acid has a great tendency to rise, the test glass must be well shaken before its contents are poured into the cup, and when this is filled the stopper must be immediately pressed down in it, whereby any excess of the mixture will escape through the glass tube, and the test box is then filled completely.

After the test boxes have been charged in this way, they are ready to be placed in the disk, which will hold twelve at a time. The disk, which before use must be heated to about 110° F. by being placed in warm water of this temperature, has twelve cylindrical holes bored from a cavity on the top, radiating and a little sloping. In these the test boxes are placed (if less than twelve test boxes are used, there should always be an even number placed, so as not to disturb the equilibrium) and the cavity is filled with water, which will keep the liquid in the test boxes from being pressed out by the centrifugal force. The disk, which fits any stand of a Laval separator, is now made to revolve for three or four minutes at ordinary speed (6,000 revolutions in the minute). When it is again at rest, the test boxes are drawn out and the column of fat in the graduated tube is read off, the divisions indicating immediately tenths per cent. of butter fat by weight.

Before entering into the question of comparative analytical results, it will be necessary to say a few words of explanation. It has been stated that any method of determining the amount of fat will give corresponding results in the hands of persons working in the same way and in the same laboratory, and that no method will give the same results on the same sample of milk in the hands of different analysts at different places. The first statement may be right, but is of very little interest; the second would be very serious indeed, if true. Any method which will extract all the fat and nothing else will give very nearly the same results in the hands of any careful analyst, but it is an essential condition of a good method that it shall extract *all the fat and nothing else.* All methods possessing these two qualities will give the same results on the same sample of milk carefully worked. To obtain a complete extraction of the fat, the milk must be given a very large surface, but this must not be done on paper containing resinous matter, as something will then be extracted besides the fat. For the same reason the ether used must be redistilled. When using Adams' method, it is indispensable that all the resinous matter shall be extracted beforehand, which does not seem very easy. [I have found in one case that five siphonings extracted 0·023 gramme of a coil, but still left 0·010 gramme behind, which was extracted by eight more siphonings.] With well-washed paper coils I have found that Adams' method will give results corresponding very closely with those obtained by the method I generally use, which was first described by Dr. V. Storch in 1883, but had then been in use for several years. According to this method, about 10 grammes of milk are dried on about 10 grammes of pumice stone, ground to the size of lentils, sifted to remove the dust, and heated to a red heat. The dry mass is finely ground in a porcelain mortar and extracted in a very simple extracting tube; 50 c.c. of redistilled ether may be forced to percolate through the finely pulverized milk any number of times so as to remove all fat, and nothing but the fat can possibly be extracted. In analyzing a sample of skim milk twice by each of these methods I found:

By Adams' method	0·70	0·68	per cent of fat.
By Storch's do	0·65	0·64	ditto

Below I give some examples showing how far I have found the results obtained by the lactocrite to compare with chemical analysis:



THE LACTOCRITE.

Chemical analysis.		Lactocrite.			
3·73	3·74	3·7	3·75	3·75	
		3·8	3·8	3·85	
		3·8	3·8	3·82	
4·08	4·07	4·1	4·2	4·2	
3·86		3·8	4·0	3·9	3·9

At least equally good results have been obtained by Mr. John Sebelien, lecturer to the Agricultural College, Ultuna, Sweden, and superintendent of the Dairy Laboratory of the same place. From his report I quote:

Chemical analysis.	Lactocrite.			
3·68	3·65	3·65	3·70	
	3·70	3·70	3·67	
	3·67	3·70	3·70	
2·76	2·77	2·80	2·77	
	2·80	2·80	2·75	
2·70	2·65	2·70	2·65	2·70

These samples, which are by no means picked, will show that the lactocrite is able to give a very close estimation of the amount of fat in milk. I think it may fairly be claimed for the lactocrite that it will give an estimation within 0·1 of the amount of fat in whole milk.

When skim milk is treated in the lactocrite, the results will fall somewhat below those of the analysis, as seen in the following examples:

Chemical analysis.		Lactocrite.			
1·14	1·17	1·05	1·0		
		1·07	1·05		
0·87	0·90	0·75	0·8	0·75	0·8
		0·8	0·75	0·8	0·65
		0·82	0 75	0·8	0·8

Separated milk, from the cream separator, having but very little fat left in it, cannot be tested by the lactocrite in the usual way, as many trials have shown the results to be about 0·2 per cent too low, which difference in analyzing separated milk of course cannot be allowed. Equally low results have been obtained from buttermilk.

Sour milk, even curdled, may be treated in the lactocrite just as well as sweet milk, as the strong acetic acid will dissolve the casein of sour milk as easily as that of sweet milk. The only difficulty lies in the measuring off the 10 c.c. of a true average quality.

* Read at the meeting of the Public Analysts, London, Dec. 8, 1886.

One great advantage of the lactocrite is the very simple way in which it is worked, so that no skill is necessary, but any dairyman may obtain as good results as the apparatus is able to yield. In order to illustrate this, I give below the results obtained by two persons at their first attempts; the first person is a dairyman used to heavy work. By way of a check I myself made some tests of the same milk:

By myself.	Dairyman.		
3·1	3·1	3·2	3·2
3·2	Failed	3·2	3·2
3·2	3·1	3·3	3 2
2·65	2·65	2·6	2·6
2·65	2·65	2·6	2·65

These very favorable results are important as showing that in the lactocrite is at last found the long wished for apparatus, possessing the two qualities not hitherto combined—simplicity of construction and working and sufficient correctness for all practical purposes.

The lactocrite will, no doubt, be found invaluable for butter dairies, or dairy factories buying milk from different farmers, by enabling them to carry out the system of paying for the milk according to the amount of butter fat, which is the only fair system. At present, both in England and in other countries, the farmer whose milk will make butter at a rate of 3 lb. per 100 lb. of milk gets the same price as the farmers whose milk is so rich as to give 5 lb. of butter per 100 lb. of milk, which of course is most unfair. When milk is paid for according to the fat contained in it, the temptation to skim it is done away with, and besides, a great encouragement is given to the production of rich milk.

The lactocrite will also prove of use for analysts who have access to a separator stand, as it will give in a short time a more exact determination of the amount of fat than any other apparatus. In this connection it will be of interest to know that a special construction of it has been adapted to fit Dr. De Laval's small hand separator, worked by hand and requiring no foundation.—*The Analyst.*

ORTHOCHROMATIC PHOTOGRAPHY.*

By J. B. B. WELLINGTON.

ORTHOCHROMATIC photography, although not new, is at the present time receiving a large amount of attention both by dry plate makers and photographers. It is a curious fact that a discovery to render the yellows lighter than the blues was not taken up with more zeal at the time of its discovery, and that it should have lain semi-dormant for some years until a commercial firm takes to supplying the public, which starts it into life again. I am referring only to England, as on the Continent they have employed it for some years, but we English are always somewhat behindhand in taking up a new discovery.

I am not going to discuss who is the legitimate claimant of producing orthochromatic effect in photography, but it is my intention this evening to give you the results of my experiments as far as I have gone (there is nothing original in the chemical I employ, it being erythrosin, and that was discovered years back), and to place in your hands a really good orthochromatic formula, but with one drawback—they will not keep many days.

The formulæ which have been published, compounded with eosine and ammonia, into which dry plates are to be dipped, have in my hands proved useless, and I believe others have found the same. One of my experiments shows me that chloride of silver, dissolved in ammonia with eosine and used as a bath, gives orthochromatic effect, and I should imagine that if a plate is made containing chloride of silver, and then bathed in a solution of ammonia and eosine, it ought to answer. Probably this may account for the failures of those using the ammonia eosine bath with ordinary plates. After various experiments with different compounds with eosine or erythrosin, I found that carbonate of silver, dissolved in excess of carbonate of ammonia and mixed with the erythrosin, gave me the best effect.

The orthochromatic effect in a plate is due, not to eosine or any other stain being an optical sensitizer, as some state, because you may stain the film as much as you please, still the yellows will refuse to impress themselves upon the film, but I believe it is due more to a chemical change, which is produced by having free silver present as well as a compound formed with the erythrosin.

Although I discovered the above (*i. e.*, the use of silver carbonate with eosine) quite independent of anything that had been published, I see that I have been somewhat forestalled in the publication of the formula, as recently in the *News* appeared a formula with ammonia, silver, and eosine, by Vogel, and, I think, previous thereto another formula containing fluoride of silver, carbonate of ammonia and eosine, which practically amounts to the same as I have given above. Mr. Hastings will bear me out in what I say, as I confided my formula to him some time ago. However, I need hardly trouble you with all this.

After trying various proportions, I find the following to work fairly well:

Silver nitrate	20 grains
Ammonium carbonate	90 "
Water, distilled	16 ounces
Erythrosin (2·100)	10 drachms

The plates are placed in this for two minutes. A rinse in distilled water gives less chance of stains, and then placed in a rack to dry. Let me here state that if they are used in the moist condition, the orthochromatic effect is practically *nil;* they must be used quite dry. By this treatment the plate is rendered three times more sensitive. I must insist upon the necessity of using only ruby light, the plates having now become so sensitive to yellow that the greatest precaution must be taken in handling them. My chief reason in not giving you this formula before was the great difficulty of developing the plates free from fog. This, I am glad to say, I have now overcome. I pass round a plate half of which is quite free from fog. This was got rid of by soaking the exposed plate before developing in the following:

Potassium bromide	120 grains
Ammonia	½ ounce
Water	12 ounces

Do not allow to remain more than thirty seconds, well rinse under the tap, and proceed to develop with any of the usual developers—ammonia, potash, or ferrous oxalate. If there is much blue in the object to be copied, a yellow screen must be used if exposure is to be made by daylight, although by gas or lamplight it is quite unnecessary. The best effect is always secured by gaslight exposure.

A very good substitute for colored glass is to color a collodion film and strip it from the glass. The glass should be rubbed over with talc or a solution of wax in ether, and well polished off, and coated with collodion containing methyl orange. The dried film should appear decidedly orange. The stripped film can then be gummed to the cap of lens, having cut out the center first, and used preferably behind the lens. The carbonate of silver and erythrosin may be mixed with an emulsion, but requires great care. It should be mixed at as low a temperature as possible, and the plates used as soon as they are dry, as their life is very short. The orthochromatic effect is very marked, and the speed increased about ten times. If any one is desirous of trying this, I give the following:

Emulsion (containing, say, 200 grains silver)	10 ounces
Silver nitrate	10 grains
Ammonium carbonate	45 "
Erythrosin (2·1000)	5 drachms

Before development they must be treated with the ammonia and bromide.

Very fine results can be obtained from collodion emulsion—in fact, the results far surpass gelatine, and can be used by daylight without the necessity of employing a yellow screen at all, but, alas! like gelatine, do not appear to keep any better. The bath for a collodion emulsion plate is best made as follows:

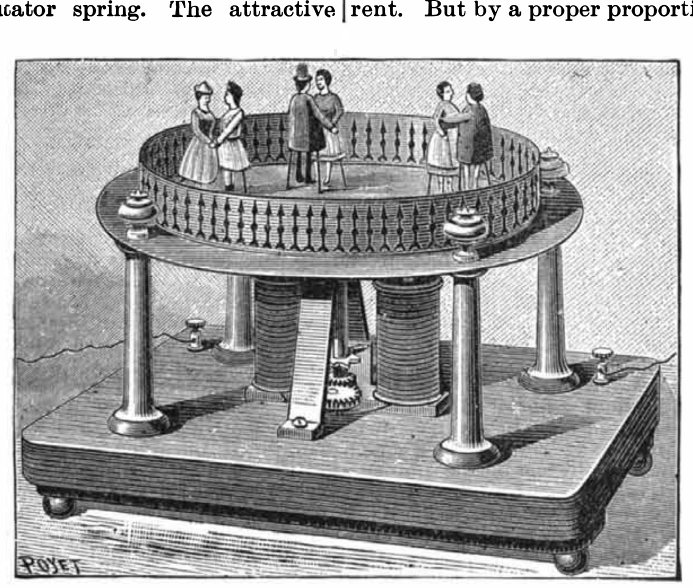
Silver nitrate	10 grains
Ammonium carbonate	45 "
Water	2 drachms
Spirit, methylated	8 ounces
Erythrosin (2·1000)	5 drachms

Dissolve the silver in a test tube by heat in two drachms water, and add the carbonate of ammonia bit by bit till all dissolved. Add the spirit gradually to the hot solution, and finally the erythrosin. Place the dried collodion plate in this solution for two minutes, and dry. The plate, before development, to be treated with the ammonia and bromide, and developed by ferrous oxalate, three to one, to each ounce of which add three grains of bromide. If mixed with the emulsion, it begins to fog at the end of three days, so it is better to dip the plates as required. The exposure is only four times more than a fairly ordinary rapid gelatine plate by daylight, and by gaslight they are about equal. The action of the erythrosin silver compound renders the collodion film exceedingly tough, very much like an alumed gelatine film, and is very difficult to scrub off the glass afterward.

* A communication to the London and Provincial Photographic Association

THE ELECTRIC WALTZERS.

THE electrical toy shown in the accompanying figure consists of three parts, viz., of a sheet iron disk, which is supported by columns, and upon which are placed a number of small dancing puppets, of an electric motor, and of a music box actuated by the motor. This latter consists simply of an electro-magnet between the poles of which revolves an iron fly. Upon the axis of this piece is mounted a collecting wheel whose circumference is provided with teeth that equal in number the vanes on the fly wheel. Against this wheel rubs a commutator spring, which, at every contact with the teeth of the collecting wheel, causes a current to pass from the pile into the electro, whose poles become magnetized, and attract all of the vanes of the fly wheel, which begins to revolve. When the vanes come opposite the poles of the electro, the commutator spring drops into one of the notches of the collecting wheel, interrupts the current, demagnetizes the electro, and allows of the passage of the vanes of the fly, which continues to revolve through the velocity acquired, and causes the collecting wheel to establish a new contact with the commutator spring. The attractive function of the electro is renewed, and the fly always revolves in the same direction, through the successive effects of attraction and acquired velocity. A pinion mounted upon the axis of the fly communicates the latter's motion to a wheel that actuates the music mechanism. The electro is vertical, and its poles, which are prolonged beyond the bobbins, nearly touch the horizontal platform.



THE ELECTRIC WALTZERS.

As may be seen, the motor up to here has no other role than that of actuating the music mechanism; but where the ingenuity of the apparatus is shown is in the application made of the running of the motor to actuate the puppets through induction. We say through induction, since the platform on which they dance does not touch the motor, and receives no motion from any part of the latter. In fact, upon examining the functions of the motor, we see that the electro becomes successively and rapidly magnetized and demagnetized, and, as its poles are near the center of the platform, the latter vibrates like the diaphragm of a telephone. Seeing, besides, that the waltzers are small objects mounted upon horse hairs, and that the surface of the platform is rough, we can readily understand the motion of the dancers, who seem to obey the movement of the music.

For operating this toy, bichromate of potash piles in bottle form may be advantageously employed. The ease with which the current can be modified permits of moving the puppets with varying rapidity. A good result may be obtained with two couples mounted for tension.

The vibrating disk can be tightened or loosened at will by means of two screws placed in the center. If too violent motions occur and upset the puppets, the disk will need tightening.

ELECTRICAL WELDING.

PROFESSOR ELIHU THOMSON, of the Thomson-Houston Electric Light Company, recently read a paper at the Massachusetts Institute of Technology, "On the Art of Electric Welding." In the Thomson-Houston factory all the copper and iron wire used is welded by aid of electricity. The largest copper rod yet joined by this method is a little less than ½ in. in

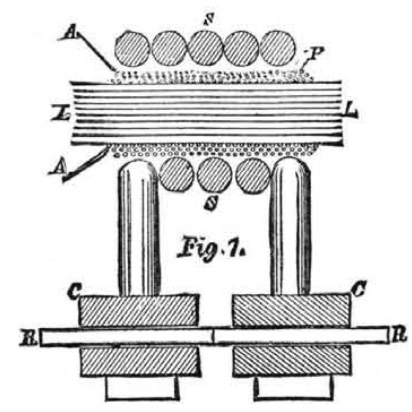


Fig. 1.

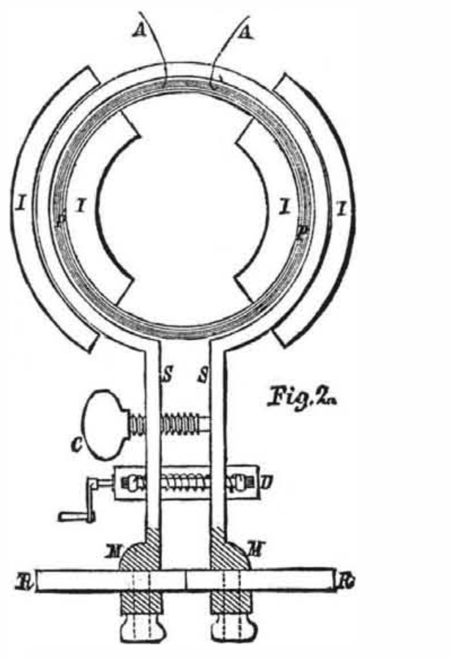
diameter, and requires a current of 20,000 amperes. The same current will weld an iron rod 1 in. in diameter, as this metal offers greater resistance. Specimens of welded wires were shown to the audience, as well as of iron, brass, and copper tubes. Also drills, bolts, and screws which had been cut and lengthened by the insertion of extra pieces between the head and the point.

The enormous currents used in welding have only a small electromotive force, sometimes as little as half a volt, so that the actual energy employed is not excessive, and is only in operation for one or two minutes. One method of obtaining it is by the use of a secondary battery. This is charged from an electric lighting circuit with the cells in series When required for use, the order of cells is changed so that they are parallel, and offer an exceedingly small resistance to the current. Very rapid discharge has, however, a prejudicial action on secondary batteries, and consequently a transformer of the induction coil type is a more convenient apparatus to use. The principle of these apparatus is well understood, and has already been turned to account in the secondary generators of the Gaulard and Gibbs system. An alternating current from a dynamo machine is made to circulate in a coil of insulated wire surrounding a wrought iron bar or core. This is called the primary coil. On the same bar is wound another or secondary coil, either above or below or alongside the primary. At every alternation of current in the primary coil, there is induced a temporary current in the secondary coil, and the energy in the induced current is equal (less the loss in the apparatus) to the energy lost by the primary current. But by a proper proportioning of the two wires the character of the secondary current may be greatly modified, and its electromotive force be made either greater or less than that of the current which induces it. In electric lighting it is customary to work with a primary current of 2,000 volts, and to reduce it to between 50 and 100 volts with a corresponding increase in the number of amperes, but for welding only one or two volts are required. Fig. 1 shows the construction

of transformer which has been employed at the Thomson-Houston works. The core, L, is formed of a bundle of fine iron wires, and around it is wound the primary coil, P, the terminals of which, AA, are connected to an alternating current generator, giving 50 to 100 alternations per second. The length of the wire core is 12 in. and its diameter 1¼ in. The secondary coil, S S, is composed of 64 No. 10 (Brown and Sharpe's gauge) copper wires, wound in parallel eight times around the primary. The ends of this coil are bolted to copper plates on which are mounted clamps, C C, for the reception of the two rods, R R, which are to be welded. One of these clamps is movable, and is constantly pressed toward the other by a spring, so that the pieces to be united are kept in firm contact. The resistance of the secondary coil is 0·00015 ohm, and the amount of energy given off by it can be varied by moving the core, L L, in and out of the primary coil.

Fig. 2 illustrates another construction of transformer. The primary coil, P, is a ring 12 in. in diameter, 2½ in. wide, and ¾ in. thick, of many turns of insulated copper wire. Its ends, A A, are connected to the terminals of the alternating dynamo. The secondary coil is a single heavy bar of copper, bent to make one turn outside the primary coil, and is represented by the heavy black ring, the terminals of which, S S, are bent out parallel, and connected to massive clamps, M M. The arms, T T, can be forced apart by the screw, C, and drawn together by the adjustable spring, D. The primary and secondary coils are wound with an endless coil of iron wire, II. This does not touch the coils, but is laid on a sheet iron casing, the secondary coil being free. The resistance of the secondary coil is 0·00003 ohm, and under the influence of a good primary current it gives an electromotive force of 2 volts; less, however, is used in most cases. In the primary circuit there is used a current of 20 amperes and 600 volts, generated in a dynamo weighing 500 lb., and absorbing 25 horse power at 1,800 revolutions.

During the lecture mild steel rods, ½ in. in diameter, were placed end to end in the clamps of the machine (Fig. 2), and were welded before the audience. Copper



and brass rods were similarly treated, and tests were afterward made to demonstrate that the joints were perfectly sound.

SEPARATION OF NICKEL BY THE MAGNET.

By THOMAS T. P. BRUCE WARREN.

DURING the winter of 1881-82, while lecturing to a class at the Silvertown Institution, on Electricity and Magnetism, I was desirous of showing to the students the magnetic property of metallic nickel. Through the kindness of Matthew Gray, Esq., at that time President of the Institution, I borrowed from the India-rubber, Gutta-percha, and Telegraph Co., Silvertown, a specimen of nickel cubes, which consisted in fact of two samples received some time before from Germany. The difference in price of the two samples was so little that they were thrown together into a drawer, as it was thought at the time that there could not be much difference between them with respect to purity, etc.

A handful of these cubes was placed on the table, and, on bringing an ordinary compound horse-shoe magnet near the cubes, I was very much surprised to find that, while some of these cubes were forcibly attracted by the magnet, others were not affected at all, or so slightly that they could not be supported by the magnet against their own gravity. Some cubes were attracted slightly when placed very near to the magnet, but could not be lifted.

I thought the matter of sufficient interest that I intrusted the chemical examination of these samples to one of the students in the laboratory of the Institution.

I afterward examined the whole of the nickel contained in the drawer with the magnet in the same way, and in two or three minutes I had the samples sorted out into their original lots of two kilogrammes each.

The magnet readily picked out the better quality at the rate of twenty or thirty cubes at a time, until what was left could not be drawn out by the magnet. To make sure of the result, the "magnetically selected" cubes were again tested with the magnet, when it was found that a few non-magnetic cubes had been drawn up by entanglement with the others. By the second operation, the separation was perfect.

There was no very marked difference in these cubes which would lead one to suspect anything worth noting. A closer examination showed that the non-magnetic cubes were a trifle whiter, and presented the absence of a striated structure, which was well defined, though unequally, with the magnetic cubes.

This method of examination was extended to samples of English grain nickel, and also to portions of anodes of English, American, and German manufacture.

It may be sufficient to remark here that the grain nickel was powerfully attracted, and that the anodes, although drawn up by the magnet, were not so strongly attracted as the grain or magnetic cubes.

The fact that nickel has become an article of commercial importance, and that chemical analysis has disclosed the fact that this metal is liable to extensive adulteration, which can be so easily detected by the magnet, led me to believe that this subject deserved a more extended examination.

Special examinations of these cubes were made for lead, bismuth, antimony, cobalt, and sulphur, which were decidedly absent, although traces of some of these were detected in the anodes.

The following gives the percentage of composition of the cubes referred to:

	Magnetic.	Non-magnetic.
Copper	0·083	33·779
Carbon	0·071	0·365
Silica	0·409	0·160
Iron	2·457	0·841
Arsenic	0·117	0 865
Tin	0·749	0·461
Nickel	96·670	63·690
	100·556	100·161

The oxide of nickel obtained from the non-magnetic sample was reduced by heating in a current of hydrogen. This reduced metal was then even more magnetic than the other sample. A portion was placed in a test tube, which was inserted between the poles of a powerful horse-shoe magnet. It readily took up an axial position, which was not disturbed on carefully rotating the tube.

Portions of this metal were alloyed with small quantities of tin, arsenic, and antimony separately, which had a decided effect on its magnetic property.

Cobalt in its pure state behaves like nickel, and when alloyed with paramagnetic metals is similarly affected.

I have extended the examination more recently to nickel crucibles and dishes, and also to the wire triangles before and after heating, all of which are magnetic both before and after heating.

I have frequently noticed that the loss on one of these crucibles, when strongly heated over a Bunsen burner, is very slight compared with the bulky accumulation of black deposit which is produced. A few days ago I collected considerably over a gramme of this powder, which on analysis consisted almost entirely of graphitoidal carbon, with minute quantities of nickel, iron, and silica.

I may mention that a platinum crucible heated in the same flame remained quite bright. The curious deduction arising from this is that these vessels are capable of actually decomposing the gas in a Bunsen's flame. A precaution which should therefore be taken is *not* to use these supports for platinum crucibles.

This unlooked for result led me to use hydrogen as a means of heating these nickel crucibles, taking care, of course, that the intense heat was not allowed to act injuriously on them. If coal gas be used, the flame must not be allowed to impinge upon the crucible.

I have now some experiments in hand with a view of ascertaining their behavior in a muffle furnace, heated with ordinary gas, as alkaline fusions for the analysis of earthy minerals are frequently required in practice.

So far as my experiments have gone, the crucible gains in weight, due to oxidation when heated in a muffle, but there is this difference—that the oxide formed is strongly adherent to the crucible, and is not rubbed off by the fingers, in the hydrogen flame. Oxidation does not take place on heating, but the precaution is necessary, to allow the cooling to go on in a current of this gas in order to avoid oxidation.

I find that there is a difference in the composition of the nickel gauze and wire supports and the crucibles and dishes. Malleability, so far as my analyses go, is produced by the addition of iron and manganese.

The composition of the malleable alloy from which the dishes and crucibles are made will be given in my next paper on this subject.

I may just state that commercial manganese and some other metals which are generally classified as magnetic are met with, in which magnetic attraction is notoriously absent. This deserves attention, as in the construction of magnets other metals are added to iron to increase its retentive power when hardened, and it is by no means improbable that the polarity of soft iron may be modified as regards its residual magnetism by the addition of other metals of the same or opposite series.—*Chem. News.*

PHOSPHORESCENCE OF ALUMINA.

By EDMOND BECQUEREL.

IN a memoir recently presented by M. De Boisbaudran to the Academy (vol. ciii., p. 1107), it is asserted that very pure precipitated alumina, when excited by electric discharges in a vacuum, does not give a red light, which, however, can be made to appear by the addition of 1-10,000 oxide of chrome. The author of that memoir deduces from his observations that the characteristic red light is not derived from alumina, but is due to the presence of chrome. M. Becquerel, on repeating the experiment with some of the very same material, obtained an opposite result, in conformity with his former observations. Some fragments of this supposed pure alumina were fixed on a slip of mica with a little gum, placed in the phosphoroscope, and excited by means of the electric arc. They gave an emission of red light, but very feeble and less intense than the light emitted by alumina containing chromium oxide, and submitted to the same treatment. But if this pure alumina is ignited for fifteen minutes in a porcelain crucible placed in a gas furnace fed with compressed air, it becomes as brilliantly luminous and red in the phosphoroscope as alumina containing chrome. In the phosphoroscope we can see bodies only if their luminous emission, after irradiation, has a certain duration measured by the speed of rotation of the disks of the apparatus, but as active bodies may emit, simultaneously, luminous rays the durations of which are different and shorter than that measured by the rotation of the disks, we can perceive these rays only at the moment when the light acts upon the bodies, that is to say, according to the case, either by means of the ultra violet light or, as the author has shown for the first time (see *Annales de Chimie et de Physique*, 3d series, vol. lv., p. 92) by the aid of electric discharges or effluves in a vacuum. In these latter conditions we have the luminous effects which have been named effects of fluorescence, and which differ from others merely by their duration. Hence the effects presented by bodies excited by these different means are not the same. Further, in case of the effluve the bodies may receive the influence of rays much more refrangible than those furnished by concentrated sunlight, or even by the electric arc, and perhaps these bodies may be also directly excited by the electric discharges themselves. The effluve in a vacuum excites bodies differently according to the degree of exhaustion, and one body may give no effect in an insufficient vacuum, while it is brilliant in one more perfect. Conversely, another body may be more luminous in the first case than the second, though both are strongly excited in the phosphoroscope. It may happen that the effluve, acting upon mixtures, excites differently each substance contained in the mixture. The effects observed in the phosphoroscope are more simple, but cannot be obtained with all bodies. Those observed in a vacuum by means of the effluve are much more complex, but on analyzing the light emitted with the spectroscope we may deduce interesting conclusions as to the nature of the substances.

THE CAPILLARITY AND DENSITY OF LIQUIDS.

TAKE two glasses (claret glasses, for example), of exactly the same diameter at the rim, and immerse them in a pail of water. Before removing them from the liquid, place them rim to rim, so that both shall re-

EXPERIMENT ON THE CAPILLARITY AND DENSITY OF LIQUIDS.

main full of water, as shown in the figure. We shall thus have two glasses full of water and containing no air. It will now be easy, by acting with caution, to separate them sightly, so as to leave a small space between their edges. Now take a third glass containing wine, and pour the latter, drop by drop, on the foot of the upper glass and allow it to spread over the latter's surface. Upon reaching the line of separation, the wine, instead of continuing its descent, will be seen to enter in streamlets between the two glasses and rise slowly in the upper one, owing to the difference in density of the wine and water. It is possible in this way to color the water in the upper glass entirely red without tingeing that in the lower one.

The wine keeps to the upper glass through the action of capillarity, and rises therein, as before stated, by reason of the difference in density of the two liquids.

This is an experiment that anybody can try, and one that may be utilized in a lecture course.

We must add that the two glasses should be placed on a tray, or something of the kind, in order that the excess of wine may be caught, since considerable trickles down the lower glass, while but a fraction of it rises in the upper one.

SULPHUROUS ACID IN THE CHEMICAL INDUSTRIES.

THE process of extracting phosphate of lime from crude phosphates by means of sulphurous acid instead of sulphuric acid is known in chemistry by the publications of Gerland, of Pavesi and Rotondi, and others, and especially described in Ger. pat. 2,364 of 1873 and 814 of 1879. The crude phosphates are treated with a strong solution of sulphurous acid in water. The solution thus obtained, containing bisulphite and monobasic phosphate of lime, is heated, bibasic phosphate of lime is precipitated, and sulphurous acid is disengaged, which passes back into the dissolving vessels. If the crude phosphates contain, however, large quantities of free lime, or carbonate of lime, all this lime is also dissolved by sulphurous acid as bisulphite of lime, and will also be precipitated, together with the phosphate of lime, by heating the solution obtained. This precipitate, therefore, would not contain more phosphoric acid than the crude phosphate. By the process of Haenisch and Schroeder, Ger. pat. 37,209, the free or carbonate of lime of the crude phosphates is reduced to sulphate of lime by treating the crude phosphates with sufficient quantities of sulphuric acid. When treating phosphates prepared thus,

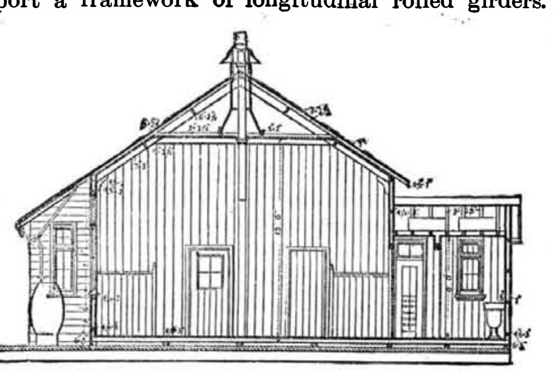
with aqueous sulphurous acid, only monobasic phosphate and bisulphite of lime from the bibasic phosphate are dissolved, while the sulphate of lime remains undissolved, and is separated from the solution. By heating this solution, only bibasic phosphate of lime is precipitated, and sulphurous acid is disengaged, and this returns in the process. The precipitated phosphate is dried and roasted for the purpose of oxidizing small quantities of sulphurous acid contained in the precipitate, which afterward is rendered soluble by the sulphuric acid treatment. In like manner, Gladyoz, of Marseilles, Ger. pat. 37,352, makes use of sulphurous acid for extracting tartaric acid from dregs of wine or other crude materials containing tartrates. The dregs, etc., are diluted by the mother liquor of the former operation, and treated in the cold with a current of sulphurous acid in a leaden vessel, supplied with a stirrer, till all the bases of tartaric acid are dissolved as bisulphites, and tartaric acid is also in solution. By heating the filtered solution to 100° C., tartrate of calcium is precipitated, while from the cold mother liquor acid potassium tartrate precipitates. This acid potassiun tartrate, dissolved in boiling water, is treated with an aqueous solution of bisulphite of calcium, whereby tartrate of calcium is precipitated, and sulphite of potassium remains in solution. Or, the solution of acid potassium tartrate is treated with hydrate of lime, and tartrate of lime is formed, while neutral potassium tartrate remains in solution. This solution is treated with sulphurous acid, and acid potassium tartrate is precipitated, while sulphite of potassium is left in solution. The former is again treated with hydrate of lime, to form tartrate of calcium, and neutral potassium tartrate, and so on, till all the acid potassium tartrate is converted into tartrate of calcium. The solutions of sulphite of potassium are decomposed with hydrate of lime, to form hydrate of potassium and sulphite of lime. Sulphurous acid also is used in obtaining phosphate of magnesia from phosphates of lime, by Von Maltzan, Ger. pat. 37,333. Phosphates of lime are dissolved by sulphurous acid, and the solution is treated with magnesium sulphate, in a quantity corresponding to the dissolved quantity of lime. After filtering from the precipitated gypsum, the solution is mixed with magnesium oxide, hydrate or carbonate, to precipitate magnesium phosphate. The remaining solution of magnesium sulphite is converted into sulphate of magnesia in a suitable manner by an oxidation process. This magnesium sulphate is used in precipitating gypsum from the sulphurous acid solution of calcium phosphate. In this manner the sulphurous acid is used twice in the same process of manufacturing magnesium phosphate.—*Industries.*

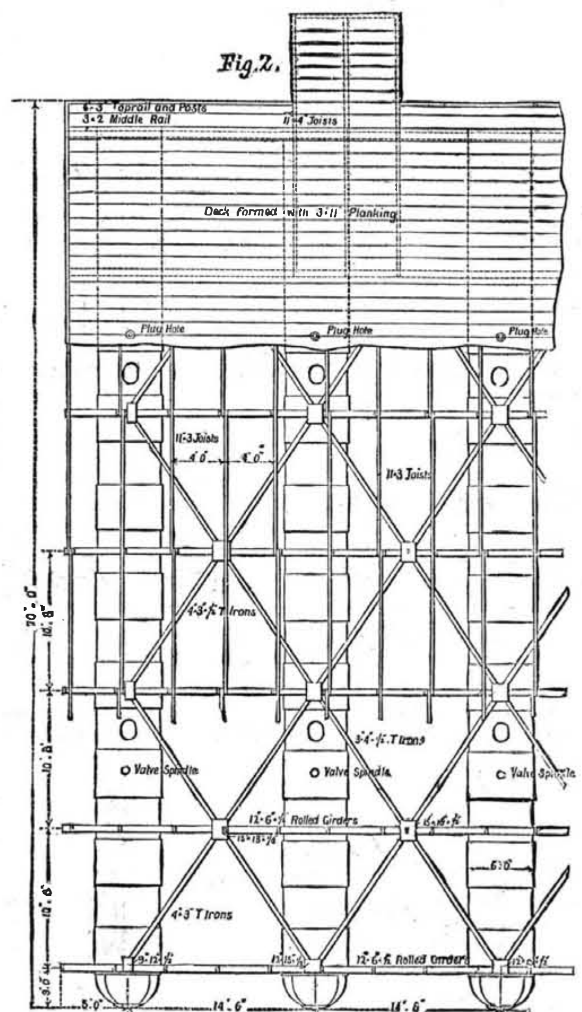
A FLOATING HOSPITAL.

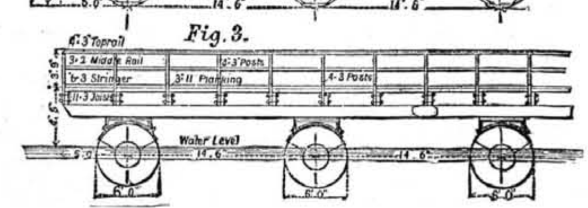
THERE was recently launched from the yard of Messrs. Wood & Skinner, at Pelaw Main, the floating hospital illustrated in the annexed engravings. It has been built to the order of the River Tyne Port Sanitary Authority, Mr. W. G. Laws, of Newcastle-upon-Tyne, being the designer.

The hospital, says *Engineering*, is built on ten cylindrical iron pontoons with hemispherical ends. The buoyancy of each of these is 53½ tons, and the floating power of the whole is equal to 535 tons. Each pontoon is 70 ft. long and 6 ft. in diameter. They can be revolved without removal, and being all separate, any one of them may be removed for cleaning or painting purposes without interfering with the rest.

Upon each pontoon are seven "saddles," which support a framework of longitudinal rolled girders.







FLOATING HOSPITAL ON THE RIVER TYNE.

These girders are braced together by diagonal T iron, and upon this is raised a deck or platform of creosoted timber, on which the hospital is erected. The hospital consists of three main buildings, six smaller ones, and a mortuary. The main buildings are about 23½ ft. wide and 20 ft. high, and are each divided into two hospital wards, the one to accommodate six beds and the other four. Between these two wards there is a nurse's room, with glazed doors on either side, so that a view of each ward is commanded. One bath-room serves for both. The space between the surface of the river and the platform is 4 ft. The houses are built of timber, colored a drab shade. The roofs are zinc. The interior is lined with pitch-pine, varnished. In connection with each block are two out-buildings, containing lavatories, etc. A fourth block is contemplated, and in the meantime it is necessary to have forty tons of ballast placed in a long box upon the open side of the platform.

THE MORPHOLOGICAL CAUSES OF HEREDITY.*

OF all the mysteries of nature, the development of the embryo is, without contradiction, the most obscure, and the one which most obstinately has eluded the researches of naturalists. During this century, since the classical works of C. Von Baer, a large number of scientists have devoted themselves to embryological studies. Certainly it would be unjust to pretend that for the explanation of this problem all the labors of the preceding years have been in vain, since they have added to science a new department full of varied and interesting observations. In extending the field of investigation to almost the whole animal kingdom, and in studying, above all, the course of development in the lower animals, these labors have at the same time given us numerous indications concerning the diverse phases of development of the higher organisms. Indeed, the embryological literature is so voluminous that the specialists themselves have difficulties in perusing all the documents placed at their disposal. But, alas! these materials are purely *descriptive*, and at best they furnish a starting point for the attempt to explain the phenomena so scrupulously observed. The embryologist takes the germ cell the moment it detaches itself from the organism of the parents, and follows it through all the phases of development through which it passes, from fecundation to the complete reproduction of the individual. Commencing with segmentation, all the succeeding modifications of form which the ovum has to undergo during its evolution are studied, observed, and described with as much fullness as precision. And then, have all these descriptions, all these manifold observations, enlightened us in regard to the problem of the development of the organism? Very little indeed! Two essential questions concerning the reproduction of the individual interest the thinker. In the first place, which are the forces inherent in the germ cell directing its development and its course through the whole cycle of the regular modifications? Secondly, what enables this cell to transmit through hundreds of generations of the vegetable and animal kingdom all the characteristic peculiarities of structure and form?

The first problem concerns the laws of development and of growth; the second, those of hereditary transmission.

In studying the embryological phenomena, the naturalist sometimes cannot help confounding or combining these two problems, since during his researches the same observation may contribute toward the solution of either. But the philosopher must always distinguish between them. The solution of the first problem may very likely give us the clew to the second. When we know the forces which govern the development of the fœtus and the laws of growth, we shall no doubt be in a position to explain also the causes of hereditary transmission. But, on the other hand, these causes might be known to us in all their details without making the answer to the first question any easier. Let us frankly admit that, up to the present, we have not advanced a single step toward the solution of the first problem, nor have we even made a single real attempt in order to solve it.

Some hypotheses, most of which are not worth serious analysis, is all that the scientific efforts made in this direction have brought about since Hippocrates and Aristotle to the present day.

More recently, Mr. Haeckel has enriched, if not science, at least the zoological literature with some theories of development, such as the paragenesis of the plastidule, the undulatory development of vital particles through the transmission of the reproductive force, etc.

We are more fortunate in regard to the problem of hereditary transmission.

First of all, we will try to clearly formulate it. How are all the characteristics of a higher organism, including the most minute details of structure, how are all the physical and intellectual capacities, transmitted from generation to generation, without sometimes undergoing any modifications during a whole geological period? This question becomes still more perplexing when we see that among the thousands of diverse organic cells *one alone* is devoted to hereditary transmission, one alone is possessed of the faculty to reproduce in a new individual all the peculiarities of structure of the organism from which it proceeded. In what way does this unique cell, through perpetual division and multiplication, reconstruct the exact image of the organism? Several solutions of this problem have been proposed. We submit only one, which has met with great approval, more on account of the famous name of its author than its intrinsic value. We mean the paragenesis of Darwin.

According to this hypothesis, each cell gives off "small germs," which are always present in the organism and which accumulate in the cell destined for the reproduction of the species. Those germs, moreover, have the permanent capacity to form new cells, or, in other words, to reproduce new organisms resembling in every respect that of the generator. But for the justly honored name of Darwin, the *naiveté* of this hypothesis would at once have become apparent. It is just as little admissible from the physiological point of view as from the morphological. The ingenious efforts of Mr. Broocks to defend it are likewise based on inacceptable hypotheses. Mr. Galton, a relative and an ardent admirer of Darwin, moreover, has furnished irrefutable evidence proving that the Darwinian "small germs" do not exist. Quite recently one of the most eminent German zoologists, Mr. August Weismann, professor in Freiburg, well known through his remarkable works on embryology and comparative anatomy, has given a new explanation of hereditary transmission, which for the present must be considered the most probable one. In spite of its apparent boldness, this theory is really one of the simplest, based on observations and incontestable data. It has easily triumphed over all objections that have been raised. In order to accept it, one need not resort to new hypotheses. Besides, it throws new light on several fundamental problems of the natural sciences. The theory of Professor Weismann will be fruitful, and serve as a starting point for further researches. All these qualities perfectly account for the favorable reception it has met with in the scientific world and have strengthened our desire to make it known to a larger public. It will be seen, moreover, that this theory touches upon a philosophical question much debated at present, and that it strikes a blow at some of the most popular evolutionists.

This theory, styled by its author "the theory of the perpetuity of germ plasm" (*continuit at des Keimplasmas*), is as follows: Granted that the hypothesis of Darwin, which considers the germ cell an *extract of all the cells of our body*, is inadmissible, there remain only two ways to explain *physiologically* hereditary transmission. Either the substance of the germ cell is possessed of the faculty to traverse the whole cycle of modifications which lead up to the *reproduction of the individual organism*, and thereupon to the *reproduction of identical germ cells, or the germ cell does not issue at all from the body of the individual, but directly from the germ cell of the parents.*

Professor Weismann pronounces in favor of the latter supposition, which also forms the basis of his theory. He admits, then, that the germ substance, being possessed of certain chemical and physical properties, as well as of a distinct molecular structure, transmits itself from generation to generation. The germ cell from which emanate our descendants contains molecules of this substance, which issue *directly* from the substance of the germ cells of our most remote ancestors. Professor Weismann calls this substance "germ plasm" (*Keimplasma*). According to this theory, the specific plasm contained in the germ cell does not participate, *in its entirety*, in the reproduction of the new organism, because a *part* of it is reserved in this organism for the formation of the germ cell of the new generation.

This theory, we have remarked, is as bold as it is simple. In reality, the idea on which it is based appears to be bold only because it is new. It possesses, however, such a degree of probability that we may accept it without doing violence to any established truth. It also explains in the simplest manner hereditary transmission, because it reduces it to a phenomenon of continuous development, which is the most constant phenomenon of life. If really the generative plasm forms part of the plasm which was contained in all the germ cells of the preceding generations, it *must* possess the same properties of reproduction, and after having passed through all the gradations of development, *must of necessity lead* to the same final result. The germ plasm thus constitutes *the immortal part of our organism.*

Where is this plasm to be found? The brilliant embryological researches made within the last years by Hartwig, Fol, and especially by Van Beneden, do not admit of any doubt that the germ cell plays but a secondary part in fecundation, which in reality results from the copulation of two nuclei contained in the male and female germ cells. This process, as Van Beneden has observed in the *Ascaris megalocephala*, takes place through the union of the nucleus of the spermatozoon with that of the ovule, which blend into one nucleus—the segmentary nucleus, the one which develops in order to form the whole organism. The germ cell containing the nucleus has merely to furnish material for the nutrition of the latter.

Germ plasm is solely the one contained in the very nucleus. The surrounding cellular plasm is but the nourishing substance. The exchange of substances in this cellular plasm depends on the germ plasm, from which emanate the molecular impulses, determining the transformations which take place in it. The molecular structure of the germ plasm is evidently extremely complicated, and this complexity is greater in the higher organisms.

We have already stated that only a part of the germ plasm contributes to the growth and gradual development of the nucleus. The rest, which forms, so to speak, *the reserve capital destined for the preservation of the species*, is deposited from the beginning of development in the future sexual organs, which may directly be observed in the "*volvox*" and the "*pandormia.*" It is easy to understand that the more the organism develops, the less complex becomes the plasm in regard to its properties for the reproduction of the different parts of the body. Little by little it loses its capacity as germ plasm, which in its entirety belongs

* An exposition of Professor A. Weismann's theory of the "perpetuity of germ plasm." Die Continuitat des Keimplasmas als Grundlage einer Theorie der Vererbung. Prof. A. Weismann. Jena, 1885

only to the plasm of the segmentary nucleus. In order to complete the exposition of the new embryological views which form the basis of the theory in question, we should state that, according to Messrs. Weismann and Strassburger, the nucleus of the spermatozoon and the nucleus of the ovule have the same physiological value, that is to say, they do not differ as to their essence.

It will be unnecessary to dwell on the observations and numerous facts which have furnished the material for the theory of "the perpetuity of germ plasm." We have already stated that it rests on too solid a basis to be doubted without serious reasons. However that may be, it gives scientifically entire satisfaction.

To the question, then, how a single cell of our organism is able to reproduce the exact image of this organism, science answers *that it accomplishes this reproduction, because a part of the plasm contained in its nucleus perpetually transmits itself from generation to generation.*

The reader, who realizes the great importance of the question of hereditary transmission in view of our actual conception of the organic world, will perceive that this answer implies something else and more than a simple explanation of the morphological causes of heredity. We can easily understand that owing to the "perpetuity of the germ plasm" the hereditary transmission of all the *innate* characteristics of the parents is an unavoidable necessity; but, on the other hand, this theory cannot be reconciled with the transmission of *acquired* characteristics, which hypothesis is precisely the basis of all the evolutionist theories. In other words, the theory of Prof. Weismann excludes this possibility of transmission, upon which transformism depends. The fact is the more significant since Prof. W. himself has been an ardent advocate of Darwinism. His remarkable works, collected under the title "Beitrage zur Descendenz-Lehre," have greatly contributed to the propagation of this system among the earnest thinkers of Germany. Mr. W. of course fully realized that his theory had struck a blow at Darwin's "On the Origin of Species."

In a work specially devoted to *heredity*, he tries his best to heal the wound he has inflicted. "If there exists no certain proof," says he "of the hereditary transmission of acquired characteristics, there is just as little proof that the theory of transformations can be sustained only by means of this mode of transmission." And he does all he can in order to save this theory, but alas! he is compelled to confine himself to some vague suppositions. It is not difficult to perceive that the author is anxious to defend his own doctrine, but that he himself despairs of saving the evolution theory, at least in its present form, after the elimination of the principle of the transmission of acquired qualities. To be sure, the first task is easier than the second. Prof. W. has no difficulty in proving that up to the present "there is not recorded a single observation, not a single fact, proving the heredity of acquired characteristics."

The eminent physiologist Pfluger is of the same opinion. "I have closely studied," says he, "all the facts cited in favor of the hereditary transmission of acquired qualities, by which I mean qualities not derived from the primitive organization of the ovum and of the spermatozoid substance, but which the organism has appropriated later under the influence of exterior causes. *Not one of those facts proves the heredity of acquired qualities and characteristics.*"

The celebrated Professor Du Bois Reymond is not less categorical in saying: "If we wish to be sincere, we ought to confess that the heredity of acquired characteristics *has been solely invented for the sake of facts which had to be explained*, and that it is simply an obscure hypothesis."

In citing all the arguments which invalidate this mode of heredity, Professor Weismann also refers to Mr. Maegeli's observations on plants demonstrating the non-transmission of acquired characteristics. In order to defend as much as possible the theory of the "origin of species," Mr. Weismann disposes of the fundamental principle of Lamarck's theory, viz., that the organ develops or retrogrades in conformity with its use or disuse, and that the sum of all these gradual modifications transmitted through heredity brings about the transformation of species. It is evident that the idea of Lamarck, as stated, cannot be reconciled with Weismann's theory of the perpetuity of germ plasm. According to the author, however, it may yet be sustained by means of natural selection. The useful or useless organs are exercised or not in the struggle for existence. Selection eliminates the individuals whose germ plasm is in itself less favorable to the development of useful organs. Thus the results of usage during life would not count at all. Consequently the strength or weakness of an organ, for a series of generations, must not any more be looked upon as the sum of the results of isolated exertions, but rather as the product of the favorable germ elements.

By means of this restriction one might, for better or for worse, succeed in saving the theory concerning the strength or weakness of certain organs.

But the development of rudimentary organs or the useless disappearance of certain other organs, in short a number of important facts of the theories of evolution, cannot for the present be severed from the hereditary transmission of acquired characteristics.

Professor Weismann resorts yet to another rather forced argument in order to ward off the blow which his theory strikes at Darwinism. During life, exterior influences might directly modify the germ plasm, which transmits the hereditary characteristics of the individual, and it is these modifications which are transmitted from generation to generation. That might be the case, and, if so, it would perfectly account for the transmission of certain *constitutional* diseases. But the modifications of *external* organs brought about by causes not affecting the germ plasm (and transformism is based on the very possibility of similar modifications)—how can they be explained by this theory without the intervention of the hereditary transmission of acquired qualities? Every candid transformist will recognize this almost insurmountable difficulty. In his last work Prof. Weismann contents himself with merely alluding to it, and refrains from attempting an impossible reconciliation.

However that may be, the theory of the perpetual transmission of the germ plasm meets with only one serious objection—the hereditary transmission of acquired characteristics; but since this transmission is only an unproved hypothesis, invented for the needs of the transformist cause, this objection, properly speaking, does not exist.

Of the two cardinal questions, then, Which are the forces transforming protolpasm into a human organism? and, How are individual characteristics transmitted from generation to generation? the second only seems at last to have received a satisfactory scientific answer.—*Translated from La Nouvelle Revue.*

[Continued from Supplement, No. 581, page 9285.]

ASTRONOMICAL TELESCOPES: THEIR OBJECT GLASSES AND REFLECTORS.

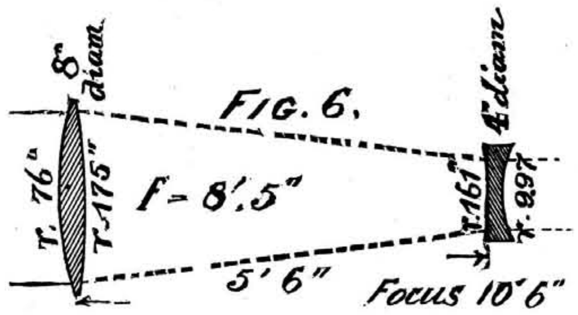
By G. D. Hiscox.

II.

THE DIALYTE TELESCOPE

is still quite a favorite among amateurs in England and on the Continent, from the fact that the adjustment for achromatism, and, with it, for spherical aberration, when the curves have the proper form, becomes only a matter of position of the corrector.

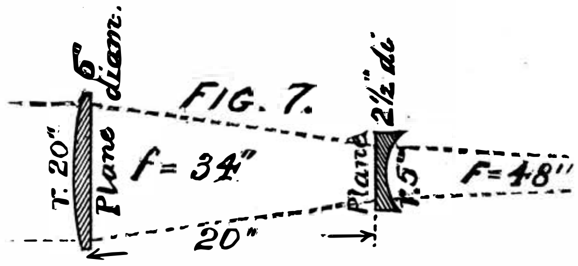
We give drawings of the leading forms; the first, Fig. 6, being the most simple one, consisting only of



two lenses, as made by Plossel and others, the figures for curves being specific, and representing the radii in inches.

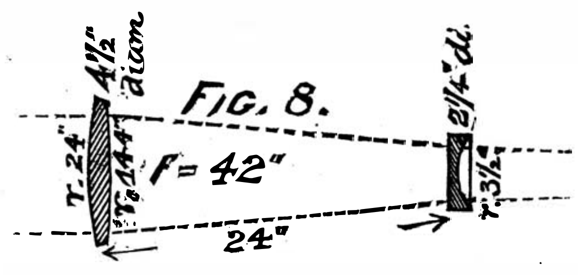
Object glass 8 in. diameter, corrector 4 in. diameter, with a combined focal distance of 10½ ft. For amateur work, a clear French or English plate glass and a medium dense flint corrector may be used.

The next, Fig. 7, is an English form, each lens having a plane side.



Combined focus about 48 in.

A more complex form, Fig. 8, and of very fine definition, is made by adopting the form of object lens for

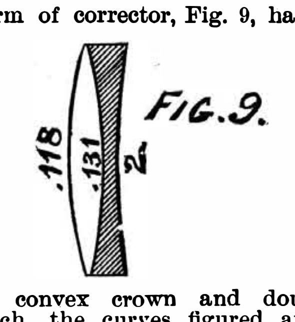


least spherical aberration and a corrector with both surfaces plane.

The flint corrector is of 3·65 density, combined with a plano-convex crown and cemented.

In this form, it will be observed, the radii of the object glass are as 1 to 6, or form of least spherical aberration. By following the proportions here given, making the radius of the first surface 5¼ times the diameter of the object glass, the distance of the corrector equal to the radius of the first surface, the interior curve of the plane corrector ⅙ the radius of the first surface of the object glass and its diameter half that of the O. G., telescopes of other sizes may be formulated.

Another form of corrector, Fig. 9, has been made



with double convex crown and double concave flint, of which the curves figured are exponents of the front curve of the object glass, in proportions of its radius, its form being that of least aberration, or 1 to 6, and their relative diameters as 2 to 1.

Thus if you have a 4 in. disk of crown or plate, your corrector may be 2 in. diameter (Fig. 9). The curves will then be from the above proportions:

4 in. diameter × 5¼ = 21 in. radius of first surface.
21 in. × 6 = 126 in. radius of second surface of object glass.

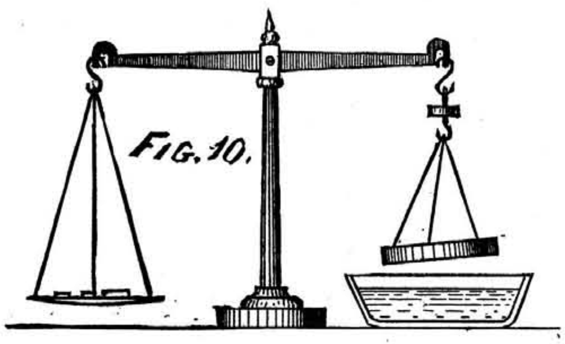
Then for the corrector:

21 in. × 0·118 = 2·48 in. radius first surface } crown.
21 in. × 0·131 = 2·75 in. radius second surface }
2·75 in. radius first surface, flint.
21 in. × 2 = 42 in. radius last surface, flint.

The distance between the object glass and corrector will be about 21 in., or equal to the radius of the first curve.

The curves of all the above correctors may possibly require to be slightly modified to suit the extreme dispersive powers of different kinds of glass; but with the above figures, we recommend amateurs to use crown or plate of 2·50 density, and flint as nearly the density of 3·50 as possible.

For ascertaining the specific gravity, use any scales that have a beam (Fig. 10), preferably a druggist



scales. Unhook one of the pans, and balance the other by hanging a weight equal to the weight of the displaced pan, close up to the eye in the beam, with a loop or hook underneath for hanging the glass to be weighed.

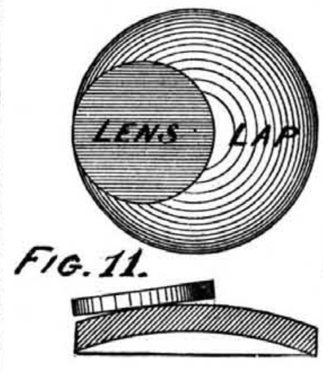
The glass disk may be suspended in a triple loop of strong thread, at a distance from the counter, to allow a basin of water to be placed beneath, and raised to immerse the glass, after the first weighing in air has been completed. The disk of glass should be clean and free from grease, so that the water will wet it when immersed. Hang it in the thread stirrup a little tilted, so that there may be no bubbles of air retained on its under side.

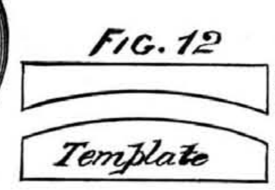
Proceed to weight the disk in air, making an exact record; then lift the pan of water until the disk is just immersed, placing a box or other support underneath, to hold it steadily in place. Take out of the scale pan the weights to exactly balance. Now subtract the weight of the disk in water from its weight in air.

The remainder is the weight of water displaced by the disk. Divide the weight in air by the weight of the water displaced by the disk; the quotient will be the specific gravity.

The tools and materials for grinding and polishing lenses, as well as their manipulation, may be considered of vital importance to the amateur; in fact, it is the block on which many ambitions have been decapitated.

When the details of size and curves have been decided upon, the next step is to provide a roughing lap, Fig. 11, which may be of cast iron, of about twice the





diameter of the object glass, to save time and labor in rough grinding. Convex on one side, concave on the other; and both of the exact radius of the proposed surfaces; supposing that you make your first trial with an object glass of three equal curves.

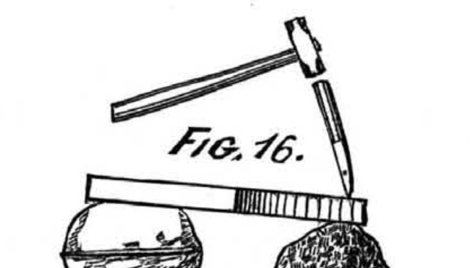
The thickness of the lap should be about one sixth of its diameter.

The pattern may be turned upon a lathe and the curved surfaces exactly matched to a pair of radial templates, Fig. 12, which may be struck on a cardboard with a radius bar, and cleanly cut with a knife. Varnish the pattern with shellac, that it may not warp; then, if a clean casting is obtained, there will be no need of turning its surfaces. A piece of sandstone may be used to grind down any roughness, when it will be ready for use.

Attach the lap to a bench with pitch that is soft, or resin softened by melting and mixing with a little turpentine and tallow, or with cobbler's wax; placing the pitch at three points on the outer edge of the lap by making three balls like marbles and sticking them to the bench warm, pressing the lap upon them to make the required bearing, thus saving time and trouble in loosening the lap for turning over.

The glass disks are supposed to be purchased of nearly an equal size. If not, they should be brought to a size, either by grinding on a grindstone to fit a circle gauge or by chucking upon a vertical spindle in a grinding machine, placing a copper band around the edge, and grinding to a proper size with emery and water.

If the glass is in squares, a glazier's diamond may be used to cut across the corners, or if no glazier's diamond is at hand, or fails, the corners may be chipped off with a small hard chisel. Lay the glass upon a piece of soft lead so that it will touch directly under the point of the chisel, as in Fig. 16, and tap the chisel with



a very light hammer, chipping off a small piece only at a time.

Try this on a piece of thick glass of no value, to gain practice.

The emery for rough grinding may be No. 20 to No. 30, which should be applied to the lap with an excess of water, so as to make the movement of the glass disk over the lap to work freely without washing the emery off before it has expended its abrading qualities.

When the edges have been brought to their proper and equal sizes, a handle of hard wood for each disk, Fig. 13, well varnished with shellac, is to be cemented

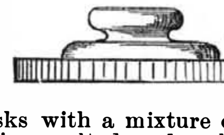


FIG. 13.

to the disks with a mixture of common black pitch and whiting, melted and well stirred, adding a few drops of turpentine, so that when cold the finger nail will easily make a dent in its surface. Warm the glass disk just enough for the cement to stick, and spread the melted cement on the handle and fasten it on the center of the disk.

The grinding and polishing of the smaller sized objectives will be largely facilitated by the use of the optician's lathe, which we here represent, as illustrating the lathe and hand work methods.

FIG. 14.

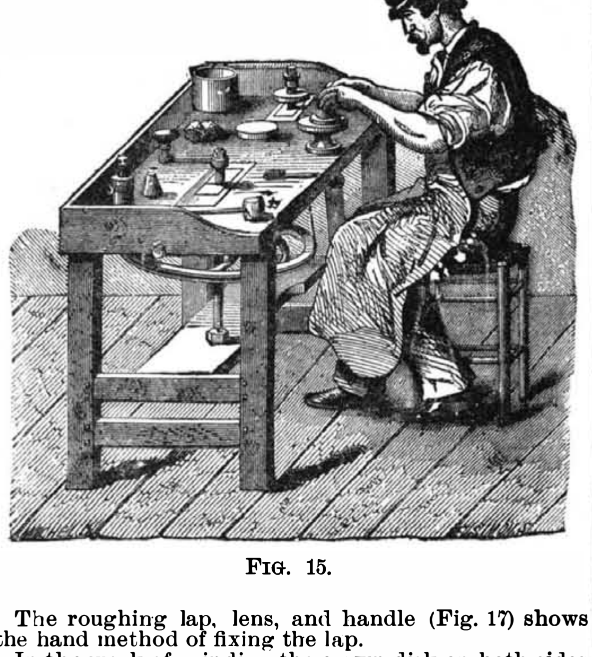
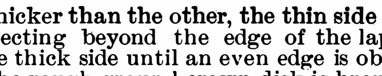


FIG. 15.

The roughing lap, lens, and handle (Fig. 17) shows the hand method of fixing the lap.

In the work of grinding the crown disk on both sides until the edge is 3-16 in. in thickness for 4 in. or 5 in. disks, care must be taken that the edge is of even thickness all around. If it is found to be coming down with

FIG. 17.



one side thicker than the other, the thin side should be kept projecting beyond the edge of the lap, so as to abrade the thick side until an even edge is obtained.

When the rough-ground crown disk is brought to an even edge and required thickness, the lap may be turned over and the flint disk ground on the convex lap until its concavity reaches the edge of the disk; the edge of the flint having been also ground and sized to exactly match the crown disk. The last or back surface of the flint disk may now be rough ground on a flat lap or any piece of flat iron to reduce its thickness in the center to about one-tenth its diameter, unless a curve for the last surface is previously decided upon, in which case a pair of laps should be provided for the proper curve. These may be made from the original pattern by changing the face curve, and casting a pair as before described.

The flint disk, when finished in the rough, should have its edge of equal thickness all around, both disks being accurately gauged with delicate calipers.

The laps for finishing should be made of brass, although cast iron makes a fair lap if cast face down. Make the patterns of clear dry pine, one-sixth their diameter in thickness, and one-tenth larger than the glass disks, with a rim on their backs one inch high and one-half the diameter of the laps, to make them easily handled.

The convex and concave faces of the patterns should be made to an accurate gauge, and rubbed together with ground glass or fine dry emery, wiped clean, and varnished with shellac.

If this is neatly done, and good, smooth castings obtained, there will be no lathe work required.

The laps may be immediately ground together with medium or No. 60 emery and water to a perfect fit. These are for bench laps only.

If the optical lathe is used, the laps will require a screw hub, cut and fitted to the chucking screw of a lathe, upon which the face must be turned true, and to fit the curve template. The screw of the optical lathe must also run true, and correspond with the screw nozzle of the turning lathe. This being, perhaps, more than an amateur may desire, we will continue the amateur method.

The laps, when finished, may be fitted to a block of wood (Fig. 18), which may be screwed to a post of con-

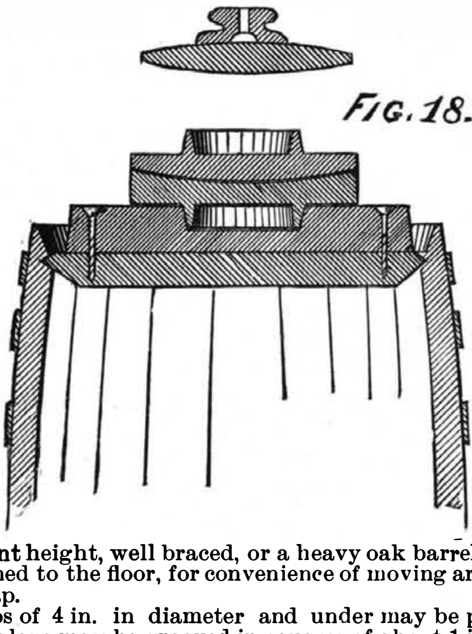


FIG. 18.

venient height, well braced, or a heavy oak barrel well fastened to the floor, for convenience of moving around the lap.

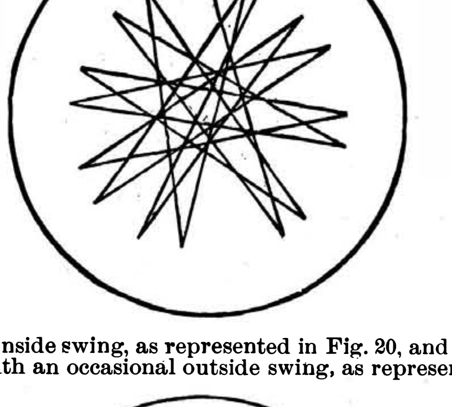
Laps of 4 in. in diameter and under may be plain, larger laps may be grooved in squares of about 1 in., as shown in Fig. 24.

Place a little soft pitch or beeswax around the edge of the block to steady the lap, and give it an even bearing.

Next proceed to grind the laps to an even grain with No. 60 emery, and start the grinding of the crown lens. Bring one side to an even, fine surface, then change the handle by warming the disk and separating it from the handle, scrape off the excess of pitch, fasten the handle to the other side and cool. Then wipe off the remaining pitch from the surface with turpentine on a cloth, and proceed as before with the second surface. Then, changing the laps, fine the concave inner surface of the flint, and again changing the handle, fine the last surface of the flint to a flat, or the curve decided upon.

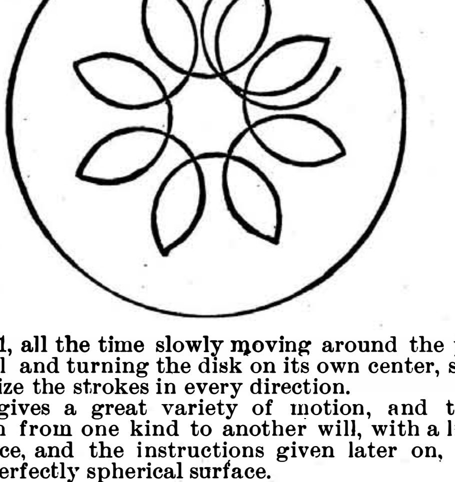
The proper motions of the hand for this work are an important means for obtaining a true spherical surface, and may properly be classed in three different forms, viz., rectilinear motion across the lap, as represented in Fig. 19, interspersed with cycloidal motions

FIG. 19



with an inside swing, as represented in Fig. 20, and also varied with an occasional outside swing, as represented

FIG. 20.



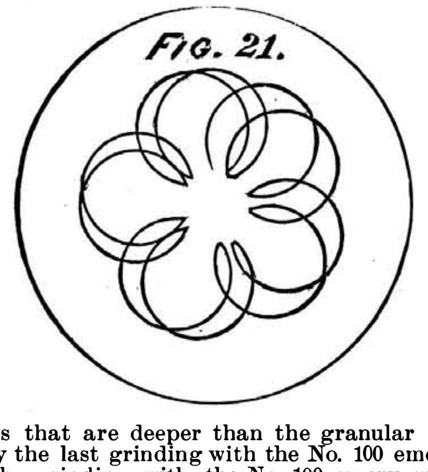
in Fig. 21, all the time slowly moving around the post or barrel and turning the disk on its own center, so as to equalize the strokes in every direction.

This gives a great variety of motion, and their variation from one kind to another will, with a little experience, and the instructions given later on, produce a perfectly spherical surface.

During the grinding of the lenses, the concave and convex laps should also be ground together to keep them of the same curve and of a true spherical form.

The process of grinding as above described may now be repeated with No. 100 emery, taking the precaution to clean away all traces of the coarser emery from lenses, handles, laps, and bench. When this grinding is finished, clean and examine all of the surfaces with a magnifying glass of about 1 in. focus, for the purpose of detecting any marks of the coarser emery. If any deeper pits or marks of the coarser emery, or any

FIG. 21.



scratches that are deeper than the granular surface made by the last grinding with the No. 100 emery are found, the grinding with the No. 100 emery must be continued until there is an even grain all over the surface.

The lenses are now ready for the final emery finish, which, after cleaning all surfaces, laps, handles, and bench of other emery, may be made with the finest washed flour of emery, or in preference Van Amringe's No. 5 to No. 10 washed flour, which is sold in one pound cans at 25 cents, and can be obtained by postal order or otherwise from Thomas Van Amringe, No. 306 Pearl St., New York.

The washing of flour of emery is very tedious, and few opticians practice it.

The process for washing is as follows: The necessary articles are a pail of clean water, a large pitcher, two flat earthenware dishes, two pieces of brass or glass tubing of about one-quarter inch internal diameter, and a piece of thin rubber tubing of a size to slip over the ends of the brass or glass tubes, one of which should be long enough to reach to the bottom of the pitcher and at the same time allow of its being held in the hand for stirring the emery.

Then place the apparatus as shown in Fig. 22.

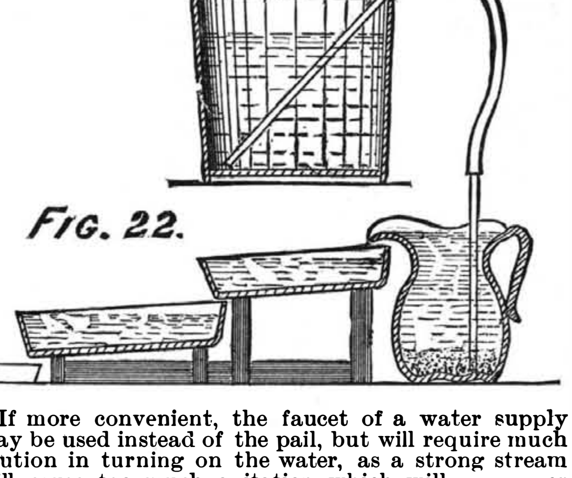


FIG. 22.

If more convenient, the faucet of a water supply may be used instead of the pail, but will require much caution in turning on the water, as a strong stream will cause too much agitation, which will carry over the coarser particles of emery. The pail will give a quiet, even flow. Notice that the dishes are placed slightly inclined, in order to discharge at the opposite ends from the pitcher.

Place in the pitcher one or two pounds fine flour emery; pour in water to half fill the pitcher; stir the emery with the pipe until it is thoroughly wetted; then fill both dishes and the pail with water, and have a supply of water at hand for replenishing the pail.

Start the siphon with the mouth, and slowly stir the emery at the bottom of the pitcher with the tube; the water gradually rising and overflowing into the first dish will carry the fine emery with it, which partially settles in the first dish, with a finer grade flowing over to and settling in the second dish; the water then may flow into a third dish or to waste. Do not wash over more than one-half of the emery put in the pitcher. If the flour emery is not of the finest grade, not more than one-quarter should be washed over.

After the dishes have settled, the water is to be carefully poured or siphoned off the dishes, the flour partially dried and scraped into a clean vessel and covered.

Much will depend upon the quality of the flour emery used as to whether the settlings of No. 1 or No. 2 should be used for the last finish. Better make a trial with No. 1. If found not satisfactory, finish with No. 2.

In working with the washed flour much care must be used in controlling an even and light swing of the hand, using the motions as shown in Figs. 19, 20, and 21. The emery should be just wet enough to flow freely, or of about the consistency of thin paste; a cup of water at hand, and small wooden spatulas for water and emery. Work the laps to a fine surface before commencing with the lenses.

Frequent turning over of the laps is desirable for insuring a perfectly spherical surface.

The overhang of the top lap, together with the slight pressure required for moving it, abrades the outer edge of the lower lap faster than other parts, producing thereby a tendency toward slight distortion from a true sphere.

This may also occur when finishing the lenses, and may be counteracted by so manipulating the contact of the fingers on the handle as to balance the overhang of the disk as it is moved off the center.

When more emery and water are required upon the lap, the top lap or lens should be carefully slid off and a little added, spreading with the spatula. Then work the lens down by degrees, so as to spread the emery evenly over the surface. If the lap works dry too fast, dip a tooth brush in the water, and snap a spray over

the partially exposed surface of the lap by drawing the finger nail across the brush. The emery should neither be so thin as to run nor so thick as to roll up and break the contact. A little practice will soon show the right conditions.

Supposing that the surfaces of the lenses or object glass are now true and free from pit marks of coarser emery or scratches, the arrangements for polishing may now proceed by a thorough cleaning of all traces of emery from lenses, laps, and bench.

Other laps than those used for grinding may be desirable, and can be made from the original patterns, using them rough for polishing beds; which enables the ready use of the finishing lap in case of failure in polishing by scratches, or bad figuring.

Prepare the cement by melting and mixing in a clean saucepan 10 oz. clear light colored resin and 1 oz. turpentine. Put the turpentine in the saucepan with the resin, cold, heat gently until the resin softens, then stir with a clean wooden spatula.

When well mixed, stir in 1 oz. fine rouge, mixed thoroughly, and with a small stick take out a drop of the cement and place it in a basin of water of the temperature of the room you are working in. When the drop has cooled to the temperature of the water, press your thumb nail upon it. If it yields readily, it is too soft, and the mixture should be stirred hot to evaporate some of the turpentine, but not boiled, great care being used that the vapor does not take fire. Keep the covers on the stove or range, and provide a cover for the saucepan in case that it might take fire.

Take the saucepan off the fire when trying for temper. When, by trial, the drop or bead will just take an impression by the nail without flattening or flaking, it is right. Next, provide a piece of pine wood, which we will call a groove mould, with its edges curved to fit the convex and concave laps, and sharpened on both edges as in Fig. 23. Lay the strip in

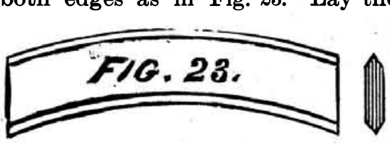
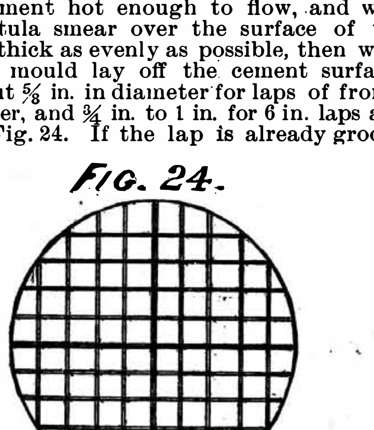


FIG. 23.

warm water and heat the lap just warm enough to melt the polishing cement to stickiness; also, melt the polishing cement hot enough to flow, and with the wooden spatula smear over the surface of the lap about ⅛ in. thick as evenly as possible, then with the wet groove mould lay off the cement surface into squares about ⅝ in. in diameter for laps of from 3 to 5 in. in diameter, and ¾ in. to 1 in. for 6 in. laps and upward, as in Fig. 24. If the lap is already grooved in

FIG. 24.



squares, the cement grooves may coincide with the lap grooves, in which case the cement may be smeared on only $\frac{1}{16}$ in. thick. In this operation the frequent wetting of the groove mould is necessary to prevent sticking.

If the surface of the polishing cement cools too fast, pour warm water over it, or set the lap in a pan of warm water deep enough to cover the cement and of about 120° temperature; this will enable you to bring up the squares evenly, and draw the little ridges toward the centers of the squares. Wet the surface of the lens with soapy water, take the lap out of the warm water, and quickly press the lens upon the cement, lightly moving it in small circles. Upon lifting the lens off, if the cement has been evenly laid, every square should show a contact of surfaces. If not satisfactory, or some of the grooves are filled in spots, they may be trimmed with a sharp knife; then warm water, as warm as the hand can bear. Pour it over the surface to soften the cement, when the lens may again be pressed upon and gently moved over the surface.

Now place the lap upon the pedestal block with the soft wax bearing to hold it steady. Provide a cup with the rouge made into a paste with water, a spatula of soft pine, also a cup of water with a second spatula, order and cleanliness being necessary to success in lens making.

The rouge should be of the kind known as jewelers' rouge, which is of a bright red color.

The kind sold as crocus is darker in color, and not recommended, it being too sharp and liable to scratch. It can be obtained from the jewelers' furnishing houses, or of Hamill & Gillispie, No. 240 Front St., New York, and J. & H. Berge, No. 95 John St., New York. It costs about $1 per lb.

Cover the face of the lap with wet rouge, and commence the strokes of the lens over the lap lightly, as in Fig. 19, for a half minute, turning the lens slowly on its center at the same time. Then slide the lens off the lap, and draw a clean finger across its face, get the reflected light from a window across the wiped streak, and observe if the polishing has started evenly across the whole face of the lens. If so, the polishing may be resumed, using the stroke Fig. 19, with frequent tests with the finger streak to see if the polishing is progressing evenly. If the center is found to be polishing the fastest, change the stroke as in Fig. 20, which tends to lengthen the radius of the lap. If, on the contrary, the outer edge of the lens appears brightest, it shows that the radius of the lap is lengthening, when the stroke Fig. 21 should be used; the lines in these figures representing the motion of the center of the lens. Sometimes a sweep around the lap is made for a change, it also having a tendency to shorten the radius. In making the strokes of any of these forms, the lens should be gradually turned on its own axis, and the person should move slowly around the pedestal, for the purpose of equalizing the friction in every direction.

Very gentle and equal pressure to be used at all times. If now particular notice be taken of the feel of the action of the different strokes by the fingers, much examination of the face of the lens may be avoided; for, toward the end of the polishing process, the feel of the fingers has to determine the condition of the lap entirely. During the process of polishing, the supply of rouge paste must be kept even, and also a light spray of water from the brush as before described, to compensate for evaporation.

Before the polishing is half finished the squares will be found to run together, so as to partially obliterate the grooves, when, with a sharp knife, they can be opened by scarfing along their edges, and washing off with a brush and clean water; when the polishing can be proceeded with as at first.

When the polishing is supposed to be nearly finished, the lens should be washed and wiped clean and dry; then examine the surface with a magnifying glass, by reflected light from the surface of the lens, to find traces of emery marks. If found in any quantity, observe if they predominate on the central or peripheral portions. Then renew the polishing, with the strokes predominating that tend to change the radius to meet the requirement as described for Figs. 19, 20, 21.

Supposing now that the first and middle surfaces of your object glass are finished, and the last surface so far finished as to be transparent, the object glass may be placed in its cell, and a trial made for centering and achromatism. See further on in regard to eye pieces. If the crown and flint lenses have their spherical centers in, or coincident with, the optical axis of the telescope, the image of the star should be round and central in the hazy patch of light caused by the imperfect polish of the last surface, as in Fig. 25.

The cone of light should be even and regular in its contour within and beyond the focal point. If there is eccentricity in the image, as in Fig. 26, find, first, if the plane of the cell holding the object glass is at right angles with the central axis of the tube. If the mounting has been made in a lathe, it may be inferred that it is right, and the cause of eccentricity must be sought in the unequal thickness of the edges of the lenses or a too loose fit in the cell. This may be remedied by turning one of the lenses around, or wedging the lenses to a common center, which will be shown by the change in the focal image. Do not fail to put a narrow slip of writing paper at three places between the outer edges of the object glass, fastened with a little soft wax, to keep the lenses from scratching each other by contact.

There is a method of perfecting the edges of object glass, after polishing, by chucking in a lathe with pitch cement, moving the lens while the pitch is warm, until both reflected images of a light shall cease to wabble, as seen in the two surfaces of the lens while revolving; when the outer edge may be turned true with a diamond.

For observing the achromatism, place the eye piece in focus and observe the color of the image of a first or second magnitude star, as you focalize both without and within the point of mean focus. If the object glass is under-corrected, the image within the mean focus will have a violet center with a red border. As the eye piece is drawn back past the mean focal center the central image will become red with a violet border. With an over-corrected object glass, the reverse of the above will take place. The inner or image next the object glass will be red with a violet border, while drawing back the eye piece produces a violet image with a red border. Fig. 27 will fully illustrate these conditions.

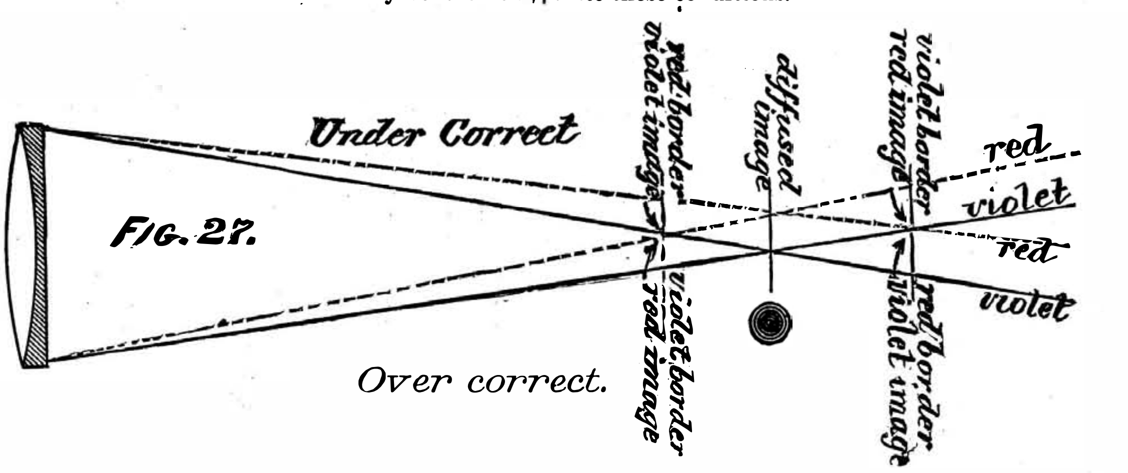


FIG. 27.

Upon examining the chromatic condition of the object glass, if it be found under-correct, the refractive power of the last surface of the flint lens must be lessened. If it is flat, it must be slightly concaved. This may be done, if a lathe is at hand, by facing the laps that the last surface was finished with to a template of a radius possibly from 30 to 10 ft.—which, in your judgment, will meet the requirement.

If there is no lathe at hand, the patterns for the flat pair of laps may be altered and ground together as before described, a pair of castings made, and the laps ground to a true long radius curve; the same routine being followed as described for the other surfaces. If the object glass is found to be over-correct, the last curve must be convexed, using the concave lap of the pair last described.

In this manner it is possible to fairly correct an object glass of unknown indices of refraction and dispersion with from one to two alterations of the last surface.

When a fairly colorless image, save the secondary spectrum, has been obtained, observations should be made for spherical aberration, if such is suspected, or shown by a diffused image.

When the spherical aberration is correct coincident with achromatism, the focal image of a star should be a mere point (even up to a moderately high power for the size of telescope under trial), with a small haze of faint violet light surrounding it, together with the scintillating rays of light from the larger stars, increasing in brilliancy with the diameter of the object glass. The violet or secondary image being due to the irrationality of the spectra of the two kinds of glass, while the scintillation may be more properly laid to a property of the eye than to any real defect in the image formed by the object glass.

The image each way from the focal point should be nearly alike, and of an even concentration of light throughout its area.

If there is any difference, the inside image should show the diffraction rings slightly and concentric.

The *rationale* of the spherically aberrated image is illustrated in Fig. 28 for an under-corrected object glass, largely exaggerated in its details, to show the principles involved in the formation of the images.

By inspection of the longitudinal section of an under-corrected image (Fig. 28), it will be observed that the

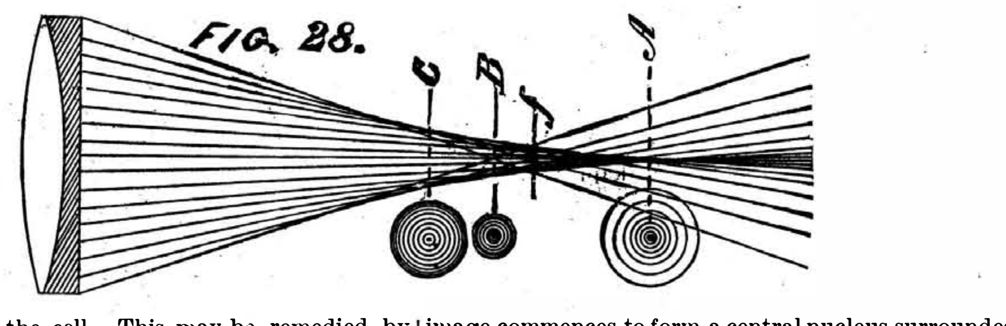


FIG. 28.

image commences to form a central nucleus surrounded by diffused light at A, as the eye piece is drawn back from the principal focus, *f*.

Moving the eye piece forward, the nucleus increases, while the diffused light decreases until a disk of nearly equal light is formed as at B, and a ring of light with diffused center at C.

The longitudinal section of an over-corrected image, as illustrated in Fig. 29, represents the same images at

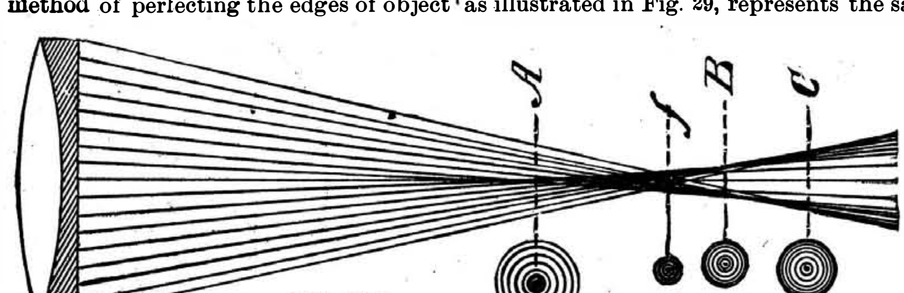


FIG. 29.

different points along the focal axis, only in a *reverse order*.

The correction of an object glass, when the first selected curves do not exactly meet the requirements for both chromatic and spherical aberration, becomes a somewhat difficult matter, and must be done by altering both internal curves and the last curve.

The simultaneous correction for both aberrations by assignment of curves from the first trial observation will be rather a difficult matter with the amateur, from want of experience in designating the relations of the chromatic and spherical images when blended; but by treating the chromatic phenomenon by itself, at first, as before described, and then making a specific observation as above for spheric aberration, you may be able to decide whether they are both under-correct or over-

correct, or whether there are opposite aberrations, and thereby apply the rule that with both aberrations under-correct the inner curves should be deepened by shortening their radii, and the reverse.

When there are opposite aberrations, the inner and last curve must be altered in opposite directions, controlling the chromatic aberration by altering the inner curves and the spherical aberration by altering the last curve.

It will be readily understood now that an amateur works under many disadvantages in initiating himself into the later intricacies of this, one of the most difficult of the optical arts; yet, to a person of will, and with a love for accomplishing difficult feats, the satisfaction of possessing a fairly good telescope of your own make will amply repay you for your labor and patience.

The so-called "spurious disk" that is observed when viewing star images under high powers is caused by the inability of all the rays of light forming the cone to pass a common center. The phenomenon of diffraction probably has much to do with the bending of the rays from their normal course in the formation of the disk. With the aperture cut down to less than half its diameter, the spurious disk is increased in size; showing that large-angled apertures in telescopes, as well as in microscopes, give the best definition, as well as the greatest amount of light.

To show the range of variation in the measured diameter of the disk of a first or second magnitude star, by varying the aperture and reducing the angle of the cone of light at the focal point, we give the measures of a trial with a telescope of 7·33 in. aperture.

Aperture, inches.		Seconds of arc.
7·33 in.	diameter of disk	0·693 in.
6· "	" " "	0·870 "
4·95 "	" " "	1·12 "
4· "	" " "	1·437 "
3· "	" " "	1·862 "
2· "	" " "	2·572 "

Thus showing the value of proportionally short focus telescopes for defining power, where qualities of glass and curves are well selected.

As the testing of a telescope, after the trials for both aberrations have become satisfactory, and the final polish completed, is of considerable importance, the double stars afford a good gauge for the different sized object glasses, of which the following are offered for ready reference.

A good object glass of 2 in. aperture with powers between 60 and 100 should show the companion to Polaris, α (alpha) Piscium, 5-6 mag., 3·6 sec. dis., μ (mu) Draconis, 4-5 mag., 2 8 sec. dis., γ (gamma) Arietis, 4·5-5 mag., 8·8 sec. dis., ρ (pi) Herculis, 4-5·5 mag., 3·7 sec. dis., ζ (zeta) Ursae Majoris, 3-5 mag., 14 sec. dis., α (alpha) Geminorum, 3-3·5 mag., 6 sec. dis., γ (gamma) Leonis, 2-4 mag., 2·6 sec. dis., γ (gamma) Ceti. 3-7 mag., 2·6 sec. dis.

A 3 inch aperture as above should show ε^1 (epsilon), ε^2 Lyrae, each double, 5-6 5 mag., 3 sec. dis., and 5-5·5 mag., 2·5 sec. dis., ς (sigma) Cassiopeia 6-8 mag., 3 sec. dis., ξ (xi) Ursae Majoris, 4-5 5 mag., 2 sec. dis.

A 3½ inch aperture should show π (pi) Aquilae, 6-7 mag., 1·7 dis., Σ (Struve) 941 Aurigae, 7-8 mag., 1·9 sec. dis., α (alpha) Lyrae, 1-11 mag., 46 sec. dis., β (beta) Orionis, 1-9 mag., 9·5 sec. dis.

A 4 inch aperture with powers from 80 to 120 should clearly define the companion to β (beta) Orionis, 1-9 mag., 9·5 sec. dis., ε (epsilon) Hydrae, 4-8·5 mag., 3·4 sec. dis., ε (epsilon) Boötes, 3-7 mag, 2·9 sec. dis., α (alpha) Lyrae, 1-11 mag., 46 sec. dis., γ (gamma) Ceti, 3-7 mag., 2·6 sec. dis., δ (delta) Geminorum, 3·5 9 mag., 7·2 sec. dis., ς (sigma) Cassiopeia, 6-8 mag., 3 sec. dis., ε (epsilon) Draconis, 5·5-9·5 mag., 3·1 sec. dis., ξ (xi) Ursae Major, 4-5·5 mag., 1·8 sec. dis.

A 6 inch aperture with powers from 150 to 250 should clearly define the companion to ε (epsilon) Arietis, 5-6·5 mag., 1 sec. dis., 32 Orion, 5-7 mag., 1 sec. dis., λ (lambda) Ophiuchi, 4-6 mag., 1·5 sec. dis., 20 Draconis, 6·4-6·9 mag., 0·8 sec. dis., ζ (zeta) Cancri *triple*, 6-7-7½ mag., 0 8 5 sec. dis., ζ (zeta) Herculis, 3-6 mag., 1·3 sec. dis., ζ (zeta) Boötes, 3·5-4·5 mag., 1 sec. dis., κ (kappa) Geminorum, 4-10 mag., 6 sec. dis., 36 Andromeda, 6-7 mag., 1·3 sec. dis.

An 8 inch aperture with powers from 200 to 300 should show clearly and with greater brilliancy than the 6 inch all the above and the companion to α (alpha) Canis Major, Sirius, 1-10 mag., 10 sec. dis., 19 Draconis, μ^1 (niu) Herculis, 10·5-11 mag., 1·2 sec. dis., μ^2 (mu) Boötes, 8-8·5 mag., 0·7 sec. dis., η (eta) Coronae, 6-6·5 mag., 1 sec. dis., γ (gamma) and γ^2 Andromeda *triple*, 3-6 mag., 10·5 sec. dis. the smaller γ^2 double 0·4 sec. dis. For a larger and more descriptive catalogue of double and triple stars, colored stars, clusters, nebula and planetary objects, we refer the amateur to Webb's "Celestial Objects for Common Telescopes."

For interesting star maps of the leading celestial objects in the evening sky for each month of the year, see the SCIENTIFIC AMERICAN, first issue in each month for 1886, except September, for which see second issue.

(To be continued.)

POPULAR ERRORS IN METEOROLOGY.*

By CLEVELAND ABBE.

OF all the heavenly bodies, except the sun, it may be safely said that the moon is most likely to have some slight influence on our atmosphere, but every effort to demonstrate such influence has so signally failed that we may say with an astronomer of 100 years ago: "The moon *ought* to have an influence on the weather, but it *hasn't.*"

We have, however, in those little dark spots that appear on the sun's surface a suggestion that has been worked up and overdone by very many. Thus we have one who stoutly maintains that the appearance of any special "sun spot" enables him to at once predict a corresponding special storm or weather. This idea has been arrived at apparently by a complete violation of all laws of logic. Areas of stormy, or cold, or hot, or windy weather are so frequent all over the earth, and spots on the sun are so frequent, that it is always possible to pick out a number of coincidences in time; and the style of logic that demonstrates a certain storm to be caused by a certain spot would equally well be applied to demonstrate that my body is warmed by the mass of hot coals in the fireplace, while my cold hands are due to one special coal that will not burn as brisk as its neighbors.

*Abstract from a lecture delivered before the Franklin Institute, December 17, 1886.

The sun's spots vary appreciably. In a general way, our observations show it to be highly probable that the total amount of spottedness, or total frequency of spots on the sun, is accompanied by a slight change in the general condition of the earth's atmosphere, by reason of which, when fewer spots are visible on the sun, we have slightly *higher* temperatures on the earth's surface as a whole, but slightly *lower* temperatures in the equatorial regions. Again, for a maximum of sun spots we have a slight minimum in the barometric pressure of the atmosphere; and again, for a maximum of sun spots we have a slight maximum in the amount of rainfall; and corresponding with this, at the time of the maximum of sun spots, there is a little more water flowing down the rivers of the world. Again, with the maximum of sun spots there is a slight tendency toward a minimum of lightning and a minimum of hail storms. But all of these relations are very feeble; that is to say, the changes in the condition of the sun's surface are very slight. They produce effects only barely appreciable in the earth's atmosphere as a whole, and it is utterly illogical to conclude that there is any direct connection between special spots on the sun and special localities on the earth. In fact, these studies simply confirm the conclusion that all our meteoric phenomena depend upon the sun's heat as such, and that any slight variation in this, by affecting the general atmospheric condition, may alter the rain in one part of the world at the same moment that it alters the temperature in another place or the wind in a third locality. May we, then, not hope that the sun spots will gradually cease to appear (as they are now often made to do by sensational writers) as the cause of some special change in the weather, and be left in peace to work out quietly the slight influence they may have upon our atmosphere as a whole?

A singular belief has been handed down to us from remotest ages, to the effect that the animals, in their natural state, know more about the future weather than does man himself, and this idea has apparently grown out of the study of the habits of migratory birds and hibernating animals, all of whom do really seem to foresee the approaching seasons, at least in a general way. It certainly has required the best power of the speculative naturalists to explain how such birds, for instance, as the wild duck or the swan ever came to think of making their long annual flights. We see the Indian go from the seashore and a marine diet in winter to the forests and flesh diet in summer (or we see the modern American reverse this process), and we are not surprised, as we attribute it all to the intelligence of human beings, the necessities of their organization, and the stress imposed by the changes in the season. Why, then, ought we to be surprised to find that the modern naturalist says that the migratory bird similarly inherits a gradually increasing amount of knowledge from his ancestors, that he has intelligence as well as the human being, and that he has not yet reached the limit of his intellectual development any more than has the white man? The migrations and the hibernating habits are, therefore, the result of the experience and teachings of many past ages, beginning with the glacial epoch, and producing a habit of life in an intelligent animal to which he persistently adheres. It is not necessary to suppose that the Creator has given these animals a deeper knowledge of meteorology than has been given to human beings.

He who consults the habits of the ground hog, the crow, the spider, the wild geese, or the goose bone, or the hundred other animals concerning which there are hundreds of rules in books of weather wisdom, is trusting to the intelligence of animals who are less intelligent than himself, and is neglecting to cultivate those faculties and habits of observation and reasoning with which his Creator has endowed him for the very purpose of getting at the mysteries of nature and utilizing her powers to his own benefit. In other words, the meteorologist would say there is scarcely any truth in the idea that all these mute creatures have for self-preservation been fitted with what is to us an unknown sense, informing them of minute changes in the atmosphere long before the coming of the danger. They have either acquired their habits, as other intelligent creatures do, from experience and reason, or they are wholly guided by natural causes beyond their control.

The case of the Rocky Mountain locust is an instance well calculated to illustrate this latter principle, *i. e.*, that natural causes sometimes direct every step. This "pest," after its last moulting, finds itself feeding in or near its native fields on the tender vegetation near the ground. Every day as the sun rises, after the dew is dissipated, it finds the atmosphere about it growing hot and dry, and soon also its own moist tender wings become stiffened. There results on its part a nervous irritability, which can be gratified best by active flapping of its wings, so that without any other profound instinct or intention on its part it is carried upward above the ground to cooler, moister air, where strong northwest winds carry it rapidly southward, even to the Gulf of Mexico. Therefore, its migration into a region where rich pasture lands await it is not due to any superior knowledge on its own part. The eggs hatch out in these southern regions at a season of the year when strong southerly winds are more frequent, and thus the young locusts are by these carried back toward their starting place, without the intervention of instinct or inherited knowledge, but by causes beyond their control.

What is true of the animals is still more plainly true of vegetables, so that in fact nearly all the rules for weather prediction founded on the behavior of plants, such as the contracting of the down of the dandelion, the closing of the pink-eyed pimpernel or of the convolvulus, in the day time, or the gathering of dew on stones, or the falling of soot in the chimney, are all simply so many hygroscopic phenomena, and a well made hygrometer, as used by meteorologists, will give more accurate indications than any of these natural objects.

Another erroneous idea, very widely prevalent, is shown by the tendency to explain this or that phenomenon as being due to atmospheric electricity or possibly to ozone. Both of these subjects have thus far eluded the attempt to observe them satisfactorily. We have, indeed, so-called records of electricity and ozone, but it is safe to say that with very few, if any, exceptions, we have thus far been unable to interpret these records, and demonstrate that we have been really observing a purely atmospheric phenomenon; hence I rate as a popular error the frequent quotation of these as an active cause of meteorological phenomena.

We have many of us been accustomed to speak of the delightful influence of a summer thunder storm in clearing and cooling the air, and it is true that cool, clear air does frequently follow these storms. We are, however, here in danger of confusing cause and effect. A certain class of thunder storms is not generally followed by cooler air, that is to say, any cooler than it would have been without the storm, while another large class is followed by a decided fall in temperature. In these latter cases, if I am not mistaken, the underflow of cooler air contributes so largely to the existence of the storm that at first sight one would say that the refreshing cooling of the air is the cause, and not the effect. But a truer philosophy would show that uprising warm, moist air has caused both the inrush of cool air and the thunder storm, so that the two latter do not stand to each other at all in the relation of cause and effect.

Many efforts have been made in this country to show that the destruction of our forests has affected our climate, and many instances are quoted to prove that the growth of forests on our treeless prairies has already materially modified the local climate; to neither of these views can I give my assent, and still less to the theory advocated by some that the extension of telegraph and railroad lines has so affected the distribution of the electricity that more rain now falls in some localities than before. Of all such propositions, the weak point consists in the fact that we have not enough observations of rainfall and temperature properly comparable with each other to justify any conclusion whatever. So variable is our climate, that a change of temperature of several degrees Fahrenheit, or a change of five per cent. in the average rainfall, could only be decided by comparing the average of 100 years of observation with the average of another 100 years taken before or afterward, under precisely similar circumstances. The mistakes in this respect have often arisen from an overweening confidence in one's memory. The oldest inhabitant confidently states that this is the coldest winter he ever knew; the leading newspaper reporter interviews him, and there appears a double leaded article, with heavy head lines: "Coldest Winter on Record. Decided Secular Changes in the Climate. Interesting Reminiscences of the Olden Time." The children and everybody read it, and become firmly convinced that the climate has changed, whereas the whole thing is based on the fallible memory of one man and the ready business talent of another, and the truth is that, so far as our records go, whether of rainfall, or temperature, or animal or plant life, all things remain as they were in the days of our fathers, at least so far as the atmosphere is concerned; a proviso that I insert because we are gradually getting proof of the occurrence of local changes of climate, consequent upon slow changes in elevation above sea level.

If I have touched upon a few widespread popular misconceptions in regard to my science, I have still to take up a long list of questions frequently put to me and showing general, if not popular, errors widespread among this most intelligent nation. For instance, "Is the whirling storm called hurricane, cyclone, or tornado caused by the friction between two great horizontal currents of air like the little whirls we see immediately behind a bridge pier in the middle of a river?" to which I answer, No! That was Dove's theory, but the meteorologists of to-day ascribe the tornado and cyclone to an uprush of air under one or more clouds, and the whirling is inevitable when the lower air rushes together from all sides to fill the place of that which has ascended. And here I would call attention to an erroneous use of the word cyclone, confined to some of the newspapers in this country, and which will, I hope, not be perpetuated, since many of the most reputable papers have already returned to a proper use of the word. The terms cyclone and hurricane should be applied to large storms only, and the term tornado be restricted to those small and violent storms in which the up draught through or around a central nearly vertical cloud or spout is the most prominent feature next after the terribly violent and destructive winds.

Again; among my questions is this:

"What is the special cause of the regular equinoctial storm?"

I am sorry to say that I know no "regular equinoctial." An old writer says, "Ye wind hath been noticed to be very tempestuous at ye time of ye equinoxes." All over the world it is a favorite habit among mankind to find a name or a proverb to suit every striking weather item; thus we have a Sunday rain, a Michaelmas thaw, an equinox storm, a dog day heat, etc. These names, however, are only names, and prove nothing as to the reasons underlying the phenomena. With the changes of the sun's position and the consequent distribution of hot and cold air, there come alike to old England and New England months of stormy weather; the storm that appears next before or after the 21st of March or the 21st of September is dubbed the equinoctial of that year, but the name does not give the storm any other peculiarity. The frequency of storms is about the same for several successive weeks, and one is as likely to occur on any other date as the date of the equinox.

Again: Why is there less rainfall caught in gauges high above the ground than in those on the ground? Do the drops grow as they descend?

The drops rarely grow after they have so nearly reached the ground, although they do grow as they descend through clouds of fog.

There is really the same amount of rainfall at 100 or 50 feet altitude as on the ground; the fault is in our rain gauge, which is exposed to stronger winds when set high up, and to almost no wind when flush with the ground. The stronger winds deflected around the gauge carry the drops to one side, and hence the higher gauge catches less than the lower one.

Among the experiments elucidating this principle are some made on your shot tower by Bache, fifty years ago, that have lately come to be more fully appreciated.

Again: Why is it colder on a mountain top near the sun?

It is a very common error to forget that everything—our own well-clothed bodies included—is giving out heat rapidly by radiation, and that the maintenance

of any pleasant temperature is due to the fact that the loss by our own radiation is equalized by an equal gain through the absorption of the radiation from other substances. But this latter is wanting in the case of objects on the summits of mountains, which, therefore, cool rapidly and stay so.

Some one asks, "Why do all signs fail in dry weather?" and "Why are Signal Service predictions of rain specially erroneous during droughts?" There are probably several reasons for this, some meteorological, some subjective. During droughts, one generally sees clouds forming during the morning hours, as the ground becomes warmer and warmer, showing that there is moisture in the air, but that it is slightly less than needed to form rain. In this delicate balance between conditions favorable and unfavorable to rain, the predictor needs, but has not, observations of the conditions prevailing in the atmosphere at large, as well as those prevailing at the surface of the earth. The absence of the necessary knowledge, therefore, increases the chance of an erroneous prediction. There is, moreover, a slightly subjective or personal consideration, namely, being aware of the existence of the drought and the great desire for rain, he is liable to yield to the desire we all feel to say something pleasant, or to predict that which will be most agreeable if it occurs. Thus, the hope that it may rain colors his predictions, so that between the two phrases, "fair weather" and "fair weather, possibly followed by light local rains," he is likely to adopt the latter as his prediction. The farmer who receives the latter sees the clouds gathering, and when the local thunder storm passes by, leaving him dry, but wetting some distant region, in his disappointment he calls the whole a failure. Whereas the occurrence of even that slight local rain in a limited region has been for the Signal Service predictor a complete verification, but the clamor of the thousands who did not receive the rain overpowers the quiet rejoicing of the hundreds who did receive it.

Finally, it may be considered as a popular error that the people should *expect* the Army Signal office to make perfectly correct local weather predictions thirty-six hours in advance for their benefit. That this is expected, we know by the grumbles we hear when a failure is announced. There even seems to be a growing disposition to look to the signal office for general weather or climatic predictions several weeks in advance of the season. Such predictions have been made in a few other countries, but when we consider the special methods that have been invented for that purpose, you will realize how very unsatisfactory such predictions may become. Thus, suppose we have for Philadelphia 100 years of daily weather records, and find that January 1 has, during these 100 years, been rainy ten times, snowy twenty times, fair—namely, neither rain nor snow—seventy times, then we should naturally predict for next New Year's day fair weather, as the chances are in favor of that. But, after all, the favorable probability is too slight to be of much value. In the present state of our knowledge, these predictions will probably not be verified one-fourth of the time, and a person will do just as well to regulate his business without them. This latter conclusion I have heard sometimes made in a carping way with reference even to the well known daily weather indications of the signal office; but this, I am sure, is altogether too sweeping, and nothing could be more erroneous than to condemn the great work of that office because of an occasional or even a frequent failure, since by general consent, and by actual numerical data made up from the returns of hundreds of independent observers throughout the country, we know that those who from day to day regulate their business by its predictions find great profit therein.

However, I am by no means sure that detailed long range weather predictions would be very agreeable or profitable—"Sufficient unto the day is the evil thereof." What would you do, my hearer, if you knew exactly what the weather is to be hour by hour for this next coming year? Would you be able to pick out the best day on which to plow, or sow, or reap? On *this* day the prediction gives you fair weather; will you plant at once, knowing that the prediction says heavy frosts on *this* day three weeks latter, just in time to kill your young crops? Will you reap to-day because the predicted weather is highly favorable, knowing that before half of that crop can be gathered into your barns the predicted hail storm will be upon you? As nearly as I can see, he who should perfectly foreknow the weather would find himself at every step confronted by some approaching dilemma, some inevitable disappointment or loss; and shrinking, as we all do, from such events, he would sit down in despair and do nothing at all. In a general way, it is true of the weather, as of anything else, that an All Merciful Father hides the future from us so that we, in our ignorance and helplessness, may labor on, full of hope that things may not turn out so bad after all.

And yet, so confident am I of the great future development of man and of science, and so clearly do I see the wise provision by which *everywhere in nature we find the right thing in the right place at the right time*, that I dare predict to-night *the time will come* when men shall be able to endure and utilize detailed weather predictions for months and years in advance; and when that time comes, the prophet and his predictions will be on hand.—*J. F. I.*

THE THIRD EYE OF REPTILES.

A German zoologist, M. Eugene Korschelt, has published in *Kosmos* a most curious paper, and one which, if its conclusions bear the test of further research, will change materially our present notions of morphology. In a few words, M. Korschelt's conclusions are: The pineal gland of the higher vertebrates, including man, has for homologue in reptiles a very singular organ, hitherto imperfectly studied, which presents, in certain types, the conformation of a true eye. In the first place, the German author describes a new organ, of apparently ocular function, a result hitherto entirely unlooked for. In the next place, he shows that this organ is the homologue of the pineal gland, which has always puzzled anatomists as well as physiologists.

Our readers will, without doubt, gladly hear the result of M. Korschelt's* labors and their principal results.

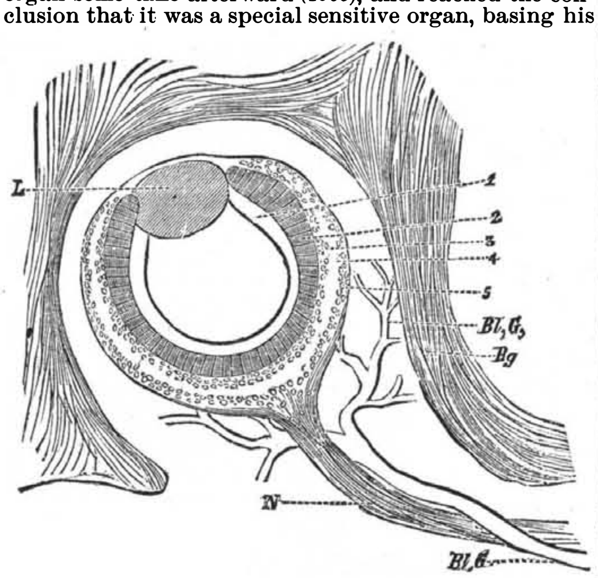
* *Ueber die Entdeckung eines dritten Auges bei Wirbelthieren* (*Kosmos*, 1886, No. 3).

The pineal gland in man consists of a small elongated body, situated in the head, and covered by the cerebral hemispheres. Among the vertebrates that are not mammals the pineal gland is more largely developed than among the latter, a fact unknown to Descartes when he made it the seat of the soul.

If the pineal gland in fishes is studied, as, for example, in the *Acanthias*, it is found to be a very elongated organ, consisting of a sort of trumpet ending in a dilatation in the form of a sac or bladder. It is the same with teleosteons and batrachians, but in these animals it occupies, on account of the smaller development of the anterior head, a quite different position from that into which it is thrown by the cerebral hemispheres in mammals.

According to Ehlers, the pineal gland of the *Acanthias* springs from the dorsal plane of the head between its middle and posterior parts, penetrates the cerebral envelope, following there a definite course, and finally isolates itself and ends by spreading out in contact with the walls of the skull. The neck or the support may have half the length of the head. Its cavity communicates with that of the ventricles. The terminal enlargement of the gland appears as a mass of definite contour, held in a cartilaginous depression of the skull, whence it can be withdrawn. This anatomic fact has for a long time been misunderstood, because of the remarkable pliability of the support of the pineal gland.

Ehlers has shown that the greatest care must be exercised in opening the skull to see the twofold relations of the pineal gland with the brain and the skull. The demonstration of the nature of the pineal gland in the *Acanthias* is of great importance for the understanding of a feature in the anatomy of the frog. In this batrachian, Stieda, in 1865, found present on the median line of the head, at about the height of the eyes, a clear spot, to which corresponded, under the skin, a compact cellular body. Stieda gave to this body the name of "subcutaneous frontal gland," and gave it no further attention. Leydig* studied this organ some time afterward (1868), and reached the conclusion that it was a special sensitive organ, basing his



VERTICAL SECTION OF THE ISOLATED EYE OF HATTERIA PUNCTATA.

1, poorly defined inner layer; 2, layer of rods; 3, layer of nuclei; 4, transparent colorless layer; 5, layer of nuclei; L, crystalline lens; N, optic nerve; *Bl*, G, blood vessels; B*g*, periocular conjunctive socket.

conclusions principally on its abundance of nervous filaments.

Later, Gotte† announced that the "frontal gland" was only the termination of the epiphysis attached to the brain by a thin ligament, which traversed the cerebral envelopes and the walls of the skull. The exterior subcutaneous organ is, then, a prolongation of the brain, a direct emanation thereof. Wiedersheim confirmed these facts, but concluded that the uniting portion, intermediary between brain and sensitive organism, is of conjunctive nature, and not nervous. Gotte considered the epiphysis as representing the point where the neural canal is longest in contact with the exterior, like the *neuropore*. The cavity of the latter then would be the last vestige of the neural canal. But the researches of different observers contradict this theory. Van Wyhe, Strahl, and Hoffmann show that the epiphysis originates in the brain under the form of a hollow excrescence, and that its terminal portion expands to form the "frontal gland" of Stieda, under the form of a small lenticular flattened body, which is still found in certain adult reptiles, near the distal extremity of the epiphysis.

The epiphysis is certainly derived from the brain. This follows from the researches of Rahl-Ruckhard, Ebers, and Ahlborn. According to the first of these observers, the epiphysis appears among the teleosteons as an excrescence of the third ventricle, whose cavity communicates directly with that of the ventricle. The envelope of the latter is also a prolongation of the cerebral envelope from the point of view of histology. But as animals more elevated in the scale are studied, the epiphysis follows a retrogressive metamorphosis, and acquires the characteristics of conjunctive tissue, losing those of nervous tissue.

While Ehlers considers the organ which he describes in *Acanthias* and other fishes as rudimentary, Rahl-Ruckhard and Ahlborn give opinions as to its functions based upon its embryogeny. The first remarks the great analogy existing between the development of its epiphysis and that of its eyes, and nothing seems to contradict the fact that the epiphysis represents an unsymmetrical sensitive organ. Ahlborn concludes the same, and goes further, in this sense, that taking into account the analogy between the primitive optical vesicles and the epiphysiary formation, and of the seat of the latter in the frontal optic region back of the skull, he regards the epiphysis as the rudiment of an

* *Ueber Organe eines sechsten Sines* (*Nov. Act. Acad. Leop. Car.*, 1868, p. 34).

† *Entwickelungsgeschichte der Unke.* Leipzig, 1875.

isolated or unpaired eye. This hypothesis had already been advanced under a more cautious form by Leydig.

This way of looking at it has been recently confirmed by two independent observers, H. De Graaf and W. B. Spencer, who have examined different reptiles, the *Hatteria*, the chameleon, etc., and have found in the place of the "frontal gland" organs which appeared to be undoubtedly eyes. In the *Hatteria punctata* the analogy with the visual organs is most pronounced. According to the description of Spencer, the epiphysis springs under the form of a hollow excrescence from the base of the third ventricle. The nearest part directly continuous with the brain is distinct from the distant part, which forms a sac-shaped organ. This last part is composed of different layers, and constitutes the accessory eye (see cut). The layers are the following:

1. An interior layer, not very definitely marked, which the author believes is formed at the expense of the liquid inclosed in the vesicle, a liquid which must have hardened and acquired a certain consistence.
2. A layer formed of juxtaposed rods, plunged into a dark brown pigment.
3. A double or triple layer of nuclei.
4. A transparent colorless layer.
5. Finally, a double or triple layer of nuclei.

Into this vesicle penetrates a nerve (N), whose filaments spread over the back of the capsule. This nerve is only subsidiary to and a continuation of the epiphysis which extends to the brain. Opposite the point where the nerve penetrates is a crystalline body or lens, L. The eye is surrounded with a conjunctive lining, B, and in the space between the eye and the socket are found vessels of an artery that enters the capsule or socket of the eye along with the optic nerve (*Bl*, G).

All the organ thus constituted is found upon the median line below the parietal foramen.

In the *Anguis fragilis*, according to Graaf, the anatomy is similar in its disposition. The organ in question is found at the same place as in the *Hatteria*. But for Graaf, the inner layer which Spencer believes is formed by a condensed and thickened liquid would be composed of rods. The next layer consists of elongated cylindrical cells, and surrounded for the most part with pigment, but free as regards their inner central extremity. But the great difference—those just given are secondary—consists in this, that the organ of the *Anguis fragilis*, as far as can be seen, possesses no optic nerve.

If this unpaired eye of which we have spoken is compared with the eye of other animals, it appears that, as far as the comparison can be carried out with the small extent of our knowledge, this organ resembles more nearly the eyes of invertebrates than of vertebrates. We know that among invertebrates the parts destined for the perception of light, the rods, have their extremities directed toward the dioptric apparatus. The same is the case in the eye we are describing, the reverse being the case with the vertebrates. De Graaf compares the unpaired eye of the vertebrates with the eyes of cephalopods, heteropods, and pteropods. Thus there would be found in certain vertebrates, eyes of the vertebrate and one eye of the invertebrate type simultaneously. To this conclusion the investigations of De Graaf lead him.

The same author has studied in amphibians the frontal gland of Stieda, lying beneath the skin of the head, and forming the termination of the epiphysis. He finds it surrounded with a conjunctive layer, and as having undergone a fatty degeneration. A nerve runs to it, but it is a subcutaneous branch of the trigeminal, and is not constant. In the adult organ, there is no further connection with the epiphysis. Here, therefore, in amphibians is a retrogressive metamorphosis. The thing is more pronounced still in birds and mammals. Among these last, the epiphysis has no relation with the exterior of the skull. It does not lie upon the dorsal face of the skull, but it is entirely covered with the cerebral hemispheres.

To sum up, then, the epiphysis represents among the lower vertebrates a solitary organ, which possesses the characters, anatomic or other, of the eye of invertebrates. But this organ disappears or becomes atrophied as its possessor rises in the scale of vertebrates, and between the unpaired organ and the epiphysis of mammals clearly defined intermediate forms are found. It seems, therefore, that the epiphysis and the outside related parts should be considered as essential parts of an isolated visual organ. Paleontology gives some support to this hypothesis, and gives grounds for the belief that this eye has performed the functions of vision in certain animals whose fossil remains are still in existence, notably the saurians of the trias. Among these saurians an orifice is found corresponding to the parietal foramen—an orifice of considerable size, traces of which are found in certain living forms, near which in these last is found the isolated organ. The special importance of this orifice in fossil species seems to indicate that among them the unpaired organ was highly developed. Perhaps it acted as an eye. In any case, the epiphysis was highly developed, as Cope has recently observed in a fossil saurian, the *Diadectes*. What could be the use of this solitary organ? Rahl-Ruckhard thought it might possess the function of conveying the perception of heat, to notify the animals possessing it of the too great intensity of the rays of the tropical sun in which they basked, as is the custom to-day with their actual descendants, lizards and crocodiles for example. But, in expressing this opinion, Rahl-Ruckhard did not know the complicated structure of the unpaired organ, and the peculiarities assimilating it to the visual organs of invertebrates. E. Korschelt does not hesitate to attribute visual functions to this organ, while fully recognizing that the services rendered by it must be much inferior to those rendered by a pair of eyes. This concomitance of two sorts of organs of identical function but of different value tends to astonish us. Korschelt, therefore, recalls the example of insects, among whom we often find, besides the facet eyes, simpler visual organs of different structure and significance. Korschelt thinks that the unpaired organ of the *Hatteria* and of reptiles possessing it would act as an eye if its subcutaneous position did not render its visual function too difficult. Nevertheless, it may serve for the perception of light and obscurity, and among the fossil species it probably served as an eye.

From a morphological point of view, Korschelt as-

similates the isolated eye to the isolated spot of pigment of the amphioxus and of the larvæ of ascidians. He is thus led to formulate interesting views upon the relations of invertebrates and vertebrates from the point of view of the relative positions of their nervous and digestive systems. It follows that the general organization of the two grand divisions of the animal kingdom are identical at the base, and that the differences deduced from the reciprocal relations of the nervous system with the digestive tube are due to erroneous interpretations which the discovery of the real signification of the epiphysis would finally do away with.

We have endeavored, as faithfully as possible, to reproduce, without sacrificing conciseness, the interesting views of M. E. Korschelt, views whose importance is obvious to every naturalist.—*H. De Varigny, in Revue Scientifique.*

AN EPIDEMIC OF MICROCOCCUS PRODIGIOSUS.*

By M. GRIMBERT.

SOME time since, several pieces of cooked meat were brought to the author for examination which presented a singular carmine-red coloration, and stained vividly the fingers or linen with which they came into contact. The phenomenon, it appeared, had then occurred regularly for three months. Food cooked over night had been found the next morning covered with red patches, and it then underwent rapid alteration.

Examination under the microscope revealed a quantity of very minute spherical cells, motionless, and appearing colorless in the midst of an amorphous red mass. Upon adding to the preparation solution of methylene, the cells appeared very distinctly, forming considerable colonies.

A trace of the red matter was deposited upon sterilized cooked potato and placed under a moist glass. On the second day after the sowing, the stains at the spots touched had broadened and assumed a rose color, and it was easy to distinguish with the naked eye a multitude of isolated points, which blended soon into a uniform mass, extending more and more over the surface of the potato. The rose tint passed afterward to blood red, a thick glairy layer being formed. At the same time a disagreeable odor was developed, recalling that of tainted meat. Later still the blood red gave place to a very dark, nearly black tint, and finally disappeared partially, leaving a yellowish mucosity. Sterilized milk was also sown and kept in a flask, the neck of which was closed with a plug of cotton. The sowing was effected by touching the surface of the liquid with a platinum wire charged with the substance. The following day the entire surface of the milk had taken a uniform red tint. Sowings effected upon coagulated albumen, cooked meat, and even raw meat, all behaved in a similar manner.

In order to study the coloring matter, the red parts of the potato were removed and treated with 95° alcohol. After some days the alcoholic solution, which had taken a magnificent carmine-red color, was filtered and evaporated. The product of evaporation treated with carbon bisulphide left a yellowish insoluble extractive-like residue, soluble in water and in alcohol. The coloring matter removed by carbon bisulphide was insoluble in cold water, slightly soluble in boiling water, and very soluble in alcohol, ether, chloroform, carbon bisulphide, benzine, oil of turpentine, amylic alcohol, acetic acid, and fats. The addition of an acid intensified its color. Alkalies caused it to assume a dirty yellow tint, but acids restored the original color. Upon shaking with ether an acetic acid solution that had thus been discolored by ammonia or baryta water, decanting, and acidifying the ethereal solution, it became of a red color—a reaction analogous to that of fuchsine. When amylic alcohol was used instead of ether, the red color was produced without the addition of an acid. Chlorine destroyed the red color. Sulphurous acid was without action upon it. A spectroscopic examination of the alcoholic solution showed a well-marked absorption band between lines D and E, another fainter band in the neighborhood of line *b*, and then the gradual extinction of the other colors to violet. This spectrum approximates closely to that of an alcoholic solution of fuchsine of a similar degree of concentration.

The form of the cells, their small dimensions, and mode of propagation in potatoes, milk, and meat, the reactions of the coloring matter and its absorption spectrum, all point distinctly to the *Micrococcus prodigiosus* as described by Erdmann, Cohn, Schroeter, and Ehrenberg.

The epidemic ceased suddenly on the day after the meat was brought to the author for examination, the disappearance coinciding with a considerable fall in the temperature. Since then it has not been observed, although no precautions have been taken to prevent its return.

Referring to this communication, a correspondent of the *Pharmaceutische Zeitung* says that the description corresponds in every detail with a case of the occurrence of this fungus which was brought under his notice in Cologne in 1883, when he also separated by similar methods the coloring matter resembling fuchsine.

BEETHOVEN'S PORTRAIT.

THE announcement was recently made that an undoubted portrait of Beethoven had been discovered at Freiburg, where it was in the possession of Herr Victor von Gleichenstein. We are enabled to give an engraving of this portrait, which was painted in oils by J. Mahler, of Vienna, in the year 1815. Beethoven was then forty-five, and in the zenith of his powers. He was also in a more prosperous state than in the earlier period of his career, and, though worried by the Kinsky lawsuit, he had managed for the first time to save up money, which he invested in shares in the Bank of Austria. The chief interest of the Mahler painting is, however, its obvious truth to life. Most of the portraits and busts extant of the greatest of all composers are mere flights of fancy, either devoid of expression or, as Sir George Grove remarks, idealized as a sort of Jupiter Olympus. The most faithful likenesses are Hornemann's miniature, taken in 1802, and the head by Letronne, engraved by Hofel. There is also a fancy Thackeray-like sketch by Lyser. But the Mahler painting, of which we give a sketch, preserves all Beethoven's known characteristics, including the high forehead, the breadth of jaw, the countenance which unmistakably betrays his Dutch origin, and above all the small but piercing black eyes, of which Madame Von Breuning speaks. The painting is in an excellent state of preservation. Our engraving is from a photograph by Messrs. Ruf and Dilger, of Freiburg.—*London Graphic.*

* Journal de Pharmacie, December, page 547.

THE SINALOA COLONY.

MANKIND would be one family or group of families, if the principles of Jesus could be imparted to the human race. But the robber races that occupy this globe at present are intensely hostile in feeling to that life of Christian love which is commanded in the books which they honor with their lips.

The so-called civilized races of to-day are as intensely barbarian at heart, notwithstanding the superficial varnish of literary civilization, as the hordes of Attila and Genghis Khan. Witness the attitude of Germany and France (the great exemplars of literary civilization), each eagerly preparing for a deadly conflict.

Yet in all ages there have been those whom nature has qualified for a better life, who wish to live in harmony, and turn with weariness and disgust from the present forms of avaricious strife, rivalry, and fraud. If the best of these could be gathered in one community, a better state of society could be organized.

Horace Greeley sympathized with such movements, and about forty years ago gave much space in the *Tribune* to the illustration of this subject. Although the co-operative principles of Fourier, then widely discussed, have not resulted in any great success in community life in the United States, it can also be said that experiments have not shown the doctrines of Fourier to be impracticable. The best thinkers have not lost their faith, and the example of M. Godin at Guise, in France, with a population of 1,800 in the Social Palace enjoying the very Utopia of happy and prosperous co-operative life, is a splendid demonstration of what is possible, and a standing rebuke to the churches of civilized nations, which have not even noticed this grand demonstration of the possibilities of humanity.

The grandest and most hopeful co-operative scheme yet proposed is that of Mr. Albert K. Owen, entitled the "Credit Foncier of Sinaloa," which has been established at the harbor of Topolobampo, in the State of Sinaloa, on the western coast of Mexico, where a large and liberal grant has been obtained from the Mexican government for the Credit Foncier Company, chartered by the State of Colorado, Mr. Owen being chairman of the Board of Directors. Its headquarters were at rooms 7 and 8, 32 Nassau Street, New York, and the members of the community are already gathered in considerable numbers at Topolobampo. The Credit Foncier of Jan. 11 reports over 4,800 persons enlisted for the colony, and over sixteen thousand shares of stock sold.

This is not a unitary community, in which the individuality of the members is lost, but a co-operative corporation, owning its lands as a society, and abolishing at once the primary evils of land monopoly and a false financial system. As stated by Mr. E. Howland, "the community is responsible for the health, usefulness, individuality, and security of each member, and at the same time each will feel secure in his social and individual rights in the existence of the collective ownership and management for public utilities and conveniences, instead of the disorganized chaos in which to-day we live."

A system of distribution will be adopted, doing away with the immense cost of trade as at present conducted. The laborer will be protected against misfortune by a system of insurance and a pension in old age. Employment and opportunity will be provided for all, and education provided for all children. It is upon this education that the *ultimate* success of the society must depend, for it is impossible to organize a perfect society of those whose characters have been moulded by the present antagonistic condition of society. All grand ideals must look to the future for their realization. That such realization may occur in the Sinaloa colony is indicated by the following quotation from the exposition of the Credit Foncier by Mr. Howland:

"As we shall have to, at least during this generation, depend upon the colonization of persons who have been subject to the influences of society as it is, we would only say that the new truths concerning moral education contained in 'The New Education,' by Mr. J. R. Buchanan, have been carefully examined by the writer of this, and its most important lessons shall be applied in the organization of our schools; for the power of love can be unquestionably applied, not only as a cure for the evils produced inevitably by the system of competition, but also as a miraculous agent in aiding the progress of society to an inconceivably higher plane of human life."

The newspaper in exposition of the society, entitled "The Credit Foncier of Sinaloa," published at $1 a year, at Hammonton, New Jersey, will be issued hereafter at Topolobampo, Mexico. A report descriptive of the site of the colony and the surrounding country (price six cents) and a map of the colony's site (price ten cents) may be obtained by addressing the editor, E. Howland, at Topolobampo, Mexico.

While the *Journal* is going through the press, the colonists are gathering in large numbers, and by our next issue we may have some account of the commencement of this noble enterprise.

Its founder, Mr. A. K. Owen, is a gentleman of great energy and enterprise, guided by noble principles, a skillful surveyor and engineer. About fourteen years ago he made extensive exploration in Mexico, especially on its Pacific coast, discovered and reported Topolobampo Bay, and introduced the scheme of the Norfolk & Topolobampo Railroad, which he urged upon the attention of Congress, winning the approbation of committees, but finally defeated by the great railroad corporations. He took an active part in Mexican affairs, forming gigantic plans for the public welfare, by a syndicate at the head of which was Gen. Torbert, which were defeated by a shipwreck in which Gen. Torbert was lost, and himself narrowly escaped death. He then organized, with the co-operation of Gen. Grant, Gen. Butler, and other distinguished men, the Texas, Topolobampo & Pacific Railroad and Telegraph Company, and obtained a concession of 2,000 miles of railroad and a subsidy of $16,000,000. Hon. Wm. Windom was president, and Mr. Owen chief engineer. In 1873 he located a hundred miles of the road from Topolobampo eastwardly, and two years ago the construction commenced. Thus in the midst of a life of great activity and experience in engineering, finance, politics, reform, and travel, Mr. Owen, as a practical and skillful man-

PORTRAIT OF BEETHOVEN, RECENTLY DISCOVERED IN GERMANY.—PAINTED 1815.

ager of great undertakings, inspired by a strong democratic philanthropy, has laid the plan of a co-operative colony on the basis of liberal concessions from the Mexican government, and opened a field in which his democratic ideas of human rights, of land, labor, finance, hygiene, freedom, and general reform can have full scope.—*Journal of Man.*

DWARFS AND GIANTS.

APROPOS of the discussion of military law, the study of the variation in human stature has been the object of important communications made to various learned bodies—especially to the Academy of Medicine and to the Society of Anthropology. Moreover, the exhibition at Paris of several dwarfs and an extraordinary giant has permitted of again comparing, in their exaggeration, the various physical, and even moral, modifications that are due to the influence of stature.

Among the questions that come up, when we consider the human stature in a general way, we may note the following: Has the human species degenerated, and were our ancestors of prehistoric times, or of a more recent epoch, taller than ourselves? Do there or do there not exist races of dwarfs or giants? What have been the variations in stature in France? What are the causes that influence the stature of populations or races? What are the causes that influence the stature of individuals, and the development and growth of children? What influence has stature upon strength, agility, resistance to fatigue, and the physical or intellectual development of individuals?

It will be seen that the study of human stature has not merely a theoretic interest or one of curiosity, but may also possess a practical and important one, from the standpoint of the development of individuals considered isolatedly, and of the development of the strength of the nation for industrial or agricultural production, or for its defense.

Before beginning a study of these different questions, we shall describe the Austrian giant, who is at present in Paris, and who may be considered as having reached the extreme limit of the highest stature.

According to data furnished by the showman who accompanies him, this giant is 8½ feet in height, is 21 years of age, is named Francis Winckelmeler, and was born in the vicinity of Friedburg, Upper Austria. Winckelmeler did not begin to attain a remarkable size until he was fourteen years of age, and, according to his showman, his growth has not yet ceased. His parents are peasants of ordinary stature, and their four other children show in this respect nothing abnormal. The giant is relatively very thin in proportion to his height, and this still further contributes to set off his stature. He stoops slightly. His arms are of an exaggerated length, and sometimes in walking about among the spectators he extends them horizontally, and passes them freely over the heads of those who are standing and have their hats on. The space that he thus embraces, and the distance that he can reach, are enormous. His legs are likewise very long with respect to the rest of his body. During his exhibition in the covered garden annexed to the theater, he stops and willingly chats with the spectators, but as it would be impossible for him to sit down on a chair, he selects a table as a seat, and even prefers a counter as being more adapted to his height. It is stated, moreover, that when he is in his room he seats himself upon his bureau, and sleeps in four beds placed side by side. This giant is really most remarkable.

According to an opinion that was pretty widely diffused in the last century, our ancestors at a certain epoch all possessed a stature equal to or greater than that of this giant. Thus, in 1718, Mr. Henrion, a member of the Academy of Inscriptions, presented to that learned body a memoir upon the variations in human stature from the beginning of the world up to the time of Jesus Christ. According to Mr. Henrion, Adam's stature was 123 ft. 9 in., and that of Eve was 118 ft. 9 in. But, starting from this moment, the stature of man underwent a progressive decrease. Noah was scarcely 100 ft. in height; Abraham, about 28 feet; Moses, but 13; Hercules, 10½; and Alexander the Great, 6½. This communication was received with great enthusiasm, and was even qualified at that epoch as an "astonishing discovery" and a "sublime vision."

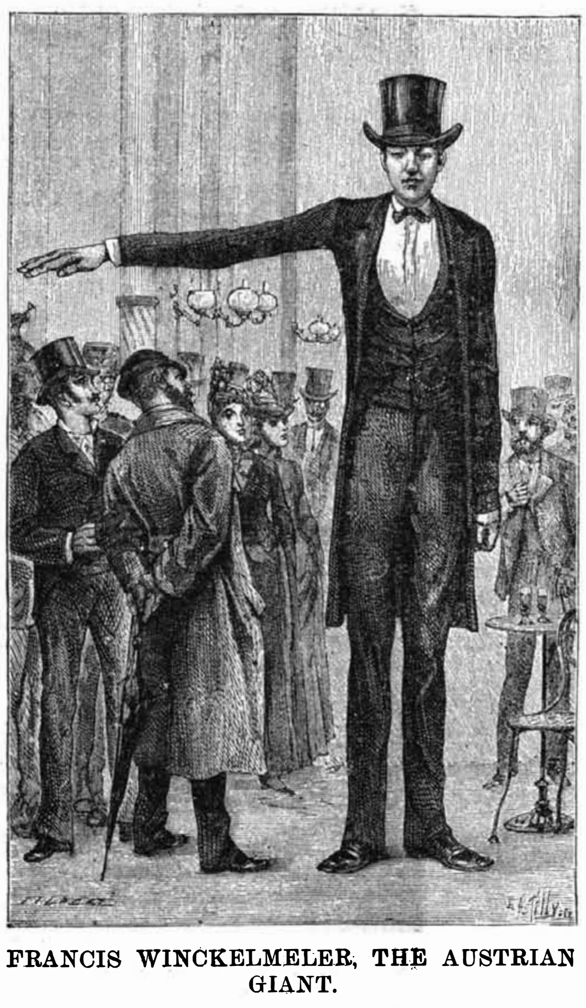
If such a hypothesis had been confirmed, the present human race would have indeed degenerated. Moreover, we are forever seeing authors and moralists treating the present generation as a "degenerate" and "corrupt," etc., race. Fortunately for us, it has been customary at all epochs to accuse the existing generation of being degenerate, and to assert that former generations were stronger, greater, and more vigorous.

Homer, even as long ago as 2,800 years, complained of the degeneracy of the men of his time. And this caused Juvenal, later on, to say (Satire 15): "If this complaint as to the degeneracy of the human species were well founded, men would have been but unfortunate dwarfs long ago." Facts, morever, entirely disagree with the opinion that the ancients were taller than modern people. In measure as we go back in time, we find numerous refutations of the error. Skeletons exhumed after several centuries, such as those that are found heaped up in the catacombs of Paris, are in nowise gigantic. The armor, cuirass, and helmets of warriors of the middle ages might be put on by our modern soldiers. Many of the coats of mail of the knights would be too small for our cuirassiers, and yet they were worn by selected men, who were better fed and were stronger and more robust than the rest of the population. The bones of the ancient Gauls that are found in digging into tumuli, while sometimes of large dimensions, might be compared to those of the population of many French localities. The Egyptian mummies indicate individuals of a small or medium stature, and the same is the case as regards the mummies and bones found in the ancient monuments of India and Persia. The same, too, may be said of the Peruvian and Mexican mummies. Finally, the most ancient vestige of individuals of the human species that we possess, the bones derived from man of the tertiary epoch, that is to say, an epoch whose remoteness can be estimated only by hundreds of centuries, shows no important differences between the stature of primitive and modern man. Men of the present epoch have not therefore to regret that they do not possess the stature of their ancestors; in fact, the present human species in civilized nations has very little to envy in the generations of past time.

If we compare the stature of the various races that constitute the human species, we find great differences, and it is an exaggeration of this fact that has given rise to the legend of dwarf and giant peoples. The individuals composing dwarf races, if considered isolatedly, would be very large to be compared to dwarfs. A dwarf who exceeds three feet in height begins to lose his interest as such; and if he reaches four feet, he loses his title of dwarf, and becomes "a little man."

In small human races, the well formed adults all exceed four feet, and therefore do not constitute races of dwarfs, but simply of small men. A study and comparison of them with races of high stature is none the less interesting. And so, in these last named races, men exceeding seven or seven and a half feet are exceptions, and merit the name of giants. But yet the mean stature in these large races is much greater than in the small ones. A man of medium height belonging to the former is a giant as compared to one of medium height belonging to the latter. Apropos of this subject, we shall give the mean stature of the smallest human races mentioned by travelers. The Eskimos of certain tribes have a mean stature of five feet. The Lapps are slightly shorter, their average, according to numerous measurements, being a few inches less. In Africa, the Akkas, seen by Schweinfurth, may likewise be considered as a very small race. The Negritos, who inhabit the wild regions of the Philippines, of the Andaman Islands, and the peninsula of Malacca, are an extremely small race. The same is the case with the dwarf race of Madagascar. But the first rank in this respect seems to be held by the Bushman race, which inhabits Southern Africa, and the average stature of which is less than 4⅓ ft.

Among gigantic races, on the contrary, we may recall the high stature of the Norwegians, Canadians,



FRANCIS WINCKELMELER, THE AUSTRIAN GIANT.

North American Indians, Caffres of Southern Africa, Patagonians of South America, and Polynesians of Oceanica. With these latter races, the average statures vary, according to travelers, between 5¾ and 6 ft. That is to say, these average heights vary by 3 in. The mean between these two figures would be 5·8 ft. This mean between the stature of extreme races is generally admitted by anthropologists as capable of serving as a datum point in the approximate classification of the human races according to their height—the name of "average races" being given to those that have a height of from 5¼ to 5½ ft., of "small races" to those that have a height less than 5¼ ft., and of "large races" to those which have an average height exceeding 5½ ft.

The French race, which has an average height of 5⅓ feet, would be classed among the average races. It should be stated that this variation of 18 inches between the mean height of the various human races is quite small, and that there are numerous examples in the different animal species of much greater variations. For example, in a zoological order near our own, that of the monkeys, we find races entirely differing from each other in aspect and dimensions. An unsuspecting person would hardly recognize the same animal race in the small oustitis and the large gorilla. Such disproportion is found again in the equine race, between the Shetland pony and the Mecklenburg horse, between the pony and the Percheron, and between Maximus and Minimus of the Hippodrome. The small Breton cow is very different from the large Durham one, and the small Landes sheep from the large English Dishley one. Upon the whole, the difference is less between the human races—between the Bushman and the Patagonian, the Lapp and the Norwegian—and we do not find it to so high a degree until we compare extreme statures, the largest men with the smallest, in other words, giants with dwarfs.

These variations in the height of the different human races are found, although to a less degree, in each country taken by itself. In France, for example, we find large and small races living near each other without mixing. Such differences can be easily verified through the results obtained by the Board of Revision.

In France, the tallest persons are found at the north and in the east; slightly shorter statures are found among the Normans and Vendeans; while the shortest are found among the inhabitants of the south and southwest, although those of the departments of the valley of the Rhone form an exception.—*La Nature.*

NITROGENOUS PRINCIPLES OF VEGETABLE MOULD.—MM. Berthelot and André.—The vegetable mould contains a notable proportion of nitrogen. This proportion generally reaches one or two thousandths. Nitrogen exists chiefly in the soil in the form of quaternary organic compounds, almost totally insoluble. The authors find that these little known principles are amidic bodies, which behave like albuminoid principles, and which generate under the influence of acids, alkalies, and even pure water, a certain proportion of ammonia and a larger proportion of soluble amidic compounds. The ammonia furnished by the soil experimented on by the authors results almost entirely from certain splittings up effected under the influence of hydrochloric acid at the expense of the insoluble amidic compounds.—*Comptes Rendus.*

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