splendid series—as representative of his general mode of working; and, in fact, he himself states that there are objections to it in its present form, to eliminate which he points out the way: but, nevertheless, the apparatus may stand as a model of ingenious contrivance, showing how fertile is the mind of the investigator in devising means, and how thorough and refined these last, when placed in tangible form.

The object of the apparatus, as already noted, is to obtain the co-efficient of expansion of metals and alloys. By co-efficient is meant a factor, which serves as a multiplier; and the co-efficient of expansion of any metal is that fraction of its length which the metal elongates or shortens by the addition or subtraction of one degree of temperature. This fraction of the length of a given metal bar is expressed decimally, and hence to ascertain the absolute amount of the expansion of any given length of the metal, we multiply the given length by the co-efficient.

In order to measure the minute differences in length of the bars, Professor Mayer desired to use Saxton's comparator, on account of various advantages which that device offered. A complete description of that instrument, as well as a very interesting biographical sketch of its inventor, Mr. Joseph Saxton, will be found in No. XI of Professor Mayers' series of articles above referred to, in the SUPPLEMENT. It will suffice here to say that it consists essentially of a mirror, which reflects a beam of light over double the angle through which the mirror is revolved, and this beam acts as an index by being caused to sweep over a graduated scale, having for its center the center of the axis of the mirror. It will be obvious how measurements may be made by this arrangement.

We can do no more here than present a very brief account of how Professor Mayer solved the problem we have stated, as our readers will find all the details in No. XII of Professor Mayer's SUPPLEMENT series, which will shortly be published. The bar, whose co-efficient of expansion is to be determined, is supported on standards in a brass tube, which is made about ⅛ inch shorter than the bar. Against the ends of the bar are placed rubber washers, which are perforated so as to allow the ends of an abutting screw and a rod connecting with the moving mirror of the comparator to come in contact with the ends of the bar. Arrangements are provided which hold the washers perfectly water and steam tight against the ends, while the bar is perfectly free to expand or contract in the tube. Inside the tube are supporting springs, which relieve the standards in some degree from the weight of the bar.

In our engraving Fig. 1, T T′ is the tube, supported on V's, V V′. Its weight is relieved by the spring balances shown. At p and p' are pins, to which springs (one of which is shown at S) are attached to pull the end of the bar against the abutting micrometer screw. A screw, E, serves to rotate the tube slowly in its V's, so that the bubble of the level, L, can be brought to the middle of the scale. Through the tube, D, water or steam is passed which, after circulating around the bar, escapes by the pipe, C. Thermometers may be introduced into the main tube through the tubulures, B B′ B″; and these last also serve as openings for the introduction of hot water to melt ice around the bar. Fig. 1 represents the machine complete, and Fig. 2 is a sectional view of the tube T T.

In beginning the experiment, ice is packed around the bar, and the tube adjusted in the balances. The head of the abutting screw is adjusted to a known reading, and the end of the bar is pulled against said screw. The tube, T T′, is then made level. The mirror rod, r r', Fig. 1, attached to the mirror, M, is next allowed to abut against the bar, when the reading of the index beam on the scale is at once noted. This is repeated three times. The tube is now removed from its V's, and hot water poured in until all the ice is melted. Steam at known temperature is then passed through the tube for thirty minutes, and the same operation for measuring above described is repeated.

Subtracting the scale reading obtained from the bar when it was in the comparator surrounded by melting ice, from the scale reading obtained when the bar was enveloped with steam, we have for remainder the amount of scale deflection produced by the bar in expanding from the length it has at 0° C. to that which it assumes at the temperature of the steam. This scale length, converted into linear motion of the mirror rod, gives the actual expansion of the bar in fractions of an inch or of a millimeter.

A Porcelain Fiddle.

Venice is considerably excited at present over a very unusual sort of a fiddle, the only one of its kind, probably, ever made. The manufacturer of this porcelain fiddle was formerly a workman in a Saxon porcelain manufactory. After his return, old and feeble, to his old home, he attempted to carry out a long cherished project for making a fiddle, the box of which should be of china. With the aid of a boy, it is stated, he has in fact succeeded in producing a fiddle of this kind, which has a tone of rare purity and astonishing richness, combined with charming harmony and extraordinary power. The box part, or resonator, is exceedingly light, and the strings are made of metallic wires, while the bow, departing from the usual form, is curved, making almost a semicircle. The success of this clever Venetian, who had enjoyed the advantages of the skill acquired in a German porcelain factory, may be the means of directing musicians to the advantages of the clear, ringing, but fragile china and glass, for various similar uses in acoustics.

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IS THERE A LAW OF INVENTION?

Whether we are to conclude with Buckle that there are laws governing human action which exist unknown and which only future and wiser generations will discover; or whether we adopt the theory of epidemic thought and assume that there is a bond of unconscious ideation forming some subtle link between minds pursuing like objects, the fact remains that no one can study the progress of invention without becoming impressed with a definite notion that there is some extraneous cause which impels inventors to reach similar conclusions and make like discoveries at about the same time. Of course this cause must be dependent upon antecedents, and these last are the steps which go to make up scientific progress, with which all may by study render themselves familiar, and thus may as it were place themselves under like influences. The question for speculation however is whether there even can be proved to exist a law which taking into account certain circumstances will enable us to recognize conditions when the production of a certain new and original conception is predicable.

Analogies in this regard are by no means wanting. In the case of artificial selection, horticulturists, agriculturists and stock breeders the world over are constantly engaged in experimenting under every imaginable combination of circumstances and conditions with the object of reaching new results which it is hoped may be superior to any hitherto obtained. The constant study of mankind has been to discover those circumstances under which the human race enjoys the highest point of mental and physical culture; and with such success has this been attended that it is quite possible to conceive of an ideal man, the product of present attainable conditions, who in all his attributes, certainly physical and probably mental, would be a far superior being to modern men. There are many instances which can be cited showing that occurrences seemingly of the most fortuitous character are subject to definite fixed laws. The number of suicides, of murders, of marriages, of letters posted unstamped, and so on through almost every imaginable event in a large community, is nearly invariable; the great business of life insurance rests upon the law of probabilities, and finds its stability in the hypothesis that out of a given number of policy holders the ratio of deaths may be definitely forecast. The entire onward march of scientific investigation is toward the formulation of these laws. The highest effort of original investigation is the grand general deduction, the establishment of a theory on the basis of a multitude of observed facts.

It may not therefore be unreasonable to suppose that, some day, laws governing invention will be revealed. No great or striking invention, not even one moderately out of the common run, appears, but that others similar to it at once come to light, not as improvements on the first announced but as the outcome of independent thought. Take the telephones as an instance. Bell's telephone is not an improvement on Gray's, nor is Edison's on that of either of the other inventors, yet all were produced, as is well known, within a few months of each other. Note the number of entirely original inventions which followed rapidly upon each other within a very few years and which together resulted in the sewing machine as now perfected. There are abundant records where in purely scientific investigations independent students find themselves pursuing exactly similar objects. The case of the magnificent discovery of Neptune by both Leverrier and Adams is a most striking example of an instance where two investigators each reached his aim in a manner original with each yet common to both.

The recently invented phonograph is proving no exception to the general rule. A preliminary notice in these columns of the Marey and Rosapelly phonograph lately devised in France elicited the announcement of Mr. Edison's remarkable invention. Two inventors have written us, since the publication of the latter device to the effect that they also have invented phonographs of substantially similar construction, which antedate (they say) Mr. Edison's device by a considerable period. It will be interesting to watch the progress of the phonograph if only to note how many other inventors have been simultaneously engaged in its investigation or have independently discovered it in various forms. Statistics based on data of this kind and kept over a reasonable period would probably lead to some remarkable conclusions relative to the conditions of invention, and possibly, as we have intimated, to the discernment of some general laws.

UNITED STATES COINAGE AND THE GREAT PYRAMID.

Some one who fails to see wherein the benefit of importing obelisks from Egypt exists sarcastically proposed not long ago that Yankee ingenuity should astonish the world by floating, not an obelisk but a pyramid across the Atlantic, and erecting the structure in some city park. The satirical proponent might have strengthened his scheme if he had added that while this nation has no bond of connection with obelisks, it actually has something in common with the Great Pyramid—and that we have a direct national interest in that mass of stone, inasmuch as a most curious analogy exists between its measurements and in the weights of our several coins. We are indebted to Dr. Watson F. Quimby for the following letter, wherein he ingeniously points out this remarkable linkage, and suggests the very plausible idea that the weights of our coins owe their origin to no fortuitous circumstance, but rather to customs established at a period dating back beyond history. Dr. Watson says:

"In the admirable work of Professor Piazzi Smith, entitled

"Our Inheritance in the Great Pyramid," it is shown that the Great Pyramid of Egypt contains in its interior standards of inch measure, while the exterior gives the same standards in the sacred cubit of 25 inches. One of the most important units of measure is the length of the so-called king's chamber, which is 412·5 English inches, and its breadth 206·2 inches. Now our silver coinage corresponds to these numbers, as the "dollar of the fathers" weighs 412·5 grs., the half dollar 206·2grs., and the quarter dollar 103·1 grs., which last is a very important pyramid number. On inquiring at the mint why the silver dollar was made of this weight, I was informed that it was the weight of a coin that would readily pass current in the Eastern Asiatic trade. It is therefore a traditional coin, by whatever name it may have been known, for thousands of years.

"But not only does the silver coinage correspond to the inch standard of the pyramid, but our gold coinage corresponds to the cubit measure. The height of the pyramid in sacred cubits is 232·5, and our gold eagle, the unit of gold coinage, weighs 232·2 grs., and the half eagle 116·1 grs.

"The relation of these numbers is such that 'the area of a square having 103.03 on the side, is equal to the area of a circle having 116·26 for its diameter.' (Phillips.) Now as there are 360 degrees in the circumference of a circle, its diameter in terms of seconds is 412529, and its circumference is 1296000. Then the number 412·5 is the thousandth part of the diameter of a circle in terms of seconds, and 1296, the number of square inches in an English square yard, is the thousandth part of the circumference of a circle in terms of seconds. This at once connects English with pyramid measure, and may indicate the origin of both.

"From the standard square yard all the rest of our measures may be deduced. The old English gallon contains 231 cubic inches, which is a number intermediate between the height of the pyramid in cubits, 232·5, and the height of the king's chamber in inches, 230·89. The diameter of a circle is to the side of a square of equal area, as 9 to 8 very nearly.

9 : 8 :: 116·023 : 103·132.

"It thus appears that in the weights of the quarter dollar and the half eagle, we have had the squaring of the circle problem typified without knowing it."

NOTES OF PATENT OFFICE DECISIONS.

The Commissioner of Patents, in deciding the interference case of Martin *vs.* Bogle *et al.*, awards priority of invention to Martin, who first perfected the operative device in interference, although Bogle was the first to apply it in series, in the manner designed for use. The reason for this is that, while the arrangement in series may be more satisfactory and permit nicer adjustment of subordinate mechanism, yet it proves operativeness no more than the test of the single device itself.

The Commissioner also holds that the fact that in one instance a claim is for a single device, and in another for a series of them, does not constitute difference of invention. The state of the art, and the Office latitude in allowing claims, may level the distinction. He also holds that the preliminary statement must be rigidly adhered to, where there is a substantial departure therefrom in the interference contestant's testimony.

The Acting Commissioner, in the interlocutory appeal in the matter of the application of Siemens for a re-issue of letters patent, decides that the applicant may include, on re-issue, matter which was neither described nor claimed, but which was actually contained in the original invention; and that the failure to describe such matter in the original patent is no bar to doing so in the re-issue application within the limits of the invention.

SHOOTING STARS.

The phenomena of shooting stars and of star showers have, undoubtedly, existed since the formation of the solar system. On any clear evening, a watchful person may see, on an average, two shooting stars every five minutes, and on certain nights of certain years, and on certain hours of the night, they appear in such vast numbers as to receive the name and deserve the title of star showers. Other meteors do not fall in showers emanating from certain constellations, but move in all directions, and from every part of the sky. Such meteors, though, as far as known, differing in no particular from those which come in showers, are called "sporadic." In their normal condition, that is, before visibility, these vagrant bodies are called meteoroids, and only while self-luminous from excessive heat by friction and arrested motion in our atmosphere, are they called shooting stars or meteors. It is important that this distinction be borne in mind, for, if true, then can no meteoroids ever be seen from the earth. In their natural condition they are circum-solar bodies, obeying the laws of motion and gravitation as rigidly as do the planets, and must be treated as such, though more numerous than the leaves of summer. The velocity with which they plunge into our atmosphere is very great, probably about 48 miles per second. The length, in arc, of their visible path varies widely. Occasionally one flashes up, and, increasing in size and brilliancy, disappears, without seemingly having moved a particle. The motion of such a meteor was exactly towards the observer's eye, and consequently it ought not to have any apparent motion. Another observer 20 or 30 miles distant may have seen the same with a path several degrees in length. Their paths may be considered to vary from zero to 90°, or even more. The length of their real paths, that is, in miles, also varies greatly, but the average is about 42 miles. By the time this distance is accomplished, unless the meteoroid is a large one, it is heated, melted, evaporated, and extinguished, all within the period of not over one second of time. The height at which they are heated to visibility is sometimes as great as 200 miles, but the average is about 75 miles, and at extinction, about 50 miles.

The above assumed rate of motion at which they enter our atmosphere is the result of the sum of the orbital motions of both the earth and meteoroid, but, owing to the earth's attraction, this motion is really very much greater than 48 miles per second, especially for those which move retrograde.

We are now prepared to understand why they are burned up, and so quickly vaporized. The heat thus generated, though all produced where the atmosphere is inconceivably rare, is estimated to be equal to three million degrees Fahrenheit. No known substance, unless of considerable size and density, like the meteoric stones which occasionally reach the earth, can long withstand such a degree of heat, unchanged in form and structure. Before the above facts were known the height of the earth's atmosphere was usually considered to be about 45 miles, but that it is, at least, five times, and probably ten times that distance, is clearly proved by the researches in meteoric astronomy.

When it is considered that, according to Professor Newton, four hundred million shooting stars are daily burned up in our atmosphere (including those that are telescopic), it would seem that the earth must constantly be increasing in weight and size from this cause, and such, no doubt, is the case in fact as well as in theory. Unfortunately the data for arriving at any very exact value as regards their size and weight rests on insufficient evidence. Professor Harkness, of the Naval Observatory, who has made a thorough discussion of all accessible evidence bearing on the subject, has arrived at the astonishing conclusion that their average weight does not exceed one grain. If we assume that those which are wholly telescopic are not larger than sand grains, and probably they are not, those that are visible to the naked eye as conspicuous objects, and especially those that are seen over a radius of 150 miles and fill several cubic miles with smoke must contain several ounces, and perhaps pounds, of meteoric matter, whatever that may be. Suppose we base our calculation on the estimate of ten grains for each meteoroid, this would equal 4,000,000,000 grains, or 290 tons a day, or 106,000 tons a year, sufficient, if distributed equally over the earth's surface, to form, in 4,000,000 years, a stratum equaling in thickness the paper upon which this journal is printed. The moon, as she revolves round both the earth and sun, must also meet with these all-pervading meteoroids, but, having no atmosphere to arrest their motion, they cannot be heated. They must strike on its surface and be instantly converted into the finest powder. This meteoric dust, from excessive attenuation, must be of a light color, perhaps a pure white, which may go far to explain the cause of her reflection of so much light, the which, when her size and distance are considered, seems out of all proportion.

While the writer was observing the memorable star shower of November, 1867, he witnessed a phenomenon which will linger long in his memory. A brilliant meteor from *Leo* passed in a westerly direction, leaving a luminous train of some forty degrees in length. Its head seemed to increase in size and brilliancy as it progressed, when, as suddenly as though it had struck a target, it vanished from sight. Soon a cloud formed, assuming a variety of fantastic shapes, several being perfect delineations of letters of the alphabet. Twice in its peregrinations was the letter N thus formed, these changes occupying some fifteen minutes. Finally, gathering to itself its scattered particles, it became a round symmetrical disk, probably a sphere, which centrally occulted the nebulous cluster in called *Cancer* the Beehive. For almost two minutes it was, from this cause, lost to view. After the occultation it continued visible for ten minutes longer. During its visibility, which was twenty-five minutes, it drifted about fifteen degrees to the north, confirming by observation the truth of the theory that the heated air of the tropics flows to the north through the upper regions of the atmosphere.

ADAM SCOTT CAMERON.

It is with regret that we announce the death of Mr. Adam Scott Cameron, of New York, who undoubtedly was personally known to a great many of our readers. He passed away on the 14th ult., of an attack of acute pneumonia; his illness was sudden and painful, but of short duration.

As a manufacturing engineer and constructor of steam pumps he had a wide and excellent reputation; and as a business man of sound principles, his loss will be felt in the many circles where he was prominent.

Mr. Cameron was a native of Scotland, but came to this country when eight years of age. During his youth he evinced a strong desire for acquiring knowledge and an aptitude for self-culture. He attended public day and evening schools, and soon became sufficiently proficient to keep books for a New York firm. He was observing, thoughtful, and industrious, entered into business with indomitable pluck, energy, and perseverance, and studied with assiduity the questions of capital, labor, and finance. The greater part of his life was spent in the construction of the well known Sewell and Cameron steam pumps. Before he was twenty-one years of age he was taken into partnership with his brother, and to the time of his last illness applied himself to business with great success. He was a friend and counsellor to the workmen in the employ of his firm (Cameron & Co.), and a member of some excellent associations for the advancement of mechanical science. At the commencement of a small pamphlet issued to his employees in 1869, proposing the system of co-operation as a practical business movement, the following sentence occurred: "To assist a person in improving his condition by his own efforts is to make a man of him." Other pamphlets on such subjects as "The Necessity of a Bureau of Mechanics," "The Eight Hour Question," "An Address to the Intelligent Workmen of the United States," were written by him, and widely circulated.

During the spring of 1873 Mr. Cameron was elected president of the Bull's Head Bank of the city of New York; and although the youngest president of any bank, at least in New York city, he displayed wonderful tact and sound judgment in arranging the complicated affairs of the institution; he had suits set aside, obtained subscriptions for new capital, re-opened the bank, and put it in a prosperous condition. This transaction was commented upon by the London *Times* as a notable one, from its having been the first of the kind, and the setting of an example which has since been followed in several instances. The last and recent public utterance by Mr. Cameron closes with these significant words: "Until we return to the old-fashioned habits of honesty, industry, and frugality, our sins will rest upon us. If our *virtues* will not, our *necessities* must bring us back to prosperity. Then we shall be envied among the nations of the earth." At the age of thirty-three Mr. Cameron closed a busy and useful life, in which integrity, generosity, and benevolence were always conspicuous.

THE DISTANCES OF THE PLANETS FROM THE SUN.

Sir George Airy, the British Astronomer Royal, has recently published a report on the telescopic observations of the transit of Venus of 1874, made by the English expeditions. Pending the appearance of the deductions to be made from the complete measuring of the photographs, the results reached must be regarded as provisional only. The mean solar parallax determined is 8·764", and this is one tenth of a second less than has been given by the most reliable previous investigations upon different principles. From Professor Newcomb's calculations, now adopted in most of our ephemerides and based on observations of Mars, the lunar equation of the earth, the parallactic inequality of the moon, the transit of Venus of 1769, besides Foucault's experiments on light, it appears that the mean distance of the earth from the sun is 92,393,000 miles. According to Sir George Airy's determination this distance must now be considered as increased to 93,321,000 miles.

For purposes of comparison and also to correct some errors which were present in our recent article on "how our world looks from other worlds," which we translated from the French of M. Flammarion, the well known astronomer, we append the following statement of correct distances of the planets from the sun. Mercury, average mean distance, 35,392,000 miles; Venus, 66,134,000 miles; Earth, 93,321,000 miles; Mars, 139,311,000 miles; Jupiter, 475,692,000 miles; Saturn, 872,137,000 miles; Uranus, 1,753,869,000 miles; and Neptune, 2,745,998,000. As regards the fixed stars, the distance of *a* Centauri, probably the nearest, is about twenty billions of miles, and light occupies about $3\frac{1}{4}$ years in traveling from that star to the earth.

The New Steamship "City of Washington."

If comparison is made between capacity and strength, this steamship, just placed on the New York, Havana, and Mexican Mail Steamship Line, appears to be undoubtedly the strongest mercantile iron vessel ever built in this country. She was constructed by Messrs. John Roach & Son, at Chester, Pa., and is of superior model and plan. The plates of the hull are $\frac{11}{16}$ inch and upwards in thickness. There are three decks, the two upper ones being mostly of iron. The length of this vessel is 323 feet; beam, 38 feet; depth, 37 feet 6 inches: draught when loaded, from 21 to 22 feet; tonnage, 2,618 tons. She can carry 10,000 boxes of sugar, besides light freight, and her outward passage capacity in bulk is 2,500 barrels. The saloons and staterooms are attractive for their comfortable appearance and elegant fittings. The engines are of the compound type, and have a high pressure cylinder 40 inches in diameter; low pressure cylinder 74 inches in diameter, with a stroke of 6 feet. The pressure of steam carried is 80 lbs. The condenser has 4,000 square feet of condensing surface. Diameter of propeller is 16 feet, with a mean pitch of 26 feet. The engines are constructed with steam valves on the Corliss principle, and are reversed quickly with little manual exertion. Steam is supplied by two vertical boilers having square bases. There are eight furnaces in each boiler, and altogether about 3,000 tubes, 2 inches outside diameter and 7 feet long. There 370 square feet of grate surface and 1,400 square feet of heating surface. The engines are rated at over 2,000 horse power, and with 63 revolutions per minute, an average speed of 14 knots per hour is attained.

F. Alexandre & Sons, the owners, state that the City of Washington will make the voyage between New York and Havana in less than four days.

COFFINS from Norway, says the *British Trade Journal*, represent the latest phase of foreign competition, a cargo of several hundred having been landed, ex steamer Cambria, during the past month. In this lugubrious branch of home industry America is also competing, and in a warehouse almost within a stone's throw of our office may be inspected a stock of 2,000 American coffins and caskets.