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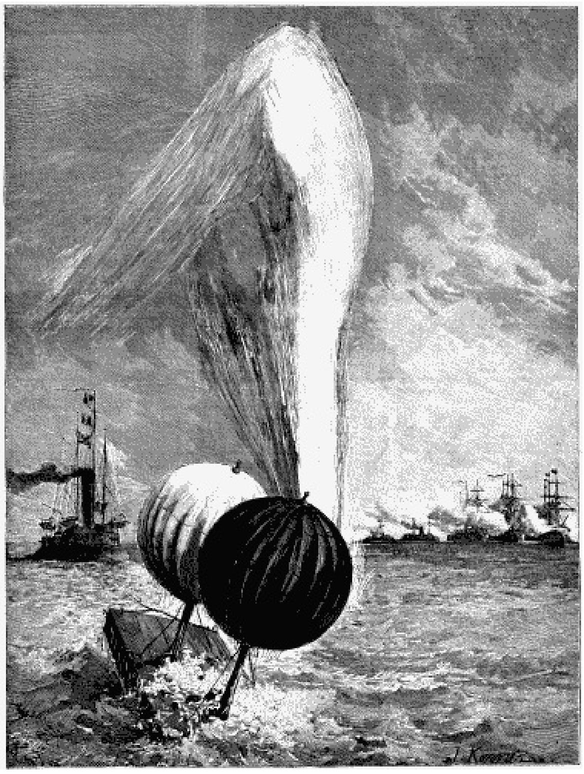
GUN PRACTICE IN THE FRENCH NAVY.

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The gunners of the French fleet are possessed of a skill which is recognized by all the maritime powers, and these picked men proved this at the siege of Paris, where they made themselves illustrious, not only by their courage and their coolness, but also by the accuracy of their firing.

Nothing is neglected, moreover, to keep up the precision of hand and eye that distinguishes them, and which has become so much the more necessary in that it is no longer a question of firing a broadside at the enemy and reckoning on one ball being more fortunate than another in damaging the enemy's ship. At present, the most powerful ironclad has four, and sometimes six or eight, guns of large caliber, which are of from 30 to 100 tons. Every shot represents not only an enormous sum, but also a prodigious force expended, and so powder must not be used too lavishly, since the shot should be in relation with the colossal power that it represents, and the shell adopted in the navy is accompanied with so disastrous effects that a single one, well directed, is capable of reducing the enemy's ship to impotence. So exercises in firing are becoming more and more frequent, and they have a right to be multiplied, inasmuch as the present guns are complicated affairs, the maneuvering of which requires constant practice.

Our engraving represents one of these exercises performed by the Squadron of the North, which is of recent organization, and which consists of the three ironclads Marengo, Suffren, and Ocean, and three coast guards Furieux, Fulminant, and Tonnerre. Each of the ironclads is provided with four 27 cm. guns and four 24 cm. ones, not counting the revolving guns, which constitute the small artillery reserved for fighting torpedo boats. The Furieux has two 34 cm. guns, and the Tonnerre and Fulminant each two 37 cm. ones.

An endeavor is made, as far as possible, to practice firing such as is done in a naval action, that is, at moving targets. To this effect, the dispatch boat Epervier tows a rectangular float about two meters in length, upon which are arranged two canvas balloons kept taut by a wooden framework. One of these balloons is white and the other is black. Each is a meter in diameter, and is supported by a rod which is usually a meter in height. The vessels of the squadron successively fire their large guns at this target, which moves at a definite velocity. The shell, on dropping into the water, raises an immense jet, which entirely hides the balloons when the projectile falls in a line with and sufficiently near the target.

The smoke that envelops the ships, the thunder that echoes in the calm of the sea, and the jet that rises in the air produce a thrilling effect and give an idea of the power of man carried to the last expression.—*L'Illustration*.

MODERN CAVALRY ON THE FIELD OF BATTLE. [1]

By Col. R. S. Liddell.

I feel that some apology is due from me for coming down to Aldershot and giving my opinions before so many officers whose daily experience renders them much more capable than I am of bringing this subject forward, and it was with some hesitation that I yielded to the flattering invitation of the Military Society of Aldershot to read a paper here to-day on cavalry. At the same time, if it is thought that anything I can say can increase the success that this society has already met with, I can only add that I render my services most willingly. It seems to me one of the many advantages that these meetings possess is the bringing together of the different branches of the service, and the mutual information they afford of each other's arm. When we look back only a few years, we have much to be thankful for in the disappearance of a vast amount of prejudice that used to exist between the different branches. Each arm thought that theirs, and theirs only, was worth studying. Infantry officers sometimes said, as long as their arm was sufficiently numerous and well equipped, that, with the exception of a few scouts and orderlies, cavalry might be dispensed with. Artillery might think that unless guns were largely used, no infantry could ever make an attack at all; while cavalry officers, who were perhaps the most conservative of all, would point to the past, and show how every battle that had ever been fought was won by cavalry, and ever would be.

Confidence in one's own arm is most desirable, and should be fostered, if at the same time we can learn how to work with others, remembering that while cavalry gives the information to and hides the movements of the army, while artillery shakes and disperses the enemy's formation, and prepares the way for attack, it is the infantry alone who can assault and hold the position, and it is for their advance and to bring them up to the point that determines the battle in the condition most favorable to insure success that all the efforts of the other two arms must be devoted. I have made these preliminary remarks, as from my paper being entirely given to the actions of cavalry, it might appear that I am claiming more for that arm in the battle field than is reasonable; but I wish it clearly understood that whatever I may say is only in an auxiliary sense to the action of infantry, and I trust that I shall not be thought underestimating other arms, while showing unbounded confidence in my own.

The necessary rest required by Europe after the exhaustion of the wars of Napoleon resulted in the long peace which succeeded the campaign of 1815. This, and the improvement that took place in fire arms in the next forty years, gave room for speculation as to whether cavalry would play as important a part in the future as it had done in the past, under Marlborough, Frederick the Great, Napoleon, and Wellington. The Crimean war helped to confirm the opinion that the days of cavalry had gone by. No account was made of the enormous distance by sea that the cavalry had to be transported, the unfavorable nature of the seat of war for that arm, the little scope given in a campaign that resolved itself into a siege, the smallness of the cavalry force employed, and the difficulty in keeping up a fresh supply of horses. After this war came the introduction and improvement in the breech loader, and with it opinions were strengthened that cavalry duties would be still further limited, and its traditions for a time appear to have been lost.

The awakening from this transient period of theory came from a nation not trained to arms, and it is to the American civil war that we owe the revival that took place in the use of the cavalry arm. The raids made by the Confederates under Morgan, Stuart, Forrest, and by the Federals under Sheridan, drew attention to advanced cavalry work, such as scouting, reconnaissance, outpost and dismounted work. As particular examples we may select Morgan's boldest and greatest raid in 1862, when he passed through Kentucky and Indiana, capturing large stores from the enemy. By his rapid and skillful marches the Federal officers were completely bewildered. He was absent from his army 24 days, in which time he traveled 1,000 miles, capturing 17 towns and destroying all the government supplies and arms. In a second raid he forced the Federal army to fall back by taking possession of the railway in its rear which brought it supplies. In October, 1862, Stuart made his greatest raid through Pennsylvania, around the Northern army. He set out with 1,800 cavalry and four pieces of horse artillery, and crossed the Potomac. The telegraph wires were cut in all directions, railways obstructed, and a large number of horses captured, and all the public stores and buildings were destroyed. His position at this time was very critical, 90 miles from his own army. He considered it less dangerous to return by the opposite way to which he came.

Forrest used his cavalry in every possible manner, dismounting in the battle field and employing it as infantry. In October, 1864, during a raid, he impeded the navigation of the Tennessee River, which was filled with Federal gunboats. Choosing a strong position on the bank, he masked his guns and awaited the approach of the enemy's vessels. He captured a gunboat and a transport, and manned them with his own men; but his naval expedition did not last long. Pursued by several gunboats, he had to run his ships on shore, when the troopers gladly mounted their horses again. His object was, however, gained—inspiring alarm throughout the country and occupying a considerable number of the enemy. Later on the Federals copied this system, when the raids of Sheridan, with his 10,000 horsemen, armed with the magazine rifle and revolver, with sword attached to the saddle, brought about the final overthrow of the Southern army.

The next campaign that took place was in 1866, known as the "Seven Weeks' War," when large bodies of cavalry were used by the Austrians and Prussians. This campaign was of such short duration that there was not sufficient time for the experience gained in the use of cavalry to be utilized while the war lasted; but when the war was over, both sides, having bought their experience, set out to reorganize their systems, and the course pursued by the Prussians after this campaign in largely increasing their cavalry was fully justified by the advantages reaped in the war in France in 1870. At the close of the Franco-German war the attention of the whole of Europe was called to the successful use of German cavalry during the campaign, more especially the advanced duties, when at times 60 miles in breadth and 50 in advance of the army was covered by the cavalry.

In England, after the termination of this war, many German military works of great value were translated and published; the battle fields in France were visited and described; every movement of both armies, strategical and tactical, was studied. All this tended to draw our attention to the extended use of the cavalry arm in future campaigns, and the shortcomings of our own system were carefully scrutinized. The movements of our drill book were simplified, the careful training of our men in shooting was more fully recognized, and the teaching of advanced cavalry duties, reconnaissance, outpost and dismounted work, were gone into most thoroughly—in such a manner that I may confidently appeal to those officers who have the best opportunities of forming an opinion, whether our cavalry does not bear comparison now with what is being done in other armies, and in these matters is advancing in a satisfactory manner. While all this good work has been going on (and I would be the last to say one word that might seem to depreciate its value) we may perhaps have permitted the action of cavalry on the field of battle to escape from sufficient notice.

It is for this reason I will ask your permission to bring before you this subject, believing that the opinions of all branches of the service being brought to bear upon it, considerable advantage maybe obtained. It will be my endeavor to show, not by my own arguments, but by quotations from others, that cavalry still has an important part to take on the battle field, and far from its duties ending when armies come in contact, that it is still reserved to them, as has been the case before, to decide, perhaps by only one charge, the issue of a whole campaign. Prince Kraft in his letters on cavalry says: "The battle of Mars-la-Tour, won by the bold employment of cavalry, made possible the blockade of Metz, and afterward the surrender of the whole of Bazaine's army. So it may be said, without exaggeration, that the charge of Bredow's six squadrons on that day was the turning point of the Franco-German campaign."

Colonel Home, in his "Précis of Modern Tactics," says: "The action of cavalry on the actual battle field is by no means a thing of the past. The use of cavalry with skill at the right moment and in the right numbers has always been considered one of the most difficult problems in war. Modern arms have increased this difficulty manifold, but to say the day of cavalry on the field of battle is past is merely another way of saying that the knowledge of how it should be used is wanting." Cavalry is apportioned to an army in two capacities: (1) Divisional cavalry, that is (if possible) a regiment, or as many squadrons as can be spared, attached to each infantry division, acting under the orders of the general of the division. (2) The cavalry division, that is, a large body of cavalry composed of several brigades, an independent body having its own commander. On the march the divisional cavalry covers the head and flanks of its own division: on the field of battle it will be as near as possible to its division, in the most sheltered spot that can be found; in the early part of the battle it would be kept as much in reserve as possible, écheloned in rear of one flank of its own infantry. It would remain there until the artillery and musketry had effected their work, and the enemy's flanks had become thinned and shaken. Then, when his infantry become tired and exhausted, under cover of the smoke, the cavalry may be further advanced.

Prince Kraft says: "At Sedan the divisional cavalry were employed during the battle, charging by single squadrons, patrolling and reconnoitering to obtain information of the enemy and the ground. Every infantry body is accompanied by patrols, however small." An instance of the too early employment of cavalry in a battle occurred at Waterloo, when Napoleon at the commencement launched his cavalry into the fight. The result was that although it far outnumbered the English at first, it became so reduced, depressed, and worn out, that it was unable afterward to offer full resistance to the British squadrons, who were comparatively fresh. Wellington, on the contrary, after his first successes, kept his cavalry, as much as possible, in reserve. The field of battle itself shows the proper situation of cavalry, but the divisional cavalry on the defensive side must always be at hand to fall upon the flanks of the enemy's infantry when in extended order, while that of the attacking side must be equally at hand to prevent the flanks of its own infantry being so attacked.

In discussing the action of divisional cavalry, the most advantageous time for its assisting in the combat must be considered. At what moment, if any, can infantry be attacked by cavalry? When opposed to a force acting on the defensive, divisional cavalry has its operations limited, and probably in the earlier part of an engagement, confined to watching, and, if possible, guarding the flanks of its own attacking infantry from surprise. It is the cavalry on the defenders' side that has the greatest opportunities. In both cases, however, a rule must be made not to attack infantry when it has taken up a favorable position, or before its ranks have been shaken by artillery or musketry. Prince Kraft, in speaking of Mars-la-Tour, says: "This same day took place a series of cavalry charges of greater or less importance, which all showed practically to the cavalry the limits of their effective action against infantry. The advancing infantry were brought to a stand, infantry who gave way were ridden down, but where the cavalry attacked infantry intact, the cavalry were unable to prevail."

The precision of modern fire arms has necessitated great changes in infantry tactics. To advance against the murderous fire of the present rifle, infantry is compelled to adopt scattered formations in small lines, and to move forward with sudden rushes. All this lends itself to the attacks of an active cavalry. When these infantry attacks take place, it may be presumed that they have already been under arms some hours, have marched some distance, and been exposed to considerable loss from artillery and musketry fire. Their advance in extended formation will have commenced at about 1,000 yards, or earlier. By this time the squadrons opposing them will have been brought to a more advanced position, to the nearest point to their flank where cover is afforded, and to carry this out successfully requires skillful handling. Files must be extended, and short rushes made with small bodies, say half a troop if over exposed ground, into sheltered places. It is true that cavalry cannot hide themselves over exposed ground as infantry can, but they have one advantage that nothing can deprive them of—rapidity of motion; and the distance that would take them say 10 seconds to traverse, viz., 150 yards, would take infantry a minute.

Prince Kraft writes: "No battle field is a *tabula rasa*, for in the most exposed country there are depressions. If strong skirmishing lines of infantry can advance directly over a country devoid of cover, cavalry can undoubtedly do the like, if by making use of the lie of the ground they can gain the enemy's flank. A skilled cavalry leader will thus undoubtedly find an opportunity to get close to the enemy." Having arrived at this more advanced position, say from 500 to 1,000 yards, according to the formation of the ground, the nearer the better, the most favorable moment to assail the flanks of the attacking infantry would probably be immediately before the last belt of the fighting line, and before the main body had re-enforced them, as they are preparing for their last united rush, and as their supports are doubling up to join them.

At this moment the men would be to some extent out of breath, their attention would be fixed on the point about to be attacked, and their flanks would be neglected. Cavalry should then descend upon them at the utmost speed that can be extracted from the horses, with a good interval from knee to knee. If there is only one squadron, one troop should take the flank or fighting line, while the other throws itself upon the support. As the distance to be covered in the open will probably be not more than from 200 to 400 yards, they will be exposed to fire, supposing none of the ground is undulating, for fifteen to thirty seconds when at full speed. As they close on the infantry neither the supports nor those in rear of them or their artillery will dare to fire, on account of their own men. If the infantry run to get into small squares, as is most likely, the cavalry must endeavor to catch them before they assemble. If they get together it may be too late for the cavalry to stop. They must then throw themselves upon them and trust to the supporting squadron to complete the attack.

Although it is rare that a battle field is on such ground that there are no undulations to afford shelter for cavalry in an advanced position, this may be the case, and if so the enemy's infantry attack must be allowed to take place, but even then, by cavalry showing itself on the flanks for a moment, infantry would get together and afford a better mark for fire, and the progress of the attack would be delayed. The very appearance of cavalry frequently frightens infantry into masses. If the ground was too much exposed for the charge, men might be dismounted, with their carbines, at a safe distance to assist the infantry. If mounted infantry were at hand, they would be utilized in the same way, and the machine guns of the cavalry would also pour in their volleys. If the enemy's attack is successful, cavalry must then advance on their flanks and take its chance, and if necessary sacrifice itself to give its own infantry time to rally. If it is unsuccessful, the cavalry must be ready to take every favorable opportunity of molesting its broken ranks.

Speaking of Mars-la-Tour, Prince Kraft says: "During the battle a German infantry brigade was forced to retire with heavy loss, and ran some danger of being annihilated by the pursuing enemy. But the First Dragoons of the Guards threw themselves on the pursuers. The enemy's infantry massed round the eagles and ceased to press on, while the thin ranks of our infantry were able to rally, and our guns were saved and brought into position. The losses were heavy; half a regiment of cavalry (250 horses) were sacrificed in order to save the brigade." At Waterloo a French division of infantry fled before three regiments of dragoons (the Union Brigade). The Royal Dragoons and the Inniskillings in first line, the Scots Greys on their left rear, the whole under Sir William Ponsonby, acting in support of the Highland Infantry Brigade, were awaiting the attack of the whole of the 1st French Division under Gen. Alix. The three Scotch regiments threw into them a concentrated fire, and as they were staggered by the shock Ponsonby gave the order to advance. Passing through the Highlanders, the Greys having come up into line, the three regiments charged the leading portion of the French column, which yielded, and those in rear were hurled back. The dragoons having the advantage of the descent of the hill appeared to mow down the mass, the Greys on the left pressed on through the supporting brigade of the French, while the Royals drove back the right, giving no time for fire. Many threw down their arms, while hundreds of prisoners were hurried off to the rear of the line. At the same time the Inniskillings forced their way through the center, when the remainder of the French division broke and fled.

It may be said that this took place before the introduction of the rifle, and is therefore no example, but it took place within the range of the weapon then in use, and at that distance it was equally effective. The celebrated charge of Bredow's brigade at Vieuville (Mars-la-Tour) also shows what an energetic attack may do. It had become necessary to demand a sacrifice from the cavalry for the good of the army, to enable Prince Frederick Charles, with only 24,000 infantry, to hold in check Bazaine's army of 180,000 until his own main body came up. Bredow's cavalry brigade consisted of six squadrons of the 7th Cuirassiers and the 16th Uhlans. They were ordered to make a breach in the front of the 16th French Army Corps.

The six squadrons advanced in column, the cuirassiers leading, when they received the word to change direction to the right, then to form line, which was done under heavy fire. The cuirassiers getting into line first, charged at once, the 16th following in echelon. In a moment the batteries, vomiting flames, were reached with a loud hurrah, and the gunners cut down at their guns, when the whole brigade, which had now got into one line, charged the long lines of infantry in rear, who received them with a heavy fire from their chassepots. These lines, too, were broken through, and the main object of the charge was attained, but, carried away by the ardor of the combat, they charged and took the mitrailleuses, when the French cuirassiers, with a dragoon brigade in support, come down upon them, and compelled them to fall back. This they did, having to force their way back through the enemy's masses of infantry with enormous loss. The object, however, was gained, and the attack of the French corps checked and never resumed. The cavalry division covers the advance of the whole army, and is a day or two in front of it. It conceals and guards the army, while finding out the movements of the enemy. It collects information, and is also used with horse artillery on great enterprises on the enemy's communications. Having finished the reconnaissance and covering the army on the day of battle, it falls back as the two opposing sides come in contact, and awaits further orders. On the battle field it should be placed so as to suffer as little loss as possible—as a rule, in rear of the flanks. How far must depend on the formation of the ground; if shelter is to be obtained nearer the front, the better. If not, then some 2,000 yards in rear of one flank would seem advisable. Its duties are to guard the exposed flank or flanks and rear of the army, while it watches the cavalry of the enemy. If within range of artillery, it should be kept on the move from front to rear. Its strength should not be wasted or frittered away on doubtful enterprises, as it maybe required for some decisive blow, in pursuit, or in covering the retreat.

Prince Kraft, speaking of the battle of St. Privat, says: "On the 18th of August the gigantic fight of St. Privat took place. The cavalry divisions were held back in reserve, but the divisional cavalry took an active part. During the battle a squadron of hussars advanced and sent information of the enemy making a flank movement." He also says: "At Sedan the cavalry division was kept in reserve." The massing of artillery at the commencement of a battle must expose a long line with some weak spot to attack. If protected by cavalry, then probably a cavalry combat will ensue. Prince Kraft says: "The action of the masses of German cavalry at Mars-la-Tour excited wonder and admiration; they surprised the enemy's cavalry when in bivouac, they met and surrounded the hostile infantry in a threatening manner, and thus 8,000 cavalry occupied 65,000 infantry, until the Prussian infantry came up. The cavalry made no charges which could not have been successful, but carried out their task of occupying the enemy almost without loss.

"In the old days these squadrons would have charged and ridden down the infantry. The change is the result of the improvement in fire arms." During the early stages of a battle, advanced parties, under officers selected for the purpose, must be kept out from the cavalry division to watch the enemy's movements, and the information they should be able to afford should be invaluable to the general-in-chief. An engagement with the enemy's cavalry should not be sought unless they are much weaker; but should the necessity arise, the ground should be reconnoitered, and every advantage of position taken to insure success. The attack being determined on, the preparations for it should be carried out rapidly. Echelon movements have many advantages. They favor the formation of oblique lines, they also insure in a charge direct to the front the bringing up of squadron after squadron in support. The attack of Vivian's Hussar Brigade upon the French reserves at Waterloo gives a brilliant illustration of this, and has been termed by Siborne the "crisis of Waterloo." This celebrated charge, intended to be in line, became virtually a charge in echelon of squadrons in consequence of the rapid pace of the head of the column.

"The movement of cavalry must be rapid and unexpected, and bear the character of determined confidence; an effort should be made by maneuvering to come suddenly on the enemy's flank. A gentle declivity for the final charge must be sought. The rapid, vigorous, and determined charge in line on to cavalry, riding knee to knee, is what is required." The charge to be made effectual, the horses must be brought up in wind, the gallop must not be begun too early; when begun it must gradually be increased to a fast gallop, the final charge for the last sixty yards made with every horse extended. "Nothing, then, must be left undone to excite the spirit of enthusiasm, even to ferocity; then, and only then, the 'cheer' to be raised." At Waterloo the charge of the heavy brigade, the 1st and 2d Life Guards and King's Dragoon Guards, with the Blues in support, is a good example of a successful attack on cavalry. The French line of cavalry as it advanced presented an imposing appearance.

They had ascended the brow of the ridge, when a vigorous fire from Ross' Horse Artillery was opened on to them. In the next moment their trumpets sounded the charge and they rushed to the attack, and as cuirassiers approached the British squares, the Heavy Brigade dashed into them. The shock was terrific. The right of the Life Guards being thrown forward, came first into collision. The right of the French was suddenly thrown out by coming unexpectedly on to a hollow way, and as they passed it the 2d Life Guards came full speed upon them. The French cuirassiers were driven back and pursued until the English brigade came under infantry fire.

The charge of the Heavy Cavalry Brigade at Balaklava, under Gen. Scarlett, is another good example, when the Russian cavalry, receiving the British charge at a halt, were entirely overthrown. One of the greatest difficulties after the charge is to know when and how to stop, and it is then that the squadron and troop leaders, well in front of their men, must use all their efforts to carry out the ends of their commander. I think this is the time when a strong whistle carried by the commanding officer and the squadron leaders can be used with good effect. Being an unusual sound, it would attract attention. The battle being over, some of the most serious duties of cavalry commence. If the enemy is victorious, the pursuit has immediately to follow. History points out the difficulty of carrying this out. Uncertainty of the victory, or how far it can be counted on, often delays its commencement. Battles are often ended by nightfall, valuable time is lost, and the golden opportunities are past. An active cavalry leader will, however, without further orders at least, follow with his advanced parties and not lose touch of the enemy. He will soon learn the condition of the enemy, act accordingly, harass his flanks and rear and play upon him with his artillery.

An example of another manner in which cavalry may be employed after a victory can be taken from the Egyptian campaign of 1882, when, after the battle of Tel-el-Kebir, by a rapid advance of the cavalry some fifty miles ahead of the infantry, the capital of the country was captured by the English cavalry division.

If the battle is lost, still greater are the responsibilities of the cavalry. Detached squadrons with scouts must be sent round the flanks to ascertain the strength of the enemy sent in pursuit. Every available position must be taken up by the horse artillery, and every advantage seized for counter attack. Above all, accurate information must be obtained for the general-in-chief of the nature of the pursuit, in order that he may not harass his main body by falling back further than necessary. This subject, however, is beyond the scope of this lecture, and is one of study of past campaigns.

Of the action of cavalry in savage warfare, the recent campaigns in Africa have given some experience. In the presence of an enemy met with in such enormous numbers as in the desert, cut off from all help, knowing that unless you win you die, it seems to be decided that our infantry must adopt the square as the most suitable formation. In the Zulu war, the cavalry at the battle of Ulundi was placed inside the square. The experience met with there was exceptional, and from the swarms of savages surrounding the square in all directions it was considered desirable to keep the 17th Lancers in the center of it, in order that they should not interfere with the infantry fire, and that when the enemy was repulsed, they should be launched out upon them, and this was done with perfect success. It is, however, contrary to the instincts and traditions of cavalry to be shut up in a square, and, where practicable, I should think cavalry outside a square, even at some distance out of the way of the infantry fire, acting with horse artillery, would very much disturb the attacking bodies of the enemy, and perhaps attract away a portion of them, and they could be brought up, when called upon to do so, to carry out the pursuit.

In the first campaign on the east coast of the Soudan, on the advance to El Teb and afterward to Tokar, squadrons were sent in front and on the flanks of the square with scouts thrown out to feel the way and obtain information, while the main body of the cavalry was echeloned on the rear and flank opposite an angle of the square in the most suitable manner to avoid any interference with its fire. During the action it remained in this position until after the first attack on the square, when it moved away past the square on the outward flank and acted on the enemy's rear and engaged their reserves until the action was over. During the desert march in the Nile expedition, the 19th Hussars, by its scouting, protected the square and gave it timely notice of the approach of the enemy.

In a country where a great deal of bush abounds the effective charge of cavalry on to groups of savages is very much curtailed. The Arabs throw themselves on to the ground behind the prickly bushes, the ranks are opened out as the horses avoid the thorns, and the men get no chance of using their swords; but although much execution is not achieved under these circumstances, the natives have great fear of cavalry, and they are prevented from attacking elsewhere. When their attention is thus occupied, horse artillery and machine guns might make great havoc among them. At the action of Tamai, where the ground, from the rocks and ravines of the neighboring mountains, was unsuitable for cavalry charges, when one of the infantry squares was broken, the cavalry advanced, and one squadron of the 10th Hussars, dismounting, helped to create a favorable diversion by pouring fire into the flanks of the attacking Arabs.

My remarks would, I think, be considered incomplete if I did not touch on the question of cavalry charging squares, as this point is always made very prominent in all discussions on the action of cavalry. I therefore must not pass it by. I will say at once that I think it most undesirable, even under favorable circumstances, that cavalry should charge a formed square and men armed with the breech loader. At best the gain can be but local and partial, while the loss to the cavalry—an arm so difficult to keep up in numbers—must be disastrous, and it seems to me that if cavalry by its appearance can force infantry to form square, it has done enough, and that the artillery, infantry, and machine guns should do the rest. The necessity might, however, arise, and by looking at the past we see its possibility. At Langensalza two Prussian squares were broken by the Hanoverian cavalry, and the major part taken prisoners.

We have only to turn to the recent campaigns in Egypt to see the effect of determined rushes of men, intending to succeed, charging on to squares carefully formed on ground affording shelter, with an enormous amount of fire being poured upon them. It will be said that these men were fanatics, but our cavalry, too, have been, and will be, fanatics in a charge; and I still think, if the necessity recurs, that an attack, properly conducted on favorable ground, one troop charging on the corner of a square, followed by another at double distance, others in echelon on both flanks immediately following, the whole charging with the greatest impetuosity, intended to win, will break down any square that Englishmen are likely to meet with. If we look back again on the past, we will find many instances of British cavalry not being called upon in vain to make a sacrifice. At Talavera, the 23d Light Dragoons, supported by the 1st Hussars of the German Legion, advanced against the French squares. In their impetuous rush they came upon a hollow cleft covered with long grass, eight feet deep, and eighteen feet broad. Too late to pull up, the foremost rode headlong into it, some tumbled in, others over it, some rode boldly at it and gained the other side. Still they went on, swept past the infantry columns, and fell upon a brigade of French chasseurs.

At Balaklava 670 British horsemen were launched against an entire wing of the Russian army. The brigade, at first in two lines, the 11th Hussars, 17th Lancers, and 13th Light Dragoons, followed by the 4th Light Dragoons and 8th Hussars, advanced down a gradual descent of three-quarters of a mile; the Russian guns vomiting shell and shot upon them, one battery bearing on their right, another on their left, and all the intermediate ground covered with riflemen. The guns were charged and forced through, the forces drawn up in rear were overpowered. They then had to turn, and, retiring up hill, ran through the same gauntlet. In the Sikh war, at the battle of Ferozeshah, the 3d Light Dragoons charged the enemy's entrenchments at a point defended by some of their heaviest batteries. When within 250 yards the regiment moved at speed under a destructive fire of grape and musketry, and pressing forward at the charge entered the enemy's camp and captured the whole of the batteries.

Cavalry attacks have been made with success after dark, and the advantage, of course, is gained of obviating opposing fire. Prince Kraft mentions that after the battle of Mars-la-Tour, the cavalry division, re-enforced by the divisional cavalry, rode forward to complete the advantages gained. It was almost night, and fault has been found with making the attack in the dark. If the ground is well known a night attack may be advisable. While criticising it, we have to think of the feelings of a half-defeated army about to bivouac being attacked by unknown forces in the dark. In this case, at Vionville, the enemy did not wait for a second, but withdrew, and abandoned the whole field of battle. Prince Kraft quotes the attack of Blücher at Gross-Gorchen and a cavalry attack at Loon. During the first Egyptian campaign the Life Guards made an attack by moonlight at Kassassin.

I have now, I think, touched lightly on some important cavalry duties on a campaign. In some points perhaps these remarks may appear contradictory. How to combine keeping cavalry in reserve for any great action it may be called upon to perform, while using it unsparingly to assist on the battle field, if the necessity arises. It may, however, be noticed that, much as they may be criticised, few cavalry commanders have been severely blamed when they have thought it best to take the bolder course. To insure to cavalry the power of carrying out its duties successfully in war, organization and practice in peace is most essential. Infantry may suddenly be increased without much deranging its action in the field, but cavalry cannot be hurried into an increased augmentation. In tactics simplicity in every evolution and rapidity in execution are the most important principles. This simplicity of drill, I think, might be assisted if our squadrons were divided into four divisions, zuges, or pelotons. When squadrons have 48 files in the front rank there might be four of these, while weak regiments with 36 files could drill equally as well with three divisions. This system, introduced by the late Gen. Valentine Baker into the English service for a time, and now used by all European countries, was found to work well.

I think the whistle could be carried with advantage by all cavalry officers. For advanced work attention can be drawn by it without being heard at a distance like a bugle. In movements the commanding officers would find it useful to call the attention of leaders to himself, especially in extended or échelon formation. I have omitted to make much mention of the action of horse artillery combined with cavalry, as it seems beyond the limits of this paper; but it is one to which the cavalry officer's attention requires to be brought most strongly to bear. I would also have wished to have made some remarks on the many advantages to be obtained by having mounted infantry attached to cavalry. I understand that this force would be under the orders of the cavalry general, and if so, I think a cavalry division well found in horse artillery, with mounted infantry, whether conveyed on horses, or, where the cavalry admitted of it, on cars, and accompanied by machine guns on wheels, could act in such an independent manner as to enable it to penetrate far ahead into an enemy's country, or threaten his communications, and be absent from its main body for many days or weeks.

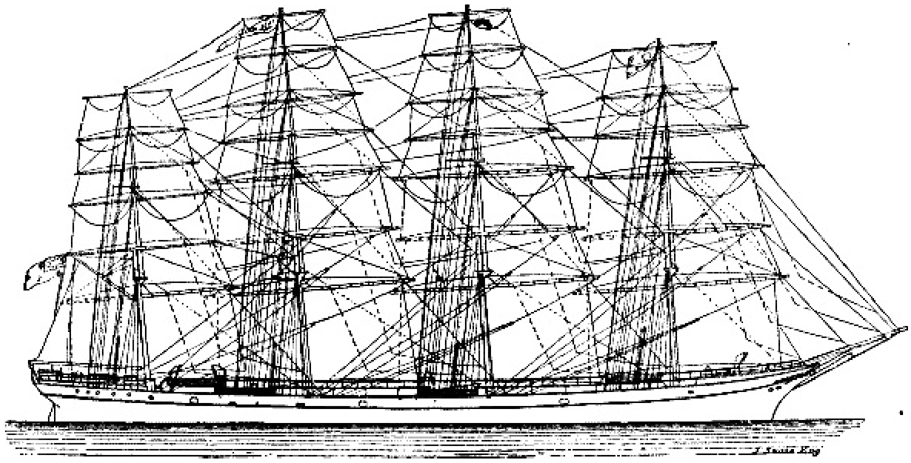
As regards the English cavalry, I think it may be said, without boasting, that the material is excellent. The men are of the best physique, recruited from a good class, and plenty of them to be had. The non-commissioned officers are intelligent and always ready for instruction; the riding compares favorably with cavalry of other nations, certainly far better than any I have ever seen abroad, either German, Russian, or French, and among all foreign countries we have the reputation of being the best horsemen in the world, which at all events has a good moral effect. Our horses are undoubtedly first-rate, having more quality and greater speed than foreigners. We have in our officers the exact stuff we want. Their very sports and amusements start them with all the makings of cavalry soldiers. But the quickness of eye, the self-confidence and readiness that these sports and games may give, require nowadays more than ever something beyond this to produce the trained cavalry leader. Cavalry is an arm of opportunity, and above all others depends greatly on its leaders, but with the chances now available of reading, in every detail, the campaigns of the past, if taken advantage of, as is now daily becoming more common, we should produce in the future the best and most accomplished cavalry officers that this country or any other has ever seen.

As there appeared to be a unanimity of opinion on the lecture, there was no discussion, and the proceedings closed with a vote of thanks to the lecturer.—*Broad Arrow*.

[1] A lecture lately delivered at the Aldershot Military Society's library.

IRON SAILING SHIPS.

Messrs. Russell & Co., Greenock and Port Glasgow, show at the Glasgow exhibition a very numerous and varied show of sailing models. First, we find the noble four-masted ships of from 1,800 tons to 2,200 tons, which sail and carry well on their tonnage, and which are worked by fewer hands than are required for a ship of the same burden with three masts but squarer yards. Some owners prefer the latter, and so Messrs. Russell show not only such handsome specimens as the four-masted Falls of Earn, but also the three-masted Ardencraig and Soudan. One of the favorite models of this firm is that of their 1,500 ton ship with three masts, represented by the Cromartyshire, of which type they have built a large number of vessels noted alike for their carrying capacity and their excellent sailing qualities. The Main, built for Mr. James Nourse, of London, is a good specimen of their 1,700 ton ship, as designed for the special trade of the owner, between Calcutta, Demerara, and London. Their 1,300 ton bark is represented by the model of the Aboukir Bay and her sisters of the Bay Line, owned by Messrs. Hatfield, Cameron & Co., of Glasgow; while their 1,000 ton barks are shown in the model of the Banca, belonging to Messrs. P. Denniston & Co., of the same city. These are about the smallest class of sailing ships built during recent years, the demands of the shipping trade being such as to make it unprofitable to sail anything smaller than about 1,500 tons; while the tendency is to exceed 2,000 tons in burden, and to reach even as high as 3,000 tons.—*The Engineer*.



FOUR-MASTED IRON SHIP FALLS OF KARN.

WATER BLAST PUMP.

It is well known that the principle which is applied to the construction of vacuum or filter pumps, and which aims at the production of rarefied air in a certain inclosed space, may also be applied to the production of air *pressure*.

A simple apparatus by which this may be accomplished has recently been constructed by A. Beutell.

A tall cylindrical flask, K (see cut), is provided with an outlet tube near the bottom, and its stopper carries two tubes, one (M) for the entrance of a jet of water, and the other (L) for the exit of the compressed air, which may be conducted to a blast lamp or wherever air under pressure may be needed. The column of water entering through M causes air to be sucked in through the little hole at c, and this air, after arriving in the flask, is gradually compressed by the continuously entering water.

In order that the apparatus may work properly, it is necessary to construct the tube, M, in a particular manner, and of certain definite proportions. Fig. 3 exhibits its bore and shape in an enlarged view. A short distance below the orifice of the tube it is slightly expanded, and then gradually contracts to the place, *b*. It then again expands to an oblong cavity, and contracts again to a neck, *e*, which is a trifle wider than that at *b*, and which must be so situated that the column of water passing through *b* is exactly perpendicular to the center of the aperture at *e*. The tube then expands again to its original diameter, and is slightly curved, which is done to prevent any of the compressed air in the cylinder, K, from regurgitating upward.

The outlet tube at A is preferably constructed as shown in Fig. 2. Instead of being made of one piece, it is there represented as consisting of two pieces joined together by rubber tubing, a sort of check valve, G, being introduced into the rubber joint. By regulating the check valve, that is by approaching it more or less to the exit of the tube, A, the outflow of water may be regulated. It is important to adjust this so that the cylindrical flask will always be at least half full, and never over three-fourths filled. While the column of water falls through the aperture at *b*, into the expanded portion of M, it aspirates air through the little orifice, *c*, communicating with the outer air, and this air is carried along with it into the flask, where it accumulates until it is under a pressure equal to that of the column of water entering the apparatus, when the latter will cease to flow. By allowing the air to escape through L, more will be successively compressed, so that a steady blast may be obtained.

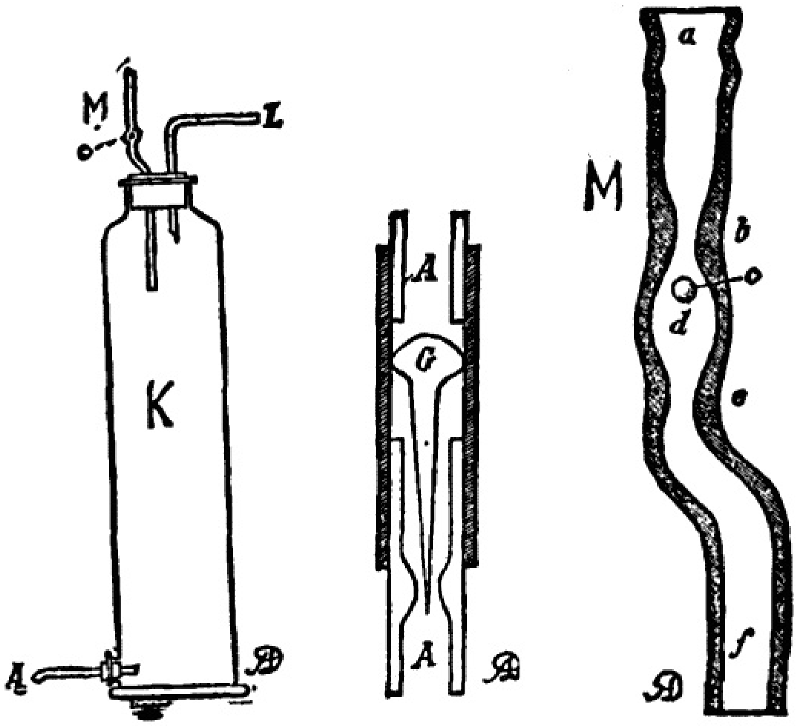


FIG. 1. FIG. 2. FIG. 3.

BEUTELL'S WATER BLAST PUMP.

The proportions between the diameters of the expanded and contracted portions of the glass tube, M, are important. If the bore at *b* amounts to 2.5 millimeters, that at e should be 3 millimeters. Under these circumstances, and with a pressure of water equal to a column of 61.7 cubic centimeters, the apparatus will furnish 890 liters of air for every 1,000 liters of water consumed. If the two diameters were: *b*, 1 millimeter, and *e*, 2.4 mm., one liter of water aspirates 2.35 liters of air. These proportions are, no doubt, capable of improvement.—*Chem. Zeit. and Ch. Centralbl.*

TRANSMISSION OF POWER BETWEEN BODIES MOVING AT DIFFERENT VELOCITIES.

A few months ago there was exhibited, in the society's reading room, a working model of an application to railway working of what the inventor calls "division of the mass." In causing a body, moving at a high velocity, to communicate motion to another at rest, or moving at a lower velocity, he splits one of them up into parts all the more numerous, and therefore tenuous, as the difference in velocity is greater; and this is accomplished by causing one of the parts to take the form of a brush composed of metal fibers.

In applying this principle to the transmission of motion for driving machinery, a disk, fitted with segmental brushes, is slid laterally along the shaft, so that the fibers come into contact with radial projections on a second disk; and, although the contact is made instantaneously, the action is exerted gradually, owing to the flexibility of the fibers. That is to say, the full power is communicated without any shock.

A similar arrangement, but with one of the disks fixed, serves as a brake for arresting motion, and this again without shock, but with gradually increasing action. Where space is very much circumscribed, the clutch and the brake may be combined, by fitting a disk with brushes on one side, and projections on the other, so that it may be brought by a lever against a second disk, for transmitting motion, and against a third, fixed, for stopping it.

Safety appliances for arresting the descent of mine cages, in the event of the rope breaking, have hitherto depended upon the entrance of claws into the guides, or the clipping of the latter, or the wedging of the cage between the guides.

In this application of the system, the guides of the shaft are fitted with corrugated iron plates, and the sides of the cage with steel brushes. In the normal state of working, the brushes are kept clear of the guides, but, should the rope break, a small brush, fitted on a sector, constantly rubbing against the corrugations of the guides, aided by a spring or counterweight, brings the main brushes into contact with the guides by a link arrangement, like that of the parallel ruler, thus arresting the cage, and holding it suspended until the brushes are gradually relaxed, for "braking" the cage slowly down to the next landing.

Many attempts have been made to cause a locomotive, running at full speed, to exert such a mechanical action as would set a signal to danger, so as to protect the train from another following in the rear. By fitting the engine with a steel brush, attached to the axle boxes, so as to preserve a uniform height with respect to the rails, a stationary lever may be gradually moved, so that the signal is set at "danger" without shock. Moreover, by means of another brush, in the event of the engine being turned upon the wrong line, a lever may be made to shut off the steam, apply the brakes, blow the whistle, or move an index on a dial, recording a neglect of duty, or may exert these four actions simultaneously.

All the above applications of this principle—"the division of the mass"—have been tested experimentally, the last named by the model above referred to. The clutch arrangement has transmitted six horse power from a petroleum motor, making 200 revolutions a minute, to a dynamo making 2,000 revolutions, while applications to industrial purposes are now being made, both in this country and in Belgium. The inventor of the system is M. Raymond Snyers, Ingénieur des Mines, du Génie Civil, et des Arts et Manufactures, of the Louvain University.—*Journal of the Society of Arts*.

STEAM GENERATOR OF SERPOLLET BROTHERS, PRODUCING STEAM INSTANTANEOUSLY.

The explosibility of a steam generator may be measured by the relation of its total capacity to its vaporizing power. The old fashioned generators and some of the modern ones are so constructed as to contain from fifteen to twenty times more water than they are able to vaporize within one hour. Thus a great quantity of heat is obtained and a uniform pressure assured, but the steam-generating apparatus is costly, heavy, and cumbersome; it requires a long time before the necessary pressure is obtained, and the generator is only suitable for a stationary installation and where it can uninterruptedly work for a long period of time. Besides, the enormous quantity of hot water under pressure constitutes a constant danger, and the explosion of a steam generator with boiler tubes becomes a real disaster.

In order to satisfy the requirements which have newly arisen in connection with navigation, locomotion, small motors and apparatus which need for their working an intermittent supply of steam, it became necessary to modify the construction of steam boilers, to augment their heating surface, to diminish their residue of water, and to gradually construct so-called *inexplosible* apparatus, of which the Belleville boiler forms one of the most characteristic prototypes.

In trying to reduce the inexplosibility to the utmost, Messrs. Serpollet Brothers have succeeded in constructing a type of boilers which may be called *absolutely inexplosible*, and this result has been obtained by reducing the capacity of the boiler to practically *nil*, thus rendering the explosibility also *nil*, for under the circumstances the relation between capacity and vaporizing power becomes itself *nil*.

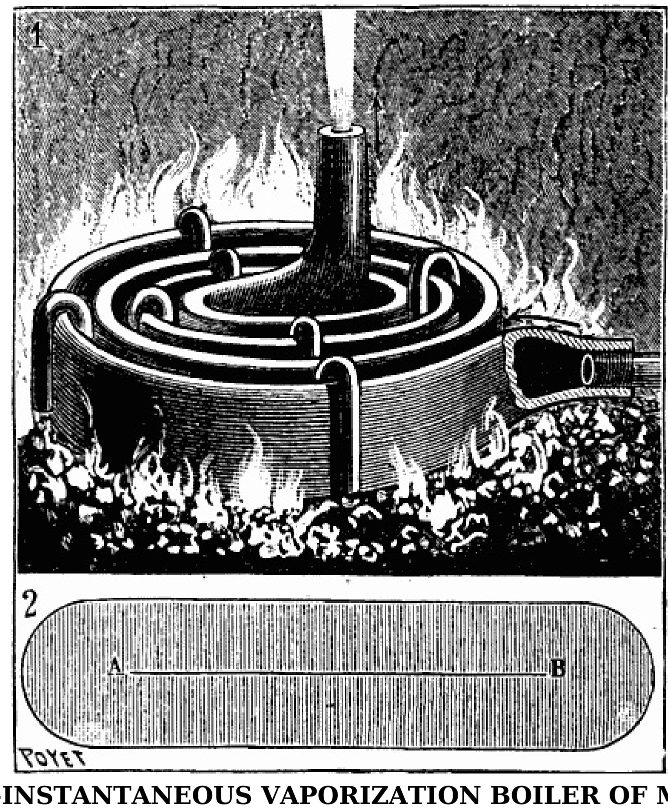


Fig. 1.—INSTANTANEOUS VAPORIZATION BOILER OF MESSRS.

SERPOLLET.

1. General view of boiler (experimental arrangement).
2. Cross section of boiler (natural size). The line A B indicates, at somewhat exaggerated scale, the cross section of the interior empty space of the boiler.

The method employed for this purpose by Messrs. Serpollet is an extremely simple one. A cylindrical steel tube of convenient diameter and sufficient thickness is rolled flat at a temperature below the white heat of the metal, and the last touch of the rollers is given to it when already cold. By this means a flat tube is obtained, the empty interior space of which looks in a cross section (Fig. 1, No. 2) like a black line not thicker than a hair, and measures from 0.1 to 0.3 millimeter. This tube is finally rolled up in the form of a spiral, or left straight, according to the use to be made of it, and put into an appropriate furnace (Fig. 1, No. 1). To either end of the tube a joint is attached, the one for the purpose of admitting the water, the other for admitting the steam.

When under these circumstances the tube has been heated to a high temperature in a convenient fire box, the water which has been pumped into it, by a feed pump fastened to one of its extremities, is instantly changed into steam and escapes at the other end at a pressure and in a state of dryness depending on the working conditions of the apparatus. The ingenious and really original and novel idea in this invention is this flattened tube, which constitutes an actual capillary boiler inside of which the water squeezed in between its walls cannot assume its spheroidal state, and the formation of drops becomes absolutely impossible. There exists no longer a residue of hot water, nor are water gauges, safety valves, or any other of those numerous accessories required which make all steam boilers so complicated and which augment considerably their cost.

It also becomes unnecessary to connect the joint from which the steam escapes by means of a valve with the motor for which the steam is to be used. If the supply of steam is to be stopped, this can be done by simply suppressing the supply of water, *i.e.*, by *emptying the boiler*.

The regular working is assured by the quantity of heat contained in the heated iron tube, to which, for this purpose, an intentionally great thickness has been given, and it is this heat of the iron which replaces the heat furnished by the hot water in the steam generators with boiler tubes. From the above it will be easy to understand the general arrangement of the new steam generator, when connected with its motor. This motor works a small intermitting pump, which supplies the capillary boiler with water, according to the quantity consumed. The machine is started by means of a small special pump worked by hand.

Whenever the velocity of the motor tends to increase, a centrifugal regulator placed upon the motor reduces the action of the pump and, consequently, the supply of water to the tube, thus checking the velocity of the machine. If the velocity tends to slacken, the inverse process is employed. In order to stop the machine, it suffices to turn off the water furnished by the pump by means of a three-way cock, and to send the water back to the reservoir of supply. The boiler can be emptied in less than a second, and the motor stops in consequence of being deprived of motive power.

The whole is marvelously simple, and creates astonishment and admiration in the mind of even the most skeptical persons who see the apparatus.

The boiler of the one horse power type weighs 33 kilogrammes. It consists of an iron tube having a length of 2 meters and a height of 10.5 centimeters after it has been flattened; the total heating surface thus obtained being 48 square centimeters. The power of vaporization amounts to 20 kilogrammes of water per hour, while the quantity of coal consumed during the same period amounts to only 4 kilogrammes, which is comparatively little for a boiler of so small a power.

Fig. 2.—TRICYCLE PROPELLED BY A SERPOLLET BOILER

Fig. 2 shows the first model of a tricycle constructed by Messrs. Serpollet as an application of their boiler for locomotion. The writer has seen the working of this apparatus, and consequently is able to give some data. The total weight of the machine is 185 kilogrammes, or about 250 kilogrammes when mounted by a person. The boiler is placed behind the tricycle, the motor is under the seat, inside of which is the water reservoir and the supply of coal. In the motor employed in the present case the feed pump is a constant supply pump, but by means of a directing lever turning around its own axis and acting upon a three-way cock, the water can be divided into two streams, the one emptying into the feeding reservoir, the other into the boiler. By varying the position of the cock, the power of the machine can be modified and its velocity regulated. The machine can be brought to a stop within less than two meters by means of the combined action of a brake and the complete suppression of water in the boiler. In order to start the machine, the water is sent into the tube by a little extra pump worked for a moment by the left hand of the cyclist when starting.

On July 25 some experiments were made before the Society of Civil Engineers with the tricycle above described, and on that occasion it traversed the Rue Girardon and the Rue de Norvino to Montmartre (streets in which the gradient rises to 15 centimeters per meter) with a velocity of three meters per second.

Fig. 3 represents the arrangement of the first stationary boiler of the new kind. The letters of reference will suffice to indicate the position of the principal parts of it, the forms of which may be varied according to the object for which the boiler is to be used.

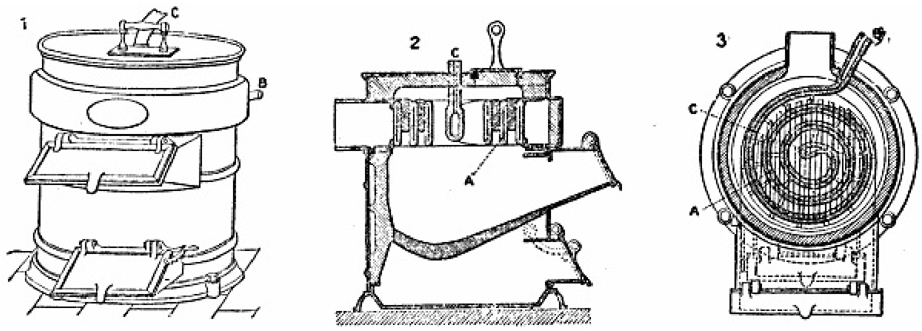


Fig. 3.—COMPLETE VIEW OF A SERPOLLET BOILER.
1. Exterior view. 2. Cross section. 3. Horizontal section at the height of the tube.

Messrs. Serpollet are occupied at present with studying the special arrangements which will be needed for connecting their boiler with a quadricycle, a torpedo boat, a stove, a locomotive, or a stationary machine of 10 horse power, and with rectangular parts.

The inexplosibility of their boiler has been tested during an experiment made before the engineers of mines, on which occasion a manometer (steam gauge) graduated for a pressure of upward 200 kilogrammes per square centimeter was used, and the pressure raised far beyond the limits indicated. The result was that the hand of the manometer, being pressed against the walls of the box, became bent, and though the boiler was submitted to a pressure the degree of which it was impossible to measure, it was not changed in the slightest.

Incrustation of the boiler is not to be feared, for, in consequence of the great velocity with which the steam circulates through the tube, the solid matter dissolved in the water becomes pulverized and is forced out, mechanically assisting to lubricate and polish the parts of the motor.

The invention of Messrs. Serpollet is still too new to foretell all its possible applications, but their apparatus, in its present form, is exactly the steam generator which will be useful for producing a small motive force; while it will be necessary to wait until it has been ascertained, by further study, how the system can economically be used for high motive power.

The most natural and immediate application of the invention seems to be its use for the electric lighting of restaurants, in which case one of the instantaneous vaporization tubes might be connected with stoves which remain lighted all day, and which might thus besides supply the necessary motive force to work a small dynamo charging some accumulators.—*E. Hospitalier, in La Nature.*

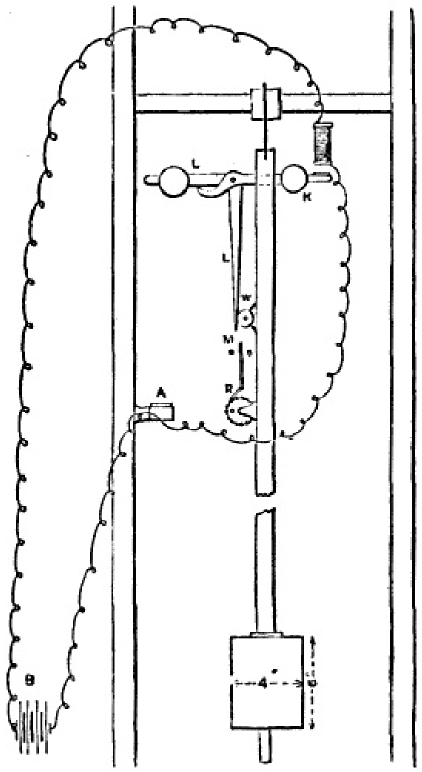
GAS LIGHTING BY HIGH-POWER BURNERS.

In the course of a communication presented to the Societe Industrielle du Nord de la France by the manager of the Wazemmes Gas Company, he made the following remarks on gas lighting with high-power burners:

For gas of a standard illuminating value, the lighting power increases with the temperature of the flame. It also increases, under favorable conditions, if the quantity of gas consumed by the burner in a certain period is augmented. Thus, two burners consuming 60 liters (rather more than 2 cubic feet) of gas, placed in juxtaposition, produce less light than one burner consuming 120 liters. As it is impossible to indefinitely increase the supply to ordinary burners, multiple-flame burners have been invented, in which two or more ordinary flames are united so that they may impinge upon each other. By an ingenious arrangement for bringing the air into contact with the multiple flames, two excellent types of lamps are obtained, consuming respectively 700 and 1,400 liters per hour, which meet with a rapid demand in Paris, and in many other towns, for lighting wide public thoroughfares, squares, and large open spaces. If, however, it is desired to obtain a flame with a much higher temperature, it is necessary to resort to a special arrangement for heating the air intended for combustion with the gas. The principle of heating the air by means of waste heat escaping with the products of the waste gas—the regenerative principle—was adopted by Mr. F. Siemens, and applied not only to gas burners, but to high temperature stoves. With the Siemens burner on the regenerative principle the following results are obtained: With a consumption of 150 liters per hour, the light of from 1 to 3 carcels; 250 to 300 liters, 6 to 7 carcels; 600 liters, 15 carcels; 800 liters, 20 to 22 carcels; 1,600 liters, 46 to 48 carcels; 2,200 liters, 72 carcels. Unfortunately, the construction of the Siemens Argand lamps is very delicate, and, moreover, they have the disadvantage of being heavy and rather unsightly. In Germany they have been widely adopted; but in France they have met with but little success. The Schulke lamp is made on the same principle; and this appears to be too delicate to come into general use. One of the latest burners of the regenerative class is the Wenham, which has been before the public for some time in England and is now being adopted in France. In point of fact it is merely a very effective improvement on Breittmayer's burner, from which it differs only in its construction; being produced in some elegant styles, which lend themselves perfectly to the decorations of private houses. The No. 2 lamp of this type, with a consumption of 283 liters (10 cubic feet) per hour, has given 126 candles, in a vertical direction without reflectors: horizontally, 50 candles. But the gas employed in the tests had an illuminating power about 20 per cent. higher than that usual in Paris. When experimenting in Paris with a No. 3 lamp in a vertical direction, it showed a consumption of 34.6 liters (1.2 cubic feet) per carcel obtained. The Wenham lamp is constructed to give light in a vertical direction; and by adopting a large reflector, the illuminating power is increased 18 per cent. in a vertical line and 55 per cent. at 80°, which is a highly satisfactory result. There are at present five sizes of these lamps. There is also the Delmas hot air burner, in which the batswing flame is completely inclosed in a glass, mounted with a sheet-iron casing, heated by the products of combustion, through which the air passes on its passage downward to feed the flame; and it thus increases the temperature, improves the illuminating power, and produces a beautiful steady light. Mention also may be made of the Siemens radiated heat burner, by means of which the heating of the air is effected simply by the radiation of the metallic parts of the appliance which are in contact with the flame. These burners produce the light of 1 carcel (9.5 candles) with a gas consumption of 70 liters (about 2½ cubic feet), and are therefore, from an economical point of view, intermediary between the high power and regenerative burners. This degree of economy can be ascertained by an ingenious arrangement of the air supply in a burner with holes, which has been made in in the laboratory of the Wazemmes Gas Company by M. Verlé, the engineer, who has invented a very simple burner called the "Lillois," with which the light of 1 carcel is obtained with a consumption of 70 liters. This produces a tulip-shaped flame, and it has a specially constructed glass arrangement on the outside for regulating the combustion. Comparing the above-mentioned burners with each other, we arrive at the following results: The "Lillois" burner consumes 70 liters of gas per carcel; the Siemens ordinary, 70 liters; the Siemens-Breittmayer, 35 to 39 liters; the Wenham, about 35 liters. Taking this into account, and considering that a carcel corresponds with 105 liters of gas consumed in the Bengal form of burner, we see that the economy in gas might, by employing these burners, reach from 33 to 71 per cent. If this is compared with the batswing burner, which produces the light of 1 carcel with a consumption of 120 liters of gas, the economy is greater—varying, according to the type of lamp, from 41 to 85 per cent.

SYNCHRONIZING CLOCKS.

At the recent meeting of the Institution of Mechanical Engineers, Dublin, Mr. Davey, of Leeds, spoke of synchronizing mechanisms. He had occupied some of his spare time in attempting to synchronize clocks from a standard clock. The problem is similar to the present one, except that it is rough-and-ready, compared to the present one. He had a novel electrical pendulum, to drive a seconds pendulum by electricity. Electrical clocks are notoriously bad timekeepers; on account of variation in the strength of the electrical current, the battery falls off. He had constructed an electric clock having a seconds pendulum, and recording an impulse once a minute. On the pendulum he had a little ratchet wheel, R, having thirty teeth. The pawl was connected with a lever, M, fixed at the top. On the face of the wheel a little pin rotates with the wheel. On the side of the clock case was a contact maker, which closed the circuit by the pin on the ratchet wheel, R, once every minute. The weight was lifted by the electric current, and by its fall gave an impulse to the pendulum. The pendulum was a free swinging pendulum for 59 sec., and the increase of the arc could scarcely be detected.



DAVEY'S PENDULUM FOR SYNCHRONIZING CLOCKS.

W, friction wheel attached to pendulum. L gives no impulse except when the electro-magnet is excited. K, lever and weight lifted by electro-magnet, E. A, open contact completed by pendulum each swing. B, battery. R, ratchet wheel and pawl. M, lever fixed at top. L, weight at end of bell crank lever, which drives pendulum once each minute, being raised

by the electro-magnets.

COAL TAR AS FUEL FOR STEAM BOILERS.

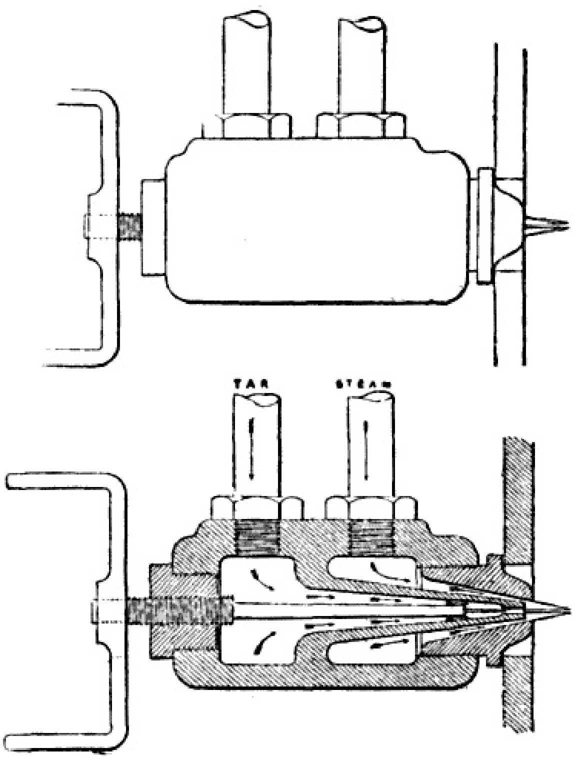
By John McCrae, of Dundee.

About three years ago, when the sudden and serious fall took place in the value of the secondary products produced in gas works, many gas managers—ever desirous of doing their very best for their employers—were forced to look around for some better market in which to dispose of the products which had so seriously fallen in value. This was no easy task; and even now it forms very uphill work indeed. A comparatively new market has been created for the disposal of boiled tar at several of the German ports. But the expense and difficulty of loading ships with tar in casks take very much from the saving derived from the new manner of disposal. It occurred to me, therefore, that we must look nearer home for a remedy.

In all gas works of any magnitude, a considerable quantity of fuel must be employed for the purpose of supplying the works with steam for the exhauster engines, chemical apparatus, thawing purposes, etc. Whether this fuel consists of coke or of coal, will not in the least affect or alter my figures. I have no doubt if any manager discovers that he is working more economically by selling the coke and using a cheap small or other coal, he will adopt the cheapest process. In Dundee, where we get a good price for coke, I found, for the purpose of steam fuel, it would be far cheaper to buy small coal costing from 5s. to 5s. 6d. per ton delivered in the works, and dispose of the coke. The question of fuel then lay between coal and tar; and I have experimented somewhat extensively to ascertain the true relative values of the two classes of fuel. For the purpose of this paper, and within the last few days, I made a further examination into the question; and the results arrived at will be those here quoted. The coal we employed was what is known as Stravenhouse small coal, which costs 5s. per ton delivered. The experiment in each case lasted 48 hours. The tar employed was what is known as boiled tar; the naphtha having been previously removed, but the pitch oil left in the tar. The value of this tar in Dundee is about 4s. per ton. The following are the figures:

Coal, 10 tons 16 cwt., at 5s.	£	2	14	0
Tar, 1,460 gallons (or 9 tons 3 cwt. 160 gallons = 1 ton), at 4s.		1	16	7
	——	——	——	——
Saving per day by using tar.	£	0	17	5

And this at the longest day, when we are using a mere fraction of steam, as compared with our winter requirements, and consequently the profit is proportionally less than it will be when we are in full work.



And now allow me to direct your attention for a short time to the appliance made use of in accomplishing this tar burning. On the wall is shown a diagram giving in detail the injector known as C. & W. Walker's patent tar sprayer burner; and it is supplied only by that firm. The tar, which has been brought forward to the boilers in a thoroughly liquid state, is discharged from the center of the injector into the furnace of the boiler. Surrounding the center nozzle of the injector is an annular space through which high pressure steam passes, also into the furnace. The meaning of this steam moving along with the tar is to force a draught, as well as to raise the temperature of the tar, and so partially convert the tar into vapor; thereby making the combustion more complete. The flow of the tar is regulated by the very delicate sluices attached to the injectors. These valves consist of elongated cones and plugs, and are constructed not only for the purpose of regulating the flow of tar, but also for removing any obstruction or incrustation which may accumulate in the nozzle. In order to keep the tar in a liquid state (which in the winter time is not an easy matter), a small steam pipe is passed through the center of the tar pipe; but, of course, no steam is discharged among the tar, as the presence of water in the injector prevents its correct working. The steam pipe is simply passed through the tar pipe, and a steam trap attached to its end. In changing from the coal or coke fuel to the tar, little or no difficulty is experienced, and very rarely is a shovelful of any kind of solid material required. The furnace bars have only to be kept covered to prevent the waste of tar and the too rapid ingress of air; and when the furnaces are in full work, and being well and carefully attended to, the tar will be found to have been nearly all consumed before reaching the solid material covering the bars. The action is very much the same as in the paraffin oil lamp. The wick is the medium by which the oil is brought to the point of combustion, where it is developed into light; but the wick remains little injured, although in close proximity to such intense heat. The oil burns, not the wick. In the tar furnace, the tar itself burns, and the tar only.

It will be easily understood that a little experience is necessary to enable the attendant to fully understand the quantity of tar by which complete combustion is to be obtained, and which in no case must be exceeded. The moment one atom of tar is sent into the furnace beyond that which can be thoroughly consumed, you have then the most hideous discharge of black smoke (carbon) which it is difficult to describe, but which can be easily understood, and, I believe, can be seen within a few miles of where we now sit. I should mention that the injectors are fitted on the furnace doors; but the connections are of such a nature that the doors can be opened without disturbing any of the permanent fittings.

And now I have told you that the results detailed in this short paper were those obtained in the Dundee gas works. This is so; but were I to leave the matter here, it might be inferred that I considered similar results might be obtained in any and every gas works. I would not mislead you; and therefore must detain you for a few moments longer in order to show you how my town is different from many others. Dundee is very peculiarly situated in this respect. It is a long distance from any tar distiller's works capable of dealing with the large quantity of tar we have for sale during the winter. A large portion of the value of our tar must, therefore, go to the railway company, to cover the cost of transit between the two points, and so the tar distiller can allow us but a small figure for it at the starting point. Then again, Dundee being far distant from the coal fields, the coal is exceptionally high in price. I quite believe that in many of the west country towns the coal for which we are paying 5s. per ton could be had for 3s.; and the tar for which we are receiving 4s. per ton, they would get not much under the double of this. Therefore, you see, in a place so circumstanced, the figures I have given would be most misleading. Still, I doubt not there are places as badly situated as Dundee; and it is to such places that my remarks are directed. I believe also that, in many towns distant from collieries, the tar might be sold to manufacturers for use in their steam boilers; and such an arrangement would, I think, prove advantageous both to the seller and the user of this liquid fuel.

I think that as much has been said in regard to my subject as is necessary; but permit me to add that I believe there is a future for liquid fuels. I do not say tar, but more concentrated fuels, such as crude naphthas, paraffins, and pitch oil. When you see one of our large steamers taking coal into her bunker, it must have appeared to you that there was great waste of power here. Every ton of coal laid in must require a certain amount of power to carry it; and every ton of coal so laid in reduces the cargo-carrying power to this extent. A few gallons of oil will give you the steam-producing power of a ton of coal; and this is a fact which the owners of non-paying steamships should note. Take our locomotives also. Everything I have said in regard to steamships applies to them; and the comfort to the stokers and the general reduction in labor would be very marked indeed. Of course, it may be argued that if there were such a large demand created for oils for furnaces, the old fashioned law of supply and demand might come into play, and so force up the price of the article for which the increased demand had taken place. But I think this state of matters is rather remote, when we bear in mind the great oil wells only now becoming developed, and the oils from which can be run in bulk direct from the wells into ships, and brought to this country at very low rates.—*Journal of Gas Lighting.*

WATCH CLEANING AND REPAIRING.

By "Old Fogy."

Before proceeding with what I consider the best methods in this department of the watch and jewelry business, I will say that I do not, by any means, consider that my way is the best, for although I have been in the business quite a while, yet I find that I learn something new almost every day that I live, and expect to do so, so long as I continue in the business. Be very particular in selecting your tools; about three widths of screwdrivers, and keep them in the best of order, square across the point of blade, and never use a screwdriver too narrow nor too wide for the screw, and in using be careful not to let it slip, and thus mar the plates or bridges of a watch. I also recommend that the handles of these screwdrivers be of different shapes or styles, so as to save time in picking up the one you want (and just here I will say that every device or method that saves time will be of great value to the operator); then have about the same number of tweezers (3), one of good, solid, heavy points, say 1/16 inch wide at the points, for taking down a watch, and handling the heavier parts, and then one a little finer, and one very fine to work in about the train, hairspring, etc., and always keep these tweezers in perfect order at the points, so that whatever you handle, you will not mar or drop the things you are handling. Right in this connection I will say that I cannot find tweezers that suit me. So I make my own, and you can do the same if you will by selecting some nice steel. Then a good assortment of pliers, cutting, flat, and round. In selecting brushes, you will have to be very particular and secure the open and straight bristle brushes, which are also hard to find these latter years. Take all the coarser brushes and hold them on a coarse grindstone, running them whole length, both ways; this takes off the new rough end of the bristles before using first time. Then there are punches, broaches, drills, calipers, countersinks, files, etc., etc. Besides this, I have adopted the plan of making any tool I happen to need for any special purpose, so that by making these at the time I happen to want a tool that I cannot purchase, I have accumulated quite a variety of odd tools; among them are a varied lot of millers, for milling and raising jewels, and deepening the countersink holes for jewel settings and screw heads, also a tool for holding a roller, to set the jewel pin, and one for holding the hair spring collet, and a pair of tweezers for holding jewels while cleaning, etc., etc. As to lathes, I have found that there is a necessity of about two lathes; one a Swiss, light running lathe for cementing any pivot work, and I prefer these because they run much lighter and easier than those heavier American lathes; and yet if confined to but one lathe, I would use a small sized American lathe, with a good assortment of split chucks, particularly those with the smaller sized holes, for holding balance staffs, wheel arbors, etc., which come in use almost everyday, for taking off the burr from the point of a balance pivot, which has come from a collapse of the case; driving the end stones down on the end of pivots, even sometimes to the extent of heading them over inside of the hole jewel. These small size split chucks I have found extremely useful for the last named purpose, and I am not so "sentimental" but that I oftener use these split chucks, even for setting fine balance pivots, rather than take time to cement them; and while I do not advise the use of a split chuck for this purpose in every case, yet with a little experience one can tell when a staff is held so that the new pivot when set will "line" and be true, and of a clear beat or swing. To make a very nice pivot the cementing process is preferable, and yet, for nearly a year, my old No. 1 American lathe was not set up (for reasons I need not take space to explain), and during that time I employed a very skillful workman to do my pivoting, and this man would not think of ever doing a nice job unless he cemented it, and I can assure you that he put in more pivots out of line, and out of true, in the course of those few months, than I had done badly in my life. Speaking of "sentiment," I will say that too many young workmen use the lathe too much, and seem to depend on a fine looking lathe and handsome tools, and spend too much time in using the lathe and in decorating their bench with a fine display. But don't construe this as meaning that one can do nice work with a jack knife and handsaw, for I most certainly believe in a good and substantial set of tools, or I would not have taken so much space in speaking of them. Next, one must have a good bench, wide and of good length: and if no other drawers, a shallow depth drawer, exactly in center of the bench, with no knob in front, but rather a lip running its whole length, underneath. So that wherever you place your hand you can pull it out. This drawer I would have large and roomy (wide and long and extending back as far as the depth of the bench will allow, but shallow, not deep down in), and then partition it off by narrow slats, diagonally across it, running these slats from the extreme near right hand corner to the further and extreme left hand corner, so that as you reach your right hand in to take out a tool, you can grasp it naturally without twisting or cramping your hand. About eight inches below the top of the bench, I would place a skin drawer (the name comes from the practice at watch factories, formerly using sheepskins for the bottoms), which is made with a square frame (say like a picture frame), sliding on slats or a groove, so that it can be drawn out toward the operator, and when so drawn, the elbows will rest on this frame, with the wrists resting on the edge of the top of the bench, thus giving a firm support for both arms and hands, and this frame having stretched across its bottom a skin or canvas, will catch and retain anything that drops or rolls from the bench. This latter drawer I consider almost an indispensable article to doing good and successful work. At the right hand of these two drawers named, running down to floor if need be, there can be a series of drawers for tools and materials. Now with these equipments, and some others, not herein named, such as vise, file block, bench stake or anvil, and a large variety of such tools as will accumulate, I am ready to give you my ideas regarding the cleaning and repairing of watches. First and foremost, do not undertake any job that you have any or considerable doubt but what you can do successfully, and never leave a job worse than you found it; and never mar, cut, or slash any part of a watch. In other words, don't undertake a job that you have doubts as to whether you can do it correctly. One of my old masters told me never to undertake to improve on the maker's work, and this, while not true in every case (particularly cheap watches), yet is a safe rule to go by. Never allow your file, screwdriver, pliers, tweezers, or any tool to deface any part of a watch. I shall speak of this as I proceed. First, be careful and not let the movement swing so as to in any way injure the balance, in taking from case, and if a lever watch, take out the balance the first thing after getting out of case. Now see that the mainspring is let down and then remove the screws from the plates, taking care not to damage or bend any of the pivots as you do this. When all in pieces, before you proceed to clean, examine with a strong glass to see if the rim of any wheel is rubbing or clashing with anything, particularly the center wheel in any full plate American watch, for these wheels are often dragging on the plate or striking the ratch wheel because it is not true, and if examined before cleaning the places where it drags, are a tell-tale of the mischief. Also make any diagnosis of the watch that is needed to discover any errors from wear or accident, and correct them before going further, such as looking to each jewel, pivot, and other parts, and make all necessary repairs before cleaning. I have been in the habit for several years of putting my balance wheel separate from all connections, and trying its freedom in all positions, and if you will try this method, you will be surprised how many you will find that bind or are not perfectly free in all positions, when you give them the very slightest impulse by a twirl of the hand, holding the plate. Then, too, a careful examination of each jewel; you will be surprised how many are either loose in the setting or plate. In regard to cleaning, I use the old method (after trying all ways suggested)—that of chalk (but I use the old lump chalk, for those carpenters' chalk balls are made with some kind of paste that adheres to the plate)—and have this lump of chalk at my right hand, in a perforated bottom box, so that any coarse pieces fall through to the floor, and by rubbing the brush across it and then giving it a slight rap, before applying it to plate, any hard or heavy substance will fall out, and then with light pressure with the brush that is medium soft (and prepared on grindstone as before mentioned, if a new one) brush the plates, with an occasional breathing on the surface, clean the old oil or tarnish, and then peg out each hole many times, until you are sure every hole is clean, by pegging both sides, and then with a soft dust brush dust thoroughly by striking the brush into the holes on both sides. Of course, remove all end stones, and clean out with soft pith, holding the jewels in a pair of hook nose tweezers, mentioned. Should the plates and wheels be very much soiled and oily, a covered dish of alcohol is indispensable, and I have had a glass stopper bottle, with ether, in which to dip the jewels, pallets, and other small pieces, which takes the oil all off, but be sure and clean off with soft pith or pegwood such pieces as you have thus dipped. This ether will carry all loose lint or other things to its bottom, from hairsprings or roller table, and if held but a moment will do effective work, and not loosen shellac.

Regarding loose jewels, I am not so sentimental as to refuse using some shellac, if the burnished lip has been so thin as to be partially gone, thus loosening the jewel to hold in the jewel, by taking small and minute particles, and placing around the edge of the jewel, and then holding the plate or bridge over an alcohol flame, and allowing the shellac to flow around the jewel and fasten it firm, and by this process I have kept jewels firm in place for years, with no other attention than the first, and as a rule this can be done and not show. When you have thoroughly cleaned the different parts, holding everything with soft tissue paper, then with the paper put the watch together, never forcing any part into place, and when screwed or pinned together, try every wheel to see that there is the proper end and side shake to each pivot, then introduce the balance wheel, having been once tried alone as described, and see that the banking pins are so adjusted that the guard pin on the fork (lever) does not drag on either side, and that the jewel pin enters the slot, clearing the opposite corner, and that the guard pin is so in position that it will not allow the pin to pass by at any point and bring the jewel pin outside the lever, or so it will strike in hollow, or on the corners of the hollow of the roller. When you have oiled each pivot exactly on its connecting point of bearing with just the right amount of oil (of course, oil those jewels having end stones before putting watch together), your watch is ready for the dial, and in replacing the hands you cannot be too particular about their being free and clearing each other and the dial and glass. There is the care of the mainspring I have intentionally reserved till the last. There are lots of theories why a spring will break just after cleaning, but I only know that since I have adopted the method of never taking out the spring (except when, after taking off the cap of barrel, I find it is all gummed up with bad oil, and then of course clean it) I have found that a spring does not break any oftener than is common, even if the watch is not cleaned; but I invariably remove the barrel arbor and clean out the holes and the arbor itself.

Of course to explain every detail of the method of repairing the various parts of a watch would take more space than you would allow in your journal, and hence I will not attempt to go into minute detail, except perhaps some of the more important items, and the most common things found in everyday experience. Among these are broken pivots, worn pivots (sometimes requiring new ones), worn holes in plates, and at the intersection of barrel arbor, ratch and bridge of Swiss watches, etc., which, as a rule, require common sense as much as practice, and it varies in different watches, so that the common sense rule applies the best to nearly all of these, and if you have not got common mechanical sense, then you have mistaken your calling and should do something else. In any of these repairs don't go it blind, but study your case carefully and do the best thing you study out. When there is a worn pivot hole in a plate, and one side is countersunk for oil, then have a punch rounded at the point, just the shape of the countersink (and if you have not one make one, and here is where my rule, that of making a tool as the need comes for it, comes in play), and by screwing this punch into the vise, and with a smooth, flat point punch (slightly cornered of course) in one hand and holding the plate or bridge with the other, with the countersink on the punch, have a striker tap light and quick blows, and you move the punch around on the side most worn (and one side is almost invariably worn most, throwing the wheel arbor out of upright) and close up, even a little too much, and then with a round, smooth broach enlarge it, so that it will be right size, and this leaves it hard and smooth.

Broken pivots, as I have hinted, I place the arbor in a split chuck, and if true, I drill into the staff with a drill, made from a nice piece of steel wire, the old and ordinary shape of a drill, which is a trifle larger at the cutting point than it is back of the point, and I make these as I need them, and harden simply by holding the wire in a flame till red hot, and then dash into an apple, potato, soap, or pure rubber. Which is the best of these I have as yet been unable to determine, so I use either as the most handy. Take a good, tough and small pointed graver and turn a slight center in the end of arbor I am to drill, and then by giving my lathe a back and forward motion, I begin to drill, and by the sense of feeling I can tell whether my drill is cutting or not, and if not, I have a small, smooth oilstone at hand and sharpen the drill as often as it refuses to cut, and if that drill will not cut, I make another.

I make my drills of very small wire, filing them at point and then tap the point (holding the wire in a very fine pin vise), thus flattening as well as spreading it, and then shape the cutting edges as spoken of above. When you have drilled sufficiently to hold a plug firmly, then have a piece of steel of spring temper filed so as to fit closely and so straight that it will not act too wedging (and split the arbor), drive it in, cut it off and turn down, finishing with an oilstone slip, and polish by running the lathe rapidly and with a piece of thin boxwood (or hard pegwood) charged with diamantine, being sure that the end of the pivot has no burr, thrown either way, over end or on side, for such a burr will cause a lack of freedom of a balance pivot particularly. This matter of setting pivots requires a longer experience than almost any other work, and it needs a long practice to do a nice job. If your split chuck will not hold your staff or arbor true, then use cement; but in this, too, you must be sure that your center is true, and that the sound pivot enters it perfectly. Sometimes you meet with steel so hard that you cannot touch it with a drill, in which case draw the temper of the staff or arbor you are drilling, and if it projects so little that you cannot draw the temper without injury to the wheel, then unstake or separate the wheel, and by drilling a hole into a piece of brass wire, about the size of the staff you are drilling, insert the staff in this hole, and then heat the wire near the staff and thus gradually and yet effectively draw the temper.

I consider it well for young workmen to practice pivot setting in some old and useless watch any spare time they may have, and thus become adepts at this work. Unhindered, I am not over on an average of one-half hour in setting any ordinary pivot, especially if I do not have to cement my work. If this is a balance pivot, be very careful to see that your balance is true and poised before putting on hairspring and roller. There are some pivots that are underturned (to make look tidy and light), and sometimes it is about an impossibility to put in a new one, and in this case, if an American watch, I always put in an entire new staff, and hence keep a full assortment on hand.

Regarding replacing broken jewels, I also keep a full stock of these, turned (the setting) to match any make or style of watch; except, of course, Swiss watches, and for these I keep a large assortment of sizes, both of cock and foot and wheel jewels, and a full stock once procured, they last a long time and are a good investment, for with them you can meet any emergency.

In a Swiss watch, or any watch where the jewel is set into the plate, have some one of the devices for throwing up the burnished lip, and then select a jewel that just fills the space, and then with a smooth pointed punch, such as I described I used for closing up a pivot hole, I turn this lip back by sliding this round pointed punch around the outside, making it act as a burnish. Cap jewels I either treat in the same manner as the last, or cut away the setting, and insert them as they are inserted in most Swiss watches.

I have now taken up the more common repairs, and will close by hastily speaking of the more rare cases, and the adjustment of the hair spring, etc., etc. It is often the case that there is never end shake to the balance to make it absolutely safe when screwed into the case, and when this happens I take the point of a sharp graver and prick up a burr on the bridge, and never on the plate, as any unskilled workman does, for the under side of the bridge never being finished, you really mar nothing, and sometimes this raising of the cock (or bridge) becomes a necessity, to have it clear the rim of the balance, which, if raised, it will clear, and then by bending down the end of the cock at point where the jewel is, and thus regulate the end shake. I hardly know how to give directions how to proceed in adjusting hairsprings, when they are disarranged, but if I could see you, I could explain by example what I cannot well do in words. To commence, a hairspring, when there is no power applied to balance from the jewel pin, should be, when pinned, just as free from any twist or cramping as it would be if lying flat and free on a smooth piece of glass, before it has been pinned at either end, and when it is pinned in the watch (at stud and collet) it should be thus free. To bring it thus requires demonstration that cannot be made on paper, unless you could make diagrams, too numerous for this article.

What I have said regarding it, however, gives an idea of how a hairspring should be pinned. Common sense is demanded here as elsewhere. To put a watch in beat, too, is a very important item, which I do by placing sharp pointed tweezers, first on one side of the arm of balance and then on the other, and so pin my hairspring in the stud, that it will let off as readily on one side as the other. I had forgotten to say that every watch should have a little oil on the face of the pallet stones. I know full well that some workmen will say that there should be none, but I can tell of scores of watches that have failed and indeed stopped simply for want of oil on the pallets. Selecting mainsprings, too, needs much more care than is usually given to this department, and as a rule even the watch factories fill the barrel too full, that is, too long springs. Whether I am correct in this or not, you cannot be too particular in selecting the right strength, length, and width of mainsprings. Mainsprings should be well and carefully oiled.

There are many ways of replacing broken teeth in wheels, and the width of the web and the size of the teeth has much to do with how they are put in, but I usually dovetail them in, and then with the very tiniest bit of soft solder fasten them, but in so doing be positive you have got off all soldering fluid, that it will not rust the pinion into which it meshes, and be very particular to have it exactly like the rest of the teeth in same wheel, and don't mar the web of the wheel more than is possible.

I will now draw this article to a close, well appreciating the fact that I have only made a superficial attempt to instruct younger men in the cleaning and repairing of watches, for there is almost an endless variety of special repairs coming almost unexpectedly to any one, even if they have been in the business a long time, as I have, and as I first said, I am learning daily some new phase of the business, and am surprised that I never had known it before. I have, too, taken perhaps more space than I ought, regarding tools and bench, yet the older I grow, the more I can see the importance of this part, that I may be enabled to do work well and quick. Besides, I have left such repairs as the chain and fusee, uprighting wheels, repairing cases, adjustment to position, heat and cold, isochronism, enlarging jewels, or changing angles of pallet stones, etc., etc., all of which I do as necessity demands, as well as the care of striking watches, fly backs, etc., which, too, I make a specialty of, and of chronometer escapement watches, which would take more space than I feel disposed to ask you to give me.—*American Jeweler*.

THE NEW CENTRAL RAILWAY STATION AT FRANKFORT ON THE MAIN.

The new central railway station at Frankfort on the Main is one of the most imposing structures of modern times, not only as regards its dimensions, but also because of the effect which its architectural proportions produce upon the eye. Nobody looking at the long line of buildings surrounded by gigantic perron halls can help being impressed with their grandeur. The beholder, however, is not only struck by the general aspect, but also by the beauty of detail in this magnificent specimen of the Renaissance style. The interior of the perron hall shown in one of our engravings is especially impressive, and every one will admire the graceful outlines of the heavy iron structures in the upper part, which, in consequence of their enormous height, look from below like a spider web.

The base and the earth works were begun in the summer of 1881, and if we take into consideration the fact that 2,700,000 cubic meters of sand and gravel were necessary for the foundation, we will have some idea of the scale on which the edifice was undertaken. In 1883, the great hall, which has a width of 220 meters and which will shortly be opened to traffic, was begun. The perspective view of this portion of the station is given in one of our engravings. Inspector Eggert had the general management of the building, which was erected after the plan submitted by him, and which received the prize in the competition between the different architects. Herr Frantz, a distinguished engineer, who undertook the general supervision of the construction, had an important part in the execution of the entrance hall for the trains, and it was he, also, who built the perron hall, after designs of Herr Schwedler.

The middle part of the station, which contains the porch, the ticket offices, the baggage department, the police quarters and the telegraph offices, projects, as shown in the picture, considerably beyond the rest of the building, and by the distinct membering of its moulding stands out conspicuously from the whole. Protruding portals of peculiar structure and corner pavilions enliven the aspect of the wings of the edifice, the great round arched windows of which are separated from each other by powerful stone pillars. The corner pavilions to the left in the view contain the so-called imperial apartments for the reception of royal travelers, and on the other side are the meeting hall and reception rooms of the different railway administrations. On the right and left of the imposing main vestibule, which is distinguished by the strength and the beauty of its style, lobbies with arched roofs lead to the waiting and dining rooms, the ladies' rooms, the imperial apartments and the above mentioned meeting hall of the administration.

THE NEW CENTRAL RAILWAY STATION. FRANKFORT ON THE MAIN.
— Drawn by Fr. Schurmann.

The ladies' and gentlemen's toilet rooms also are in that part of the building.

The architect has laid especial stress upon the architectural ornamentation of the building. Upon the apex of the arch over the main vestibule a great group will be placed, representing Atlas carrying the world on his shoulders, and supported in his work by the allegorical figures of Steam and Electricity.

This group, which is at the present moment being executed in copper by Houwald, in Brunswick, is the work of a Frankfort sculptor, Herr Gustav Herold. In the arch itself, near the clock, we see two allegorical female figures, over life size, in a sitting posture, modeled by Prof. Gustav Kaupert in Frankfort, and representing Day and Night. In front of the pillars supporting the arch, two other female sitting figures, also above life size, will be perceived. These were modeled by Professor Calandrelli in Berlin, and represent Agriculture and Commerce, and in the niches on both sides there are the statues of Navigation and Industry, the work of the sculptor Hundrieser, of Berlin. The two side portals of the entrance hall are surmounted by figures of boys, having a height 2.40 meters; on the left the commercial traveler and traveling student, modelled by Rudolph Eckhardt in Frankfort; on the right the traveler for pleasure and the emigrant, the works of the sculptor Scholl, of Mayence. The groups of the corner pavilions, allegoric representations of machine building and engineering, were modeled by Professor Max Wiese, of Hanau. The figures, like the whole building, are of Heibronn sandstone. Either wing has a vestibule leading to the middle perron of the great hall. They resemble in style the architecture of the front of the middle building, only their arches are smaller. Here also we meet rich architectural ornamentation on the pillars in the great arch. The ornaments consist, as in the former case, of allegorical figures of boys. They have a height of 2.20 meters, and represent Agriculture and Art Industry on the one side and Art and the Retail Trade of Frankfort on the other side. The two former figures are the work of the sculptor A. Brutt, of Berlin; the two latter were modeled by Hermann Becker, of Frankfort. The side facades are very long, but of simpler style than the front of the building, and connect with the perron halls, which on their part end in semi-towers. There the offices of the administrations are located. The main vestibule leads directly to the middle of the perron in the large hall, which consists of three naves, and into which enter the trains of six railway lines, each separated from the other by perrons. The perron hall has a length of 186 meters and a width of 168 meters. The height of the naves, with their low arched roofs, rises in the center to 28.5 meters. Tunnels connect the different railway lines, in order to assist the rapid transit of through trains. The port also benefits by these tunnels. The inside front of the main vestibule is very richly decorated. In its center a large clock is situated, and on both sides of it are colossal allegorical figures modeled by F. Kruger, of Frankfort, and representing the hours of Morning and Evening, while on the pillars we perceive large male figures in a sitting posture, representing the Defense of the Country and Mining, the work of Herr Keller, of Frankfort. The pillars are crowned by groups of sculpture, representing the Honeymoon Travel and Instruction in Traveling, the one modeled by A. C. Rumpf, and the other by Friedrich Schierholz, of Frankfort.

The whole edifice is fire proof, scarcely any wood having been used in its erection. The hall as well as the other parts of the building are heated by steam and lighted by electricity. The whole cost of the structure amounted to about $8,500,000. —*Illustrirte Zeitung*.

THE COMMERCIAL EXCHANGE, PARIS.

At the beginning of the year 1881, the committee on finances of the common council of Paris received a petition from the central committee of the syndical chambers asking for the establishment of an official exchange for merchandise and commercial transactions for the especial use of Parisian commerce. To this petition was added a project of organization which proposed the appropriation of the grain market, with a clearing of the approaches. The Paris chamber of commerce had likewise been for a long time contemplating the establishment of a merchandise exchange, and was studying the practical means of organizing it.

Called upon to decide, the common council, at its session of May 28, 1881, decreed that an official merchandise exchange for the commerce of Paris should be organized, and that the grain market, or any other place considered favorable by the administration, should be appropriated.

Desirous of aiding in carrying out this decree, the chamber of commerce offered its services to the city. It proposed to take upon itself the responsibility of organizing and managing the exchange, and of borrowing the money necessary for converting the grain market into a merchandise exchange, and for clearing the approaches and opening Louvre Street.

The study of this project soon became connected, by reason of the proximity of the places, with the one having for its object the enlarging of the central markets and the construction of two pavilions to complete them. It was recognized that it would be of interest to make the appropriation necessary for the enlarging of the markets and to unite the two operations. After many vicissitudes, this project received the approval of the common council.

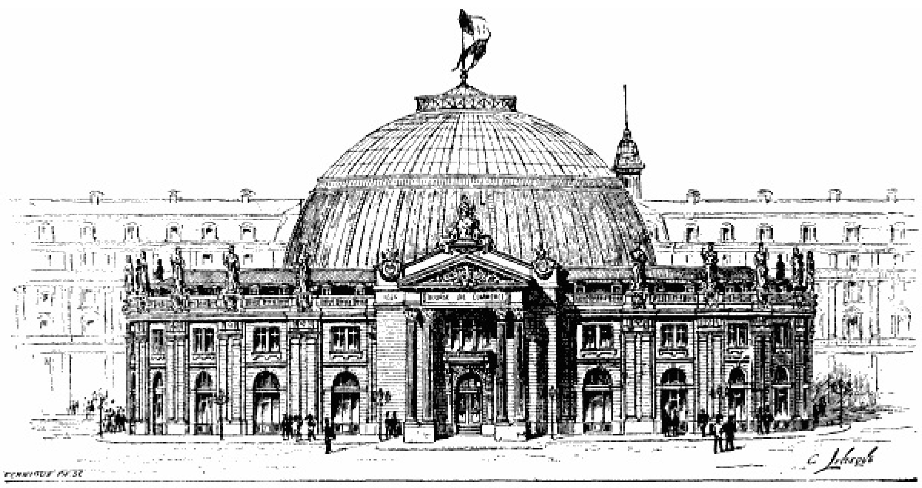


Fig. 1.—EXTERNAL VIEW OF THE COMMERCIAL EXCHANGE OF PARIS.

The contract for the work was given on the 2d of March, 1886, to Mr. Blondel, the well known architect.

Let us now see how the contract has been followed out. The grain market was built in 1767, upon the site of the hotel of Soissons. Of this, nothing was preserved but the astronomical tower of Catherine de Medicis, which still remains. The central part of the market left free was soon covered with a wooden framework, which was destroyed by fire in 1802. This was then replaced by the architect Brunet with an iron cupola covered with sheet copper. This market was designed for the reception of the grain and flour necessary to supply the city, but was soon supplanted by public granaries, and then by general stores. It afterward became a depot in which grain and flour brokers received merchandise from shippers in order to effect a sale of it. The abolition of the *factorat* gave it its last blow.

Let us examine the transformations made by Mr. Blondel in the old structure. He began by excavating under the entire extent of the market a basement 13 ft. in depth. The old foundations of the circular walls, which are more than 6 ft. thick, and which are extremely solid, extend to a depth of about 2½ ft. beneath the surface. The ceiling of the basement, in the annular part between the walls, is formed of large T iron girders, resting upon the circular walls. These support transverse girders, which, in turn, support the floor irons.

The flooring of the hall is formed of ordinary floor irons, assembled upon large girders, which are supported here and there by cast iron columns. Under this flooring there is a second one, leaving a free space of about ten inches, in which will be placed the tubes serving for ventilation. To these pipes will be joined vertical ones debouching in the flooring of the hall.

The old dome did not have apertures enough, and the skylight even was not transparent, and so the lighting of the hall was very defective. The mode of covering the dome was therefore completely modified. The copper was removed, and upon the old framework was laid a wooden framework, to which will be nailed laths designed to receive a slate roof. The slate will not extend to the summit of the dome, but will leave above it a spherical cap, which will be glazed, and through which the light will enter the hall in abundance.

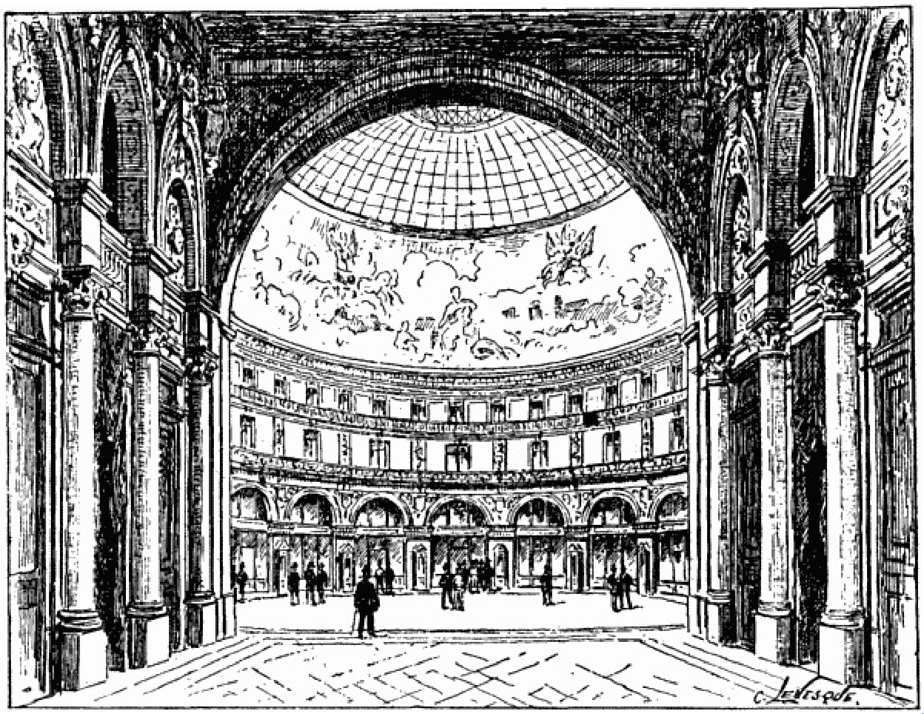


Fig. 2.—INTERNAL VIEW OF THE EXCHANGE.

In the basement will be installed the ventilating and heating apparatus. Another part of the basement will be occupied by the dynamo machines that are to furnish the electric light. Another part will receive the bake ovens that belong to the laboratory of the committee on grain and flour. The rest of the basement will be rented. The central part will probably be converted into a cold room for the preservation of early fruit and vegetables.

On the ground floor, we find, in the first place, the rooms that the contractor is to furnish gratuitously for post office, telegraph, and telephones, and to licensed brokers, and especially a hall of superb dimensions designed for the public sale of raw materials by the brokers.

What remains of the ground floor will be devoted to offices looking at once upon the hall and Viarones Street. The entresol and the two stories will be connected by several staircases. The various stories will also be reached through elevators. A circular balcony will extend around the hall at the level of each of the two upper stories. These will be occupied by offices smaller than those on the ground floor, which will, some of them, get their light from the hall, and others from the street.

A part of the second story will be reserved for the service of the committees on grain and flour, who, as experts, are called upon to determine to what type each specimen is to be referred.

From the exchange, let us pass to the annexes. The one on the right is destined to become a large hotel for the accommodation of provincial and foreign merchants. The one to the left will be a tenement house, with shops and apartments. Along each of these annexes, on Viarones Street, will extend a covered colonnade.—*Abstract from Le Genie Civil*.

A BASIS FROM WHICH TO CALCULATE CHARGES FOR ELECTRIC MOTOR SERVICE. [1]

The theoretical side of the electric motor question has been very ably presented to and discussed by this association, but thus far the practical side has been somewhat neglected.

It will be my purpose in this paper, if possible, to show that there is a general average controlling the use of machinery which it will be safe for electric light and power companies to follow in making their charges for motor service, rather than adopt an arbitrary price per horse power regardless of the character of service required of the motor.

I have arranged what might be called a power curve, representing the approximate average actual service in electric motors in connection with the several classes of work represented in the list accompanying the diagram.

This curve is calculated on motors which are only of sufficient capacity in each case to carry the full load. If the motor should be larger than is necessary to drive the machinery, the percentage of actual service will, of course, drop below that shown in the diagram.

By adopting a basis of averages which shall be general among members of this association, the charges for a constant horse power of current may vary with the circumstances of its first cost in each case, but the general classification of motor service may be a comparatively fixed rule. I am not prepared to say that this is the best plan to follow, but respectfully submit the following as a possible solution of the frequently asked question, "How shall we charge for electric motor service?"

EXHAUST FANS.

First on the list of power consumers is the exhaust fan, taking it in average use. There are, however, circumstances under which its use will be limited to as low as 70 or 75 per cent. of its contract hours of service. As, for instance, in a dining room it may be cut out except during meal hours, or entirely cut out on cool days. In places of this description, however, its contract use is usually limited to five or six months in the year, and other than electric power is, by circumstances of first cost and inconvenience, but a feeble competitor.

The first four applications on the accompanying list, viz., exhaust fans, blowers, ceiling fans, and fan outfits, are all more or less subject to the foregoing conditions, and therefore currents supplied to motors for these purposes command the maximum price per horse power. One important feature in the installation of ceiling fans is the countershafting to the motor. In one recent case we had a complaint from a customer that the half horse power motor sent him would not drive the ceiling fans, and that the motor must be defective, and should he return it for repairs. We immediately sent a representative to find out the difficulty, which was found, as is usual in such cases, in the countershafting, or rather the want of it. The 3 in. pulley on the motor was connected to a 6 in. pulley on the line shafting. The rated speed of the motor was 2,000 revolutions, and had it been able to develop this speed, would have driven the line shaft 1,000 revolutions and the fans a relative speed. To accomplish this would probably require a motor of 3 or 4 H. P. The line shafting driving ceiling fans usually runs about 75 revolutions. To give this speed on the line shaft with a rated speed of 2,000 on the 3 in. pulley of the motor would require a countershaft with a 24 in. pulley belted to the motor. On the same countershaft should be a 5 in. pulley belted to a 15 or 16 in. pulley on the line shaft. Fully three-fourths of the trouble found in electric motors arises from improper shafting and belting. The average make of 30 in. exhaust wheel, a ½ H. P. motor should drive about 400 revolutions. Say, then, the speed of the motor is 2,000 and the pulley 3 in., it would require a 15 in. pulley on the fan to do the work. A 36 in. wheel requires 1 H. P. to develop the same speed. If the motor speed is 1,800, the pulley 4 in., it would require an 18 in. pulley on the fan to do the work. These are the most popular sizes of exhaust wheels.

The next application on the list, open tank elevator pumps, commands the highest price for current per H. P. in the motor of any elevator application. The methods of operating the open tank hydraulic elevators in question are undoubtedly familiar to you all. Instead of the usual steam pump, a power pump of some approved design is substituted, and connected to the motor by suitable countershafting to give the required revolutions at the pump. The regulation of the motor in this case should be controlled by the position of water in the lower tank, as in the case of the steam pump. And in this connection let me suggest the necessity of great care, both in installation and insulation.

On all installations in basements and cellars or elsewhere where there is the slightest tendency to dampness, raise the motor off the floor on a suitable frame or stand and build around it on all sides of possible approach a low platform, using glass insulators as legs or standards to support it. So arrange this that the motor or its connections cannot be reached except when standing on this insulated platform, and the liability to a shock will be reduced to the difference of potential between the terminals of the machine. To return to the subject. Let us take for an illustration an elevator using 120 gallons of water per trip and consuming one minute in making its entire up trip or about two per round trip. The lower tank or water supply is on a level with the pump. The upper tank is 70 ft. above the pump, and in the piping to the upper tank are five elbows. For each elbow add 2 ft. to the elevation, or an approximate total elevation of 80 ft. × 120 gallons gives us 9,600 foot gallons. This amount would be required every two minutes if the elevator was in absolutely constant operation, or 4,800 foot gallons per minute × 8½ gives us 40,800 foot pounds. This we must at least double to allow for friction in pump shafting, etc., making 81,600 foot pounds, or about 2½ H. P., say 3 required in the motor.

This class of elevator is confined almost entirely to passenger use. Therefore the service required of the motor is much more constant and the margin between the H. P. hours contracted for and the H. P. hours of actual service much smaller than in any other elevator use, excepting possibly the services in connection with pressure tank elevators in the more popular office buildings. In this case we have a maximum average use of 80, and instances such as the hotels, small office buildings, etc., where the service will not exceed 60 of the contract H. P. hours. In order, however, that the electric light company shall derive the greatest benefit from this inconstant service, the installation and wiring should be the best, and only the most approved and economical apparatus employed.

The next application on our list, pressure tank pumps in connection with elevators, represents a somewhat smaller percentage of H. P. hours of actual service in the motor as compared with the possible H. P. hours than in the case of an open tank pump. In case of the pressure tank the water reserve is usually limited, and the motor therefore must be equal to the continuous operation of the elevator at maximum load. Taking this fact into consideration, and the circumstances of elevator use being about the same in this case as in the case of the open tank elevator, we have a greater ratio of difference between the possible or contract H. P. hours in the motor and the H. P. hours of actual service, the maximum average use being about 70 per cent. to 75 per cent. and the minimum as low as 35 per cent. to 40 per cent., depending, of course, on the character of building in which the elevator is employed or the character of service. In calculating the size of motor required on an elevator of this description, a very convenient fact to remember is that every pound of pressure per square inch is equivalent to lifting water about 23 ft., or about 230 ft. per 100 pounds pressure, By reducing the required pressure to a relative lift in feet, and knowing the amount of water required by the elevator per minute, the motor calculation becomes the same as in case of the open tank elevator, the same allowances being made for friction, etc., as in the first case. The regulation of the motor in this case should be accomplished by the conditions of pressure in the pressure tank, as is the case with a steam pump employed in this service.

The next application of importance on the list is sewing machines. In the tests I have been able to make on this class of work I have obtained some singular results. One item of importance is the fact that the single thread machines, which are lightest running, consume the most power in operating. Paradoxical as this may seem, it is easily explained. As a rule this class of machine is used on light work, such as shirts, ladies' underwear, etc., and operated at a higher speed than any other class of machine. At equal speed the volts consumed on a single thread machine as compared with a shuttle machine is about as 2 to 3. In average commercial use, however, the positions are reversed, and the ratio of volts consumed in the single thread as compared with the shuttle machine is about as 5 to 3. To double the speed on a sewing machine requires about 2½ times the power. The difference in volts consumed on the different makes of sewing machines is so small that we may disregard it entirely, as well as the character of work done by the machine, for the heavier the work the slower the speed, and more frequent and longer stops on the machine, thus keeping the average volts per operator about constant in all cases. This leaves the speed in stitches per minute at the sewing machine the factor from which we must calculate the power required in a sewing machine plant. To illustrate this I will give you the record of two cases which are about the average. Case No. 1 is a shop in which are 30 sewing machines connected to a 2 H. P. motor. At the time tests were made there were but twenty operators at work, leaving ten idle machines, the entire shafting, however, being in operation. The class of goods manufactured in this shop is a cheap grade of cotton and wool pants, rather heavy goods to sew. A volt meter across the terminals of the motor gave the following readings with the current at 9 amperes: Minimum 90 volts, maximum 148 volts, average 119, which gives us a minimum average per operator of 4.5 volts and a maximum average of 7.4 volts, or a general average of 5.9 volts per operator. This motor was driving the shafting for 30 machines, and as the average operators employed the year round will not exceed 75 per cent. of the shop capacity, it will, I think, be entirely fair to estimate the average volts per machine rather than per operator, as the user of the motor has contracted for power sufficient to drive his entire plant. In this case, then, we have a minimum average of 3 volts per machine and a maximum of 4.9 volts, or a general average of say 4 volts per machine. A 2 horse motor of 82 per cent. efficiency with 9 amperes of current will require about 200 volts to develop 2 actual H. P. Two hundred volts therefore is what the electric light company contract to deliver, while, in reality, they deliver only 129 volts or 60 percent., or a minimum average of 90 volts or 45 per cent. of the power contracted for. These machines were making about 1,200 stitches per minute—an average of 4 volts per 100 stitches.

Case No. 2 is a shop in which there are 32 machines, running about 1,200 stitches, each being supplied with an individual motor of 1/8 H. P. capacity, and the class of goods manufactured being men's summer clothing, such as white duck vests, flannel coats and vests, etc., the duck from which these vests are made being about as hard work on a sewing machine as can be found. In this shop were 24 operators at work. The maximum volts in this case were 116 and the minimum 40, or general average of but 78 volts, or about 2½ volts per machine with 4 more operators than in the first case, in which we had an average of 119 volts. This shop has been paying the electric light company $32 per month for more than a year, which is the price the company charge for current for a 4 H. P. motor which approximates 400 volts, the company contracts to deliver. This gives us a minimum average use of but 10 per cent. and a maximum of 29 per cent. with a general average of 19½ per cent. In other words, the company is saving in this shop the price of a 1/8 H. P. motor each month, besides making a profit on the volts actually delivered. On a contract for three years the electric light company would be money in pocket if they would present the customer with 30 small motors, charging him $1 per month per motor for current, rather than let him buy a 2 H. P. motor to operate the same machines with the necessary shafting at a charge of $18 per month for current. Taking this average in case No. 2 of 2½ volts per machine, from a 50 light machine, we could run not less than 900 sewing machines, or about 18 to the arc lamp. At $1 per month per machine an income of $900 per month would be derived from a 50 light machine without any lamp expenses, such as carbons, repairs on lamps, globes, etc. On the average, in case No. 1, of 4 volts per machine, we could operate but about 562, say 600 machines. Divided up in shops of 30 machines and a 2 H. P. motor to each shop, we would have 20 two H. P. motors. At a charge of $18 per month each, we would have an earning capacity of but $360 per month from the same 50 light machine.

This is but one page from the thus far unwritten history of the much maligned small motor. Still the question is frequently asked, "Can we sell current for $1 per month for a small motor driving a sewing machine and make a profit?" As a matter of fact, 50 cents per month for small motors driving sewing machines yields a better profit to the company supplying the current than $10 per month per H. P. in large motors to drive the same machines, besides the immense advantage which the small motors possess of keeping the circuit in much better balance, the fluctuations due to the stopping and starting of large motors being at times a serious matter. One electric light company, making rather a specialty of these small machines, rent the motor and supply the current for $1.25 per month per sewing machine, and report that at this price the motor pays them a better percentage of profit than their lamps. This company have some 200 small motors on their circuits.

A more striking illustration of the advantages to the electric light company in the subdivision of power into the smallest possible units it would be hard to find. There is a difference in efficiency of from 15 to 20 per cent. in these two sizes of motors, but this difference is fully lost to the large motor in driving the shafting, and the small motor still has the advantage of being out of circuit entirely when the machine it is driving is stopped. There is scarcely a manufacturing industry which does not possess its busy and dull seasons. This means that in no industry will over 75 per cent. of the machines or machinery employed be in average operation. The entire shafting in the shops must be kept in operation the entire year, often for less than 50 per cent. of the machinery. Subdivide these same shops into as many small units as possible, and the current necessary to operate the shafting for this idle machinery will be saved, besides the saving from frequent stops while the machinery is in active use.

To return again to the list, the next two applications, picture frame manufacturers and moulding manufacturers, are very similar. Their busy seasons, as a rule, are in the spring and fall, and also follow closely any activity in house building. In the case of the larger manufacturers in this line, a maximum average of 75 per cent. will possibly be reached, but probably never exceeded. In the case, however, of the picture dealer who has a small shop in which he makes picture frames and mouldings to order the actual service of the motor will fall as low as 25 per cent. or 30 per cent. of its contract hours, one case in our experience the actual service having reached this low average. A fair general average in this class of works would be about 60 per cent.

The next application, nickel and silver platers and buffers, are good contract customers as a rule; one case in our experience showing but an average use of 20 per cent. of the contract horse power hours. This, however, is probably an exceptional case, and, as near as we can estimate on this class of work, the actual motor service will not exceed in any case 60 per cent. of the contract hours; a fair average being probably 45 or 50 per cent.

The next two applications, printing presses on news and job work, are probably met with more frequently than any other. On exclusively news work, the instances where the motor is in service more than 3 or 4 hours is rare. It is, however, usual in news offices to find two or more job presses. If the newspaper printed happens to be a morning paper, the hours of news work are usually between 12 midnight and 4 o'clock in the morning, the job work being done through the day. I have in mind a case of this description. In the shop is one cylinder press and three job presses connected to a 2 H. P. motor. This motor is on an incandescent circuit of 110 volts. To develop its rated power at 110 volts would require about 16 amperes in the motor. An ampere motor in series with the motor while running off the morning paper with only the cylinder press in operation stood at 12 amperes. For 3 hours this load was practically constant, when it was thrown off entirely. This gave on the night service but 30 per cent. of the contract hours. This motor required 5 amperes to drive the shafting, and but 8 amperes or one H. P. to drive the three job presses with the cylinder press off. Here then is but a 50 per cent. use if the presses be used constantly; there are, however, many days when they are comparatively idle, 30 to 40 per cent., therefore, is a very safe estimate of the maximum use of this motor on the day circuit, or, had the motor been a 1 H. P., which would have been sufficient to drive the job presses, the use would be 60 to 80 per cent. of the contract hours, probably not above 60 per cent. All printing offices will probably come within this range, unless the motor be larger than is necessary to do the work.

Machine shops doing principally lathe work as a matter of course use a larger percentage of their contracted power than shops doing lathe and bench work with the same hands. In no case will the service of the motor exceed 65 or 70 per cent. of its contract use, for machine shops, like sewing machine shops, will never average over 75 per cent. of the shop capacity for operators the year round. The average, especially in the case of a shop doing much bench work, will fall as low as 40 per cent.

The driving of laundry machinery, which is our next application, usually proves a profitable contract, according to reports. This fact arises from the intermittent use of the machinery. The heaviest service on motor will probably be found during the early part of each week, with a general falling off in work during the summer months, while the patrons of the laundry are away at the sea-shore or in the mountains. In this application, therefore, a 75 per cent. service would probably be an exception, with, probably, many instances where the service would fall below 50 per cent.

The next application, model and pattern makers, are small users of power, as their occupation requires a large proportion of hand work. 50 per cent. service in the motor will be found a fair average maximum use, with instances as low as 20 or 25 per cent.

The next application, direct power or belt elevators, is another application frequently met. The average service in the motor is also much smaller than in any other elevator application. Let us suppose a case of the familiar grip connected to the ordinary hand hoist, with a lifting capacity of 2,000 pounds. In this case the motor is in use only going up, and the usual brake is used in coming down. Connected to this elevator, in the loft of the building, we have a 5 H. P. motor wired to a cut-out on the ground floor. We will call the lift 45 feet and the time consumed per trip 1 minute. We will allow 60 full trips of the elevator at full load, at 2,000 lb. per trip, each day. This would approximate 10 car loads of merchandise handled by the elevator, which is certainly above the average. This motor, we will say, is on a ten hour day circuit. Its possible horse power hours, therefore, would be 5 H. P. for 10 hours, or 50 H. P. hours per day. 60 trips of 1 minute each gives us exactly 1 hour's service of the full 5 H. P. or 5 H. P. hours. To drive the shafting only while the elevator is coming down or idle would require about 150 volts or 1½ H. P., and if this was in constant operation the balance of the day, 9 hours, its total use on shafting would be 13½ H. P. hours, which, added to the 5 H. P. hours, gives us a grand total of 18½ H. P. hours, or 37 per cent. of the contract hours. If, however, the user of the motor avails himself of the cut-out box, and cuts the current out when the motor is not in use, the average use would drop to 20 or 25 per cent., instead of 37 per cent. In the case of a direct power passenger elevator, the use might possibly run up to 60 per cent., but this would be exceptional.

Coffee mills will average from 40 to 60 per cent. of their contract hours, manufacturing jewelers about the same, while retail jewelers will run as low as 25 per cent. Ice cream freezers will not average over 25 per cent., but as the contract season in this case is usually short, they should be rated at least a 50 per cent. basis, except possibly in cases where the customer pays the cost of installation and wiring, which is usual in these cases.

A dentist is one of the smallest of power users, so small, in fact, that if every one in a city were connected with a circuit, the load from this cause would never be felt. We will, however, put them down at from 10 to 20 per cent.

The optician uses a motor to turn his grind stones, and its use in this case will average from 20 to 30 per cent.

The last application on the list—church organs—uses only from 10 to 20 per cent. of the contract service.

These are, of course, but few of the very many applications of the electric motor, and if, as I trust, the possible subsequent discussion of this general plan may establish a basis for rating motor applications, not only will the objects of this paper be obtained, but a question of considerable annoyance now existing between the motor man and the electric light or power company will be solved.

In conclusion, Mr. Chairman, I beg to suggest that the supply and rates of charge for electric power have become of sufficient importance to this association to be represented by a permanent committee, whose duty it should be to obtain from the different members of the association, as far as possible, their experience in the supply of power in such manner and form as shall be deemed by the committee best suited to the wants of this association.

[1] Read before the electric light convention, New York, August, 1888.

SOME ABYSSINIAN CUSTOMS.

WOMAN WITH UNDRESSED HAIR.

Abyssinian women have an extraordinary head of hair. The hair, though not very long, is very bushy, so that it takes the capillary artist no less than a day to succeed in reducing this forest into a small bulk. As it requires some force to draw the comb through the hair, the operation is painful, and this is why the Abyssinian women have it performed every forty or fifty days only. The Abyssinian women of rank pass their life in almost complete idleness, occupied almost exclusively in bedecking themselves and in making or receiving calls. It is not the same with the women of the people. They have many labors to perform, and are the ones who manipulate the grains, hydromel and beer, and grind pepper in the *matt-biett*. This latter operation is very painful, and so they take the precaution to first close the nostrils with plugs of cotton. Women who have children of a tender age go at these operations with their progeniture upon the back, after the manner of negro peoples. —*L'Illustration.*

ABYSSINIAN HAIR DRESSER.

A PEPPER GRINDER.

HOW A MOUND WAS BUILT.

"While exploring mounds in Ohio this season, under the direction of the National Bureau of Ethnology," says Mr. Gerard Fowke, in a paper prepared for *Science*, "I used great care in the examination of one mound in Pike County, in order to ascertain, if possible, the exact method of its construction.

"The mound was built upon the site of a house, which had probably been occupied by those whose skeletons were found. The roof had been supported by side posts, and at intervals by additional inner posts. The outer posts were arranged in pairs a few inches apart, then an interval of about three feet, then two more, and so on. They were all about eight inches in diameter, and extended from two and a half to three feet into the ground, except one a few feet from the center, which went down fully five feet. All the holes were filled with the loose dark dirt which results from decay of wood; a few contained fragments of charcoal, burned bones or stone, but no ashes; nor was the surrounding earth at all burned.

"Around the outside a trench from three to four feet wide, and from eighteen to twenty inches deep, had been dug, to carry away the water which fell from the roof. Near the middle of this house, which measured about forty feet from side to side, a large fire had been kept burning for several hours, the ashes being removed from time to time. The ash bed was elliptical in form, measuring about thirteen feet from east to west, and five from north to south. Under the center of it was a hole, ten inches across and a foot deep, filled with clean white ashes in which was a little charcoal, packed very hard. At the western end, on the south side (or farthest from the center of the house), was a mass of burned animal bones, ashes, and charcoal. This was continuous with the ash bed, though apparently not a part of it. The bones were in small pieces, and were, no doubt, the remains of a funeral feast or offering.

"After the fire died down, rude tools were used to dig a grave at the middle of the house. It measured ten feet in length, from east to west, by a little more than six in breadth. The sides were straight, slanting inward, with rounded corners. The bottom was nearly level, fourteen inches deep, but slightly lower at the center. Over the bottom, ashes had been thinly sprinkled, and on these a single thickness of bark had been laid. The sides had been lined with wood or bark from two to four inches thick. When this was done, two bodies were placed side by side in the grave, both extended at full length on the back, with heads directly west. One, judging from the bones and condition of the teeth, was a woman of considerable age. She was placed in the middle of the grave. Her right arm lay along the side, the left hand being under the pelvic bones of the other skeleton. This was apparently of a man not much, if any, past maturity. The right arm lay across the stomach, the left across the hips. This skeleton was five feet ten inches in length; the other, five feet four inches.

"The space between the first skeleton and the south side of the grave was covered with the ashes that had been removed from the fire. Beginning at the feet in a thin layer—a mere streak—they gradually increased in thickness toward the head, where they were fully six inches thick. The head was embedded in them. They extended to the end of the grave, reaching across its entire width and coming almost, but not quite, in contact with the other head. A considerable amount of the burned bones lay in the southwestern corner of the grave, and the ashes along this part curved up over the side until they merged into what remained of the ash bed. This had extended to the west slightly beyond the end of the grave.

"As the earth removed from the grave had been thrown out on every side, the bodies were in a hole that was nearly two feet deep. The next step was to cover them. There was no sign of bark, cloth, or any other protecting material above them. They were covered with a black sandy earth, which must have been brought from the creek not far distant. This was piled over them while wet, or at least damp enough to pack firmly, as it required the pick to loosen it, and, besides, was steeper on the sides than dry dirt would have been. It reached just beyond the grave on every side, and was about five and a half feet high, or as high as it could be conveniently piled.

"So far, all was plain enough; but now another question presented itself that puzzled me not a little; and that was, What became of the house? That there had been one, the arrangement of the numerous post holes plainly showed; but the large earth mound above the tumulus or grave was perfectly solid above the original surface, giving not the slightest evidence that the posts or any part of the house had ever reached up into it. I incline to the opinion that the great fire near the middle of the house had been made from the timbers composing it; that the upper timbers had been torn down, and the posts cut off at the surface, the whole being a kind of votive offering to the dead. At any rate, it is plain that a house stood there until the time the mound was built; and it was not there afterward.

"For the purpose of covering the grave, sand was brought from a ridge a short distance away. There was no stratification, either horizontal or curving. Earth had been piled up first around the black mass forming the grave mound, and then different parties had deposited their loads at convenient places, until the mound assumed its final conical arrangement. The lenticular masses through almost the whole mound showed that the earth had been carried in skins or small baskets. The completed mound was thirteen feet high, and about one hundred feet in diameter.

"Two and a half feet above the original surface was an extended skeleton, head west. It lay just east of the black earth over the grave. Sixteen feet south of the grave, on the original surface, and within the outer row of post holes, were two skeletons extended, heads nearly west. It would seem that the flesh was removed before burial, as the bones were covered with a dull red substance, which showed a waxy texture when worked with a knife blade.

"No relics of any description were found with any of the skeletons; but a fine copper bracelet was picked up in a position that showed it was dropped accidentally."

A CHINESE IMPERIAL CEMETERY.

By Lieut. Hon. H. N. Shore, R.N.

Some ten miles north of Peking, in a valley where silence reigns supreme, is situated one of the most remarkable and imposing burial grounds in the world. Here, nestling along the slopes of the inclosing mountains, which form a natural amphitheater, are a series of vast mausoleums where lie buried the emperors of the last Chinese dynasty. This was the celebrated Ming dynasty, which continued from 1366 till 1644, when, after a sanguinary struggle lasting for twenty-seven years, it succumbed to the Manchu Tartars, who, under the title of the Tsin dynasty, have occupied the throne to the present time.

THE AVENUE.

It has been very truly remarked of the Chinese that they have probably expended more labor over their public works than any other nation of antiquity; and assuredly when any great national work is undertaken, however rare the occurrence, it is invariably carried out on a scale of unparalleled magnificence. It was, therefore, only fitting that the tombs containing the emperors of their own native dynasty should be constructed on a scale commensurate with the wealth and extent of the empire whose destinies they swayed for nigh 300 years. The valley contains altogether thirty tombs, each of which stands in the center of a wooded inclosure several acres in extent, surrounded by a high wall, with an imposing gateway. The largest and most celebrated is that of Yen-wang, whose body reposes in a lofty building resting on an immense brick mound pierced by a slanting tunnel, whose curious acoustic properties entitle it to be ranked as a "whispering gallery." In front of the mausoleum is a hall measuring 220 ft. long by over 90 ft. broad, which contains the emperor's tablet. The roof of this building is supported in the center by thirty-two pillars, composed of single trees 60 ft. high and over 11 ft. in circumference, which are said to have been brought from Corea. The transport of these enormous blocks must have been a work of no ordinary difficulty, more especially in the absence of good roads. According to the description of a missionary who recently witnessed the moving of a somewhat similar object, it would seem that the Chinese followed the practice of the ancient Egyptians, as depicted on their tombs, and in a country where labor is abundant such a method would be natural.

An inscription near the entrance states that this tomb, among others, was repaired by the Emperor Kienlung, who reigned in the early part of last century; but like every other ancient building in China at the present day, it is fast going to ruin for the want of ordinary care, large trees being permitted to grow out of the very roof itself, although there are several attendants residing in the inclosure; while, doubtless, certain officials are entrusted with the care of this splendid mausoleum, and draw their salaries regularly. But *laisser faire* is the order of the day everywhere in the neighborhood of Peking, and nothing is ever repaired nowadays by any chance.

THE ROAD TO PEKING.

A part of the original scheme, which shows the magnificent scale on which the whole thing was planned and executed, was a fine paved road, carried over streams and rivers by marble bridges and extending the whole way from Peking, a distance of ten miles. On approaching the valley where the tombs repose the road passes under three handsome "pailaus," or gateways, and then through one of the most imposing avenues that was ever constructed. This avenue, which extends for about two-thirds of a mile, is flanked on either side with colossal stone figures at intervals of about 50 yards, representing men and animals in the following order: Six men, apparently warriors and priests, in pairs, standing; four horses, four griffins, four elephants, four camels, and four lions, the first pair in each set standing, the second recumbent. As the Chinese have never achieved any great distinction in the art of sculpture, the representations of animal life are, needless to say, somewhat caricatured. But the conception of the whole was magnificent, and the effect of this long avenue of colossal figures standing in silent grandeur is as impressive as anything that ever emanated from the genius of the Chinese race.—*Ill. Naval and Military Magazine.*

DYSPEPSIA: ITS CAUSES AND PREVENTION.

Dyspepsia has once been called the "American sickness," and although this may be a slander against which many of the inhabitants of our great republic might protest, bad digestion is a disease frequent enough among us to justify us in considering its causes and in ascertaining by what means this curse of modern civilization may be avoided. A Frenchman, under the title "La dyspepsie des gens d'esprit," in the Paris *Revue Scientifique* of August 18, shows how utterly disregarded are the sanitary rules at the dinners of well bred people in France; and an American lady in a recent edition of a well known New York daily humoristically enlarges upon the offenses committed against health by persons of her own sex while dining in the largest city of the United States. Speaking of the lunch of shop girls up town, the contributor to the American paper deprecates the fact that the young American girls employed in business houses at luncheon time live almost entirely on sweets and food that renders little or no nourishment, rather than procuring at the same cost a repast which, though perhaps less dainty, would be far better for their constitution. "Left to herself," the writer says, "Miss Saleslady, pretty and refined though she may be, day after day and day after day keeps her temper, and waits on her customers, leaning on a slim luncheon of pie and tea. 'It is sweet and nice,' pleaded one girl to me the other day, 'and it goes so much further than anything else.'

"'Not further than bread and milk' I urged, 'and it is surely not half as good for your complexion.'

"'Oh, but the other ladies would laugh at me well if they saw me eating bread and milk for my luncheon. I think myself a bit of something light and nice, like eclairs or a charlotte russe, is ever so much more ladylike and nice.'

"Heaven save the mark! What sort of flesh and blood do they make to put on the slender bones of a growing girl? How will they stand by her, when perhaps she leaves the shop and chooses the life of wife and mother? The answer is easy. When the pie-eating, cooky-feeding girl gets married, put it down in your note book: One more dyspeptic, peevish woman entered the lists of the unlovely."

The contributor to the French review, although also condemning the careless choice of food, more especially points out the evil consequences of eating too hastily; and though M. Julva directs his attack chiefly against the *gens d'esprit, i.e.*, the well bred people of France who neglect the rules of health for politeness' sake, his words apply equally well to the American business man who sacrifices his health during luncheon to the "almighty dollar."

"The feverish activity of modern life," he says, "induces many people to abridge the duration of their repast, and, particularly, luncheon is taken too hastily—a practice the danger of which, as a cause of dyspepsia, cannot be overrated."

This practice might not be so dangerous if, during the short time which we dedicate to our midday meal, we would at least imitate the habit of the Japanese, whom politeness requires to be absolutely silent while eating. When they like a certain dish, they express their satisfaction by graceful gestures addressed to their host, but they think it would offend him if they open their mouth for anything else except eating.

Watch, on the other hand, one of our lawyers at luncheon. He has just dismissed his last client, at the moment when he should be already at court, and in order not to be too late he has to lunch in double quick time. He has to eat his viands without having time to masticate them, and he swallows his big pieces, washing them down with several glasses of wine and water, and hastens to his carriage almost without giving himself time to breathe, in order not to miss his call.

Look at a Parisian dining in town. French politeness forbids him to be silent like the Japanese, and also requires of him not to speak with his mouth full of food. And if this were not enough, French gallantry commands him to serve the ladies first, so that just about when they have finished, he may commence to eat. In addition to this, if he does not want to appear ill bred, he must reply to all their questions, which he would not be able to do if he did not gulp down his morsels unchewed. What wonder, then, that most men have to suffer from eating dinner in such a manner, while all discomfort could be avoided, if the viands were served to one guest after the other in succession?

We don't want to exaggerate. There are privileged stomachs which can stand all that. But there are many to which half-masticated food is a real poison.

The unconscious dyspeptic constitutes an extremely frequent variety. Dyspeptics rarely complain of suffering from the stomach; many of them will even say to you that their stomach is excellent. But let us remember the old fable of Menenius Agrippa: The whole organism suffers when the stomach is ill treated.

Premature calvity (baldness), some eruptions of acne (pustules of the skin), a slight dyspnœa (difficulty in breathing) when mounting stairs, a blush of heat on the cheeks a quarter of an hour after luncheon, a violent craving for smoking after the repast, a feeling of sleepiness, which, however, quickly fades toward ten o'clock in the evening, little inclination to work during the first hours after awakening in the morning, all these symptoms, or any part of them, show that you have before you a candidate of the disease known as bloating of the stomach or the gout. According to the wise enumeration of Moliere, who was evidently prompted by Renaudot, such a person begins with bradypepsia (slow digestion), then suffers from dyspepsia (bad digestion), afterward from apepsia (indigestion), and later lyentery (a lax or diarrhea in which food is discharged only half digested), and at the last the vicious circle is often completed by obesity, uric affections of the liver or bladder, and all the other diseases belonging to that class.

Unfortunately, we are still far from the time when the public will appreciate that "prevention is better than cure." Perhaps this fundamental principle of health will be honored during the 20th century. At present it certainly is not. Meanwhile, those who have ruined their health by modern city life take recourse for their cure to a holiday, hasten to places where they find mineral waters, or try laxatives or milk diet to improve their condition. They wish *to do something for their health* once or twice a year. How much better, if they had not been *acting against their health all the year round*.

It is extremely difficult to teach our people to eat healthily. You will find no difficulty to persuade them to take medicine. People have always time to swallow a pill, but you will certainly have trouble to teach them to chew with leisure. How many people who find time every year to spend the season at Vichy will tell you it is quite impossible for them to spend five minutes more every day at luncheon time. And nevertheless they would regain these few minutes a day with interest, if they would avoid that host of maladies which will stop them one day in the midst of their occupations. I have seen a good many of my clients getting entirely rid of their rheumatic pains and gout and ceasing to suffer from sleepless nights by observing the following simple rules.

In order to chew meat conveniently—and this is one of the main points—one must accustom one's self never to mix meat and bread in the same mouthful. Take a small mouthful, chew it about thirty times, then swallow that part which has been reduced to pulp, and so on until all has been masticated. In doing this you will soon find out that roasted and broiled beef or mutton requires a longer trituration than boiled meats or stews; you will also perceive that fish is more easily masticated than meat, and you will finally understand why certain dyspeptics are forced to limit their food to fish, eggs, and milk diet. In fact, milk diet serves no other purpose than to furnish a perfectly digestible nourishment.

One of the indirect and unforeseen benefits of a careful mastication is that people gradually become accustomed to be satisfied with a comparatively small quantity of food, for as slow chewing is always more or less tedious, those who observe this rule soon cease to be great eaters, and also learn quickly to accustom themselves to another very important rule, viz., to drink moderately while eating. Two glasses of liquid will then quite suffice for a person who would drink four if he ate his viands swallowing them down without chewing.

Many obese dyspeptics when they once commence to carefully and to take liquid moderately while eating lose weight with an astonishing rapidity and become cured of the bloating of the stomach without being finally obliged to have recourse to the rigorous dry diet of Prof. Bouchard.

Wine and water, the French national drink, is an extremely frequent, and very often misunderstood, cause of dyspepsia. A good many people would enjoy excellent health if they were satisfied with pure water, that favorite drink of the aged. It is quite perplexing sometimes to see at the same table three neighbors, drinking at their dinner, the one wine, the other beer, and the third tea. How much better would it be if people, instead of choosing their habitual drink according to the place that they come from, would select it more with regard to their individual constitution! I know many who, after having, for fifty years, quietly ignored the fact, have come to the recognition that for them, wine, even if diluted with much water, is absolutely hurtful, and who, by giving it up, and by taking pure water, tea, or cider, to which Prof. C. attributes great success in his practice, instead, have got rid of their ailments almost as if by enchantment.

In conclusion, I should like to say a word with regard to salt, this panacea of arthritic persons (persons suffering from arthritis, swelling of the joints, as in gout).

For many years I have been laboring under the wrong impression, that salt is placed on the table merely for the purpose of salting boiled eggs, which the cook cannot salt in advance. Great mistake! The wisdom of nations has discovered that there are people for whom a great quantity of salt is a necessity, and that there are others who would become ill if they were to eat viands that are much salted. The salt cellar is there in order to enable every one to salt his food according to his own requirements. Many people are led by their natural instinct to salt their viands in a proportion to suit them. But there are others, among them, above all, the well bred persons previously mentioned, who treat eating with disdain and for whom the whole attraction of a repast is the charm of conversation, and to them the idea of having recourse to the salt cellar never occurs.

Whether salt is needed in order to add acid to the gastric juice or whether it has an antiseptic action in the digestive channel, I do not know. Certain, however, it is, that it possesses very appreciable laxative qualities, and under its influence those who go to drink the waters at Wiesbaden often see their intestinal functions restored to a surprising degree.

It is just as well, however, and even better, to take one's *Vichy at home*, and nothing is more simple than to use one's *Wiesbaden at home*, by using the salt cellar. The cure may then be completed by distributing over a whole year the thirty warm baths which have to be taken during the season at that watering place. The bath at 40° Celsius is a real boon for arthritic persons. The warmer it is, whether salt or not, the better it acts in producing an exuberant perspiration, and the less is one apt to catch cold when leaving it.

The above by no means exhausts the vast subject of dyspepsia and arthritis. But without ignoring the utility of thermal waters, of morning promenades, of dry frictions and gymnastics, the sufferers should, above all, be advised to minutely masticate their food, to limit the amount of liquids at meal time, to use salt, which will by no means increase their thirst; and in certain cases to abstain entirely from alcoholic drinks. Those who observe these rules may with impunity dine out, although those so-called great dinners, where all rules of health are left aside, are absolutely baneful for a great number of the inhabitants of our cities.

A NEW SURGICAL OPERATION.

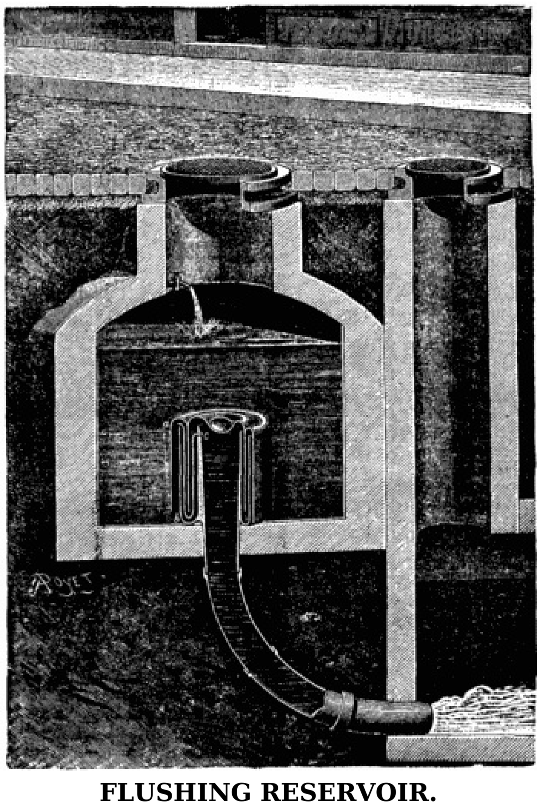
Among the matters of interest which were brought before the British Medical Association, at the recent Glasgow meeting, was an account by Mr. Brudenell Carter of a method which he had devised of opening the sheath of the optic nerve behind the eye, for the relief of pressure within this sheath and within the cavity of the skull. The brain is invested by firm membranes, which secrete a certain amount of fluid and are continued down to the eye in the form of a sheath which surrounds the optic nerve; and, whenever the pressure within the cavity of the skull is increased, as by the growth of a brain tumor, or even by excess of secretion from the membranes themselves, a superabundance of fluid is apt to find its way down the nerve sheath to the level of the eye, to subject the optic nerve to injurious pressure, and, in many cases, to destroy the sight. It not infrequently happens that the pressure within the brain cavity may be increased by temporary or curable causes, which, nevertheless, continue in action sufficiently long to produce permanent blindness, even although the patient may, in other respects, recover. In view of these conditions it was suggested by Dr. De Wecker, of Paris, sixteen or seventeen years ago, that it might be possible to open the optic nerve sheath, and thus not only to relieve the nerve from pressure and to preserve it from injury, but also, on account of the position of the eye relatively to the brain cavity, to drain the latter by gravitation, and to relieve the brain as well as the eye. Dr. De Wecker made two endeavors to accomplish this object, but he tried to feel his way to the optic nerve without the aid of sight, and to incise the sheath by means of an instrument carrying a concealed knife, capable of being projected by means of a spring. The risks of failure, and, still more, the risks of inflicting irreparable injury upon the nerve, were such that he only attempted his operation in two well nigh hopeless cases, and only one attempt to follow his example has been recorded. Mr. Carter's attention was called to the matter last year by a case in which the diminution of pressure within the optic nerve sheath was manifestly desirable; and he devised a method of operating by which the sheath could be exposed to view, and the object attained with certainty, under the guidance of sight at every step of the process.

He read before the Medical Society of London, last year, an account of the first case in which he operated, which was successful; and he read an account of three more cases at Glasgow, in one of which the result was negative, as far as sight was concerned, while in the other two the patients were not only quickly restored to useful vision, in one instance from complete, in the other from nearly complete, blindness, but were at the same time relieved or cured of other symptoms, such as headache and sickness, arising from direct pressure on the brain. In his paper at Glasgow, Mr. Carter claimed for the new operation that it could be performed with certainty and without risk either to life or to any important structure, and that it afforded a reasonable prospect of the preservation of sight in many forms of disease in which it is now habitually or frequently lost. As in the case of every new operation, time and further experience of its effects are required in order to determine the precise limits of its usefulness.

In the discussion which followed the paper, Mr. Bickerton, of Liverpool, said that, in consequence of reading the account of Mr. Carter's first case, he had himself performed the operation in two instances, in one of which temporary restoration of sight was followed by relapse, while in the second the ultimate issue was favorable. —*London Times*.

PUTZEYS' FLUSHING RESERVOIR.

Every sewer is more or less exposed to intermissions in the flow of the water that it leads, and the result is a diminution in velocity which leads to deposits of solid material. Hence the necessity of regularly flushing the sewer with water, which removes from the sides the substances that have attached themselves thereto, and which, without such precaution, soon decompose. In a word, it is necessary that a *perfect* washing shall be assured, and this can be done only by heavy rains or by strong currents of water. As regards rain, that could not be relied upon; and to have a force of men specially charged with the service of washing, that would be too costly, and so recourse has been had to automatic apparatus.



FLUSHING RESERVOIR.

The automatic siphons used for flushing sewers are characterized in general by the presence, at the base of the discharge branch, of a fixed or movable receiving vessel full of water. This vessel has the inconvenience of breaking the effect of the charge, and the result is that these apparatus do not render the services that might be expected from them. Some of these apparatus have valves, floats, chains, pulleys, and levers. These are still more defective, since their operation is delicate. The parts of which they are composed easily get out of order, and then the reservoir does no more flushing at all. A good automatic flushing reservoir must therefore be of the greatest simplicity, and its parts must be fixed and strong, and the outflow of the water must be rapid and energetic and directly from the reservoir into the sewer. In a word, its construction should be such that there shall be no need of inspecting it, and that its operation be regular.

The apparatus devised by Mr. E. Putzeys, Director of Works of the city of Verviers, well fulfills the conditions of an excellent flushing reservoir with an automatic siphon. The siphon has a double curve, but may, however, have different forms according to the various uses for which it may be employed, such as for flushing sewers, urinals, closets, etc.

The annexed figure represents the apparatus as arranged for flushing a sewer. The apparatus operates as follows: In the bottom of the branch of the siphon, S, there is always some water, so that, during the filling of the reservoir by means of the cock seen in the figure, the air is compressed in the branch S to a degree that cannot exceed the pressure of an equal height of water to about double the height of the siphon. The reservoir therefore can continue to fill without the water escaping.

The submersion of the small siphon, *a*, *b*, *c*, is less than that of the principal siphon, S, and it follows that when the level of the reservoir reaches a height equal to *b*, *a*, a new influx, however small it be, causes the discharge of a few drops of water from the auxiliary siphon, *a*, *b*, *c*, which is always full of water. At this moment the water that it contains can no longer resist the thrust of the compressed air in the branch of the siphon, S, and is therefore forced, along with the compressed air, into the flushing pipe.

By virtue of the principle of communicating vessels, the water of the reservoir tends to resume its level in the interior of the apparatus, and it then enters with such impetuosity that the siphon, whatever be its dimensions, is primed. The entire reservoir empties instantaneously, and the water flows to open the sewer.

From the experiments made at Verviers by the inventor, it results that, with a pipe 10 inches in diameter, the emptying of a 175 cubic foot reservoir can be effected in 30 seconds.

We may remark that with this apparatus we obtain the maximum of useful effect, seeing that the work developed is represented by the total head of the water diminished simply by losses of charge due to friction in the pipes. In other apparatus the loss of charge is much less, since the flushing is broken by a receiver.

Putzeys' apparatus, therefore, with a much less discharge of water, is capable of producing an effect superior to that of similar apparatus. On account of its simplicity and plain character, there is no need of precision in the installation of this apparatus, and horizontality, even, is not a *sine qua non* for its perfect operation.

The siphon is very easily cleaned, and this is a great advantage, since it permits of utilizing sewage matter for filling the flushing reservoir.—*Chronique Industrielle.*

PEPSIN.

By A. Percy Smith, F.I.C., F.C.S., Rugby.

The method usually adopted for estimating the peptonizing power of pepsina porci consists in dissolving 1 to 2 grains in 8 to 12 ounces of water, to which 40 to 60 minims of hydrochloric acid has been added. 500 to 1,000 grains of hard-boiled white of egg, granulated by rubbing through a wire sieve, is immersed in the liquid, and the whole kept at 98° to 130° F. for four hours, when the undissolved albumen is filtered off through muslin, and, after partial drying, is weighed to ascertain the amount dissolved. The variable numbers above quoted embrace various formulæ recommended by different experimenters.

This method of analysis is excessively crude and untrustworthy. When hard-boiled white of egg is kept in warm water, it absorbs a considerable quantity of that menstruum, as much as several units per cent.; consequently, on weighing the residual albumen, you may find that the weight is greater instead of less than that with which you started, the gain in weight due to absorbed water more than counterbalancing the loss obtaining through solution, as has happened with indifferent samples of pepsin. Then who shall say when, by simple air drying, the albumen has regained its former condition? The enormous quantity of albumen is foreign to the usual habits of the scientific analyst, and involves an enormous waste of time in manipulation.

One trial of this method was enough for me. The first modification I adopted consisted in substituting for the large quantity of granulated albumen a single half of the white of an egg in one piece. I likewise arranged a check experiment in which the pepsin was omitted, other conditions remaining unaltered. At the end of four hours the residual pieces of albumen were placed on blotting paper to remove superfluous moisture, and weighed. The gain in weight of the albumen in the check experiment, due to absorbed water, was calculated into percentage, and the same deducted from the weights of the other portions which had been subjected to the action of various pepsins. This, although an improvement upon the old method, proved likewise unreliable, because the water absorbed was not equal in each experiment. The albumen which was immersed in acidulated water only quickly dried, superficially, when placed on blotting paper, whereas that which had been acted on by pepsin was rendered glutinous and incapable of being dried in this manner. In fact, one sample weighed considerably more than it did at starting, even after deducting the allowance for water absorbed.

I next tried much smaller pieces of albumen, about 1 c.c., in hope that complete solution might ensue, and a time value be obtained. I soon found, however, that the solubility does not depend upon the mass, but upon the surface exposed.

Finally I discarded altogether the use of fresh white of egg, and had recourse to dry powdered albumen, prepared by drying in a steam oven and levigation in a mortar. With this I succeeded in getting accurate comparisons between the digestive powers of various pepsins. Albumen in this form dissolves with rapidity, owing to its state of fine division. Any remaining undissolved can be filtered off on a counterpoised filter paper, and heated in a water oven until absolutely dry. It is, however, unnecessary to do this when two samples only are compared against each other, nor is it essential to know the actual weight of albumen employed, provided it be the same in each experiment. This is insured by placing some on the naked pan of the balance (there is no objection to so doing, as it is a dry gritty powder, and does not adhere to the metal), and counterpoising by a similar addition to the other pan.

Let the albumen fall on the center of the filtered liquid, avoiding, if possible, contact with the glass of the beaker. It soon sinks, and after the lapse of some time, a simple inspection will show which is dissolving with the greater rapidity. Agitation assists solution. Therefore take the two beakers, one in each hand, and rotate the contents equally. When one sample has dissolved all the albumen, it is manifestly superior to the other which has failed to do so in the given time. If many samples have to be compared, it will be necessary to start with known quantities of albumen, and weigh the undissolved residues in the manner above indicated.

An objection may possibly be raised to this modified method, viz., that albumen as ingested is not in the form of a dry powder, and that we ought to copy as nearly as possible the conditions existing in the stomach. To this I would reply that it does not matter in the least, to us, as analysts, what are the conditions which obtain in the stomach; since there is no absolute test for pepsin, we can only compare one sample against another, and that which dissolves the most albumen in the shortest time is taken to be the best.

Another imperfect method of analysis is that employed in the examination of malt extracts for diastase, in which a certain weight of extract ought to dissolve a certain weight of starch in ten minutes, when if it does so dissolve it, the extract is a good one; if not, it is to be condemned. The more correct way is to ascertain the reducing power on Fehling's solution, before and after digestion with an *excess* of starch, and I intend to say a few words upon this subject on a future occasion, when I have ascertained the maximum amount of diastase existing in the best samples of malt. —*The Analyst*.

SUBTERRANEOUS FLORA AND FAUNA.

By Dr. Otto Zacharias.

It is generally correct to say that air, light and moisture form the chief conditions necessary for the development of organic plant or animal life. One of these conditions, however, namely light, is not of equal importance with the two others. For modern investigation and the discoveries made during the progress of natural sciences have shown that in the depths of the ocean, where an everlasting darkness reigns, and where the temperature is extremely low, nevertheless a great abundance of animal life is to be found, and that there exist living beings, not only of the lowest organization, but even fishes and crustaceans of very complicated structure, all of which thrive without enjoying the slightest ray of light.

A similar example of animal life in the absence of light is to be found in the fauna of caves and grottoes. This was first made known to the world by Austrian and American naturalists. The well known Adelsberg grotto in Krain, and the gigantic Mammoth Cave in Kentucky, furnished much interesting material for a detailed study of the biological conditions of subterraneous animal life. It was gradually discovered that in those dark places there existed not only insects, spiders, crustaceans, centipedes, worms, and snails, but also a kind of salamander and fishes. But what gave special interest to these discoveries was the fact, ascertained by careful study, that not all of these beings were gifted with normally developed organs of vision, but that in some these organs had undergone a retrograde development, while others were entirely blind.

Fig. 1.—THE SEMI-BLIND SALAMANDER (PROTEUS ANGUINEUS) OF THE ADELSBERG GROTTO, IN AUSTRIA.

Among the latter, the blind fish of the Mammoth Cave (*Amblyopsis spelacus*) is especially remarkable, because in this being the retrograde development of the organ of vision is accompanied by the production of certain ridges of skin on the body which are endowed with an extreme sensitiveness of touch, and which, according to a work lately published by Professor Von Leydig, are composed of little warts in which the nerve fibers end. Nature, therefore, has in this case compensated the amblyopsis for his loss of sight by endowing him with a highly developed organ of feeling.

A similar phenomenon is to be observed in the blind crab (*Cambaras pellucidus*), which is also found in the Mammoth Cave, for in this being, according to Professor Von Leydig, the little warts on the interior feelers, which constitute the organ of smell, have also received an abnormal development.

Better known than the blind fish and the blind crab of Kentucky is the *Proteus anguineus*, a kind of salamander, of a pale rose color, endowed with gills and found in the Adelsberg grotto in Austria. (Fig. 1.)

This amphibium has an eye which lies very deep in the body and is almost overgrown by the skin. But this eye is by no means as developed as the organ of vision, for instance, of the water salamander (the triton) or of the so-called axolotl, for it exists only in a kind of embryonic development, and contains neither a vitreous humor nor a lens for the refraction of the rays of light. As, however, the nerve of vision exists, it is possible that this salamander may be able to discern in some manner between light and darkness.

The thinking student, when discovering such imperfect organs of sight, will naturally ask how the eye of this salamander, which is so useless for its real purpose, has come into existence, and he will weigh the comparative value of the two following explanations. It may be assumed that there existed once in the Adelsberg grotto a salamander which was absolutely blind, and in which, in consequence of an innate power of evolution, an organ of vision of the lowest kind was gradually formed. But to this assumption the objection may be raised at once, why nature should have produced an organ of vision in an animal living in a grotto, where such an organ is absolutely useless, and where such a development would be quite as paradoxical and improbable as, for instance, the development of fins instead of legs in an animal living on dry land.

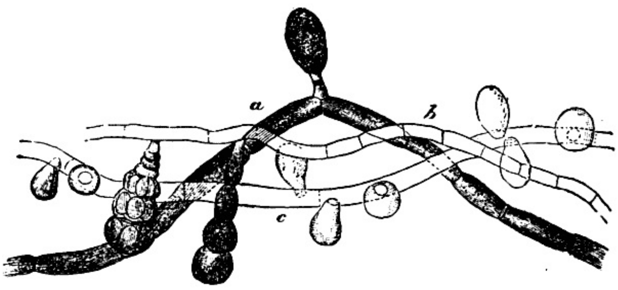


**Fig. 2.—GROUP OF PYRENOMYCETES,
A SPECIES OF FUNGI FREQUENT IN THE WATERS OF MINES.**

***a*. Found in the mines of Waldenburg; *b*. In the brown-coal pits near Westeregeln; *c*. In the Dorothea pit at Klausthal.**

On the other hand, one may suppose, and this is the more probable explanation, that the *Proteus anguineus* is descended from a kind of salamander, which possessed perfectly developed eyes in the beginning, and that the imperfect organ of vision in the descendants living in the dark caves is the result of gradual degeneration. This is the more likely to be true as in many other cases, also, we find that organs which become useless and cannot be employed have gradually degenerated.

Our common mole furnishes an example. Its eyes also have become small and are deeply hidden in the muscles, although they are by no means as much degenerated as in the *Proteus anguineus*, and are still possessed of a lens and a retina. Their nerve of vision, however, has become very imperfect, and its connection with the brain is interrupted, so that the animal for this reason can have no perception of light. Notwithstanding the above, however, it is doubtful whether the degeneration and gradual disappearance of the visual organ is in all cases the result of their being no longer employed, since there exists in dark caves a kind of beetle, the *Machaerites*, in which species the female only is blind, while the male has a well developed organ of sight. In this case it cannot be maintained that the absence of light has been the cause of the blindness of the female beetle, because it would have acted equally upon the male. Nevertheless, no other explanation can be found for the blindness. The problem, therefore, is hitherto unsolved.

Of late the investigations of naturalists have been extended to the animal life existing not only in grottoes and caves, but also in mines and pits created by the action of man, and this has led to many interesting discoveries and remarkable results. A naturalist who has especially enlarged our knowledge with regard to the subterraneous fauna and flora is Dr. Robert Schneider, of Berlin, who made his studies in the coal mines near Waldenburg and Altwasser, in Silesia, the salt mines of Stassfurt and the metal mines of Klausthal, in the Upper Harz Mountains.

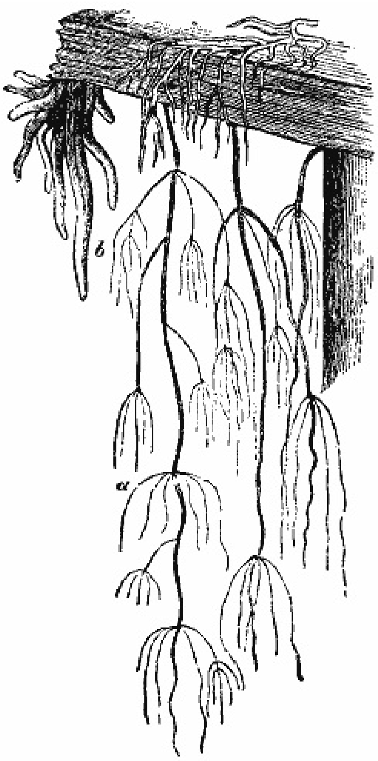


Fig. 3.

***a.* Rhizomorpha canalicularis of Hoffmann, *b.* Club fungus (Clavaria deflexa) of Hoffmann, found in the mines at Klausthal.**

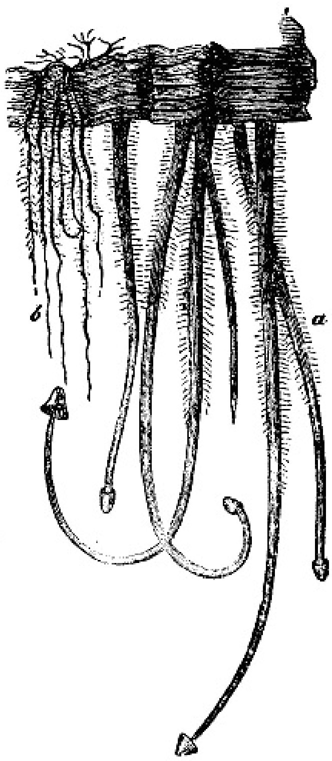


Fig. 4.

***a.* Agaricus myurus of Hoffmann, a subterranean fungus. *b.* Himantia villosa, a species of rhizomorpha found in the Upper Harz Mountains.**

As regards the subterraneous flora, Dr. Schneider's investigations resulted in showing that the plants which thrive in the dark regions under ground are those which possess no chlorophyl and are sensitive to light. Those which vegetate most luxuriantly there are the *fungi*, and among them especially the *pyrenomycetes,* which are frequent in the waters of mines. Their general aspect is shown in a 480 times magnified form in Fig. 2. They resemble fine threads of delicate structure, and where found are always discovered in great abundance. Most conspicuous by their shape and considerable size are the *rhizomorphæ*, Fig. 3a, and they are remarkable, not only for their brilliant phosphorescence, but also for the peculiar fact that they are only found in places where light does not enter. These *rhizomorphæ*, though this is not easily recognizable from their external appearance, also belong to the fungi and are often seen in strings of the length of over a meter and the thickness of a quill, spreading out in peculiar branches and hanging down from moist beams in dark places. Sometimes they grow like seaweed in the water of the mines, and in this case they give much embarrassment to the miners, because they are apt to obstruct the channels constructed for leading off the superfluous water. In the mines of Freiberg these *rhizomorphæ* exist in great abundance, and Humboldt already mentions specimens of the length of 4½ feet. Miners in Germany call them *zwirn* (thread). The student of natural sciences, when encountering these peculiar forms of vegetation, will ask in how far they are the product of their surrounding circumstances (*i.e.*, of the absence of light or the presence of moisture), and in order to find a reply to this question experiments have been made to grow these *rhizomorphæ* under different conditions of existence. These experiments have shown that from several species of *rhizomorphæ* other ordinary fungi can be developed, and that the subterraneous specimens therefore may be considered a degeneration and variation of the fungi found above the surface of the ground.

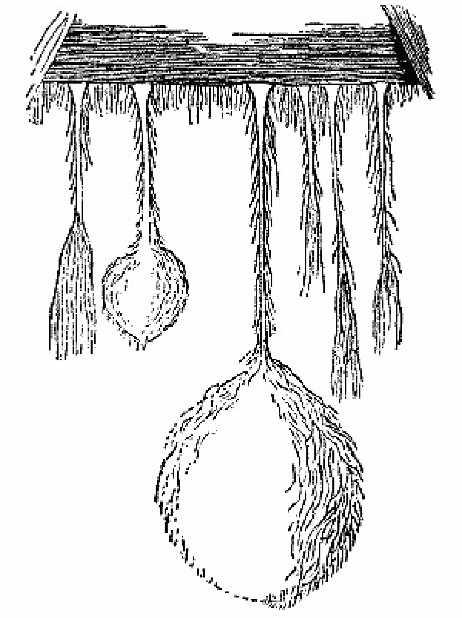


Fig. 5.—FORMS OF MOULD FUNGI FOUND IN THE BROWN-COAL MINES NEAR HALLE A. S.

In Fig. 4*b* the *Himantia villosa* is represented, a rhizomorpha found in the mines of the Upper Harz Mountains, thus showing another form of this vegetable growth. Though it is difficult, as above stated, to recognize by their shape the rhizormorphæ as fungi, the origin of the peculiar *Agaricus myurus* of Hoffmann (Fig. 4*a*) will be much easier discovered, though a retrograde development and degeneration has taken place also in this fungus. It still shows, however, the elements of a regular toadstool, only that the stem is much elongated and looks like a thread or a tube, while the cap is small, and this explains how, by gradual degeneration, the cap may disappear entirely, leaving nothing but a stem, as, for instance, in the case of the *Clavaria deflexa*, the club fungus, shown in Fig. 3*b*.

In connection with the above it may be well to speak of the fungi constituting the mould which often covers the roof and the doors in the brown-coal mines of Halle, specimens of which are shown in Fig. 5.

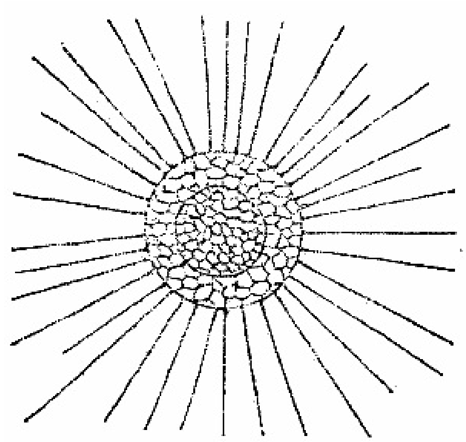
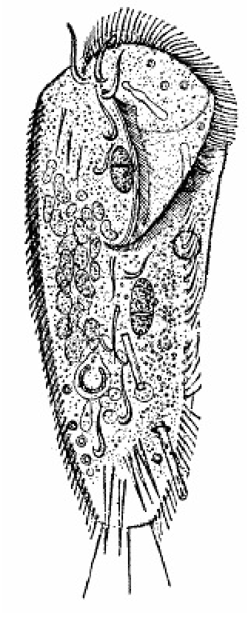


Fig. 6.—THE SUN INFUSORIUM (ACTINOPHRYS).

We now come to the animal life in mines and pits. This is mostly represented, of course, by lower organisms, as infusoria and worms. Thus, in the slime on the bottom of the waters in mines, several species of *amœbæ* are found, which consist of microscopically small animated bodies, continually floating about, nourishing themselves by absorbing organic matter, possessing sensation, propagating, etc., and, in fact, having actually the qualities of real animal nature. Further, we find in those subterraneous waters a species of the sun infusorium (*Actinophrys*), which is especially frequent in the mines of Klausthal. Fig. 6. shows one of these peculiar little beings. Also the *Stylonychia* (Fig. 7) is a characteristic inhabitant of those places, and always present there.



It moves with great rapidity in the water by means of the numerous hairs covering its body, can turn quickly in any direction, and thus is enabled to catch suddenly the little beings on which it lives and which it hunts; for which reason the stylonychia is called the "rapacious infusorium."

The above are organisms which can be seen only through the microscope, but the fauna of mines contains also larger organisms, though they are not found as regularly and are not as characteristic for those places as the forms mentioned hitherto. Among these organisms there are several species of worms, spiders, gnats, and, above all, crustaceans of the lower class. The most interesting of the latter is perhaps a variety of the sand flea (Fig. 8—*Gammarus pulex*). The crustacean found in the pits of mines, which is related to the sand flea, shows, according to Dr. R. Schneider, a slight degeneration of the organ of sight, which has taken place in consequence of its adaptation to the dark places, in which this variety of the *Gammarus pulex* is found, which can make no use of eyes, while the sand flea possesses them fully developed. Otherwise, however, the two varieties are almost absolutely alike, differing only in some details.

Fig. 7.—THE RAPACIOUS INFUSORIUM (STYLONYCHIA).

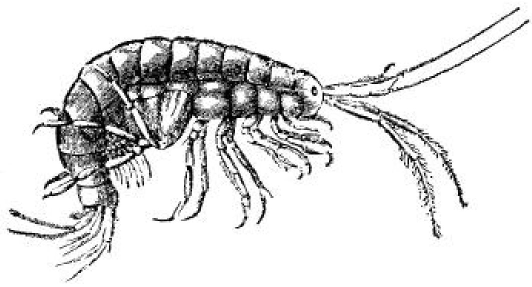


Fig. 8.—THE SAND FLEA (GAMMARUS PULEX).

From the above the reader will see that "breathing in the rosy light," as Schiller calls it, is not an absolutely necessary condition for the existence of organic beings, but that life exists everywhere, where there is air and moisture, and a temperature which is not always below freezing point, though even eternal frost does not exclude life entirely, as is proved by the existence of the glacier flea, showing that even in the icy coverings of the Alps life still is possible. Mephistopheles may therefore well say:

"From water, earth, and air unfolding,
A thousand germs break forth and grow
In dry and wet, and warm and chilly;
And had I not the Flame reserved, why really,
There's nothing special of my own to show!"

—*Leipziger Illustrirte Zeitung.*

[NATURE.]

TIMBER, AND SOME OF ITS DISEASES. [1]

By H. Marshall Ward.

IX.

In the months of April and May, the younger needle-like leaves of the Scotch pine are occasionally seen to have assumed a yellow tinge, and on closer examination this change in color, from green to yellow, is seen to be due to the development of what look like small orange colored vesicles standing off from the surface of the epidermis, and which have in fact burst through from the interior of the leaf (Fig. 31). Between these larger orange yellow vesicles the lens shows certain smaller brownish or almost black specks. Each of the vesicular swellings is a form of fungus fructification known as an *Æcidium*, and each of the smaller specks is a fungus structure called a *Spermogonium*, and both of these bodies are developed from a mycelium in the tissues of the leaf. I must employ these technical terms, but will explain them more in detail shortly: the point to be attended to for the moment is that this fungus in the leaf has long been known under the name of *Peridermium Pini* (var. *acicola*, *i.e.*, the variety which lives upon the needle-like leaves).

FIG. 31.—To the right is a pair of leaves of the Scotch pine, with the blister-like Æcidia *a.* of Peridermium Pini (var. acicola) projecting from their tissues: these blisters are orange yellow in color, and contain spores, as shown in Fig. 33. Between the blisters are the minute spermogonia, *b.* To the left is a small branch, killed at a a a by Peridermium Pini (var. corticola), the blister-like yellow Æcidia of the fungus being very conspicuous. (Reduced, after Hartig.)

On the younger branches of the Scotch pine, the Weymouth pine, the Austrian pine, and some others, there may also be seen in May and June similar but larger bladder-like orange vesicles (*Æcidia*) bursting through the cortex (Fig. 31); and here, again, careful examination shows the darker smaller *Spermogonia* in patches between the *Æcidia*. These also arise from a fungus mycelium in the tissues of the cortex, whence the fungus was named *Peridermium Pini* (var. *corticola*). It is thus seen that the fungus *Peridermium Pini* was regarded as a parasite of pines, and that it possessed two varieties, one inhabiting the leaves and the other the cortex: the "varieties" were so considered, because certain trivial differences were found in the minute structure of the *Æcidia* and *Spermogonia*.

If we cut thin vertical sections through a leaf and one of the smallest *Æcidia*, and examine the latter with the microscope, it will be found to consist of a mass of spores arranged in vertical rows, each row springing from a branch of the mycelium: the outermost of these spores—*i.e.*, those which form a compact layer close beneath the epidermis—remain barren, and serve as a kind of membrane covering the rest (Fig. 33, *p*). It is this membrane which protrudes like a blister from the tissues. The hyphæ of the fungus are seen running in all directions between the cells of the leaf tissue, and as they rise up and form the vertical chains of spores, the pressure gradually forces up the epidermis of the leaf, bursts it, and the mass of orange yellow powdery spores protrude to the exterior enveloped in the aforesaid membrane of contiguous barren spores. If we examine older *Æcidia*, it will be found that this membrane bursts also at length, and the spores escape.

FIG. 32.—Blisters (Æcidia) of Peridermium Pini (var. corticola) on a branch of the Scotch pine: some of the Æcidia have already burst at the apex and scattered their spores, b, b; the others are still intact. (Natural size, after

Similar sections across a *Spermogonium* exhibit a structure which differs slightly from the above. Here also the hyphæ in the leaf turn upward, and send delicate branches in a converging crowd beneath the epidermis; the latter gives way beneath the pressure, and the free tips of the hyphæ constrict off very minute spore-like bodies. These minute bodies are termed *Spermatia*, and I shall say no more about them after remarking that they are quite barren, and that similar sterile bodies are known to occur in very many of the fungi belonging to this and other groups.

Hess).

Sections through the *Æcidia* and *Spermogonia* on the cortex present structures so similar, except in minute details which could only be explained by lengthy descriptions and many illustrations, that I shall not dwell upon them; simply reminding the reader that the resemblances are so striking that systematic mycologists have long referred them to a mere variety of the same fungus.

Now as to the kind and amount of damage caused by the ravages of these two forms of fungus.

In the leaves, the mycelium is found running between the cells (Fig. 33, *h*), and absorbing or destroying their contents: since the leaves do not fail the first season, and the mycelium remains living in their tissues well into the second year, it is generally accepted that it does very little harm. At the same time, it is evident that, if very many leaves are being thus taxed by the fungus, they cannot be supplying the tree with food materials in such quantities as if the leaves were intact. However, the fungus is remarkable in this respect—that it lives and grows for a year or two in the leaves, and does not (as so many of its allies do) kill them after a few weeks. It is also stated that only young pines are badly attacked by this form: it is rare to find *Æcidia* on trees more than twenty years or so old.

Much more disastrous results can be traced directly to the action of the mycelium in the cortex. The hyphæ grow and branch between the green cells of the true cortex, as well as in the vast tissues beneath, and even make their way into the medullary rays and resin canals in the wood, though not very deep. Short branches of the hyphæ pierce the cells, and consume their starch and other contents, causing a large outflow of resin, which soaks into the wood or exudes from the bark. It is probable that this effusion of turpentine into the tissues of the wood, cambium, and cortex has much to do with the drying up of the parts above the attacked portion of the stem: the tissues shrivel up and die, the turpentine in the canals slowly sinking down into the injured region. The drying up would of course occur if the conducting portions are steeped in turpentine, preventing the conduction of water from below.

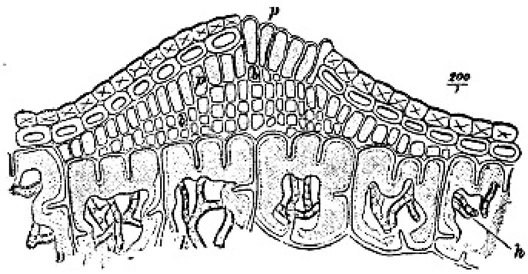


Fig. 33.—Vertical section through a very young Æcidium of Peridermium Pini (var. acicola), with part of the subjacent tissue of the leaf, h, the mycelium of the parasitic fungus running between the cells of the leaf; immediately beneath the epidermis of the leaf, the ends of the hyphæ give rise to the vertical rows of spores (b), the outermost of which (p) remain barren, and form the membrane of the blister-like body. The epidermis is already ruptured at p by the pressure of the young Æcidium. (After K. Hartig: highly magnified.)

The mycelium lives for years in the cortex, and may be found killing the young tissues just formed from the cambium during the early summer: of course the annual ring of wood, etc., is here impoverished. If the mycelium is confined to one side of the stem, a flat or depressed spreading wound arises; if this extends all round, the parts above must die.

When fairly thick stems or branches have the mycelium on one side only, the cambium is injured locally, and the thickening is of course partial. The annual rings are formed as usual on the opposite side of the stem, where the cambium is still intact, or they are even thicker than usual, because the cambium there diverts to itself more than the usual share of food substances; where the mycelium exists, however, the cambium is destroyed, and no thickening layer is formed. From this cause arise cancerous malformations which are very common in pine woods (Fig. 34).

Putting everything together, it is not difficult to explain the symptoms of the disease. The struggle between the mycelium on the one hand, which tries to extend all round in the cortex, and the tree itself, on the other, as it tries to repair the mischief, will end in the triumph of the fungus as soon as its ravages extend so far as to cut off the water supply to the parts above: this will

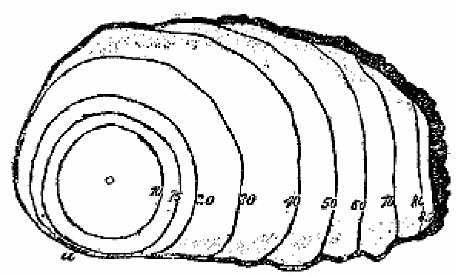


Fig. 34.—Section across an old pine stem in the cancerous region injured by Peridermium Pini (var. corticola). As shown by the figures, the stem was fifteen years old when the ravages of the fungus began to affect the cambium near a. The mycelium, spreading in the cortex and cambium on all sides, gradually restricted the action of the latter more and more; at thirty years old, the still sound cambium only extended half way round the stem—no wood being developed on the opposite side. By the time the tree was eighty years old, only the small area of cambium indicated by the thin line marked 80 was still alive; and soon afterward the stem was completely "ringed," and dead, all the tissues being suffused with resin. (After Hartig.)

occur as soon as the mycelium extends all round the cortex, or even sooner if the effusion of turpentine hastens the blocking up of the channels. This may take many years to accomplish.

So far, and taking into account the enormous spread of this disastrous disease, the obvious remedial measures seem to be, to cut down the diseased trees—of course this should be done in the winter, or at least before the spores come—and use the timber as best may be; but we must first see whether such a suggestion needs modifying, after learning more about the fungus and its habits. It appears clear, at any rate, however, that every diseased tree removed means a source of Æcidiospores the less.

Probably every one knows the common groundsel, which abounds all over Britain and the Continent, and no doubt many of my readers are acquainted with other species of the same genus (*Senecio*) to which the groundsel belongs, and especially with the ragwort (*Senecio Jacobæa*). It has long been known that the leaves of these plants, and of several allied species, are attacked by a fungus, the mycelium of which spreads in the leaf passages, and gives rise to powdery masses of orange yellow spores, arranged in vertical rows beneath the stomata: these powdery masses of spores burst forth through the epidermis, but are not clothed by any covering, such as the *Æcidia* of *Peridermium Pini*, for instance. These groups of yellow spores burst forth in irregular powdery patches, scattered over the under sides of the leaves in July and August: toward the end of the summer a slightly different form of spore, but similarly arranged, springs from the same mycelium on the same patches. From the differences in their form, time of appearance, and (as we shall see) functions, these two kinds of spores have received different names. Those first produced have numerous papillæ on them, and were called *Uredospores*, from their analogies with the uredospore of the rust of wheat; the second kind of spore is smooth, and is called the *Teleutospore*, also from analogies with the spores produced in the late summer by the wheat rust. The fungus which produces these uredospores and teleutospores was named and has been long distinguished as *Coleosporium Senecionis* (Pers.) We are not immediately interested in the damage done by this parasite to the weeds which it infests, and at any rate we might well be tempted to rejoice in its destructive action on these garden pests. It is sufficient to point out that the influence of the mycelium is to shorten the lives of the leaves, and to rob the plant of food material in the way referred to generally in my last article.

What we are here more directly interested in is the following. A few years ago Wolff showed that if the spores from the *Æcidia Peridermium Pini* (var. *acicola*) are sown on the leaf of *Senecio*, the germinal hyphæ which grow out from the spores *enter the stomata of the Senecio leaf, and there develop into the fungus called Coleosporium Senecionis*. In other words, the fungus growing in the cortex of the pine, and that parasitic on the leaves of the groundsel and its allies, are one and the same: it spends part of its life on the tree and the other part on the herb.

If I left the matter stated only in this bald manner, it is probable that few of my readers would believe the wonder. But, as a matter of fact, this phenomenon, on the one hand, is by no means a solitary instance, for we know many of these fungi which require two host plants in order to complete their life history; and, on the other hand, several observers of the highest rank have repeated Wolff's experiment and found his results correct. Hartig, for instance, to whose indefatigable and ingenious researches we owe most that is known of the disease caused by the *Peridermium*, has confirmed Wolff's results.

It was to the brilliant researches of the late Prof. De Bary that we owe the first recognition of this remarkable phenomenon of *heterœcism—i. e.*, the inhabiting more than one host—of the fungi. De Bary proved that the old idea of the farmer, that the rust is very apt to appear on wheat growing in the neighborhood of berberry bushes, was no fable; but on the contrary, that the yellow *Æcidium* on the berberry is a phase in the life history of the fungus causing the wheat rust. Many other cases are now known, *e. g.*, the *Æcidium abietinum*, on the spruce firs in the Alps, passes the other part of its life on the rhododendrons of the same region. Another well known example is that of the fungus *Gymnosporangium*, which injures the wood of junipers. Oersted first proved that the other part of its life is spent on the leaves of certain Rosaceæ, and his discovery has been repeatedly confirmed. I have myself observed the following confirmation of this. The stems of the junipers so common in the neighborhood of Silverdale (near Morecambe Bay) used to be distorted with *Gymnosporangium*, and covered with the *teleutospores* of this fungus every spring: in July all the hawthorn hedges in the neighborhood had their leaves covered with the Æcidium form (formerly called Rœstelia), and it was quite easy to show that the fungus on the hawthorn leaves was produced by sowing the *Gymnosporangium* spores on them. Many other well established cases of similar heterœcism could be quoted.

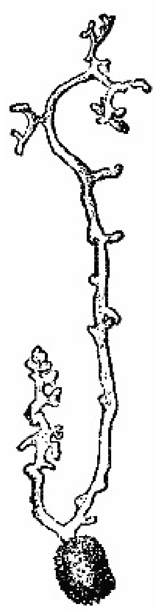


FIG. 35. A spore of Peridermium Pini germinating. It puts forth the long, branched germinal hyphæ on the damp surface of a leaf of Senecio, and one of the branches enters a stoma, and forms a mycelium in the leaf: after some time, the mycelium gives rise to the uredospores and teleutospores of Coleosporium Senecionis. (After Tulasne: highly magnified.)

But we must return to the *Peridermium Pini*. It will be remembered that I expressed myself somewhat cautiously regarding the *Peridermium* on the leaves (var. *acicola*). It appears that there is need for further investigations into the life history of this form, for it has been thought more than probable that it is not a mere variety of the other, but a totally different species.

Only so lately as 1883, however, Wolff succeeded in infecting the leaves of *Senecio* with the spores of *Peridermium Pini* (*acicola*), and developing the *Coleosporium,* thus showing that both the varieties belong to the same fungus.

It will be seen from the foregoing that in the study of the biological relationships between any one plant which we happen to value because it produces timber and any other which grows in the neighborhood there may be (and there usually is) a series of problems fraught with interest so deep scientifically, and so important economically, that one would suppose no efforts would be spared to investigate them: no doubt it will be seen as time progresses that what occasionally looks like apathy with regard to these matters is in reality only apparent indifference due to want of information.

Returning once more to the particular case in question, it is obvious that our new knowledge points to the desirability of keeping the seed beds and nurseries especially clean from groundsel and weeds of that description: on the one hand, such weeds are noxious in themselves, and on the other they harbor the *Coleosporium* form of the fungus *Peridermium* under the best conditions for infection. It may be added that it is known that the fungus can go on being reproduced by the *uredospores* on the groundsel plants which live through the winter.

[1] Continued from SUPPLEMENT, No. 661, page 10558.

In St. Genevieve and Cape Girardeau Counties, Mo., in the Niagara limestone is found a handsome marble of a variegated liver color. Near Sheppard Landing it is 80 feet thick, and at Janis Mill, in St. Genevieve County, Dr. Shumard speaks of beds of fine texture and various shades of flesh, yellow, green, pink, purple, and chocolate, all handsomely blended.

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