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ARE PATENTS INJURIOUS?

"Another difficulty in the way of securing proper appropriations has been a prejudice in the minds of many people of this country against patents and the patent system. It has been, certainly until very recently, a very common belief that the whole system was a humbug; that it was in fact an amiable way of permitting cranks to indulge their humors in regard to perpetual motion, &c., an inventive genius being regarded as one who was more or less erratic; and, as stated, there was and is to-day throughout the country an impression that the patent system in its practical operation levies a burdensome tax upon the people. It is also believed by a great many artizans, mechanics, and laborers that the system tends to abridge the opportunities for securing employment, and that it reduces wages.

"Touching the first objection, I submit that careful investigation will show that the patent system is the foundation upon which the industrial interests of this country are based. We are, in fact, indebted for our unequalled growth and prosperity as a manufacturing people to its influence. Nor is its healthful influence confined to the shops and factories, but extends to the fields, mines, and forests. The mere desire which all our people naturally feel to secure increased comforts and improved methods would never have resulted in even a distant approach to our present condition as a productive nation but for the great incentive found in securing to the inventor for a term of years the absolute ownership of the improved machine, method, process, or discovery which is the result of his efforts. It has been urged that the inventive genius of our people would have given to the world substantially all the improvements we have now without this incentive. Such a proposition seems so unreasonable that it is hardly worth while to combat it by argument. We sow not only to reap, but in the expectation of reaping an adequate harvest. No one would devote years of patient study, careful and profound thought and investigation, based on experiments, merely to produce a machine for his own individual use. The British Parliament a few years since appointed a committee to take testimony and to make full reports as to the influence of and necessity for a patent system. That investigation settled beyond all controversy, at least so far as the English nation is concerned, that without the patent system the inventive genius of that people would have remained inactive, and little progress would have been made during several centuries in the direction of developing the great industries which are now the source of English wealth and power.

"While preparing the exhibits for the World's Industrial and Cotton Centennial Exposition at New Orleans, I endeavored by correspondence to gather what information I could touching the relation our patent system sustains to the growth of our own industries, and from the investigations I have made, I feel safe in saying that to this system we are chiefly indebted for our present great industrial prosperity. The percentage of manufacturing establishments in this country which have not utilized the patent system in one way or another, as a means either of founding a business or building up and extending it, is very small. But as suggested before, it is urged that this exclusive property in a patent imposes burdens upon our people. The exact reverse is true. In this connection one important fact in the matter of using articles or machines which have been patented seems to be generally overlooked, and that is that no one is compelled to use any patented invention. The blessed privilege of sticking to the oldway abides with all of us, notwithstanding the patent system. Farmers are under no obligations whatever to lay aside the sickle, scythe or cradle, and use the reaper and mower. There does not rest upon them the slightest obligation to use a thrasher or separator, since they are at perfect liberty to swing the flail or use the tramping-floor. The hand-loom may still be used, notwithstanding the inventions of Jacquard and Arkwright, supplemented and improved by modern inventions. The old spinning wheel need not be thrown aside because the inventive genius of man has given us the spinning-jenny and its kindred aids in that art. There rests no obligation upon any of us to use the telephone, the telegraph, the locomotive or the engine. In fact, in all things we may stick absolutely to the old way, and submit ourselves to all the inconveniences and discomforts of the olden time. Every farmer may continue to build a worm or post-and rail or stone fence, instead of using barbed wire. In this connection it is proper to remark that he pays for his barbed-wire fence but little, if any, more than fifty per cent of the cost of the old board or post-and-rail fence, and it has been demonstrated that the farmers of the country have, in the last few years, saved over sixty millions of dollars by the use of this valuable invention. In fact, all inventions are utilized, not simply because they are convenient, but because they are cheaper and better. Touching the statement that laborers are thrown out of employment and wages reduced by the use of patent devices, it is sufficient to say that the allegation is entirely at variance with the best information obtainable from the returns of the last census. The utilization of valuable inventions does not throw laborers out of employment, but re-distributes labor and opens up new avenues of employment, calls into requisition a higher order of skill and secures an increase of wages. For example, take the boot and shoe industry, where a few hundred machines have changed the whole course of labor. The census of 1870 showed that there was an average of twenty-nine persons employed in every shoe factory in this country, whereas in 1880 there were fifty-six persons so employed. The same number of persons in 1875 made three times as many shoes as in 1845. In a table prepared by Colonel Wright, Chief of the Bureau of Labor, it is shown that in 1870 there were employed 91,702 men, women and children, while in 1880 there were 111,152. In estimates based upon four hundred and sixty shoe manufacturing establishments in Massachusetts, it is shown that three millions of dollars more are paid in wages than the cpaital invested, and that the labor-saving machinery has given to the laborer in 1880 almost double the wages of 1850.

"But for the growth of our industries, due to the patent system, there would have been no employment in this country, otherwise than in the field, for ten per cent. of the immigrants who have come among us. While an important invention may result in utilizing a machine which will do the work of a dozen men, the result is to open up an avenue of employment which will give work to double the number. The comforts and conveniences of life are made more abundant and cheaper, the consumption larger."—*Benjamin Butterworth, U. S. Commissioner of Patents in* 1884.

THE GOVERNMENT TIMBER TESTS.

Comprehensive timber tests have been inaugurated in the Forestry Division of the Department of Agriculture, concerning which we have received the following information:

To define the objects of the work more in detail, some of the questions which it is expected ultimately to solve may be formulated as follows:

What are the essential working properties of our various woods, and by what circumstances are they influenced?

What influence does seasoning of different degree have upon quality?

How does age, rapidity of growth, time of felling, and after treatment change quality in different timbers?

In what relation does structure stand to quality?

How far is weight a criterion of strength?

What macroscopic or microscopic aids can be devised for determining quality from physical examination?

What difference is there in wood of different parts of the tree?

How far do climatic and soil conditions influence quality?

In what respect does tapping for turpentine affect quality of pine timber?

It is also proposed to test, as opportunity is afforded, the influence of continued service upon the strength of structural material, as, for instance, of members in bridge construction of known length of service. This series of tests will give more definite information for the use of inspectors of structures.

Besides these problems, many others will arise and be solved as the work progresses, and altogether a wealth of new knowledge regarding one of our most useful materials must result. It is proposed to publish results from time to time.

The collection of the test material is done by experts (Dr. Charles Mohr, of Mobile, Ala., for Southern timbers). The trees of each species are taken from a number of localities of different soil and climatic conditions. From each site five trees of each species are cut up into logs and disks, each piece being carefully marked, so as to indicate exactly its position in the tree; four trees are chosen as representative of the average growth, the fifth, or "check tree," the best developed specimen of the site.

Disks of a few young trees, as well as limbwood, are also collected for biological study. The disk pieces are eight inches in height and contain the heart and sapwood of the tree from the north to the south side of the periphery. From fifty to seventy disk pieces and from ten to fifteen logs are thus collected for each species and site.

A full account of the conditions of soil, climate, aspect, measurements, and determinable history of tree and forest growth in general accompanies the collection from each site.

The disks are sent, wrapped in heavy paper, to the Botanical Laboratory of the University of Michigan, at Ann Arbor (Mr. F. Roth in charge), to be studied as to their physical properties, their macroscopic and microscopic structure, rate of growth, etc. Here are determined (a) the specific weight by a hygrometric method; (b) the amount of water and the rate of its loss by drying in relation to shrinkage; (c) the structural differences of the different pieces, especially as to the distribution of spring and summer wood, strong and weak cells, open vessels, medullary rays, etc.; (d) the rate of growth and other biological facts which may lead to the finding of relation between physical appearance, conditions of growth and mechanical properties.

The material thus studied is preserved for further examinations and tests as may appear desirable, the history of each piece being fully known and recorded.

The logs are shipped to the St. Louis Test Laboratory, in charge of Prof. J. B. Johnson. They are stenciled off for sawing and each stick marked with dies, corresponding to sketch in the record, so as to be perfectly identified as to number of tree, and thereby its origin, and as to position in tree. After sawing to size, the test pieces are stacked to await the testing. One-half of every log will be tested green, the other half after thorough seasoning. A determination is made at the time of testing of the amount of water present in the test piece, since this appears greatly to influence results.

From each tree there are cut two or three logs, from each log three or four sticks, two of standard size, the other one or two of larger size. Each standard stick is cut in two, and one end reserved for testing two years later after seasoning. The standard size for the sticks is 4 by 4 inches and 60 inches long for cross breaking tests. There will, however, be made a special series of cross-breaking tests on a specially constructed beam testing machine, gauged to the Watertown testing machine, in which the full log length is utilized with a cross section of 6 by 12 up to 8 by 16 inches, in order to establish the comparative value of beam tests to those on the small test pieces. It is expected that, in the average, 50 tests will be made on each tree, besides 4 or 5 beam tests, or 250 tests for each species and site.

All due caution will be exercised to perfect and insure the accuracy of methods. and besides the records, which are made directly in ink into permanent books, avoiding mistakes in copying, a series of photographs, exhibiting the character of the rupture, will assist in the ultimate study of the material, which is also preserved.

Such work as this, if done as indicated, and well done, will never need to be done over again. The results will become the standard the world over. The strength and value of a given species or even stick will then no longer be a matter of opinion, but a question of established fact, and we will learn not only to apply our timbers to the use to which they are best adapted, but also what conditions produce required qualities, thus directing the consumer of present supplies and the forest grower of the future. —*Scientific American.*

EVAPORATING APPLES FOR PROFIT.

All fruit growers, and more especially of the apple, know that much of their fruit is unfit for market, being either wormy, specked, scabby, knotty, or small. Now, all this fruit can be utilized by the evaporator, and placed upon the market at remunerative prices. It is not necessary to have a large establishment to accomplish this result. There are driers with their capacities ranging from one to two bushels of green apples per day up to thousands.

The work can be done just as well and as cheaply on a ten bushel machine as in any of the large factories, and my experience has been that they are the least expensive. Often it will pay to evaporate the whole crop. I have often realized more for culls than for the shipping fruit.

One hand can run a ten bushel drier, with twenty-five cents' worth of fuel, and make fifty pounds of white fruit per day, which, at ten cents per pound, about the average price, would net four dollars and seventy five cents, making nearly fifty cents a bushel, including the day's work, and, at this year's prices, would be over seventy cents, and if the waste is dried, almost a dollar.

Again, one important point thus gained is culling out your shipping fruit, making it grade fancy, and thereby obtain the highest market price for it.

Market only the best, evaporate the rest. Thus you would avoid the breaking down the markets for the green fruit. This is always done by inferior stock being run on the market, and never by good choice fruit. We can, at nearly all times see apples quoted on the market at 75 cents to $1.45 per barrel. These represent loss to the grower. All of this kind should never go on the market, but in the evaporator. The world is your market for evaporated fruit; you have nearly four barrels of apples in a fifty-pound box that can be shipped just as safely to Alaska, China, or India as to St. Louis, and you need be in no hurry to market it. Next spring is as good as this fall, and often better prices are obtained.

When properly packed, and with proper storage, it can be kept for years as fresh and sweet as when first prepared, except a little loss in color, but even this may be overcome by cold storage.

If prices are as low as they were two years ago, when it was worth only from four to six cents a pound, and the waste and chop less than one cent, it can safely be kept over until there is a shortage like the present, when fifteen cents can be obtained for the white fruit, and four to five cents for chop and waste. The chop is apples sliced just as they are without any paring or coring, and dried; in this the small and knotty apples that cannot be pared are used. The work is done quite rapidly with a machine made for the purpose. Forty or fifty bushels can be sliced in an hour by two hands.

One bushel of apples will make ten pounds of chop, which is now worth four cents a pound.

The waste is the skins, cores, and trimmings from white fruit, which needs no other preparation only to put it in the evaporator, dry it and pack it in sacks or barrels ready for shipment. It is used for making jellies, and usually brings about one-half cent more than the chop. Most of the chop is, I understand, shipped to Europe and there manufactured into fine wines and sent back to this country, and sold at from one to five dollars a bottle. The price is, therefore, greatly influenced and governed by the grape crop in the old country. Many thousands of tons are manufactured each year. Everything can be used, nothing wasted.

A delegate said: "I think still more can be done than the gentleman says. I evaporated some 1,400 pounds of fruit, which sold for ten cents per pound. I made use of every part of the fruit, except the wormy part. Vinegar was made of the waste. I sold some ten or twelve barrels at twenty cents per gallon, $9.60 per barrel of forty-eight gallons.

"I picked out the choicest to ship and evaporated the culls and seconds, which would have damaged the whole lot if shipped together. The vinegar apples made nearly as much money as any. I netted $85, using a cider mill that cost $15. We use a pear corer and slicer to prepare the apples for drying. Wife and two little girls did the work, apples and wood being brought to the house for them.

"Some of the apples kept a year and a half were as white and good as when first put up. No trouble to keep them five years. We used about a tablespoon of sulphur to a half bushel. When dry, we put the fruit right into flour barrels, and headed it up tight. Some kept eighteen months are as nice and fresh as when first put up. They are better to cook than fresh fruit, as they don't require sugar, while fresh fruit does.

"We pack them hot, right from the trays. If they stand open the miller will get into them. Turn them from the tray into the barrel, and keep them perfectly close. Just as soon as a barrel was full, I headed them up."—*J. B. Durand, before Missouri Hort. Soc.*

HINTS TO ENGINEERS.*

BY EDWIN WOODWARD.

The endless uses to which the steam engine is now put makes it a machine of incalculable worth, and while its worth when used with ordinary care is so great, the evils and disasters arising from the careless or more often ignorant engineer, makes it sometimes seem a questionable blessing. With every new industry requiring power, it is the ultimate duty of the engine to furnish it, and at every change of method such as we are daily, or at most yearly, meeting with, we see some new application of steam power.

This is especially true now, in the agricultural sections of the country, where the saw-mill, having done its work, is replaced by the steam threshing engine, which also drives the lath and picket mill. The small semi-portable is now very available to drive the tubular well, run feed mills, churns, chopping machines, pump water, and a thousand other duties constantly rising before the face of the agriculturist. What is more, their use is imperative, and not of volition. Need being the incentive, the engine is bought with the comforting assurance that "It will almost take care of itself. Keep plenty of water in the boiler and fire enough to keep the steam up, plenty of oil, and that is all there is of it."

A boy is given charge of it. The boiler, being new and tough, stands the abuse well, and before many weeks the boy "Knows how to run an engine as well as any one," and with this extensive practice and uniform success to recommend him, gets a more responsible position, with a steam plant, perhaps not so new, but his past luck, in the minds of the owners, insures safety; and with no new recklessness—only too much fire, too little water—an explosion is the usual result.

The loss of property is of little importance compared with the loss of life or the maiming of the innocent victims of—what? Ignorance, criminal neglect on the part of the Legislature in not giving us a law requiring evidence of the ability of the man in charge, or rapacity of the manufacturer? Let the guilty ones answer.

A person who is to take charge of a boiler should make himself familiar with all the needs or defects of it. In the first place its strength should be known, and this is best found by a force pump, warm water—cold water pressure is injurious—and a test gauge, or a steam gauge known to be correct, and the test made at least 20 per cent greater than the maximum steam pressure to be used. Knowing the boiler to be strong enough, the next step is to examine the pump, which should be in perfect working order. Having absolute evidence that the pump can supply, the business of supplying is a mere matter of routine, but a pump that will sometimes work and sometimes will not, is eligible for the most rigid and instantaneous examination. It may fail when its work is most important. Granted motion to the piston or plunger, a pump fails because it leaks. There can be no other reason, and the leak should be found and repaired. Leaky valves are common and should be ground. Leaky pistons are not so common, but sometimes occur. Repairing is the remedy. Leaky plungers are common. They need returning. The rod must be straight as far as in contact with the packing. The packing around the plungers is sometimes neglected too long, gets filled with dirt and sediment, and hardens and scores an otherwise perfect rod, and so leak.

The stuffing box should have a generous allowance of hemp—not drawn tightly around the rod, but the box well filled, and the gland screwed down tight enough to prevent a leak. Too tight only ruins the elasticity of the packing, and causes undue friction. The suction pipe should be also looked to. It is usually the source of exasperating leaks. It is usually made up of poorly-fitted nipples, elbows, couplings, and to complete the train of evils, a globe valve without any gland, and poorly packed. Freezing weather often opens the weld at the top of the water, or in some water pocket not properly drained. Any of these causes will destroy the efficiency of a pump, and are so known to exist—effectiveness is wanting. A leak on the delivery side of a pump is instantly visible, the water spurting at every stroke.

Leaks affect injectors the same as pumps, and in addition, the accumulation of lime and other mineral deposits in the jets stops the free flowing of the water. The heat of the steam is the usual cause of the deposits, and where this is excessive it would be well to discard the injector and feed with the pump. In many small industries it is impracticable to use a feed-water heater and purifier, but when this is not so it will be found a great aid, for one of the most import ant cares of an engineer is to keep the boiler clean. No scale should be permitted to collect. Mud should be allowed no place in a boiler. The writer has seen the sheets in the water leg of a locomotive type of a boiler sprung half an inch between stay bolts six inches apart, from accumulation of scale lodging and burning fast there.

There are many compounds in the market that are recommended for dissolving scale. They should be used with care. Some are strong enough to "dissolve the boiler."

* *In Scientific Machinist*

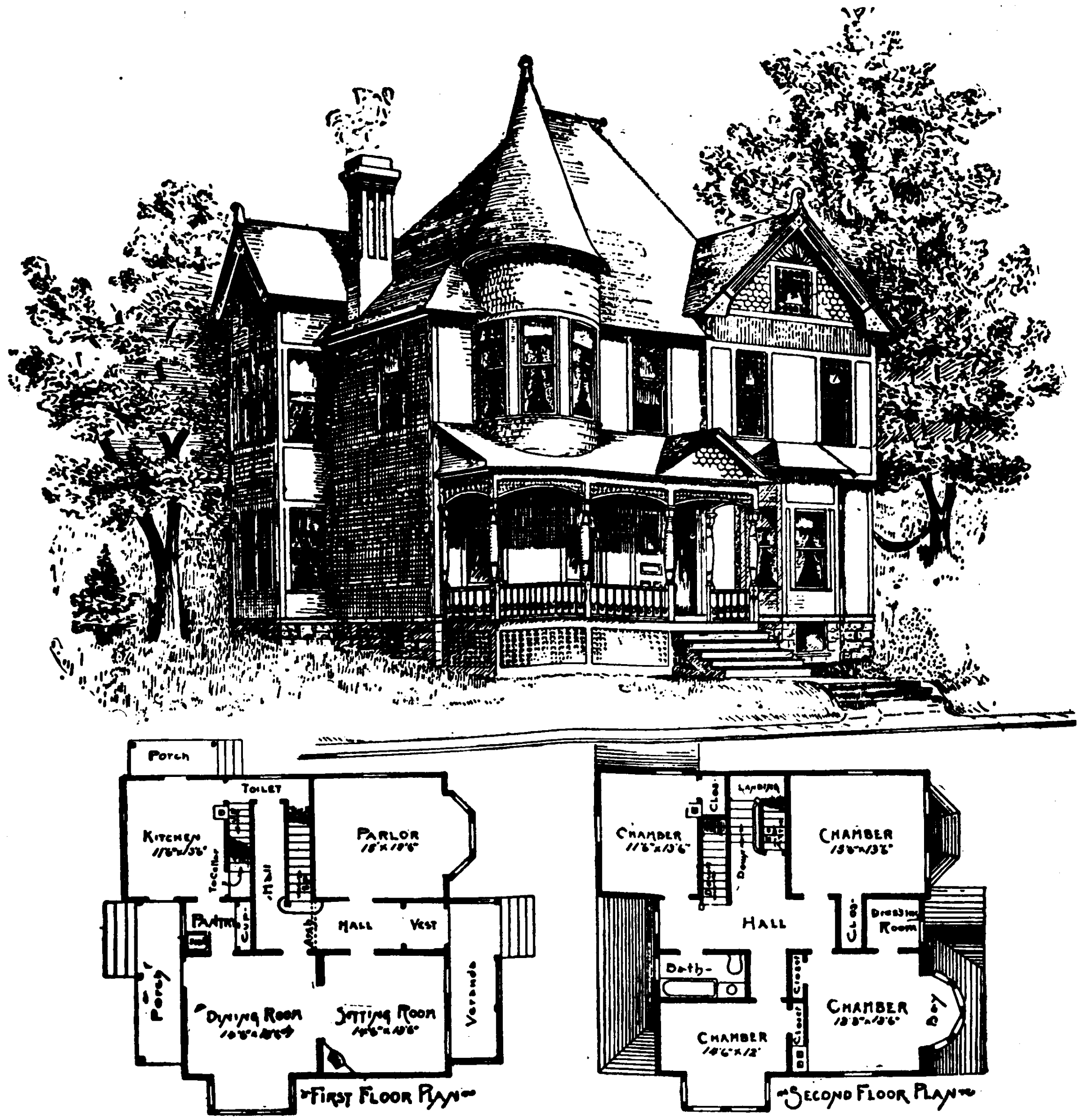
ESTIMATING.

A short way to estimate the cost of a plain house: I do not approve of the method in full, for the reason that I think my way of estimating is far better and more correct than any plan that I have ever seen in print. I first commence with the excavation.

Each cubic yard of dirt to be left on the lot, as thrown out, 20 cents. All sand and clay to be used by contractor free that is found in the cellar and trenches.

Stone to be of freestone rock-work, face 25 cubic feet to the perch, at $4.50 to the perch.

Cellar, 12×20 feet, to cost: Grates, $1 each; outside cellar stairs, complete, with doors, $6.



Design for Dwellings.

Now, the lower floor—joist, bridging, flooring and time, each square, $12. Second floor, the same a square—$12. Upper tier of joist, lumber and pine, per square, $8.

Roofing, per square—rafters, lath, sea-green slate, and time, $7.50. Coping, per foot, 10 cents. Chimney backs, each back, 75 cents. Flashing, per foot, 8 cents.

Cornice—Plain cornice, per lineal foot, flooring, fillet, and time, 15 cents.

Siding—All sides where siding, studding and time, per square (10×10 feet make a square), $3.60.

Partitions—Studding and time, each square, $1.75.

Box Stairs—Each flight (no rail), lumber and time, $12. With rail and baluster at landing, $19.

Doors—Door frames, doors No. 1, locks and butts, casing and time, each door, $6.50. No. 2, $5.50. Front doors and transom, $10.

Windows—Each window, sash and glass, $6.50; frame, casing, time and locks, $5.

Base—Each room, lumber and time, per room, $3.50.

Pantry—Shelves, common way, lumber and time, from six to eight shelves, $4.

Wainscoting—Per lineal foot, time and lumber, 20 and 25 cents.

Spouting—Per foot, put up, 10 and 11 cents.

Veranda—Per foot, face measure, turned posts, brackets, tin roof and spindle work, $3.50 and $4.

Chimneys—Per foot, 75 cents, 90 cents and $1.

Mantels—Each mantel, slate and hearths set in place, $18 and 20.

Painting—Per square, $1.25, $1.50 and $1.75.

Sundries—Such as door bumps, sash lifts, hooks, strips, etc.

Any new beginner that makes his estimates according to this rule, will save at least one-third the figuring, and is just as correct as the long way. If this is of any benefit to any brother chip, he is welcome to it.—*H. C. R. in the American Builder.*

THE SUN COOLING OFF.

BY PROF. ALEXANDER WINCHELL, LL.D.

We are not driven to the necessity of summoning exaggerated and imaginary agencies to the destruction of the earth. There are hostile powers reserved for the final conflict that will not be content with directing toward us merely "Quaker guns."

The sun, we say, affords us thirty-nine fortieths of all the warmth which we enjoy, and we feel quite unconcerned about the alleged slow cooling of the earth. To the sun we owe the numberless activities of the organic and inorganic worlds, and we feel quite independent of the waning temperature of this dying ember which we call the earth.

The amount of heat dispensed by our solar orb is truly something the contemplation of which overpowers the imagination. The rays which fall upon a common burning glass, converged to a focus, speedily ignite a piece of wood. The heat which is received by a space of ten yards square is sufficient, as Ericsson states, to drive a nine horse power engine. The amount of heat which falls upon half a Swedish square mile is sufficient to actuate 64,800 engines, each of 100 horse power. The total amount of heat received annually by the earth would melt a layer of ice one hundred feet thick. As the solar heat is radiated equally in all directions, it is easily calculated that the total emission of heat from the sun is 2,300 millions of times the whole amount which reaches our earth.

Such an enormous expenditure of heat is sufficient to reduce the temperature of the sun two and one-fifth degrees annually. During the human period of 6,000 years, the temperature would have been reduced more than 19,000 degrees. At such a rate of cooling it is obvious that the sun must speedily cease to warm our planet sufficiently to sustain vegetable and animal life. But it is certain that the sun's high temperature has been maintained during almost countless ages anterior to the commencement of the human era. Those titanic reptiles which could luxuriate only under tropical warmth flourished a hundred thousand years before the world was prepared for man; and those rank, umbrageous ferns, whose forms we trace upon the roof-shales of a coal mine, existed before the reptile horde, and purified the air for their respiration.

What unseen cause has perpetuated, for a million of years, those solar fires? Kepler asserted that the firmament is as full of comets as the sea is of fishes, and Newton conjectured that these comets are the fuel carriers of the sun. Alas! we only know that the wandering comet, though flying in tantalizing proximity to the sun, but accelerates its speed and hurries onward, as virtue hastens past the vortex of ruin. Is it a chemical action which maintains the solar heat? The most efficient chemical action for this purpose is combustion. Now, if the sun were a solid mass of coal, its combustion would only suffice for the brief space of forty-six centuries to replenish the solar system with its vivifying influence. Is it the effect of the sun's rotation on his axis? Such rotation could generate no heat without the resistance of another body. Even if that other body were present, a calculation based upon the sun's mass and his rate of rotation shows that the heat generated could only supply the expenditure for the space of one hundred and eighty-three years.

There exists, nevertheless, a means of recuperation to the solar energy. It is not an exhaustless resource, but it prolongs materially the period of the sun's activity. Though no comet has been *known* to fall into the sun, it is now generally admitted that cosmical matter is raining down upon the sun from every direction.

Besides the planetary and cometary bodies which revolve about the sun, it is now demonstrated that the interplanetary spaces are occupied by smaller masses of matter, from the size of a meteorite to particles of cosmical dust. These are all flowing about the sun in a circling stream, but forever approaching nearer and nearer, until they are gradually drawn into the solar fires. The showers of meteoric hail which pelt our earth at certain periods of the year are merely cosmical bodies that have been diverted from their path in certain parts of her orbit. That faint cone of light which streams upward from the setting or the rising sun, near the time of the equinoxes, is but a zone of planetary dust illuminated by the sun's rays—a shower of matter descending upon the solar orb, and rendered visible to us, like the rain sent down from a summer cloud and projected upon the clear heavens beyond.

Arrested motion becomes heat. The blacksmith's hammer warms the cold iron. A meteorite falling through the earth's atmosphere develops so much friction as to generate heat sufficient to dissipate the body into vapour. One of these cosmical bodies falling upon the sun must, by the concussion, produce about 7,000 times as much heat as would be generated by an equal mass of coal. It is thus that the enormously high temperatnre of our sun is maintained.

But the very mention of this source of recuperation of exhausted solar energy suggests a limit to the process. For how many ages can the cosmical matter within the limits of the solar system be rained down upon the sun without complete exhaustion? The space inclosed by the orbit of Neptune is not infinite. The supply of cosmical matter is but a finite quantity. Time enough will drain the bounds of the solar system of all its wandering particles of planetary dust. What then will be the fate of the sun?

The conviction cannot be resisted that the processes going forward before our eyes aim directly at the final extinction of the solar fire. Helmholtz says: "The inexorable laws of mechanics show that the store of heat in the sun must be finally exhausted." What a conception overshadows and overpowers the mind! We are forced to contemplate the slow waning of that beneficent orb whose vivid light and cheering warmth animate and vivify the circuit of the solar system. For ages past unbounded gifts have been wasted through all the expanding fields of space—wasted, I say, since less than half a billionth of his rays have fallen upon our planet. The treasury of life and motion from age to age is running lower and lower.

The great sun which, stricken with the pangs of dissolution, has bravely looked down with steady and undimmed eye upon our earth ever since organization first bloomed upon it, is nevertheless a dying existence. The pelting rain of cosmical matter descending upon his surface can only retard, for a limited time, the encroachments of the mortal rigors, as friction may perpetuate, for a few brief moments, the vital warmth of a dying man.—*Methodist Magazine.*

KEEPING FRUIT IN WINTER.

A writer is quoted as objecting to the practice of gathering apples for keeping "as soon as the pips begin to turn brown." He says apples gathered at this stage "do not keep as well, or average of so good quality." Certainly they do not. An apple makes a noticeable portion of its growth—often as much as one-fourth—while its seeds are colouring. But, on the other hand, the keeping of late-ripening apples is greatly lengthened by gathering them as soon as the seeds are fully coloured. Up to that time the fruit improves on the tree. After that it deteriorates, so far as keeping is concerned, and, with some varieties, it deteriorates rapidly, so that winter fruit soon becomes fall fruit.

The art of handling fruit for keeping is very imperfectly understood, both as regards principles and practice. The season of many of our fruits is capable of being much lengthened in the hands of growers and dealers who are willing to learn and make use of the principles involved. In the first place, so far as Nature's purpose is concerned, the external covering of the true fruit—that is, the seed—exists primarily for the sake of the seed itself, and only secondarily for its envelopes, which are the parts that give it its chief value for human use. As soon as the fruit and its seeds are ripe the fleshy exterior part begins to decay, and what we call ripening or maturing are only primary stages of that process, which is to release the seed, so that it may grow into a new plant.

After the fruit is carefully gathered, the whole question of keeping resolves itself into a question of temperature, but with due attention also to moisture. Pears, apples, and grapes require a low and uniform temperature, and proper protection from fungous attacks. Aside from the latter danger, which may be favoured by dampness, a saturated atmosphere is not objectionable; but care must be taken not to allow cold fruit to be taken into a warm atmosphere, producing that deposit of visible moisture upon its surface which is erroneously called sweating. In such cases it is not so much the moisture itself that harms the fruit as it is the mouldiness which is apt to ensue. Apples can be well preserved in very damp cellars if these points are kept in view. In fact, a cellar with a spring in it is thought by many fruit growers to be specially favorable to the perfect keeping of apples. In Russia it is a custom to preserve apples fresh in cold water; and the late Charles Gibb, of Abbotsford, Quebec, once told me of some very fine Fameuse apples which he found on sale in April, and which, he was told, had been part of the cargo of a canal boat that had sunk and been frozen in and had just been raised. The Fameuse can rarely be kept in air much beyond the first of February.

The temperature of a fruit cellar is best when kept as near to the congealing temperature of the fruit as possible. It is not safe to freeze so watery a fruit as the grape; but apples and pears can be frozen without injury, if slowly thawed again in the dark. I am not quite sure of the latter condition being essential, as I have had apples that had been slowly frozen, and as slowly thawed, in a light cellar, come out of the trial apparently uninjured.

But, unquestionably, an even temperature, near to freezing, is the best. Even this, however, is of small avail toward good keeping if the fruit does not go into its cold storage in perfect order and at the right stage of its existence. That stage is reached, in apples and pears, as soon as the seeds are fully coloured. Fruit designed for long keeping should be gathered early in the day or in cloudy weather. A barrel of sun-heated apples, even if put at once into a cool cellar, has lost greatly in keeping quality. If fruit must be gathered in the heat of a sunny day, let it be in baskets, which are to be kept under airy cover until they are well cooled before they are placed in the cellar.

For the best results, gathering and assorting ought to be simultaneous; but in a large orchard, when careful hands are scarce, this is not possible, and the best alternative is a large and airy sorting shed, where the work can be deliberately done by skilled hands. I prefer round-bottomed half-bushel baskets, with drop handles, for use in gathering and assorting. It takes a good many of them in a busy time, but in the end they are economical. They are easily handled, and will not be slung around, as bushel baskets with side handles are sure to be, to the great injury of their contents. The small baskets can be put down into the barrel and emptied without bruising their contents in the least. Hand barrows for two men are much better than wheelbarrows. A stone boat answers well on smooth, level ground.

As an evidence of the value of careful attention to all the points above referred to, I may be allowed to say that our chief winter apple in Northern New England is the Wealthy. Observing all these rules, I find that I have not the least difficulty in keeping it firm, fresh, and free from decay up to April, while less careful neighbours (and growers generally) decry it as merely a fall apple. By similar care, the Gravenstein, grown in Southern Maine, is found in the Boston market all winter in prime order.—*T. H. Hoskins, Garden and Forest.*

THE NATURE OF SOLUTION.

Some interesting experiments have been made recently, by Messrs. Wanklyn and Johnstone, upon the phenomenon of solution, from which they have deduced some facts which, if substantiated by further investigation, will be as useful as they are interesting.

Taking the solution of sugar in water as a starting point, the accuracy of the statement that the volume of a solution of sugar is equal to the sum of the volumes of the water and sugar was first established. Hence each gramme of sugar entering into a 100 c. c. of solution raises the weight of the solution in a definite proportion.

This coefficient of increment has been experimentally determined, having the value of 0·371 gramme displacing 0·629 gramme of water. Moreover, this coefficient is practically constant for all degrees of concentration. Experiments made on various other bodies, such as chloride, bromide, and iodide of sodium, barium chloride, etc., confirm this statement, indicating that solution is simple and regular in its action, unless interfered with by chemical change.

It has also been observed that solution is often attended by expansion or contraction, and that the coefficient of increment determined by experiment does not, in some cases, agree exactly with that calculated. This fact is looked upon by the investigators in the following way: When a gramme of a salt enters into solution in the 100 c. c., instead of an equal volume of water being displaced and overflowing as it were, there is a chemical combination between the salt and the water, a condensation or absorption of part of the water taking place, this condensation being represented by the difference between the experimental and the theoretical increment. Experiments were made upon various nitrates and sulphates, the condensation phenomenon being observed in all cases, but in a varying degree.

The results obtained in these experiments led to the conclusion that this property of condensation constituted a definite physico-chemical function. Experiments were then made upon various salts all containing the same base, with the result that it would seem that this function not only existed, but that it bore an atomic relation to the substance dissolved, so that the variation in condensation would be characterized by the base contained in the salts employed. The experiments made on sodium and potassium salts, some of which have been published in detail, seem to substantiate this hypothesis, and the investigators contemplate ultimately establishing a complete volumetric relationship.—*Scientific American.*

THE MAXIM FLYING MACHINE.

The newspapers of recent date contained an interesting interview with Hiram J. Maxim descriptive of a new aërial machine in which he is interested, and concerning the possible applications of which he appears to be very enthusiastic. We give in what follows the substance of this interview, which makes interesting reading. Mr. Maxim is reported to have opened the interview with the following bloodthirsty announcement:

"If I can rise from the coast of France, sail through the air across the Channel, and drop half a ton of nitro-glycerine upon an English city, I can revolutionize the world. I believe I can do it if I live long enough. If I die, some one will come after me who will be successful where I failed."

"It is not necessary to imitate the flapping of wings in making a flying machine," continued Mr. Maxim. "Suppose Stephenson had said that, as a horse was the most perfect form of locomotion over roads and fields, he would make his steam engine walk. What speed would he have secured? He might have made his engine walk as fast as three miles an hour. By using wheels, he obtained continuous motion, and that is why I use the screw. But the screw has to revolve with great rapidity—all the way from 1,000 to 2,500 revolutions a minute. You cannot make sufficient impression on the air with anything less.

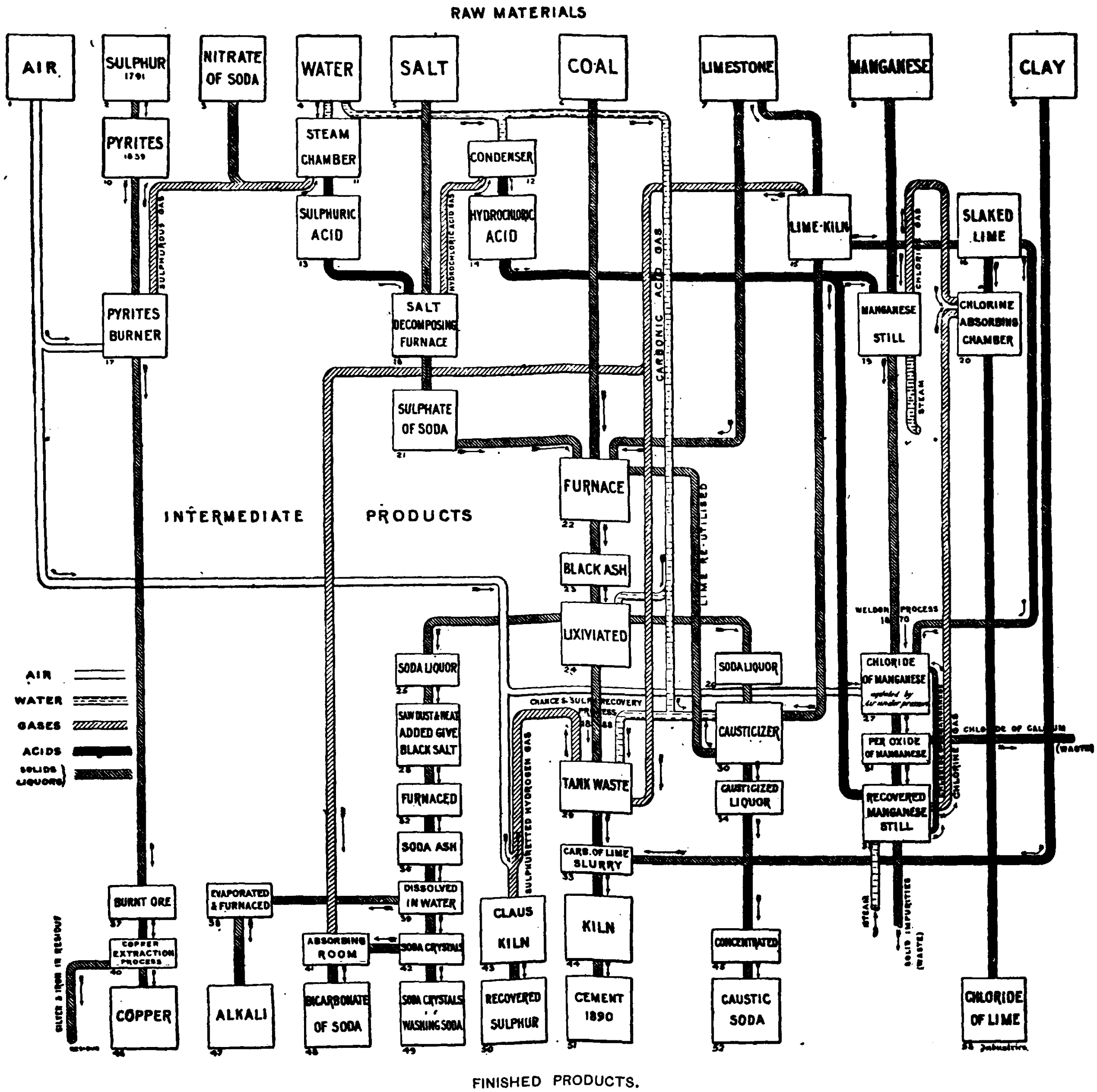
"My first machine was a small one. It was an inclined plane 13 feet long and 4 feet wide, and set edgewise against the air. I balanced it on an arm about thirty feet in length, revolving in a circumference of 200 feet. The arm was movable, so that it would rise and fall. When the machine traveled at the rate of 30 miles an hour, it remained on the same plane. When the speed was increased to 35 miles, it began to rise. At 90 miles, it pulled its guy wires with such force that it broke them, and now we have to keep it chained. All our experiments were conducted with the greatest accuracy. Delicate machines measured the speed per minute and per hour, the push and lifting power of the screw, the horsepower of the motor, and every other factor.

"I am now at work on a large machine, built of silk and steel, that will do on a large scale what the other machine does on a smaller scale. We found by experiment that one horse-power would carry 133 pounds at a rate of 75 miles an hour. We proved, also, that our screw would easily lift forty times as much on a plane as it could push. I have built a motor weighing 1,800 pounds, and which pushes 1,000 pounds. It will, therefore, lift 40,000 pounds. The weight of my engines, generator, condenser, water supply, petroleum and two men, is 5000 pounds. The large machine will be 110 feet wide and 40 feet long. It will be propelled by two immense wooden screws, nearly 18 feet in diameter, looking very much like the screws of ocean steamers, only with broader blades. The steam is generated by heating copper by petroleum, and is condensed after being used, so that we get along with two gallons of water. The boiler is of the finest Whitworth steel, and we shall use about 40 pounds of petroleum an hour.

"The machine will be placed at an angle of about 1 foot in 18 inches on a railroad track 12 feet wide. At 30 miles an hour it will barely skim along, the pressure of the air underneath it being then equal to one pound for each square foot, or just sufficient to lift it. At 35 miles an hour it will begin to rise, and as the speed increases it will mount higher and higher. When you want to descend, you will slacken speed; or if you wish to proceed in a straight line at a certain height, you come back to 30 miles an hour."

CENTENARY OF THE LEBLANC SODA PROCESS.

We illustrate on p. 297, an ingenious and instructive diagram, which has been devised by Mr. J. J. Miller, 8, Affleck Street, Gateshead-on-Tyne, in commemoration of the centenary of the Leblanc soda process. We may state that the above illustration is reproduced, by permission, from a large coloured diagram which Mr. Miller has prepared—together with a key in pamphlet form—for sale at a small cost, and which will be found extremely useful to teachers of applied chemistry. In fact, several leading chemists have already expressed very favourable opinions as to the teaching value of Mr. Miller's diagram.



Centenary Diagram Illustrating the Leblanc Soda Process.—Devised by Mr. J. J. Miller, Gateshead-on-Tyne.

In the preface to the key of the diagram Mr. Miller points out that "It is a noteworthy fact that the first deed of partnership between the founders of the first soda factory should have been signed in London, in presence and in the office of James Lutherland, Notary Public, on the 12th February, 1790. The final deed was signed by Leblanc, Dizé, and Shee, on the 27th January, 1791—and the first patent for the manufacture of soda from marine salt was granted in Paris to Nicolas Leblanc on the 19th September, 1791."

From this extract it will be seen that it is just 100 years since Leblanc obtained the French patent for a process which has since acquired a world-wide fame.

Referring to the diagram—which is to a large extent self-explanatory—it will be seen that the raw materials are shown along the top; the finished products along the bottom; and the intermediate products and processes are shown in the space between, in a connected manner, corresponding with the special processes. The small number at the corner of each square in the diagram relates to a number in the key, where a brief explanation is given. For example, in connection with the manufacture of sulphuric acid, the following is an extract from the key prepared by Mr. Miller:—

"To make sulphuric acid (13) the following plant is necessary:—The pyrites burners (17) are small fire-brick kilns encased with cast-iron plates securely bound with wrought-iron binders and rods. The Glover tower, so named after the inventor, consists of a timber frame from about 22ft. to 30ft. high, and 10ft. or 12ft. square; the enclosing walls are made of sheet lead securely air-tight; the enclosed space is packed with pieces of flint. The chamber (11) is a large timber frame, usually about 180ft. long, 25ft. wide, and 20ft. high; the walls, floor, and roof forming the enclosed space are made of sheet lead, securely air-tight. The absorbing tower, known generally by the name of its inventor 'Guy-Lussac,' is constructed in the same manner as the Glover tower, either circular or square, and from 4ft. in diameter to 12ft or 14ft. square, and about 40ft. high; it is packed with coke. Cisterns made of wood and lined with lead are used to store the acid. Usual furnaces and boilers are used to generate steam for the chambers (11)."

PURIFYING FEED WATER.

Mr. Archimedes Stephenson Wall, of Chicago, writes on this subject in the *Railroad Gazette*, and the following portions are of interest to our readers generally, although the writer specifically treats of feed water for a locomotive engine. The stationary engineer may draw a broad hint from the following remarks:

The most common substance which forms the scale in the locomotive boiler is lime in solution, and it is well known to be instantly precipitated in still water by the addition of more lime. When all has fallen to the bottom of the tank, the purified water may be drawn off, and the lime in the bottom of the tank will be available for the purification of the next charge of water. By having several tanks which can be alternately used for the precipitation of the lime and then drawn upon for the water supply, there is no labor necessary after the first charging of the tanks with a due proportion of lime, except the turning of the valves to change the flow into the empty tank, and to draw from the one which has completely settled.

Many years ago, I saw a plant upon these principles erected under the direction of Gordon H. Nott, C. E., at Adrian, Mich., which seemed to be very successful. Only two storage tanks were used, however, and the removal of the precipitated lime was sought to be in part accomplished by a rude sort of filtration, which was troublesome and cost something in labor for cleaning out; and it was evident that a better way would have been to use a greater number of tanks, or larger ones. But with this increased expense, the cost figured up only about one cent per thousand gallons treated, including interest on the cost of the plant and estimated depreciation. This experiment was on a practical scale, the tanks used being each of about 50,000 gallons capacity, equal to about two days' supply for the locomotives watering at that station in each tank; but two days is not a sufficient length of time to admit of the total subsidence of the very fine precipitate through so deep a tank as those in use there, which were about 15 or 16 ft. high. Evidently, broad, shallow reservoirs would be the best for this mode of treatment.

I made a comparative analysis of this water, which was very hard before treatment, and found that something more than 90 per cent of the lime was removed by the method of precipitation employed. Of course there can be no patent upon the method of purifying water, which has long been practiced in England, as well as on a small scale in this country, but I believe that some special form of apparatus for the convenient application of the principle has been patented. It ought, however, to be quite within the capacity of any engineer or master mechanic to construct an arrangement for this purpose which will be so elementary as to avoid any patents, and yet one which would be entirely efficient and satisfactory.

The same system is applicable to water impregnated with other salts than those of lime; but in order to determine the proper substance to be used for precipitating them a chemical analysis will be necessary, while as to the lime a single experiment in the office with a tumbler and a pinch of lime thrown into the water will determine something although the well-known soap test is better. Or to precipitate the lime, if any, by the oxalate of ammonia, is a yet better method, because the quantity of lime contained by the water can, in this way, be accurately determined.

There is much waste of fuel incurred, in many parts of the country, simply from the use of muddy waters, for it is not usual for a settling basin or tank to be used, no matter how much sediment may be contained in the water pumped from a turbid stream. So far as I have observed, the master mechanic has nothing to do with designating the sources from which the water for the engines shall be supplied, but he must get along with such as has been provided for him by the department of the chief engineer, who, unless he is more than usually attentive to matters outside his department, will consider almost any water good enough for a locomotive if there is a sufficient quantity of it. I have known an engineer of reputation to arrange for the entire supply of water on his road to be drawn from wells in a region where every well yielded hard water, because this was cheaper in first cost than to secure pure water from running streams.

MANUFACTURE OF TIN PLATES.

The form of tin plate known as "roofing plate" is now made in Philadelphia, by taking imported steel plate of proper quality and coating it with a mixture of tin and lead. A mill near Front and Laurel Streets is turning out every day a score or more of boxes of the American roofing plate thus prepared. This mill has been in operation just two months, and, with the exception of a plant at Pittsburg, it is the only one in Pennsylvania. At the close of two months' operations the proprietors of the manufactory maintain that they can produce a first class article of roofing tin plates as cheaply as they can be made in England or Wales, plus the duty of $14 per ton. In other words, the consumer can purchase American roofing plate of a good grade for as small a price as he can get the British article and pay the duty thereon of 2 1-5 cents, to be collected after July 1, 1891.

So far, this mill has not attempted to produce bright tin, which is used for the manufacture of tinware. However, the firm has completed plans for the duplication of its present plant, and still other additions are anticipated. N. & G. Taylor Co., large manufacturers of tin plate in Great Britain, and extensive importers, are making an earnest test to determine definitely whether or not they can hereafter make their plates at home instead of 3,000 miles away.

Tin plate is made of sheets of iron or steel coated with pure tin or a mixture of tin and lead. When the sheets are covered with pure tin the product is called "bright" tin, and when the coating is a mixture of tin and lead the product is called "roofing" tin. The value of both kinds depends entirely upon the quality of iron or steel used, the manner in which the tin plates are made and the quality and quantity of the coating. In making cheap tin plate, Bessemer steel is employed, and is coated by a cheap process, acid being used as a flux, and the plates finally rolled to squeeze all the coating possible off the steel, leaving only enough to cover the base. The flux is the wash put on the steel plates to make the coating stick fast to it, or, as the Welsh say, to make it "bite."

There are mills in England where rolls are used which spread the coating of tin so thinly upon the steel plates that one pound of the tin is made to cover 100 square feet of plate. This, of course, is a low grade article. As the steel costs but four cents a pound and pig tin costs 21 cents a pound, there is a general desire on the part of manufacturers to put as little tin on the plates as possible.

A first rate grade of "bright" tin contains about 10 pounds of pure tin to 100 square feet of plate. This is put on Siemens-Martin steel. An average of 6½ pounds of tin to 100 square feet of plate make a good article. As lead costs but 4½ cents a pound, it is usually mixed in liberal quantities with the tin to make the coating metal. To be sure, lead alone will not adhere to iron or steel, and a little tin is absolutely necessary.

Tin plates are usually made in two sizes, 14 by 20 inches and 20 by 28 inches. They are packed in boxes containing 112 plates. A box of the best quality of bright tin, of the 14 by 20 inches size, sells for $11. A fair grade sells for from $6.50 to $7. The steel before it is coated is cut to thicknesses. One size is 14-1000 of an inch and the other 12-1000. The first is called the I X, and the second the I C brand.

On July 1 the new tariff duty of 2 2-10 cents a pound or $44 a ton, went into effect.

The process of making roofing at the new mill of N. & G. Taylor Company, near Front and Laurel Streets, is an interesting one. The company buys its steel plates in England. The manner of converting them into tin is this, there being sixteen distinct steps in the process:

1. The sheets of steel are cut into perfect sizes by a squaring machine.
2. From the squaring machine the steel is put into a pickling box. This pickle contains a good deal of sulphuric acid, and is applied for the purpose of removing rust.
3. Then the plates are lifted with swing tongs from the pickling box into a trough of water, where they are thoroughly washed.
4. The next is another water bath.
5. Then they are scoured with sand to remove the last particle of rust, and to make the plates bright and smooth.
6. A short distance away over a hot furnace are arranged six pots, the first of which contains boiling palm oil. Into this the steel plates are immersed.
7. The second vat contains the mixture of lead and tin metal, which is kept at the boiling point, and here the plates get another bath.
8. A second pot of metal comes next, in which the plates remain but a few minutes.
9. The plates are then laid on a tin-covered table and both sides are vigorously brushed with a heavy brush. This is to remove any little blisters that may have been formed before the coating gets cold.
10. A pot of metal similar to the other mixtures is next, and into this the hot plates are swung.
11. The plates are put in a vat of boiling oil.
12. Then they are dumped into a pot of metal once more and for the last time.
13. One by one they go to a bin of sawdust and are rubbed on both sides.
14. Alongside of this is a bin of bran, and here a boy again rubs the sides of the plate.
15. The plates then go to a boy who lays them on a sheep skin and rubs both sides thoroughly. This is the final touch, so far as the making of the tin is concerned.
16. The plates go from the sheep skins to the stamping machine. Then they are packed into boxes and are ready for shipment.

From the time a plate leaves the water bath until it is stamped not more than twenty minutes elapse. The pickling, sand rubbing and washing processes do not require everything. The mills are run in "sets." Each "set" consists of the vats, pots, etc., mentioned above. To work them properly seven men and six boys are employed. Such a force can turn out forty boxes of tin plates a day. This is the capacity of the Taylor mill.

Several new steel plate mills are being built in this country, when it is expected the factories that make American tin will be able to purchase the black sheets at a more advantageous price.—*Phil. Record.*

NEW METHOD OF UNLOADING GRAVEL TRAINS.

The accompanying engravings illustrate a new method of unloading gravel or ballast trains which was tried with success last winter on the Delaware & Hudson Canal Co's railway. Messrs. Drake & Stratton of New York, have a contract for grading seventeen miles of second track, near Whitehall, N. Y., through a country where the material is of such a character that in cold weather it freezes badly during the haul on cars from the pit to the place where it is to be unloaded. It was found that a mogul engine of the heaviest type could not drag the side unloader or plow through a train of this frozen material, and when two locomotives were used the brakes would not hold the train stationary.

To have abandoned the work until the spring would have caused considerable loss and inconvenience to the contractors and company, and the contractors therefore decided to try the plan of fitting to the first car of the train a stationary winding or hauling engine for dragging the plow.

The plant was furnished by the Lidgerwood Manufacturing Company of New York, and is shown in figures 1 and 2. It consisted of an improved Lidger-

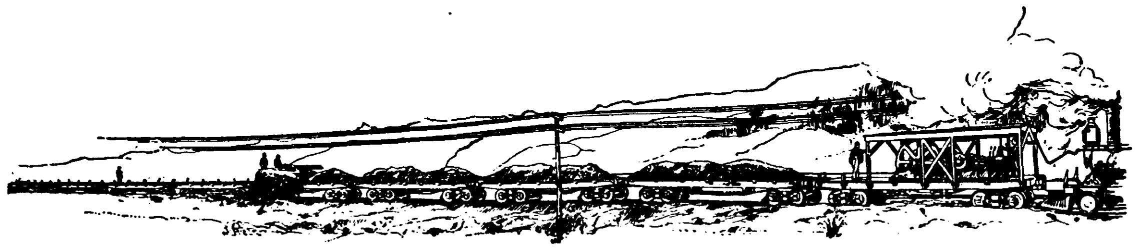


FIG. 3.—NEW METHOD OF UNLOADING GRAVEL TRAINS.

wood heavy hoisting engine with one drum, guaranteed to lift twenty-five tons on a single line at a speed of 100 feet per minute. This engine was mounted on a flat car, thirty-four feet long, of 60,000 lbs. capacity over which a temporary roof was erected, and was supplied with steam from the locomotive through the flexible piping shown in the general view of the construction train, Fig. 3.

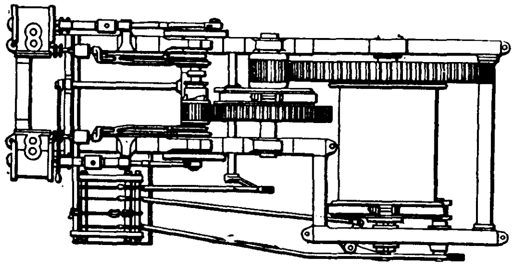


FIG. 1.—HAULING ENGINE FOR PLOW USED FOR UNLOADING GRAVEL TRAINS.

The plan proved very successful, and resulted in a considerable saving of time as compared with the ordinary plan of attaching the plow to the locomotive by a cable and hauling it along by running the engine ahead. Mr. A. J. Swift, chief engineer of the road, in a letter to the Lidgerwood Manufacturing Company, dated January 24th, 1891, stated as follows:

"From the very first trial the plan proved very successful, and the work is now progressing at a satisfactory rate, the unloader breaking up and depositing the frozen material in a way that is surprising. It seems to me so desirable and satisfactory a plan of operation that I feel sure it would recommend itself

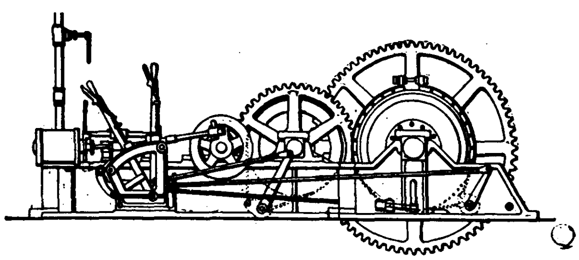


FIG. 2.—HAULING ENGINE FOR PLOW USED FOR GRAVEL TRAINS.

to any contractor or engineer interested in handling bad or frozen material. It is particularly valuable to the railway company interested in such work, because the action is certain and quick, and enables a construction train to finish its work on the main track and resume to the gravel pit in a fraction of the time occupied by abortive attempts to do the same work by locomotive traction."

The engine does the work well, and is very satisfactory and economical.

It has been used to unload trains of sixteen flat cars.

The contractors have recently purchased another hoisting engine of the same kind, and will place it on a car with a boiler, so as to be independent of the locomotive.—*The American Engineer.*

EXPLODED STORIES.

We are easily led to wonder that preachers will cling to theological ideas and theories long after they are clearly shown to be false. It is hard to part with a once cherished idol. And it is even so with regard to natural traditions, or what we are led to believe about animals, and things that are seen.

In the recently past generations travellers returned from long journeys with strange tales not only of adventure, but what they declared they had seen. A writer in *Forest and Stream* says: I am the owner of a natural history written by one Riley and published about the year 1789. It is a quaint old book, and its yellow leaves and odd type furnish the reader with a number of strange accounts. Among others may be found something like the following: "The digestive apparatus of the ostrich is said to be very strong indeed; that bird not only being able to digest such things as stones, bits of glass and iron, but it is even said that it makes a good meal of a bed of live coals."

We laugh at such a statement, but no doubt at the time of publication it was stated for a fact says the Boston *Journal of Commerce*. What right have we to laugh? It is not long since almost every one believed the porcupine capable of shooting its quills like arrows, and regarded it as an animal well able to defend itself against almost any foe, instead of the quiet, inoffensive little creature, that curls itself into a ball at the first approach of an enemy, trusting solely to its spine-covered skin for protection.

Men who lived only a short time before us did not question but what the pretty, graceful swallows that skimmed so lightly o'er the blue waters in summer, buried themselves in the mud at the bottoms of our rivers and ponds when the season was over, to await the return of spring.

It has been but a short time since investigation has shown that the supposed happy family made up of the prairie dog, the burrowing owl and the rattlesnake, is not only not a happy family, but does not exist at all.

Our first idea was that these three animals of such different habits lived in perfect harmony, like the so-called happy families of the modern circus; but our faith in this belief is somewhat shaken by the following, which may be found in Wood's Natural History: "According to popular belief, these three creatures live very harmoniously together; but observation has shown that the snake and the owl are interlopers, living in the burrow because the poor owner cannot turn them out, and finding an easy subsistence off the young prairie dogs."

We were satisfied with this for a time, but judge the astonishment created when Elliott Coues, in one of his latest writings, makes the following statement in speaking of the burrowing owl: "I have found colonies in Kansas and other States, in all cases occupying the deserted burrows of the quadrupeds, not living in common with them as usually supposed."

Naturalists are now telling us, continues our Boston contemporary, that the opossum does not play 'possum, but is merely paralyzed with fear for the time being; articles are published every day in our ornithological papers and magazines which go to prove that owls can see equally as well by day as by night. It is still an undecided question whether snakes "charm" their prey or not. In the western backwoods these old stories are still believed in; the ignorant classes cling with fondness to them and will not learn anything different, and down in our own hearts do we not all cling to them, more or less? Do we not hate to give them up, and is it not with a little regret that we are forced to acknowledge that the porcupine does not shoot his quills, that the bird of paradise really has feet and legs, and that our national bird, the white-headed eagle, is far from the noble bird we once thought him to be.

OLD AND MODERN WAYS OF STEAM HEATING.

An article is going the rounds to the effect that the use of steam for heating purposes far antedates the time when James Watt conceived the utilization of it for power. As long ago as the days when Pompeii flourished in its original splendour, steam was used for the purpose of heating buildings, for subsequent excavations have brought to light indisputable evidence of its use. In those days the "true and reliable" way to utilize this convenient mode of heating was to build in the partitions of the houses hollow passage ways, into which the steam was supplied, when by radiation solely the desired heat was transmitted to the apartments to be warmed. With the introduction of pipe it was found more convenient and economical to convey the steam to hollow receptacles, which were set in the different rooms to be heated. The joints in the pipe were made tight by the use of yarn packing, and it is a matter of great surprise to the enlightened American that even to-day this mode of connecting pipes is largely used in England, says *Specialties*. The Englishman takes slowly to the idea of threading pipes and connecting them by the use of a little red lead. Following along the line of advancement we find that wrought iron pipes are now largely supplanted by neat and ornamental radiators. It is found that greater possibilities of ornamental designs are to be had by the use of cast iron, and again cast iron, being homogeneous, gives off heat with greater freedom, representing a superiority over wrought iron as a radiator of from 18 to 25 per cent. Wrought iron conducts heat; cast iron radiates it; wrought iron is a fibrous structure, cast iron a homogeneous one; and so where heat is to be imparted and not stored, cast iron is more desirable to use.—*The American Engineer.*

DYNAMITE SHELLS.

HIGH EXPLOSIVES SUCCESSFULLY USED IN A COMMON CANNON.

Experiments were made recently in Aberdare, a town of South Wales, with an invention known as Snyder's dynamite projectile. The inventor of these dynamite shells is Mr. F. H. Snyder, of New York, who some years ago conducted a series of trials at Sandy Hook, and on the Potomac, near Washington. The experiments lasted from noon until five o'clock in the evening and proved to the satisfaction of the many English and foreign military and naval experts present, that dynamite bombs may safely be fired from ordinary guns by the Snyder system.

Nine shells, each charged with from ten to thirteen pounds of nitro-gelatine, were fired. A six-inch armor plate was indented at 110 yards and bent at sixty yards. Four-and-a-half inch plate was bent and indented to the extent of one and a half inch at 250 yards. In each case the explosion scattered timbers many yards. One shell rebounded a distance of seventy yards without exploding, although it was flattened. It was charged with only four pounds of some different explosive, the nature of which Mr. Snyder declined to divulge.

Some of the experts present expressed disappointment because the armor was not penetrated, and said that they had expected that it would be shattered. General Fleroff, a Russian officer, declared that the shells used were not more effective than other shells

MECHANICAL DRAWING A PART OF EDUCATION.

A good many young men who have been denied the advantages of a technical education, or even a first-class public school education, but who are nevertheless desirous of standing high in their calling, even though they must work their way slowly upward from the bench, the forge or the foot plate, sometimes ask if there is any necessity of obtaining a good knowledge of mechanical drawing. To all such we would most earnestly reply, "By all means obtain a thorough knowledge of drawing." A man may rise to a fair position in any of the mechanical pursuits without it, but if he really wishes to become proficient, and to avoid having his upward progress permanently arrested, his knowledge of mechanical drawing must be considerable. By such knowledge we do not mean the ability to make pretty pictures, or even handsome drawings, but rather a perfect understanding of the principles of the art and their applicability to every day work. We have frequently seen the intelligent shop foreman make a drawing which a draughtsman might say looked "tough," but though his lack of expertness in the use of the instruments gave his drawing that appearance, they would be intelligible and correct. Such knowledge always makes it possible for one to communicate his ideas to others, and aside from this convenience there is a drilling of the powers of conception which is invaluable, and can be obtained no other way. A still further advantage accompanying a good knowledge of mechanical drawing, is the better understanding of the fundamental principle of mechanics which almost invariably comes to the student as he becomes proficient in drawing. Every mechanic trying to rise should study drawing, even though he may never intend to work an hour in a draughting room in his life.—*The Railway Review.*

MAXIMUM LOCOMOTIVE SPEED.

Most experienced railroad men feel that the possibilities of steam practice are nearly reached, and that much greater speed is not practicable. A maximum of ninety miles an hour, with a running speed of sixty to seventy, is all that can be hoped for under the very best conditions. The limitations are numerous, and are well known to all engineers. The maximum speed of which a locomotive is capable has not been materially increased in a number of years. The schedule time has been shortened, principally by reducing gradients, straightening curves, filling up ravines and replacing wooden structures by permanent ones of iron or stone; by the use of heavy rails, safer switches, improved methods of signaling, the interlocking switch and signal system, the abolition of level crossings; in fact, by improvements in detail and management which permit a higher speed on a more extended section of road because of greater safety and the greater degree of confidence inspired in the engine driver.

PARAFFINE IN DIPHTHERIA.

Mr. A. M. Sydney-Turner, Surgeon to the Gloucester County Infirmary, informs the *Lancet*, in reply to inquiries, that he has treated thirty cases of diphtheria (children and adults) with paraffine, and has had the satisfaction of seeing every one recover. His plan is to ask for the ordinary paraffine used in lamps, and, having scraped off the diphtheritic patch, to apply the paraffine to the throat (internally) with a large camel's hair brush. As a rule, the throat gets well in from twenty-four to forty-eight hours, and with improvement in the throat paraffine is applied less frequently, but he continues its use for two or three days after the complete disappearance of the patches. He speaks definitely as to the therapeutic effects, but is unable to state what the chemical action of paraffine on the diphtheritic membrane is; probably the hydrocarbons in the liquid exert some powerful influence on the membrane.

ELECTRICAL.

The storage batteries hitherto in use for lighting the cars of the Grand Trunk R. R. are being changed for those of the Roberts' Storage Battery Co.—thus proving the merits of the Canadian-made cell.

One of the attractions of the new Queen's Theatre in Montreal is the incandescent illumination which keeps the hall much cooler and the air much purer than they otherwise would be with gas. The footlights consist of three rows of lamps, red, green, and white respectively, and striking effects can be produced by turning on the red or green alone. These lights may also be turned down as gas.

A novelty among Canadian launches has been built at Toronto for Mr. G. H. McFarlane, manager of the Roberts' Storage Battery Co. It is run by electricity, and is fitted out with the Roberts' Co's cells. The motor is of three H.P. and is attached directly to the screw. The necessary current is furnished by 60 two-volt cells. The cells are charged by the Toronto Electric Light Co., and when developing three horse-power will yield a day's supply. The cost of charging them is twenty cents per hour.

The consolidation of the Bell and Federal telephone companies in Montreal has resulted in the raising of the price of that useful instrument, and now instead of its being twenty-five dollars per annum it is fifty dollars. A great deal was said at the time of the lowering of the price, and indignation was shown over the fact that the people had been paying much more than was necessary. If these people would stop for one moment and think of the remarkable cheapness of the telephone at fifty dollars, they would cease to be indignant. The price makes it a little less than one dollar per week, and in a store where the telephone is in constant use this is remarkably reasonable. What office boy could be got to do the work in carrying and receiving messages for the same price? Compare the rate of our telephone service with that of many other cities and it will be seen that we are favoured with a good efficient service at a very moderate cost.

GUILEY'S ELECTRICAL BLOCK SYSTEM FOR RAILWAYS.

An invention which will tend to prevent railway collisions, by giving a timely alarm to an engineer on a moving locomotive when approaching a standing or moving locomotive on the same track, and which will give notice of an occupied grade crossing, an open switch, an open drawbridge, or a car projecting from a side track over the main track, and which will afford a signal effective in daylight or darkness, on a straight or curved track, or in a tunnel, is one which would cover most of the causes of disaster on railways, and would prove a boon to travellers, and a paying investment for railways if generally adopted.

Such an invention has been made by Dr. A. H. R. Guiley, and has been patented in this and most other countries in the world.

According to this invention, which is illustrated in the annexed engraving, one of the rails is made a continuous conductor by connecting the rails electrically at the joints, and the other rail is divided into sections or blocks, and provided with electrical connections which overlap from one block to the other. Between the rails at suitable intervals, preferably at opposite ends of the blocks, are placed electric contact pieces, each formed of two plates insulated from each other and provided with vertical ribs arranged diagonally.

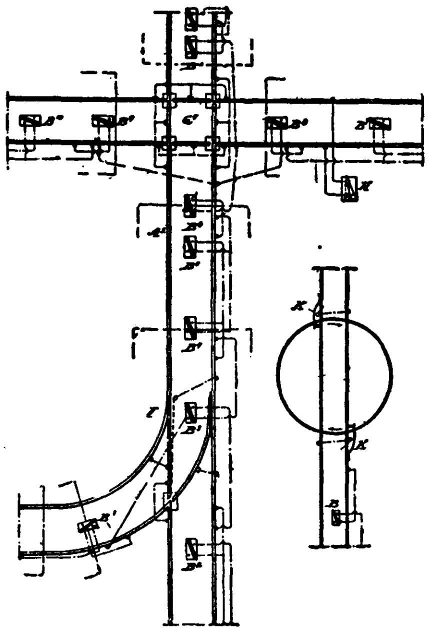
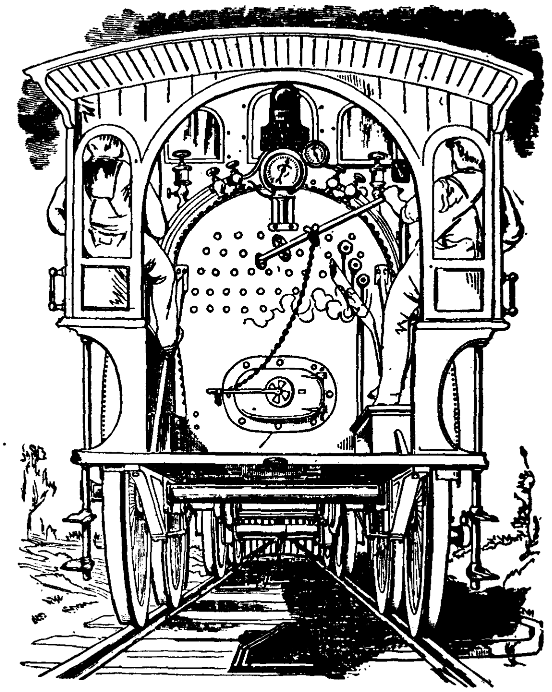


Diagram of Guiley Block System.

These ribs lie in the path of an armour or "feeler" carried by the locomotive, and upon the locomotive is placed a battery and alarm mechanism.

The arrangement of the circuits is such that when a train is passing in one direction, the feeler strikes a set of contacts controlling the circuit arranged for trains passing in that direction. When the train passes in the opposite direction, the feeler strikes the opposite contact plate, securing opposite results. The feeler, which extends downwardly from the pilot of the locomotive, is capable of swinging laterally, and is protected so that it is not injured by the shock due to striking the contact plates, or other objects lying on the track.

In the cab of the locomotive is arranged an electrical alarm which is set off by the contact of the feeler with one of the plates, and continues to ring until the engineer readjusts it for another alarm. The inventor has devised an attachment to the feeler by means of which steam is taken through pipes and through the contact end of the feeler for thawing snow and ice that may accumulate upon the feeler or upon the contact plates.



New Electrical Block System for Railways.

This improved system applied to a railway furnishes a complete grade crossing protection, and a very efficient block signal, while at the same time, under certain conditions, it may be used as a train signal by which one train may signal to another.

In the annexed diagram, the contacts, B, B′, etc., and the electrical connections, as arranged upon the main track A′, and branch track, and on opposite sides of the crossing, as shown in the diagram, protect the grade crossing, G^4, and the switch, I.

The switch, H, is provided for the use of the track master and others for signalling a train in case of necessity. The detached view shows the application of the invention to a draw bridge, J, the contact springs, K, in this case serving to make or break the connections as the bridge is closed or opened.

Mr. E. B. Cornell, 922 N. 19th Street, Philadelphia, Pa., has the business management of this invention. —*Scientific American.*

North Carolina is to have the honor of having the longest electric railway in the world, a line from Asheville to Rutherfordton, a distance of forty-one miles, being about to be constructed. The power is to be furnished by water.

DIFFERENT FORMS OF CARBONS USED IN ARC LIGHTING.*

BY W. C. WARNER.

In the period just preceding the introduction of the arc electric lighting commercially, experimenters and inventors had brought forward numerous plans, ideas, and theories regarding the size, form and manner of using carbons, and in view of the fact that no reasonably cheap method of generating the electric current then existed, a surprising amount of attention was given to the subject, and the developments of the art shown by many publications, form no small part of our history of arc lighting.

It is not my purpose to dwell at length upon the history of carbons generally, but rather to touch lightly on some of the more notable forms known, at the time of which I am speaking, and then to pass on to a consideration of the utility and practical results obtained with the different forms of carbons in use at the present time, paying special attention to the matter of form and size as affecting the results.

The form of a cylinder or pencil, it is noteworthy, was that used by Sir Humphrey Davy, in his earliest experiments, and he even devised special holders or claims to retain the carbon pencils in all alignment and facilitate their adjustment with a view of maintaining a constant and steady light.

Archereau subsequently adopted the pencil form of carbon and used it in his lamp now so justly considered as the first practical arc lamp, it does not appear, however, that he turned his attention particularly to the matter of form.

Wright and others stand on record as experimenters with carbon discs brought edge to edge and made to rotate as they were consumed, and the combination of a disc placed on edge above a vertical pencil of carbon was also tried at this early date.

Wallace and Farmer made use of broad, flat plates of carbon, placed in a vertical plane, one above the other, the arc forming between the edges as they were drawn apart and shifting back and forth from one end of the plates to the other. Another inventor, at about this same date, placed flat plates of carbon side by side with the arc forming at the upper edges of the plates and an intervening insulation of some refractory material, the arc forming at the upper edges of the plates and gradually consuming them.

Jablochoff in 1876 introduced his well-known electric candle, a form of arc lamp in which cylindrical carbons are employed placed in a vertical position and held separated by a thin filling of refractory insulating material.

Now when we look back at the work of these early inventors and consider what special object they had in mind in making their experiments, it is at once apparent that it was continuity of action, and it stands on record that they met with fair success so far as the feature is concerned, some of the lamps being capable of twenty hours' burning without attention.

In 1874 Mathias Day produced an arc lamp in which two cylindrical pencils were placed in the upper holders and two in the lower holders, the upper ones occupying a plane with the lower and directly over them. Here the avowed object of the invention was to secure long-continued operation of the light without requiring attention, and it is certain that he accomplished it in a very creditable and ingenious manner.

Coming now to the time of the commercial birth of arce lectric lighting, we find Jablochoff in the lead, closely followed by Brush and Weston, each making use of the cylindrical form of carbon pencil and turning their attention most assiduously to the feature of continuity of operation, the first move being an increase in length of the pencils. Carré, a French manufacturer, at this time, became prominent as a maker of carbons, and succeeded in producing pencils about 7 1-16 inch. diameter, and 32 inches in length, and it was thought by the use of lamps of suitable length these long carbon pencils could be advantageously used when long-continued burning was a necessity, but owing to the difficulties encountered in the manufacture and also trouble in maintaining proper alignment for the carbons a length of 22 inches was soon settled upon as most practicable and convenient.

As the business increased and the demands became better understood, the inventors again essayed to solve the problem of continuity of action, but, in many cases such attempts were but returns to old forms and methods, and did not result in any practical advance.

Various forms of double carbon lamps were introduced, and, for a time, these were thought to be the only practical and commercially successful way out of the difficulty, but more recent developments have shown a far simpler and better way, and one furthermore, that cannot fail to impress the practical electrical engineer. I refer to the simple expedient of using a carbon pencil of $\frac{5}{8}$ inch diameter 14 inches in length in an ordinary single carbon lamp. It is true that this is not new, and that carbon pencils of such size, or even greater, were tried long ago; nevertheless, the introduction of carbons of this size and form has a very great bearing on the commercial side of the situation, but before going into that matter I wish to say a few words regarding the lighting efficiency of $\frac{5}{8}$ inch carbons.

Having noticed that the question had been raised as to whether these carbons would give as much light for a given expenditure of electrical energy, as would those of one inch diameter, I tried the following experiments:

Two single lamps were connected in series in an arc circuit, one being supplied with $\frac{5}{8}$ inch carbons 14 inches in length, the other with $\frac{1}{2}$ inch carbons 12 inches in length, around each lamp was branched a voltmeter indicating the voltage. The lamps were then adjusted until they had the same voltage, and as current was of necessity the same in each, it was a safe conclusion that equal amounts of energy were being supplied. Photometric comparison of the two lights was then made at the horizontal and at many different angles above and below with the result that no perceptible difference could be found in the power of the lights, during the tests of the current was maintained as constant as practicable and care was taken to base the comparison on an average deduced from a large number of readings.

* Paper read before the National Electric Light Association Montreal.

Now while this matter of lighting efficiency is one that concerns the people operating electric plants; it does not interest them to the extent that other features upon which I have yet to touch may, as I happen to know that the management of lighting stations look long and lovingly on any plan that seems to give good promise of reducing running expenses. To begin with there is the difference in first cost between a single and a double carbon lamp, and the difference in the expense for repairs and attendance, these items varying of course with the different lighting system. Still another important saving is in the cost of carbons, the cost for a given number of hours run, being fully thirty per cent greater with ½ inch than with ⅝ inch carbons. There is the further important saving in the breakage of globes which often is caused by the sudden shifting of the arc in the double carbon lamp. Twin carbons consisting of two cylindrical pencils placed parallel and in close juxtaposition to each other, and connected by a web throughout their entire length have of late been introduced and when in use the arc alternates between the different pencils comprising the upper and lower twin carbons. A test of these carbons made principally with a view of determining the life and lighting quality gave unsatisfactory results in the following particulars. It was observed that the duration of a burning for a given weight of material was not near equal to that which could be obtained with the same amount of material in a single cylindrical pencil. This I attribute to the more rapid disintegration of the turn carbon resulting from the very frequent heating and cooling of each member; indeed this is found to be true of two carbons where arranged as in the Day lamp, or so that the arc alternates frequently between the different sets, and there is quite a noticeable difference in consumption of carbon for a given duration of lighting as compared with an ordinary single carbon of the same diameter burning without interruption.

Another undesirable feature of twin carbons is the shadow cast by the non-burning members, which while it may not be disagreeably noticeable when the lamp is provided with an open globe, most certainly operates to reduce the total output of light.

It may be argued that the main item of expense in the manufacture of carbons does not lie in the material, and the fact that ⅝ inch carbons cost so little more than ½ inch would bear out such a position, and I have merely mentioned the fact of the rapid disintegration and burning away of the turn carbons by way of explanation.

TONS OF LEATHER USED IN THE BELTS.

The magnitude and importance of the Electric Power Station of the West End Street Railway Co. of Boston may be somewhat estimated from the following description of the belts used, taken from the *Boston Weekly Trascript*:—

"The largest leather belts ever made in New England are those manufactured for the power station of the West End Street Railway Company on Albany street. Their approximate breaking strain is 64,800 pounds. Twelve of the belts are each about 150 feet long and 54 inches wide. It required 1980 hides, or 79,200 pounds of leather, for their manufacture. Two of these belts are to be used on each fly wheel, giving a belt surface of 108 inches, which is supposed to be the largest belt surface ever used on a single fly wheel. The order also includes twenty-four belts thirty inches in width to run the generators. These are also made double, and of the same high quality of stock. This will consume 625 hides, or 27,000 pounds of leather. The whole order will reuuire over 2,600 hides, or about 104,200 pounds of leather."

EXPLANATION OF ELECTRICAL WORDS, TERMS, AND PHRASES.

(From Houston's Dictionary.)

Cables, Underground.—Cables designed for use underground.

These are either placed directly in the ground, or in *conduits*, or *subways*, especially prepared to receive them.

Calibration, Absolute and Relative, of Instrument.—The determination of the absolute or the relative values of the reading of an *electrometer, galvanometer, voltmeter, ampère-meter*, or other similar instrument.

The calibration of a galvanometer, for example, consists in the determination of the law that governs its different deflections, and by which is obtained in ampères, either the absolute or the relative current required to produce such deflections.

For various methods of calibration, see standard works on Electrical Testing, or on Electricity.

Calibration, Invariable, of Galvanometer.—In galvanometers with absolute calibration, a method for preventing the occurrence of variations in the intensity of the field of the galvanometer, due to the neighbourhood of masses of iron, etc.

Calorie, or Calory.—A heat unit.

There are two calories, the small and the large calorie.

The amount of heat required to raise the temperature of one gramme of water, 1° C. is called the *small calorie*.

Sometimes the term is used to mean the amount of heat required to raise 1,000 grammes of water 1° C. This is called the *large calorie*. The first usage of the word is the commonest.

Calorescence.—The transformation of invisible heat-rays into luminous rays, when received by certain solid substances.

The term was proposed by Tyndall. The light and heat from a voltaic arc are passed through a hollow glass lens filled with a solution of iodine in bisulphide of carbon. This solution is opaque to light but quite transparent to heat.

If a piece of charred paper, or thin platinum foil, is placed in the *focus* of these invisible rays, it will be heated to brilliant incandescence.

Calorimeter.—An instrument for measuring the quantity of heat possessed by a given weight or volume of a body at a given temperature.

Thermometers measure temperature only. A thermometer plunged in a cup full of boiling water shows the same temperature that it would in a tub full of boiling water. The quantity of heat present in the two cases is of course greatly different and can be measured by calorimeters only.

Various forms of calorimeters are employed.

In order to determine the quantity of heat in a given weight of any body, this weight may be heated to a definite temperature, such as the boiling point of water, and placed in a vessel containing ice, and the quantity of ice melted by the body in cooling to the temperature of the ice, is determined by measuring the amount of water derived from the melting of the ice. Care must be observed to avoid the melting of the ice by external heat.

In this way the amount of heat required to raise the temperature of a given weight of a body a certain number of degrees, or the capacity of the body for heat, may be compared with the capacity of an equal weight of water. This ratio is called the Specific Heat.

The heat energy, present in a given weight of any substance at a given temperature, can be determined by means of a calorimeter; for, since a pound of water heated 1° F. absorbs an amount of energy equal to 772 foot-pounds, the energy can be readily calculated if the number of pounds of water and the number of degrees of temperature are known.

Calorimeter, Electric.—An instrument for measuring the heat developed in a conductor, in a given time, by an electric current.

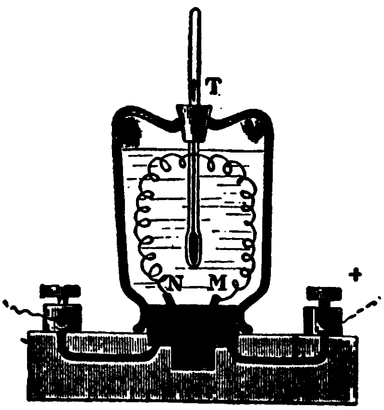


FIG. 77.

A vessel containing water, is provided with a thermometer T, Fig. 77. The electric current passes for a measured time through a wire N M, immersed in the liquid.

The quantity of heat is determined from the increase of temperature, and the weight of the water.

According to Joule, the number of *heat units* developed in a conductor by an electric current is proportional,

1. To the Resistance of the Conductor.
2. To the Square of the Current passing.
3. To the Time the Current is passing.

The heating power of a current is as the square of the current only when the resistance remains the same.

Candle, Electric.—A term applied to the Jablochkoff candle, and other similar devices.

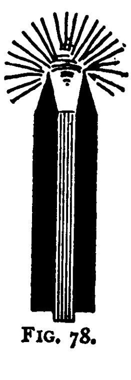


FIG. 78.

The Jablochkoff electric candle consists of two parallel carbons, separated by a layer of kaolin or other heat-resisting insulating material, as shown in Fig. 78. The current is passed into and out of the carbons at one end of the candle, and forms a voltaic arc at the other end. In order to start the arc, a thin strip called the *igniter*, consisting of a mixture of some readily ignitable substance, connects the upper ends of the carbons.

An alternating current is generally employed with these candles, thus avoiding the difficulty which would otherwise occur from the more rapid consumption of the positive than the negative carbon.

Candle, Foot.—A unit of illumination equal to the illumination produced by a standard candle at the distance of one foot. Proposed by Hering.

According to this unit, the illumination produced by a standard candle at the distance of two feet would be but the one-fourth of a foot-candle; at three feet, the one-ninth of a foot-candle, etc.

The advantage of the proposed standard lies in the fact that knowing the illumination in foot-candles required for the particular work to be done, it is easy to calculate the position and intensity of the lights required to produce the illumination.

Candle, Standard.—A candle of definite composition which, with a given consumption in a given time, will produce a light of a fixed and definite brightness.

A candle which burns 120 grains of spermacetti wax per hour, or 2 grains per minute, will give an illumination equal to *one standard candle.*

Candle, A, or, Unit of Photometric Measurement.—The unit of photometric intensity.

Such a light as would be produced by the consumption of two grains of a standard candle per minute.

An electric lamp of 16 candle-power, or one of 2,000 candle-power, is a light that gives respectively 16 or 2,000 times as bright a light as that of one standard candle.

Capacity, Electrostatic.—The ability of a conductor or condenser to hold a certain quantity of electricity at a certain potential.

The electrostatic capacity of a conductor, or of a *condenser*, is measured by the quantity of electricity which must be given it as a charge, in order to raise its potential a certain amount. In this respect the electrostatic capacity of a conductor is not unlike the capacity of a vessel filled with a liquid or gas. A certain quantity of liquid will fill a vessel to a level dependent on the size or capacity of the vessel. In the same manner a given quantity of electricity will produce, in a conductor or condenser, a certain difference of electric level dependent on the electrical capacity of the conductor or condenser.

Or, the quantity of gas that can be forced into a vessel depends on the size of the vessel and the pressure with which it is forced in. A tension or pressure is thus produced by the gas on the walls of the vessel that is greater, the smaller the size of the vessel, and the greater the quantity forced in.

In the same manner, the smaller the capacity of a conductor, the smaller is the charge required to raise it to a given potential, or the higher the potential a given charge will raise it.

The capacity K, of a conductor or condenser, is therefore directly proportional to the charge Q, and inversely proportional to the potential V, or

$$K = \frac{Q}{V}.$$

From which we obtain Q=KV; *or,*

The quantity of electricity required to charge a conductor or condenser to a given potential, is equal to the capacity of the conductor or condenser multiplied by the potential through which it is raised.

Capacity, Electrostatic, Unit of; The Farad.—A conductor or condenser of such a capacity that an electro-motive force of one volt will charge it with a quantity of electricity equal to one coulomb.

Capacity of Polarization of a Voltaic Cell.—The quantity of electricity required to be discharged by a voltaic cell in order to produce a given polarization.

During the discharge of a voltaic battery, an electro-motive force is gradually set up that is opposed to that of the battery. The quantity of electricity required to produce a given polarization, depends, of course, on the condition and size of the plates. Such a quantity is called the Capacity of Polarization.

THREE YEARS' DEVELOPMENT OF ELECTRIC RAILWAYS.*

BY CAPT. EUGENE GRIFFIN.

The first recorded description of the electric car is found in the fourth verse of the second chapter of Nahum: "The chariots shall rage in the streets; they shall jostle one against another in the broadways; they shall seem like torches, they shall run like the lightnings."

Notwithstanding this early mention, it was not until 1888 that the electric railway became a practical commercial success. I fix the date at 1888 as it was in that year that Bentley and Knight opened the Allegheny City road to regular traffic; that the Sprague Company equipped the Richmond road, and the Thomson-Houston Co. installed the Eckington and Soldiers' Home road in Washington. It was in 1888 that railway officials began to realize the possibilities of this new tractive force; that the great West End system of Boston adopted electricity to the exclusion of cable, and that orders began to flow in upon the electric companies for street car motors to such an extent as to soon make the manufacture of such motors one of the leading branches of the electric industry.

Previous to 1888 electric motors had been used on several roads. Some of these roads were doing well and have been prosperous since; but to the public these were experiments on a comparatively small scale, and did little to inspire general confidence. The early inventors found it difficult to secure financial backing; orders were few and business unprofitable. The stronger companies which took up the work in 1888 had the organizations and capital necessary to achieve success.

The pioneers who devoted their brains and frequently their purses to this work previous to 1888 are deserving of all credit. It was their misfortune, not their fault, that their ideas were not developed and worked commercially. It is difficult for one man to combine the qualities of inventor, manager, superintendent, seller, expert, and financier, and yet this is what Van Depoele, Daft, Bentley and Knight and others had to attempt. The record of their efforts is an interesting one, but the chronological record of electric traction has been so frequently given that it would be a waste of your time to repeat it again.

There are, however, one or two of the early trials that are specially worthy of consideration, not only because of what was actually accomplished, but principally on account of their bearing on later developments. On the 27th of July, 1884, an electric car was running scheduled trips over a mile of track of the East Cleveland Street Railway Co. in Cleveland, Ohio. This was the first electric car in regular operation on a street railway track in the United States. The motor was placed between the wheels and supported from the car body, and geared to the axles by belts of spring wire cables. The current was conveyed to the car by conductors supported on insulators in a small, wooden conduit, and connection made with the conductors by means of a plow extending through the slot to the conduit. This was the initial installation of the Bentley & Knight system. Mr. Bentley has a photograph of the car in his office in Boston.

The road was given up in 1885, and the Bentley-Knight works transferred to Providence, R. I. After various experiments the road in Allegheny City was begun in the summer of 1887. The cars were started during the winter of 1887-8, although the road was not formally opened to traffic until February, 1888. Four cars were furnished to this road which, I believe, are still running. On the lower end of the road was a mile of double track conduit which was continued by an overhead system of about five miles. The conduit was on a long grade of about 12 per cent. Over-running trolleys were used with the overhead system. The conduit was in operation for two years or more, but has now been taken up and replaced by the overhead system.

As early as 1874, while C. J. Van Depoele was engaged in Detroit, experimenting with electric motors, generators, etc., it occurred to him that trains of cars, and even ordinary street cars, could be run by electricity. This was demonstrated to the satisfaction of his associates in various ways, but no public exhibition was made until 1883. When the Chicago elevated railway was under consideration, it was proposed to demonstrate the feasibility of utilizing electricity as a motive power. A track 400 feet in length was built, with a 5 per cent. grade in the centre. One car was equipped with a 3 h. p. motor and ran for several weeks with considerable success, carrying crowds of people. This was in February, 1883. In the same year an elevated railway car was operated electrically at the Chicago Inter-State Fair. The car was suspended from the truck instead of being mounted on it, and was in operation during the entire exposition—some fifty days.

During the Toronto Annual Exhibition in 1884, an electric railwa some 3000 feet long was operated from the entrance to the grounds to the main building. This was a conduit road and the wires carried a potential of over 1000 volts without accident. A thirty horse-power electric locomotive was used hauling trains of cars.

The Van Depoele Company subsequently equipped roads at Minneapolis, Minn., Montgomery, Ala., Detroit, Mich., Windsor, Ont., Appleton, Wis., Port Huron, Mich., Scranton, Pa., Lima, O., Binghamton, N.Y., Ansonia, Conn., Dayton, O., Jamaica, N.Y., St. Catherines, Ont., and elsewhere, many of which are still in operation.

In the fall of 1887, Frank J. Sprague contracted for the electrical equipment of the Union Passenger Railway at Richmond, Virginia. This was an important road in a large city, and Mr. Sprague's undertaking was the most ambitious effort

*Paper read before the National Electric Light Association, at Montreal.

in this direction up to that date. It is worthy of note that Sprague's original intention was to use motors with but one reduction, but he was forced to abandon this idea as none of the electrical companies at that date were able to produce single reduction motors. The motors used at first were too light for the work, the copper brushes scored the commutators badly and were rapidly consumed. Nevertheless, Mr. Sprague persevered despite all obstacles, and in 1888 the road was running with so much success that it was one of the object lessons which induced Henry M. Whitney and his brother directors of the West End Street Railway of Boston, to adopt electricity as a motive power when they were already far advanced in the plans for cabling their system.

As nearly as can now be ascertained the following electric roads were actually in operation on January 1st 1888.

ROADS.		LOCATION.	Miles.	No. of Mtr. cars
Union Pass. Ry. Co.	(Daft)	Baltimore, Md.	2.00	3
Windsor Electric Ry	(Van Depoele) opp.	Detroit, Mich.	1.25	2
Appleton do.	do.	Appleton, Wis.	5.50	5
Port Huron do.	do.	Port Huron, Mich.	2.75	4
Highland Park	(Fisher)	Detroit, Mich.	3.25	4
Scranton Suburban Road	(Van Depoele)	Scranton, Pa.	5.00	12
Los Angeles Electric Ry. Co.	(Daft)	Los Angeles, Cal.	5.00	6
Lima Street Ry. and Motor Power Co.	(Van Depoele)	Lima, Ohio	4.00	8
Columbus Consolidated Street Ry	(Short)	Columbus, O.	1.00	2
St. Catherines Street Ry. Co.	(Van Depoele)	St. Catharines, Ont.	7.00	12
Seashore Electric Ry. Co.	(Daft)	Asbury Park, N.J.	4.00	18
San Diego Street Ry. Co.	(Henry)	San Diego, Cal.	3.00	9
East Harrisburg Pass. Ry. Co.	(Sprague)	Harrisburg, Pa.	4.50	10

A total of 13 roads, 48.25 miles of track, and 95 cars.

On July 1st, 1891, there were 354 roads in actual operation, with 2,893 miles of track equipped electrically, and 4,513 motor cars. Such has been the growth of three and a half years.

This development has been marvellous and unprecedented. Referring to it, General Francis A. Walker said to me, not long since, that it seemed as though at least thirty years' normal development has been crowded into three years.

It has indeed been a fruitful period, and the progress has been so rapid that the public are just beginning to appreciate the benefits which science has conferred upon them by the adaptation of the electric motor to street car propulsion.

During the past spring the legislature of the State of Massachusetts was considering a proposition which practically amounted to the imposition of new taxes upon the West End Street Railway Co., and the abrogation or virtual annullment of certain vested rights which the Company might claim. In his able and vigorous defence of his corporation, President Whitney was forced to investigate and determine the true relations which exist between his company and the public, and he was surprised himself to see how closely the welfare of the city of Boston and its surrounding suburbs was identified with the welfare of its street transportation system.

He at once entered upon a "campaign of education," and his speeches in Somerville, Roxbury, Dorchester and elsewhere (several of which have been published in pamphlet form) are masterly, impressive, straightforward and convincing presentations of the close relations which exist between the rapid transit systems and the health, wealth, morality and prosperity of our large cities.

I commend these speeches to the consideration of you all. I have not hesitated to draw from them largely myself.

I consider this growing realization of the true position which transportation companies occupy in respect to the public, as one of the most important of recent developments, and it may be well to give it some consideration.

The officers and directors of a street railway company are quasi public officers with most important and serious duties devolving upon them. Their duty to their stockholders is to see that the company is economically and efficiently administered so as to produce a fair return upon the capital invested. Their duty towards the public is to see that the best possible transportation facilities are afforded, having in view "the greatest good of the greatest number." This broad statement of their public duty is unquestionably true, and yet the failure to appreciate this axiom is the most fertile source of adverse criticism of railway management. The critic almost invariably argues from a personal standpoint. If he would only remember that the road is run for the benefit of the masses and not for his personal individual benefit, the lives of general managers would be made less burdensome.

The last census has clearly shown a strongly-marked tendency of our population to gravitate towards the large cities. In every state the percentage of growth in cities is far greater than in towns and villages. Such condensation of population means an increase of the tenement house system in contradistinction to the cottage system, a crowding of people beneath each roof, an increase in vice, immorality, misery, crime and the death rate. How is it to be avoided? The laborer must live near his work, near in time and near in money. He can spare but a fraction of his time, but a fraction of his day's wages in going to and from his work. If the zone fare system exists as in Europe, the area within which he can live is limited by this consideration. Two cents per mile might restrict him to a radius of 2½ miles (5 cents). If the single-fare system prevails as in this country, time is practically the only restriction. Let us assume that he can allow thirty minutes morning and evening for his car ride, paying five cents for each ride. At the rate of six miles per hour, fast for horses, he has a radius of three miles and an area of 28¼ square miles within which to select a home. At the rate of nine miles per hour, slow for electricity, he has a radius of four and a half miles and an area of 63½ square miles within which to select a home. This example suffices to illustrate the point. An increase of only three miles per hour in rapidity of transit doubles the available residence area without increasing the time or expense of the laborer in going to and from his work.

The steam road, the elevated road, the underground road and the cable, each and all afford rapid transit; but their application is restricted within very narrow limits because of their great cost, while the electric roads can be profitably extended in all directions.

The great advantage of increasing the available residence area, of encouraging the cottage system and discouraging the tenement system, will be readily conceded by all. The health and morality of a great city are universally proportional to the number of people beneath each roof. The Electric Railway is one of the great moral agents of the nineteenth century.

The experience of the past three years has settled many disputed questions, resolved many doubts, systematized methods and improved construction.

A variety of styles, systems and methods were used prior to 1888. We had storage batteries, conduits and overhead wires; single trolley and double trolley wires, over-running trolleys and under-running trolleys.

Storage batteries have made little progress. They have nowhere scored a pronounced success, and have been abandoned on nearly every road. They are but little considered in the field of electric traction, except in reference to future possibilities.

The very few conduits built have disappeared and have been replaced with overhead wires. The overhead wire is now generally recognized as the only practicable method of conveying electricity from the generator to the car motor.

The objections to overhead wires have been, and in many places still are, very strong; but actual experience has shown that the objections are not well founded. Wires are not an ornament to the street, and objections on this ground will always exist; but lamp-posts, signs, railway-tracks, and many other similarly useful objects are not ornaments. Overhead wires will never be condemned on this ground alone. Objections on the score of unsightliness become of less and less importance each year as the methods of construction are improved and the public appreciate more freely the benefits of electric motive power.

One of the early apprehensions in reference to the use of overhead wires was the possible danger to life from the current used. On this point I think the public are now well satisfied. While there are few employees on any of the roads now in operation who have not had the full shock of 500 volts repeatedly, there is not a single instance of any of the patrons of these roads who have been killed or even seriously injured by the 500 volt current from the overhead wire. Electric cars will run over and kill the careless pedestrian or the drunken passenger who falls from the platform in front of the wheels as will the horse car, but no passenger or pedestrian has ever been killed by the trolley wire, and statistics do not show that the electric car is in any respect more dangerous to life than the horse or cable car. Last year (1890) the West End Street railway system of Boston carried 114,853,081 passengers and all the steam railroads of the whole state of Massachusetts only carried 98,843,712. The West End system killed 15 passengers and employees and the steam roads killed 325. Of the 15 fatal accidents on the West End system 5 were attributable to electric cars and 10 to horse cars. It is only fair to say that the narrow and crooked streets of Boston and the enormous traffic of the West End system are conditions peculiarly conducive to accidents.

The fear of the electric current is one born of ignorance, and time alone can overcome it.

In the year 1889, nine human beings were killed by the arc light wires in New York city (2500 volts) and the authorities were roused to such a pitch of frenzy that the poles were chopped down and a large part of the city left in darkness. Yet with perhaps one exception all of the victims were employees of the lighting companies and suffered because of failure to observe proper and well-known precautions. In the same year, twelve persons were asphyxiated by gas and over thirty were killed by signs and other objects falling on their heads as they walked peacefully along the streets.

In time we are able to estimate every danger relatively, but in the beginning unknown dangers, those to which we are not accustomed, are greatly exaggerated.

Ralph W. Pope, in a very interesting paper read before the Franklin Institute last year, gives some curious illustrations of this tendency to magnify unknown dangers and arrest the progress of improvement. I quote :.

"In an article, entitled 'How our Ancestors Travelled,' we find the following pertinent observations on the subject :

"Carriages met with great opposition at their first introduction, and laws were made to suppress their use. As early as the year 1294, Philip the Fair, of France, issued an ordinance for suppressing luxury, in which the wives of citizens were forbidden the use of carriages. Beckmann tells us that there is preserved in the archives of the County of Mark, an edict, in which the feudal nobility and vassals are prohibited from using coaches under pain of incurring the punishment of felony. Duke John, of Brunswick, published an order in 1588, roundly rating his vassals for neglect of horsemanship, and forbidding them to appear or travel in coaches. A few years after this, the English Parliament took up the discussion of the subject; but, on the 7th November, 1601, the bill to restrain the excessive use of coaches within the realm of England was rejected. But the bitterness of antagonism to them did not cease with this legislative decision. In a pamphlet called the 'Great Concern of England Explained,' published 1673, the writer very gravely attempts to make out that the introduction of coaches was ruining the trade of the realm. Following is an example of his method of reasoning: 'Before coaches were set up, travellers rode on horseback, and men had boots, spurs, saddles, bridles, saddle-cloths, and good riding suits, coats and cloaks, stockings, and hats, whereby the wood and leather of the kingdom were consumed. Besides, most gentlemen, when they travelled on horseback, used to ride with swords, belts, pistols, holsters, portmanteaus and hat cases, for which in these coaches they have little or no occasion. For when they rode on horseback, they rode in one suit, and carried another to wear when they came to their journey's end; but in coaches they ride in a silk suit, silk stockings, beaver hats, etc., and carry no other with them. This is because they escape the wet and dirt, which upon horseback they cannot avoid; whereas, in two or three journeys on horseback these clothes and hats were wont to be spoiled; which done they were forced to have new very often, and that increased the consumption of manufacture.' In another part of his pamphlet, the same writer puts the following query, evidently with the notion that it was a clincher: 'Is it for a man's health or business to be laid fast in four ways; to ride all day with strangers, often times sick, diseased, ancient persons, or young children crying; all whose humors he is obliged to put up with, and crippled with their boxes and bundles?' As an additional objection against the introduction of coaches, the writer urges that they would discourage the breeding and lessen the value of horses.

"The following passage occurs in a protest against the construction of railways, which is preserved in the archives of the Nurnberg Railway, at Furth, which was the first line constructed in Germany. It was drawn up by the Royal College of Bavarian Doctors :

"Travel in carriages drawn by a locomotive ought to be forbidden in the interest of public health. The rapid movement cannot fail to produce among the passengers the mental affection known as Delirium Furiotum. Even if travellers are willing to incur this risk, the Government should at least protect the public. A single glance at a locomotive passing rapidly is sufficient to cause the same cerebral derangement, consequently, it is absolutely necessary to build a fence ten feet in height on each side of the railway."

"These were all European, however, so in order to assure you that these peculiar views were held in our country the following protest from the good citizens of Philadelphia, in 1833, against the introduction of gas, will be of interest to you :

"*Philadelphia, November* 28, 1833.

"REMONSTRANCE AGAINST LIGHTING WITH GAS.

"To the Honorable, the Select and Common Councils of the City of Philadelphia :

"GENTLEMEN :—

"The subscribers beg leave to respectfully remonstrate against the plan now in action for *lighting the city with gas*, as they consider it a most offensive, inexpedient and dangerous mode of lighting. In saying this they are fully sustained by the accounts of explosions, loss of life and destruction of property where this mode of lighting has been adopted.

"We consider gas to be as combustible as gunpowder and nearly as fatal in its acts ; as regards the immense destruction of property, we believe that the vast number of fires in New York and other cities may be in a great measure ascribed to this mode of lighting. The leakage of pipes and carelessness of stopping off the gas, furnish almost daily instances of its destructive effects. And when we consider that this *powerful and destructive agent* must necessarily be left often to the care and attention of youth and domestics and careless people, we only wonder that the consequences are not most *appalling*. It is also an uncertain light, sometimes suddenly disappearing and leaving streets and houses in total darkness.

"The waters of the Delaware and Schuylkill, now considered the most pure and salubrious in the world, as many long voyages have fully tested, must soon, we fear, experience the deterioration which has reduced the water of the Thames to the present impure state, for no reservoir will be able to contain such fetid drains from such an establishment, and very soon the rivers must be their receptacle, to the destruction of the immense shoals of shad, herring and other fish, with which they abound; the same cause must produce the same effect. Salmon, smelts, and other fish formerly caught in vast quantities in the Thames, have nearly all disappeared. The constant digging up of the streets, the circumstances of the gas pipes, which, at the intersection of each square, must come in contact with the water pipes, are difficulties and evils which we would anxiously avoid.

"In conclusion, we earnestly solicit that the *lighting our city with oil may be continued.*

"And your petitioners, etc.

"Signed by 1,200 of the leading citizens of Philadelphia, whose names are attached hereto, such as Horace Binney, Hartman Kuhn, Jacob Ridgway, Paul Beck, Henry Pratt, Benjamin Chew, (on whose farm the battle of Germantown was fought), John Sargent, Charles Wharton, Richard Willing, Edward Pennington, Robert Baux, Joshua Longstreath, Matthew Newkirk and 1,200 others.

"N.B.—The above are only part of the names, as many of the remonstrances have not yet come in."

The double and single trolley systems have each had ardent advocates, but three years' experience has decided the question in favor of the single trolley and the ground return.

In July, 1888, several roads were using the over-running trolley and it was a question whether the over-running or under-running system was preferable. Three years have decided this question also, and practically all of the electric roads of to-day operate with under-running trolleys. The "fish pole" of 1888 has been supplanted by the neat steel rod of 1891, and the "broomstick train" can no longer be spoken of with disrespect as regards outward appearances.

Three years have not passed without much litigation and already we have historical cases finally determined, which tend to fix the legal boundaries of the rights of electric railways. Some of these decisions are of great importance.

The telephone companies have quite naturally been ardent advocates of the double trolley, and to avoid suffering from the induced currents of the single trolley, they have sought to induce the courts to compel railway companies to use metallic circuits. A recent decision of the Supreme Court of the State of Ohio, is a fair statement of the present legal aspect of this question.

Single Trolley System vs. *Double Trolley.*

(Supreme Court of Ohio.)

SYLLABUS.

1. The dominant purpose for which streets in a municipality are dedicated and opened, is to facilitate public travel and transportation, and in that view, new and improved modes of conveyance by street railways are by law authorized to be constructed, and a franchise granted to a telephone company of constructing and operating its lines along and upon such streets, is subordinate to the right of the public in the streets for the purpose of travel and transportation.

2. The fact that a telephone company acquired and entered upon the exercise of a franchise to erect and maintain its telephone poles and wires upon the streets of a city, prior to the operation of an electric railway thereon, will not give the telephone company, in the use of the streets, a right paramount to the easement of the public, to adopt and use the best and most improved mode of travel thereon ; and if the operation of the street railway by electricity as the motive power, tends to disturb the working of the telephone system, the remedy of the telephone company will be to re-adjust its methods to meet the condition created by the introduction of *electro-motive* power upon the street railway.

3. Where a telephone company, under authority, derived from statute, places its poles and wires in the streets of a municipality, and in order to make a complete electric circuit for the transmission of telephonic messages, uses the earth, or what is known as the "ground circuit," for a return current of electricity ; and where an electric street railway afterwards constructed upon the same streets, is operated with the "Single Trolley Overhead System" so called, of which the ground circuit is a constituent part, if the use of the ground circuit in the operation of the street railway interferes with telephone communication, the telephone company, as against the street railway, will not have a vested interest and exclusive right in and to the use of the ground circuit, as a part of the telephone system.

The telephone companies have been beaten in every case, and the fact has been definitely settled that railway companies may use a single overhead trolley wire and a ground return without infringing any rights of the telephone companies.

Many interesting legal questions have arisen in reference to line construction.

Objection was made by the summer residents of Newport to the construction of an overhead electric railway, and eminent counsel was employed to place every possible legal obstacle in the way. The case was carried to the Supreme Court of the State of Rhode Island for determination of some of the novel points involved, and one of these points was :

Are Poles and Wires an Additional Servitude upon the Streets?

The Court held:

"The fourth ground alleged is that, if the act of incorporation authorizes the use of electricity for the operation of said street railway, and the erection of the poles as ancillary thereto, it is unconstitutional and void, because it authorizes the imposition of additional servitude upon the streets without providing for any additional compensation to the owners of the fee of said streets. We think it is settled by the greater weight of decision that a railroad constructed in a street or highway and operated by steam in the usual manner imposes a new servitude and entitles the owner of the fee to an additional compensation; but that a street railway operated by horse-power, as such street railways are ordinarily operated, does not impose any new servitude, and does not entitle the owner of the fee to any additional compensation.

"The distinction is not often stated as a distinction between steam and horse railroads; but the distinction properly rests not on any difference in motive power, but on the different effects produced by them respectively on the highways or streets which they occupy. A steam railway is held to impose a new servitude, not because it is operated by steam, but because it is so operated as to be incompatible with the use of the street in the other usual modes, or, in other words, so as practically to exclude the usual modes of use.

"A steam railroad on a street, so operated as to be consistent with the use of the street in the usual modes, has been held not to impose a new servitude.

"It is not the motor but the kind of occupation, whether practically exclusive or not which is the criterion.

"The only considerable privilege which the horse-car has over other vehicles, is that, being confined to its tracks, it cannot turn aside for other vehicles, while they are forced to turn aside for it; but this is an incidental matter, insufficient to make the horse railroad a new servitude.

"The street railway here complained of is operated neither by steam or horse-power, but by electricity. It does not appear, however, that it occupies the streets or highways any more exclusively than if it were operated by horse-power.

"Reference has been made to cases which hold that telegraph or telephone poles and wires erected on streets or highways constitute an additional servitude, entitling the owners of the fee to additional compensation; and from these cases it is argued that the railway here complained of is an additional servitude, by reason of the poles and wires which communicate its motive power. There are cases which hold as stated, and there are cases which hold otherwise, but, assuming that telegraph and telephone poles and wires do create a new servitude, we do not think it follows that the poles and wires erected and used for the service of said street railway likewise create a new servitude. Telegraph and telephone poles and wires are not used to facilitate the use of the streets where they are erected for travel and transportation, or, if so, very indirectly so; whereas the poles and wires here in question are directly ancillary to the uses of the streets as such, in that they communicate the power by which the street cars are propelled."

In the purely technical field all obstacles have been overcome. Like Perry, "We have met the enemy and they are ours." The severe strain imposed by railway work on the generating plant has necessitated the development of new types of engines and the fluctuations of the dynamos have been prevented by compound winding and series coils. Self-regulating dynamos are now considered necessary in any well-planned power plant.

I attended the exposition at Bremen, in North Germany, last summer and had the pleasure of riding on an electric railway operated by two 80 h. p. Thomson-Houston dynamos. One dynamo was driven by a 70 h. p. Armington & Sims engine, and one by a 125 h. p. German engine. So closely did the small American engine regulate that no variation in potential could be observed under the most violent and sudden variations in load. Notwithstanding its greater power, the German engine was slow to respond and the variations in speed were marked. I was subsequently informed that a medal was awarded to the American engine although it had not been entered as an exhibit.

This is indicative of the enterprising way in which the inventors and manufacturers of the United States have met the new conditions imposed by the adoption of electricity as a motive power.

The difficulties Mr. Sprague encountered in Richmond in using copper brushes have now been avoided by the introduction of the carbon brush, for which we are indebted to Mr. C. J. Van Depoele.

As early as 1883-4 Van Depoele used carbon brushes with his motors. When the Van Depoele Electric Manufacturing Co. was purchased by the Thomson-Houston Co. in 1888, Van Depoele went to the Lynn factory of the latter company. Many did not then consider the carbon brush as practicable, and it was some time before Mr. Van Depoele had an opportunity to demonstrate its possibilities. When the time did come its great value was so apparent that it was at once adopted for motor work and subsequently has been used exclusively with generators.

Since the general adoption of the present method of mounting the motors directly on the axles, double reduction motors have been used. The supposed necessity of high speed of revolution in the armature made this obligatory. In 1890 it was found practicable to make motors in which the armature revolved at a slower rate and a single gear sufficed for the now greatly reduced reduction. From 10 and 12 to 1 with the old motor we come to 4½ to one with the new motor. The gears are enclosed in boxes and run in oil so that the noise has been reduced to a minimum, the offensive noise of the gears being practically eliminated. We have also gearless motors with no reduction and no gears.

Generator construction has kept pace with the improvements.

As large stations have been built generators have increased in size, and electrical companies are now producing 500 h. p. dynamos as readily as the steam engine builders respond to similar demands.

We have learned what it costs to operate electric railways and the result is gratifying. In 1888 it was prophesied that while electric roads might make good showings so long as the apparatus was new and curiosity riding lasted, in a short time the machinery would begin to wear out and the roads would be swamped by the great repair bills. In reality we find the almost universal testimony is that the longer the road runs, the less is the cost of repairs. This is, of course, not due to the fact the apparatus improves in quality with age, but the explanation is to be found in the very simple fact that as small defects are eliminated and the employes become more experienced and the organization is perfected, the apparatus is better cared for and injuries are prevented.

A very conspicuous example of this is the West End Street Railway, which has been under my own immediate observation.

In the contract between the Thomson-Houston Electric Company and the Railway Company it was provided that we should keep the overhead line and electrical apparatus on the cars in repair at a given price per car mile. There were many reasons which influenced us to enter such a contract, but the chief reason was that this was the uncertain element in the operation of an electrical railway, and unless this uncertainty could be eliminated, the West End would not make any contract. The cost of these repairs has steadily decreased, and on the 1st of October the West End Company avail themselves of their option and relieve us of this part of our contract, knowing there is now no uncertainty and that they can do the work themselves for less money than they pay us.

Some months since President Whitney gave to the public the detailed figures showing the receipts and operating expenses of the West End road. These are of very great interest to all, and I give them in full for the purpose of drawing some conclusions from them :—

THE ELECTRIC SYSTEM.

	April.	May.	June.	July.
Gross receipts	$134,321	$144,638	$153,988	$144,552
General expenses	8,193	7,796	7,465	6,955
Track and car expenses	47,447	45,443	39,629	43,891
Motive power	30,194	30,924	26,359	26,398
Total op. expenses	85,534	84,163	73,459	77,249
Net earnings	48,487	60,475	80,529	67,303
Miles run	394,459	376,321	360,567	3,7,191
Ratio of mileage	26·68	25·58	25·15	25·19
Per cent op. expenses	63·36	58·18	47·70	53·44
Earnings per mile run	34·05	38·43	42·71	38·32
Expenses per mile run :—				
Motive power	07·65	08·22	07·31	07·00
Car repairs	01·39	01·33	01·18	01·17
Damages	00·75	00·89	00·16	00·12
Conductors and drivers	07·33	07·36	07·25	06·92
Other expenses	04·63	04·56	04·47	05·37
Total expense per mile run	21·75	22·36	20·37	20·48
Net earned per mile run	12·30	16·07	22·34	17·84

HORSE CAR SYSTEM.

	April.	May.	June.	July.
Gross receipts	$344,396	$374,605	$395,555	$409,878
General expenses	22,514	22,682	22,217	20,657
Track and car expenses	136,693	127,902	125,393	135,954
Motive power	117,740	118,972	116,210	116,271
Total op. expenses	276,947	269,556	263,825	272,888
Net earnings	67,449	105,049	131,729	136,990
Miles run	1083,887	1094,683	1073,718	1120,377
Ratio mileage	73·32	74·42	74·85	74·81
Per cent op. expenses	80·62	71·95	66.70	66·58
Earnings per mile run	31·77	34·22	36·85	36·58
Expenses per mile run :—				
Motor power	10·86	10·86	10·83	10·38
Car repairs	00·93	00 60	00·61	00·61
Damages	00·78	00·37	00·15	00·06
Conductors and drivers	08·24	08·24	08·25	08·23
Other expenses	04·70	04·55	04·24	05·07
Total expenses per mile run	25·55	24·62	24·58	24·35
Net earned per mile run	06·22	09·60	12·27	12·23

THE ENTIRE SYSTEM.

	April.	May.	June.	July.
Gross earnings	$478,717	$519,244	$549,543	$554,431
General expenses	30,707	30,478	29,683	27,613
Track and car expenses	184,141	173,344	165,027	179,853
Motive power	147,933	149,896	142,570	142,670
Total op. expenses	362,781	353,720	337,284	350,137
Net earnings	115,935	165,524	212,250	204,294
Miles run	1478,346	1471,004	1433,785	1497,568
Ratio of mileage	100	100	100	100
Per cent op. expenses	76·82	68·12	61·37	63·15
Earnings per mile run	32·39	35·29	38·33	37·02
Expenses per mile run :—				
Motive power	10·01	10·19	09·94	09·53
Car repairs	01.05	00·79	00·76	00·75
Damages	00·77	00·50	00·15	00·07
Conductors and drivers	08·03	08·[illegible]1	08·00	07·91
Other expenses	04·68	04·55	04·67	05·12
Total expenses per mile run	24·54	24·04	23·52	23·38
Net earned per mile run	07·85	11·25	14·81	13·64

Taking the June figures, it will be noticed that the net earnings per electric car mile exceed the net earnings per horse car mile by 10.07 cents, while the operating expenses of the horse car lines exceed those of the electric car lines by 4.20 cents per car mile. The difference is 5.86 cents per car mile which is the gain to the Company due solely to the public satisfaction with the electric service. Mr. Arthur Jones of the T. H. International Co. first produced this figure which he calls the "satisfaction figure."

The net earnings per electric car mile exceeded the net earnings per horse car mile by the following amounts :

In April	6.08	cents	per	car mile.
" May	6.47	"	"	"
" June	10.07	"	"	"
Mean	7.54	"	"	"

The net earnings of the horse cars for the three months averaged 9.36 cents per car mile, hence the electric cars showed a gain of 80 per cent. in the net earnings per car mile over the horse cars.

For the three months, we have the following figures for the electric cars :—

Total receipts	$432,947
" expenses	243,456
Percentage of expenses to receipts	56 p. c.

In St. Paul and Minneapolis, with a combined population of 350,000, there is to-day not one single horse car. Minneapolis has 120 miles of electric railways, all equipped with the overhead system, and St. Paul has 75 miles of electric railways and 15 miles of cable. Most of the cable mileage is to be abandoned and supplanted by electricity. The last car horse disappeared from the streets of Minneapolis in June of this year. The July report of the Minneapolis system shows :

Gross earnings	$107,571
" expenses	52,585
Net earnings	54,985
Percentage of expenses to receipts	49 p.c.

Cleveland, Buffalo, Rochester, Toledo, Omaha, Cincinnati and many other large cities are now operating their street cars almost exclusively with electric motors, and the universal testimony is favorable to the increased facilities afforded the public and the increased profits to the stockholders.

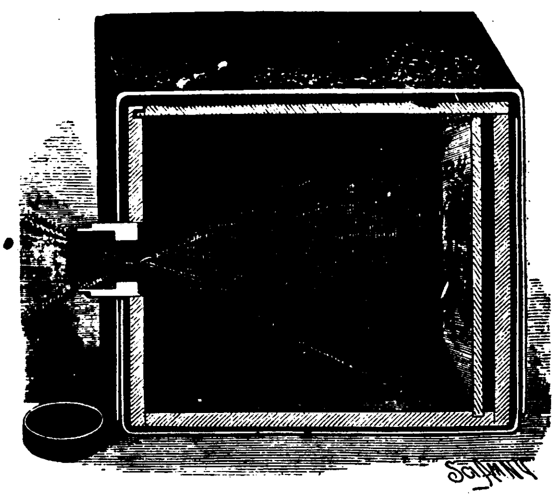
Not the least important of the developments of the last three years has been the financial development. The fine showings as to earnings, the gradual decrease in operating expenses, where increases were expected, the oft-demonstrated ability to run electric cars in all kinds of weather, in ice, snow, sleet, hail or rain has greatly improved the standing of electrical securities. An electric road is no longer an experiment, it is a paying investment and there are not a few instances where the introduction of electricity has been the salvation of a horse road that otherwise would have soon been in the hands of a receiver. The rapidly increasing demand for electrical securities is an evidence of a healthy growth of public sentiment in this direction. To equip electrically means the expenditure of money which must come from an increase of the bond of stock issued. The ability of the public to rapidly absorb these new bonds of stocks must be the ultimate limit of the ability of the railway companies to move in this direction.

In August the West End Street Railway Company put out four millions of common stock for additional electrical equipment under a plan of subscription which provided for two deferred payments. When the subscription books were closed on the 5th of August, 33,000 shares had been paid in and only a paltry 245 shares had taken advantage of the option for deferred payments. I know of no more striking object lesson than this, except perhaps the rapid rise of the West End common stock from 63 to 77, which immediately followed.

Electric securities have heretofore been offered at tempting figures, but the day for this is passing. The public are realizing that a good street railway security is better than a western railroad bond or stock, and the electric roads are better than the horse roads. Electric railways will pay where no one would dream of building a horse road, and when the public taste is whetted for electrical securities, we shall see a marvellous increase in the number of roads and the equipment of existing roads that will mean transportation facilities for thousands who are now unprovided, and many years' work for our electrical factories.

A ONE DOLLAR PHOTOGRAPHIC OUTFIT.

One would have supposed that the photographic craze had reached its climax when cameras costing from ten to fifty dollars were produced, together with conveniences which would enable almost any one to take photographs, but it appears that a large field has been left unoccupied. A camera has been needed which could produce a good picture with a small outlay.



Longitudinal Section of Glen Camera.

Such a camera is shown in the annexed engravings. The instrument, together with the entire photographic outfit, including chemicals, is sold for one dollar, and this is the chief novelty of the outfit. This instrument is known as the "Glen Camera," made and sold by Ives, Blakeslee & Williams Company, of 294 Broadway, New York. Inasmuch as all the light used in this camera enters through a pinhole instead of a lens, a rather longer exposure is required than with an ordinary camera, but the results obtained are very good and pictures $2\frac{1}{4}$ inches square are produced.

The construction of the camera will be understood by referring to the longitudinal section, Fig. 1. The light coming from the object passes through the pin hole, producing the image on the plate held by a groove in the rear portion of the camera box. As there are no plate holders, the camera must be taken to a dark room for an exchange of plates.

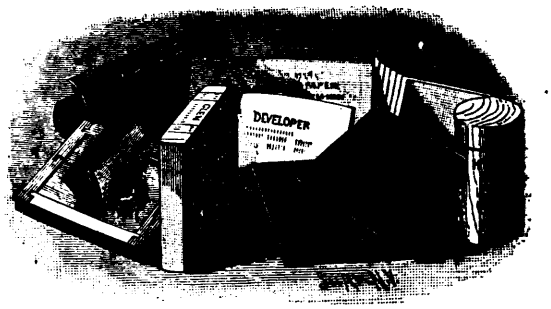


Fig. 2.—Materials and Accessories.

With the camera is furnished the materials and appliances shown in Fig. 2, consisting of six dry plates, a package of blue process paper, one ounce of hyposulphite of soda, a package of developing powder, card mounts, a printing frame, two japanned trays, together with a sheet of ruby paper for making a red light for the dark room. With these the amateur photographer may make, develop, print and mount his pictures.

The camera is put up for mailing, and the package contains full instructions for making the exposure and all the operations for the completion of the picture.—*Scientific American.*

FLANGING AND WELDING BOILER STEEL.

Can boiler steel be satisfactorily welded? Is any test applied on the individual weld? Has the weld to bear tension when the boiler is at work? In answering these, experience over the many hundreds of shell welds that have been made in 200 steel boilers shows that with ordinary care an ordinarily good workman can make a sound weld by using a best Yorkshire iron glut, and we have never had a single weld show leakage. Perhaps the very best test of all that could be applied under the circumstances is applied to each individual weld, viz., the weld being made before the plate is flanged has to stand the subsequent flanging in the hydraulic press, and it seems certain that if it were a mere surface weld it would divide when the disturbance caused by the flanger came upon it. With regard to tensional stresses, the writer wishes to be very emphatic in disclaiming any application of the tensional stresses of the boiler shell to the weld. The butt straps extend to the very edge of the curve of the flange, and the flange itself represents an extra amount of shell material given in beyond what is required to sustain the stresses due to the length of the boiler. Even this flange is also in the condition of having a strap passing over the weld, for the end plate forms a good practical strap to the flange. To put the matter another way, the flange of the shell forms a kind of strengthening bead at the edge of the plate, adding considerable to its strength, and greatly reducing liability to rupture from the edge. The weld, therefore, is only exposed from beneath the straps at the curve of the flange, where, from the form of the plate, it is very strong, and where practically it has nothing to do but secure steam tightness. An eminent engineer, whose views on practical matters are greatly valued by this institution and the profession at large, remarked, in his usual original way, on seeing one of these boilers:—"Suppose you saw-cut the weld through at the part where it is exposed, what would happen? The boiler would not burst, for the stresses are securely carried by the straps. All that could happen would be leakage."

Will heavy boiler steel satisfactorily stand flanging to a right angle? Does the necessary local heating seriously injure the plate? Are the plates annealed after flanging? The writer is of opinion that if boiler steel cannot be flanged at right angles with a fairly large radius in the corner when red hot, without injury, it is not fit to build boilers with at all, and since he has now flanged about 1,000 large thick shell plates without returning to the makers more than two plates which showed slight surface tearings on being flanged, he has no hesitation in saying that ordinarily good mild boiler steel will stand this flanging in a perfectly satisfactory manner. With regard to local heating, there is probably a great difference in effect on the plate between heating along the edge and heating locally towards the middle of the plate. In any case the writer again appeals to the large experience he has now had of this method as the proof that no damage accrues to the plate. It does, however, seem to be a wise precaution to anneal the plate after the welding and flanging is completed, and before any riveting is done, and therefore these shell rings are lowered flange downwards into an annular furnace, heated to a red heat, and allowed to remain to cool down with the furnace.—*Engineer and Iron Trades' Advertiser*, London.

THE TIDES.

The ocean tides, notwithstanding the amount of scientific search which has been turned upon them, are still largely an enigma, even to the scientists. There are phenomena connected with them which are difficult of satisfactory solution. All the phenomena connected with them have in all ages excited much curiosity. The difference of height at one time and another is a puzzle to many, although to the educated that phenomena is perhaps, well understood. The usual extraordinary height and fury of the tides in some places is a wonder to many and is an interesting sight to all.

It is related of the soldiers of Alexander the Great, who were natives of the Mediterranean shores, that when they reached the confines of the Indian Ocean and saw its waters rolling up to a great height, and then flowing back twice every day, they became alarmed and attributed the phenomena to a special interposition of the deities of the country which they had invaded. Various remarkable theories have been advanced regarding the tides. Many of these are truly so absurd that it is hardly worth while to refer to them. Persons find it difficult to understand why the tides are higher at one time than another, and why they rise to the height of 60 feet in the Bay of Fundy, 40 feet in the ports of Bristol, England, and St. Malo, France, and only rise to a few feet in New York and other places, while they are scarcely perceptible in the Baltic and other seas. Descartes was the first philosopher who advanced the theory that the tides were due to the influence of the moon, but Newton was the first who worked out the problem and discovered the true cause. Descartes believed that the moon acted on the waters of the ocean by pressure. Newton demonstrated that it acted on the ocean by attraction —that instead of pressing the waters, it rolled them up directly under it, and also at its antipodes at the same time, thus producing the two tides every day.

The tides are attractions of both the sun and moon. If the earth had no moon, the attraction of the sun would produce two tides every day, but their ebb and flow would take place at the same hours, not varying as they do. These tides would also be much smaller than those of the moon. Although the mass of the sun is far greater than that of the moon, and though attraction is in proportion to the mass, yet it is also inversely as the square of the distance. As the sun, therefore, is 400 times more distant than the moon, the attraction of the waters of the sea toward the sun is found to be about three times less than that of the moon. There are really two ocean tides—the lunar and solar—but the latter is absorbed by the former, which is wholly observable in respect to the time; the solar only as it influences the height of the tidal wave. That caused by the moon is three times greater than that of the sun, and it follows the moon's motion around the earth, rising and falling 12 hours and each succeeding tide later by three-quarters of an hour than the preceding one, exactly in accordance with the positions of the moon, or, as it is commonly called, its rising and setting.—*Mining and Scientific Press.*

THE ELASTIC LIMIT.

When engineers first began to test the materials they used in their structures it was very quickly recognized that if a specimen was loaded beyond a certain point it did not recover its original dimensions on removing the load, but took a permanent set. The limiting stress on straining below which no permanent set could be detected on removing the load, was called the elastic limit. Since under these conditions a bar appeared to recover completely its original form and dimensions on removing the load, it appeared obvious to the first experimenters that it had not been injured in any way by the load, and hence the working load might be deduced from the elastic limit by using a small factor of safety.

Experience showed, however, that in many cases a bar would not carry safely a stress anywhere near the elastic limit of the material as determined by these experiments, and the whole theory of any connection between the elastic limit of a bar and its working load became almost entirely discredited, and engineers employed the ultimate strength only in deducing the safe working load to which their structures might be subjected. Still experience gradually accumulated, and it was observed that a higher factor of safety was required for a live load than for a dead one. This was at first attributed to the effect of impact, and to a certain extent this was no doubt true, since if a moving body strikes a structure, the work stored up in the body must be taken up by the elastic deformation of the structure, which will be correspondingly greater than if the load was gently laid on it. In 1871, however, Wohler published the results of a number of experiments on bars of iron and steel subjected to live loads. In these experiments the stresses were put on and removed from the specimens without impact, but it was nevertheless found that the breaking stress of the materials was in every case much below the statical breaking load. Thus a bar of Krupp's axle steel having a tenacity of 49 tons per square inch, broke with a stress of 28.6 tons per square inch, when the load was completely removed and replaced without impact 170,000 times. These experiments were made on a large number of different brands of iron and steel, and the results were absolutely concordant in showing that a bar would break with an alternating stress of only, say, one-third the statical breaking strength of the material if the repetitions of strength were sufficiently numerous. At the same time, however, it appeared from the general trend of the experiments that a bar would stand an indefinite number of alterations of stress, provided the stress was kept below this limit.

These experiments, whilst they showed that the impact was insufficient to account for the peculiar detrimental action of a live load, and that the statical breaking strength was not sufficient in itself to properly proportion a structure, did nothing towards rehabilitating the elastic limit as a measure of the safe working load of a material. For this it now appears there were several reasons. We believe it was Sir Frederick Bramwell who professed to be unable to say what a horse-power was, because, first, there was the true horse-power of about 22,000 foot-pounds per minute, next there was Watt's horse-power of 33,000 foot-pounds per minute, and finally there was nominal horse-power, which was anything the engine builder liked to make it. A remark of the same nature might be made with reference to the elastic limit. There is first the maker's elastic limit, which is the yield point of the material as it comes from the rolls; next there is the real primitive elastic limit of the material, which corresponds to the point at which stress ceases to be sensibly proportional to strain, the bar being tested after being brought to a state of ease; finally, there is the elastic limit of the bar after it has been loaded in various ways, which may be anything the experimenter chooses to make it, up to nearly the breaking point.

It is to Prfoessor Bauschinger, of the Munich Technological Laboratory, that we owe the proof of the fact that the elastic limit has nothing whatever to do with the breaking down point with which it is so commonly considered as identical. Professor Bauschinger defines the elastic limit as the point at which stress ceases to be sensibly proportional to strain, the latter being measured with a mirror apparatus reading to $\frac{1}{5000}$th of a millimetre, or about $\frac{1}{100000}$ in. This limit is always below the yield point and may on occasion be zero. On loading a bar above the yield point, this point rises with the stress, and the rise continues for weeks, months, and possibly for years if the bar is left at rest under its load. On the other hand, when a bar is loaded beyond its true elastic limit, but below its yield point, this limit rises, but reaches a maximum as the yield point is approached and then falls rapidly, reaching even to zero. On leaving the bar at rest under a stress exceeding that of its primitive breaking down point, the elastic limit begins to rise again and may, if left a sufficient time, rise to a point much exceeding its previous value.

This property of the elastic limit of changing with the history of a bar has done more to discredit it than anything else, nevertheless it now seems as if it, owing to this very property, were once more to take its former place in the estimation of engineers, and this time with fixity of tenure. It had long been known that the limit of elasticity might be raised, as we have said, to almost any point within the breaking load of a bar. Thus in some experiments by Professor Styffe, the elastic limit of a puddled steel bar was raised 16,000 lb. by subjecting the bar to a load exceeding its primitive elastic limit, and similar cases could be multiplied indefinitely. Most experimenters, however, had overlooked the importance of the fact that a bar has two limits of elasticity, one for tension and one for compression, and it was reserved for Professor Bauschinger to determine whether the raising of the elastic limit in tension had any effect on the limit for compression. Taking a number of bars as received from the factory, these bars were first loaded in tension until stress ceased to be sensibly proportional to strain. The load was then removed and the bar tested in compression until the elastic limit in this direction had been exceeded. This process raises the elastic limit in compression, as would be found on testing the bar in compression a second time. In place of this, however, it was now again tested in tension, when it was found that the artificial raising of the limit in compression had lowered that in tension below its previous value. By repeating the process of alternately testing in tension and compression, the two limits took up points at equal distances from the line of no load, both in tension and compression. These limits Bauschinger calls natural elastic limits of the bar, which for wrought iron correspond to a stress of about 8½ tons per square inch, but this is practically the limiting load to which a bar of the same material can be strained alternately in tension and compression without breaking when the loading is repeated sufficiently often, as determined by Wohler's method, and it is now possible to explain why the bars break at such unexpectedly low loads when thus subjected to alternating stresses. As received from the rolls the elastic limit of the bar in tension is above the natural elastic limit of the bar as defined by Bauschinger, having been artificially raised by the great deformations to which it has been subjected in the process of manufacture. Hence when subjected to alternating stresses, the limit in tension is immediately lowered, whilst that in compression is raised until they both correspond to equal loads. Hence in Wohler's experiments, in which the bars broke at loads nominally below the elastic limits of the material, there is every reason for concluding that the loads were really greater than true elastic limits of the material. This is confirmed by tests on the connecting-rods of engines, which of course work under alternating stresses of equal intensity. Careful experiments on old rods show that the elastic limit in compression is the same as that in tension, and that both are far below the tension elastic limit of the material as received from the rolls. It thus appears that those engineers who have discarded the idea of the elastic limit as a measure of the working strength of a bar, and have proportioned their structures from the results obtained by Wohler, have really in spite of themselves been working on the very assumption they professed to discard. "Thus the whirligig of time brings in its revenges."—*Engineering.*

THE ADJUSTMENT OF DAMAGES ARISING FROM A DIVERSION OF WATER.*

There is no one feature more essential to the health, growth, and prosperity of a municipality than an ample supply of pure water. When a city is situated on or within a comparatively short distance of a stream of fresh water from such a source that it flows throughout the entire year through a region in which it is not liable to contamination other than a temporary discoloration by earthy matter washed into it during storms, it is customary to lift such portion of the water as is required from the bed of the stream to a distributing reservoir by means of pumps operated either by water power or steam pumping engines. In some cases a stream is available at a sufficient elevation above the city to enable the water to be conducted by gravity through an aqueduct or pipes to a distributing

* Chas. E. Emery, Ph.D., in the *Crank*, a publication issued the 15th of each month by the students of Sibley College.

reservoir at a sufficient elevation above the city to enable the distribution to be effected by gravity over the greater portion thereof, when water for the higher portions is supplied by a subsidiary pumping station which lifts a smaller quantity of water either into a small reservoir at a higher elevation or into a water tower or stand pipe directly supplying water to the higher district. In some cases pumps receiving water direct from the bed of a stream or from a low service reservoir are operated to simply maintain a pressure in the whole or part of the distributing pipes of a city, and the speed of such pumps regulated merely to supply the demand. Frequently the distributing reservoirs are at such a height that the water is delivered to the mains under considerable pressure and can be utilized directly from the hydrants for the extinguishment of fires. In the direct pumping systems referred to, comparatively small pumps are generally kept in motion to supply the regular demand and larger pumps started (when notice is given by an electric or other signal) to deliver into the same mains water at a higher pressure which can be utilized at the hydrants for fire purposes.

In many cases, however, towns, villages, and cities are so situated that no stream is available to supply a sufficient quantity of water at all seasons of the year, in which case it is customary to work back into the hills, preferably at a considerable elevation above the village or city to be supplied, and to erect a dam across the course of the stream in a narrow portion of the valley where the hills rise with sufficient abruptness to form an artificial pond or lake. In such case all vegetable growth should be removed from the soil to the elevation of the proposed water level. The pond will fill up during the heavy rains in the fall and spring, and although the stream supplying the same be a small one, the water stored in the pond will be sufficient to supply deficiencies during the droughts in the summer, when there is little rain, and in the winter when the rainfall is congealed and temporarily remains as snow and ice on the hillsides. These various operations affect in different ways, according to location, the rights of the owners of the soil. If water be abstracted from a stream to supply a village or city, necessarily the amount flowing in the stream, below the dam or other point where the water is taken, is less in quantity than before and the diversion may cause injury to riparian owners by reducing the quantity of water available for water power or other manufacturing purposes, or in extreme cases that required for the proper irrigation or regular watering of the land. In very extreme cases the navigation of rivers or certain reaches in the same may be affected. It is well settled that a riparian owner is entitled to the proper use of the water as it passes his own land, and he may even divert it upon his own property so long as he returns it to the stream upon his own land, and this, evidently, may include the use of water for irrigation where the drainage returns the water to the stream. The rule brought from the Old World and established by the decisions of all countries is: "A watercourse begins *ex jure naturæ*, and having taken a certain course cannot (lawfully) be diverted." While not exactly in the line of the present discussion, it may be added that this principle applies not only when the water is usefully applied, as for water power and irrigation, but also when the water is useless, as in case of drainage. It is an established principle that "no man can divert water upon a neighbour's land," and "no change can be made in respect to surface water to the injury of any other owner." The difference in the two cases will be observed. In the first case the property owner, who wishes to utilize the water, would complain, and in the second case other parties would complain who do not wish to have the surplus water from undesirable swamps and low lands discharged upon their property. It will be seen, however, that if a natural watercourse has ever been established for the drainage of a swamp or low lands the first principle comes into play for the benefit of the owner of such low lands, for the reason that he has a right to discharge the water into the natural stream. There are also legal provisions by which low lands with no natural outlet can be drained across the lands of others in regular channels initiated and maintained under the provisions of law, and here it may be stated again collaterally that the principles of drainage are somewhat modified in large cities, where the health of all is of paramount importance, and in which, therefore, watercourses are frequently closed and the streams diverted and low lands drained under the provisions of law.

At this time we have to deal only with the question of obtaining a pure supply of water for municipal purposes. In designing a system of water supply, the first problem is to find a proper source. Even though pure streams may be near at hand at a low level, it is better first to examine all available sources at such an elevation that the distribution may be made by gravity. Natural lakes or ponds will frequently be available within five to ten miles of the place where the water is to be used, and if not, particularly if the stream is small, an artificial pond, as previously referred to, must be provided. When a desirable site is found, the first question is to ascertain whether sufficient water can be obtained at that point for the purposes required. All the water available is derived primarily from rainfall, which varies in different localities and in different years in this latitude from say 30 to 70 inches per year. An inch of water in this sense means that sufficient rain falls to cover, to a depth of one inch, the horizontal projected surface of the land, that is not the actual surface of the hillsides, but the sum of the horizontal components of all the inclined surfaces, or the area of an imaginary lake with its surface above the tops of the hills. Ordinarily the total quantity of rainfall in a year would cover this projected surface to a depth of 40 to 45 inches in this latitude, but even at the same place the quantity of water would vary greatly in different years, and this possible deficiency must be considered in connection with the size of the pond or reservoir which it is proposed to build. The quantity of rainfall will also vary greatly in different localities comparatively near each other, those on one side of a hill or mountain having more rainfall than those on the other. So it is desirable to base all calculations on records of rainfall taken for a series of years in a particular region.

There must next be determined the proportional quantity of rainfall which reaches the streams. In very sandy soil in an elevated position most of the rainfall would percolate through the soil and feed streams lower down the slope; whereas in clay soil, or basins in which part of the strata were of that nature, a larger portion of the water would reach the elevated streams. The quantity would, however, in either case, be very much dependent upon the kind and quantity of vegetation. A very large quantity of water is evaporated from the foliage of the ferns and luxuriant bushes which grow in swampy land. The evaporation from short growths of grass and weeds is greater than from tall trees. In addition to this there is always a considerable quantity of water evaporated from moist earth and quite a large quantity from all water surfaces exposed to the atmosphere. This is particularly the case where the air is dry, as it is in most inland locations. The quantity of water reaching the streams at a given elevation can only be determined accurately by actually measuring the rainfall and gauging the streams throughout the year for a number of years. This is, however, rarely practicable. It is generally necessary to estimate the flow. Gauging can, however, be made of the summer flow and of the average flow as nearly as can be judged by conference with the residents of the vicinity. It is in general necessary, however, to estimate the flow on a basis of similar conditions, which requires a study of waterworks reports and other information available in similar localities. It can frequently be assumed that 25 per cent of the rainfall reaches the streams during the summer months, from 50 to 60 per cent during a portion of the remaining period, and as high as 80 to 90 per cent when the ground is frozen, so that it will sometimes be safe to assume that one-half the rainfall reaches the streams on the average through the year. It will rarely be proper, however, to assume that so much can be utilized. This depends largely upon the amount of storage available.

One inch of rainfall corresponds to 27,152 gallons per acre, and if the average rainfall be 40 inches, a little less than one-half of this will furnish half a million gallons for each acre included in the watershed, which should in all cases be measured approximately by tracing out the height of land on a county map, or from actual survey, or something of that kind. On this basis one square mile, or 640 acres, would furnish 320,000,000 of gallons per year, or less than one million gallons per day. It may here be stated that under very favourable conditions with large storage reservoirs an average supply of 1,000,000 gallons per day throughout the year has been obtained from one square mile, but this was on a stream used for power purposes and in which the flow was frequently much less than that rate in the summer season. This example shows that such a quantity can rarely be depended upon for municipal purposes, though more than two-thirds of a million can generally be secured where the storage capacity is ample.

In calculating the proper size of storage reservoirs, the relative winter and summer flow must be considered separately, much in the same way as above described, and it must be remembered that there is an evaporation in this latitude of about 25 inches per year from the surfaces of ponds and lakes, which in effect decreases the amount of water actually available from a particular watershed. This evaporation represents an enormous quantity of water, but fortunately the loss applies only to that portion of the watershed represented by the area of the pond or lake and that of the streams entering the same.

STRAIGHTENING TEMPERED STEEL.

It is well known that files are not usually drawn after being hardened, and that the burning frequently springs them out of line. But notwithstanding that the files are made as hard as they can be by heat and cold water, they are readily straightened after being hardened. This operation is performed at once, as soon as the files have been dipped. The files are taken from the bath of melted lead and chilled while red hot in a tank of running water. This immersion for the instant hardens only the surfaces, while the interior is soft and pliant with heat. At this time the file may be straightened by bending over and under bars. By similar means crooks in steel arbors, reamers and other long tools may be removed, even after they have been hardened and tempered. A cast steel saw arbor had received an offset or crook in the journal at one end, just inside the shoulder. The crook was at the worst end, that next the saw, and, although scarcely perceptible to the eye, when the arbor was turned on its centers, it was sufficient when the arbor was in the boxes to throw the periphery of a 2 ft. saw considerably out. The arbor at the bearing part was very gradually heated, not enough to change color, but a "black heat." A V-shaped block was placed in a vice bearing against the offset side of the journal, and the vice screwed up. At a third trial the arbor came out perfectly true. A contemporary says a tempered reamer was straightened in the same way, the point at which it was crooked being heated by an alcohol lamp. The heat was sufficient to allow the steel to give, but not enough to start the temper. Steel that has a blue temper only may be straightened by blows with a peaned hammer on a smooth, clean anvil, the face of which should be warmed enough to remove the chill. —*Exchange.*

THE NEXT ADVANCE IN TELESCOPE MAKING.

Why, asks the *Pall Mall Budget*, is it so difficult and expensive to construct an immense telescope? From the time of Galileo to that of Clark, steady work has been done, and each step has given us a larger object glass. The pupil of the eye is one fifth of an inch in diameter, and can grasp but a limited amount of light. A 25 inch object glass will enable the eye to take in over 15,000 times more light, and with such a glass the moon can be seen as though it were only 80 miles away; but if the size of the object glass could be furthur increased, the moon would be brought considerably nearer. To make a large object glass is the difficulty, and it is only after years of patient work of the most skilled men on earth and after repeated attempts that one can be produced which is accurate. Slight differences of specific gravity, changes of structure due to jarring, strains resulting from unequal pressure and changes of temperature, are all capable of ruining the work. Some one who is anxious to anticipate events has asked: Why not replace the glass, which is only a medium transmitting light at a different velocity from air, by a properly constructed electric field? It is conceivable that an electric field 50 feet in diameter could be arranged. Just what the nature of this field should be, with our present knowledge, we cannot say, but some day it will be known, and then the secrets of the other planets will be ours. Ether (says a technical paper) is now paramount with experimentalists; some day it will form the basis of all electrical text books. We seem to be on the verge of discovering something really great in the world of ether. The early experiments of Faraday, the marvelous mathematical researches of Maxwell, and the crowning experiments of Hertz, all show the intimate relations which exist between electricity and light. They have so entirely changed our views of science that it has been truly said that electricity has annexed the whole domain of optics.

BORAX FOR EPILEPSY.

Dr. Dijoud has tried this remedy in twenty-five cases, and he claims to have entirely cured one, and to have relieved all except six. The duration of the treatment varied from one to seven months, and he was able without inconvenience to carry the dose up to ninety grains a day. This was only possible if a beginning was made with small doses, which were gradually increased; and when the dose exceeded sixty grains daily he found it advisable to add some glycerine to the water and sirup in which the drug was usually administered. The patients to whom Dr. Dijoud administered borax had been treated unsuccessfully with the bromides.—*Med.Record.*