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Communications relating to the Editorial Department should be addressed to the Editor, HENRY T. BOVEY, 31 *McTavish Street, Montreal.*

The Editor does not hold himself responsible for opinions expressed by his correspondents.

No notice will be taken of anonymous communications.

NEW BOOKS.

The Art of Ore-Dressing in Europe, by Wheaton B. Kunhardt, (New York: John Wiley & Sons.)

This volume is the second of the Columbia School of Mines Quarterly Series. It purports to be a general description of the methods of working pursued in the ore-dressing establishments of Europe, and has been compiled from data obtained from the owners and managers of the foreign mills. The points discussed are the following: The general principles pursued in ore-dressing, under-ground separation, general size classification, cleansing, spalling, rock breaking, sizing, hand-picking, cobbing, roll-crushing, jigging, rough hydraulic separation, review of coarse-dressing and introduction to slime treatment, comminution, hydraulic classification, slime washing, crushing and drying of concentrates, losses in wet dressing, special dressing operations, features of mill construction. The work is of much interest, touching, as it does, upon the early methods in use, and noting in brief the great development in the mechanical manipulation of the ore during the past few years.

American Engineers and Surveyors' Instruments.—This is the twenty-fifth edition of W. & L. E. Gurley's (N.Y.) illustrated catalogue. Full and lucid descriptions are given of the various instruments, with rules for their use and adjustment.

The Contracted Liquid Vein, by R. Streckel.—An essay describing the results of certain experiments upon the flow of water through orifices, read before the mathematical section of the Royal Society of Canada.

The Metrological System of the Great Pyramid.— By F. A. P. BARNARD, L.L.D., S.T.D. (New York: John Wiley & Sons; Montreal: Dawson Bros.)

An Important Question in Metrology.—By Lieut. CHAS. A. S. TOTTEN, M.A. (New York: John Wiley & Sons; Montreal: Dawson Bros.)

These two works represent the views of those who swell the ranks of the parties engaged in the now famed metric struggle.

President Barnard in the essay before us, which is a reprint of a paper contributed to the Proceedings of the American Metrological Society, accounts for the existence of a large body of believers in a religious mystery surrounding the great Pyramid, as being the result of the natural law, that the faith of fanatics is intense in proportion as its foundations are weak, and that its disciples multiply in proportion as its doctrines are deficient of common sense."

After a brief description of various weights and measures, and a statement of the necessity and advantage of introducing the metric system which would "remove the confusion and remedy the inconvenience to all mankind occasioned by the multiplicity of the forms of expressing the quantities of exchangeable commodities," an introduction which he goes on to say is now only a question of time, he gives an account of the "Theory of the Divine Legation of the Great Pyramid.

The principal propositions advanced in support of the theory are:—

1st. That the external dimensions of the pyramid have been determined by means of a unit of linear measure which is one ten-millionth part of the polar radius of the earth: and that this unit is identical in length with the sacred cubit.

2nd. That the linear measure of one side of the pyramid, at its base, contains this sacred unit of measure as many times as there are days in the year, including the fraction of a day beyond the three hundred and sixty-five.

3rd. That the height of the pyramid (in its original and perfect condition) when multiplied by the *ninth power of ten*, expresses the distance of the sun from the earth with an exactness which puts to shame all determinations from transits of Venus, oppositions of Mars, perturbations of the moon, or any other merely human scientific method.

4th. That the daily motion of the earth in its orbit is expressed "in the round decimal number of 100,000,000,000 pyramid inches.

Various other propositions are also given relating to the dimensions of the interior passages of the pyramid, the measure of capacity discovered by John Taylor in the Sarcophagus in the king's chamber, the geographical position of the monument, &c., concluding with the article of the pyramid faith that the date of its creation is defined by the peculiarities of its construction

These propositions Dr. Barnard opposes at length and with very forcible arguments, which must be followed in detail to be appreciated. In order to shew, as he says, how easily a system such as the above may be built up on the most slight foundations, he himself makes a supposition and thereon erects a new plausible theory of the pyramid, which he styles a human theory.

The subject of this work is one which has attracted much attention and it cannot fail to be of interest to the general reader.

AN IMPORTANT QUESTION, BY TOTTEN.

This book originated in an Address to the International Institute for Preserving and Perfecting weights and measures, but its author, being convinced of the national importance of his discoveries, has been induced to lay them before the public, to which, he thinks, and not to scientific men, or even to its temporary representatives in the government of the country, belongs the right of deciding questions of metrology.

His principal theme, as he says, is the rectified system of metrology, by which is meant a rectification of the older system of measures still used in England and the States, which, without any important changes either in fact or in nomenclature, would thus become, in his opinion, an absolutely perfect system.

He thinks the unit of metrology should be harmonious to nature and believes that such a unit has been bequeathed to us by our ancestors and that its slight loss of exactness might be rectified by means of the study of the Great Pyramid. Independently of this, however, he shows the great adaptability of the old system, and conceding that the decimal system is very necessary for purposes of rapid calculation, etc., he shows that a new decimal system could be based upon the former, where it would possess all the advantages of the metric system without its disadvantages, as for example, the necessity of overturning a system which has been in use for so long.

The book is much marred as have been so many others of its class by the assumption of propositions which can scarcely be considered as proved, for example that Anglo-Saxons are directly descended from Joseph and being entitled to all the blessings promised to his race, are born to rule the world, by its appeal every now and then to a sort of religious sentimentalism, which is much more easily persuaded if it can be persuaded in biblical phraseology, and by its ignoring the existence of men both scientific and otherwise, who while accepting the Bible Bible as a standard of faith and morals do not regard it as also furnishing a standard for metrology. Apart from these defects the subject is one of great interest and importance, and the treatment is clear and practical.

TELEPHONING BETWEEN LONDON AND DOVER.—An experimental illustration of telephonic communication between distant towns was performed last week by the United Telephone Company. A numerous party was invited to witness the transmission of messages between Dover and London, along the telegraph wires of the London, Chatham, and Dover Railway, permitted by the chairman of that company, Mr. Forbes. The first experiments consisted of messages transmitted from the Grosvenor Hotel to Dover along a single wire brought to earth at both ends, and having in its route no less than nine block signal stations, the single needle instruments in which, and the other apparatus, being equal to over nine miles per station. These constituted a resistance of nearly 100 miles beyond that of the line wire, which was 78 miles long. The second experiment was the transmission of messages along a metallic circuit, making 156 miles of wire, to which the block instruments added 200 miles resistance, making the total traversed by the messages the equivalent of 356 miles. Nevertheless, the words were clearly and distinctly heard, so much so that one listening in the Grosvenor could instantly detect the errors of the operator in mis-quoted words in the nursery rhymes which he narrated for the edification of his London audience.

AMERICAN PERMANENT WAY.*

BY JOSEPH M. WILSON.

(*Continued from page* 261.)

There may be cases where reverse curves come close together and this rule cannot be strictly carried out, but an endeavor is always made in such cases, if possible, to secure at least 50 feet of level track on a tangent. Where two curves in the same direction are connected by a tangent less than 100 feet long, the elevation is carried through from curve to curve without reduction, and if the tangent exceeds 100 feet the regular inclinations are made from each curve until they meet, or until level track is reached. These illustrations will serve to show the variation in practice with different roads. The rules for elevation of course do not apply in yard tracks. All rails for curves should be bent to the proper curvature before being laid on the ties.

Several different standards of gauge of track have been used on American roads; 6 feet, 5 feet, 4 feet 8.½ inches or 4 feet 9 inches, (a modification adopted for compromise cars,) also the various narrow gauges, from 2 feet 6 inches to 3 feet 6 inches. There is a considerable tendency towards a uniform gauge of 4 feet 8.½ or 9 inches, and there have been several noted changes on long lines from 6 feet gauge to 4 feet 8.½ or 9 inches, and there have been several noted changes on long lines from 6 feet gauge to 4 feet 8.½ inches, the operation being performed in an almost incredibly short interval of time.

Rails are connected together by joints and the more closely a joint approximates to a continuous rail, the nearer it reaches perfection. Some years ago the joints were placed on the supports, but they proved too rigid, the ends of the rails being hammered or battered down under service, and it was found best to place them between the supports. The use of double fish plates has now become almost universal. These fish plates or splices are made to hug up well between the top and bottom flanges of the rail, and in their best form are generally about 24 inches in length with a wide angular flange spreading out over the lower flange of the rail. Two splices are used at each joint, one on each side of the rails and they are connected together through the webs of the rails by four bolts which draw them up tightly together, rigidly binding the rails into line and surface. These bolts have semi-spherical heads allowing as little obstruction as possible, and they should be arranged so that they cannot turn in the holes, the nuts, which are always placed on the outside of the track, being provided with some approved mechanical device to prevent turning and consequently the loosening of the

* A paper read before Section G at the Meeting of the British Association in Montreal.

bolts. A spiral washer employed in the standard track Pennsylvania Railroad answers very well, and the arrangement used by the Cambria Iron Company, (see Pages 291 and 292), is also good. An allowance must always be made in a joint between the ends of the rails, for expansion The maximum amount will vary probably somewhat with the climate, being dependent upon the difference between the extremes of temperature at different times of the year, and the space actually allowed in the process of the track laying is of course different at different seasons. In latitude 40 degrees it is customary to give 5-16 of an inch in winter and 1-16 of an inch in summer. Iron shims of the requisite thickness should be used to separate the rails in laying. The best practice places the joint of one line of rails opposite the centre of the rail on the other line of the same track. This arrangement tends to break up any tendency to a regular jolting or jumping of the cars as they pass over the joints, an effect that increases by the regular repetition and is very disagreeable on roads laid with the joints opposite. On pages 291 and 292, are shown some forms of rail fastenings, for which the author is also indebted to the Cambria Iron Company. Fig A is the Cambria Patented rail joint. Fig. B, is that used by the Pennsylvania and other roads indicated on the plate. Fig. C, is an old form used by the Pennsylvania and other roads, but is not now standard on the P.R.R. Figs. J, K, and L, show recent peculiar forms of street rail now being adopted, and laid, not on longitudinal stringers as has been usual with tramways, but on cross ties. On the Chicago & North West Western Railway the joints are laid opposite and suspended, the joint ties being 6 inches apart. Angle splices are used, 22 inches long, bolted with 4.¾ inch bolts 4.½ inches to centres. Plate III shows the standard splice of the Pennsylvania Railroad.

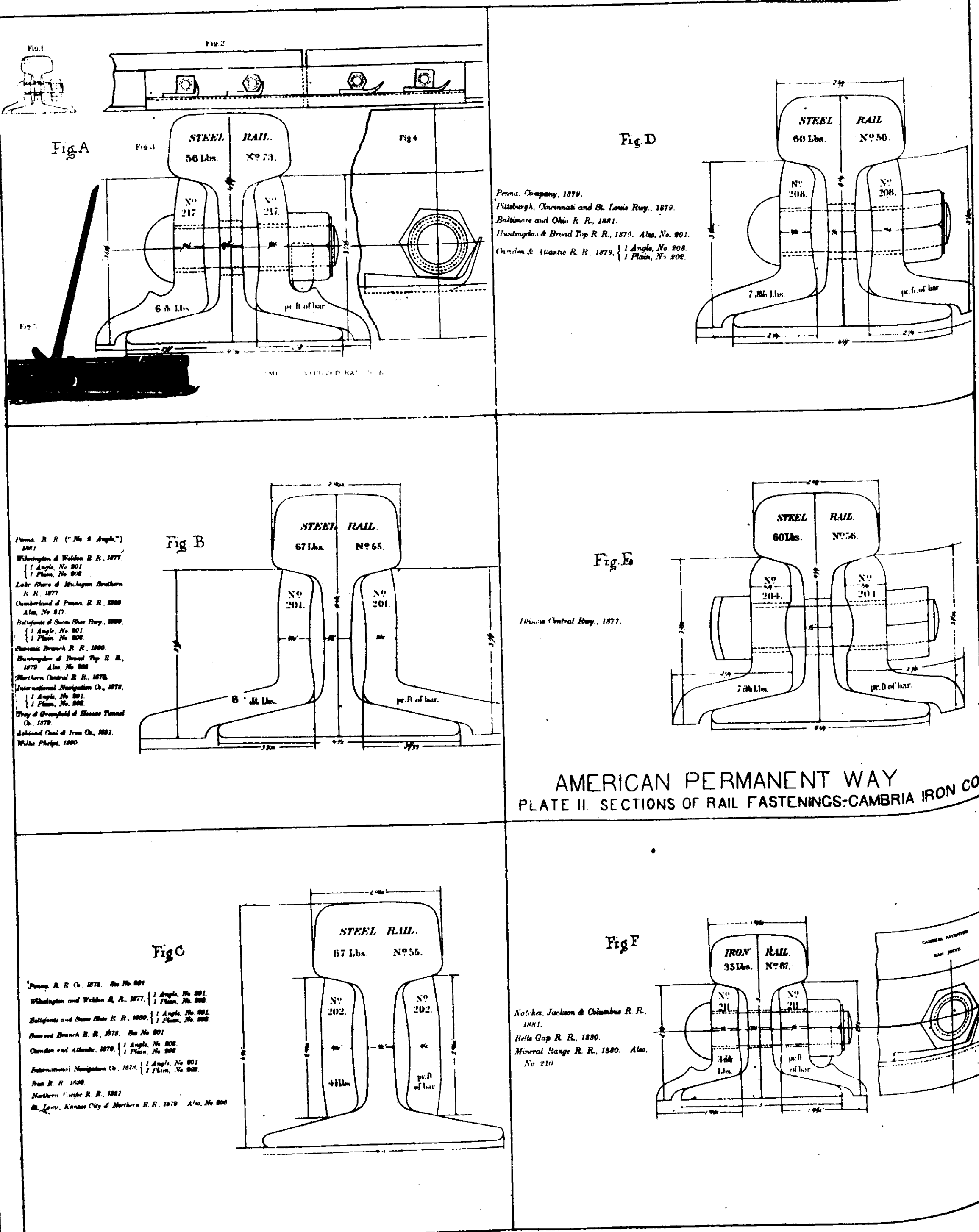
Supports for the rails where timber is very scarce or is liable to rapid decay, as in India or other tropical countries, have been adopted of iron with success. In temperate climates however, timber is used almost universally, creosoting or some other preservation process being sometimes employed, particularly in Europe, to increase its longevity. There is a prevalent opinion that timber on account of its elasticity is essential for supports in order to make a good road, but this does not seem to be borne out in fact, as iron has been used quite successfully where its expense has not been an objection. In America, timber is still abundant and many years may elapse before other material is used to any extent, but the time will come when something else must take its place, and far seeing railroad men are already looking forward to the wrought iron or steel cross-tie of the future. Notwithstanding the experience of Europe, it is a question whether preservatives are of much use for wooden ties in America. On roads where there is heavy service, the material often wears out before decaying; the harder kinds of wood, which are the best for service, do not absorb a preservative solution as readily as the softer and inferior kinds, which latter wear out very rapidly, and the cost of using a preservative would only be a useless expense.

On roads with very light traffic, operated by horse power, as street railways, longitudinal timbers placed under the rails have been generally used as supports, those for the same track being tied across at intervals to preserve the gauge of track. This arrangement however will not answer for locomotive traffic, and even for street railways, as already intimated by the author, it is being abandoned, a form of rail being adopted that will admit of the use of cross ties. A longitudinal sleeper is very apt to split with the spikes which must be driven into it at frequent intervals in its length to hold the rail, water gets into these cracks softening and decaying the timber, and there is a great tendency in the rail to sink into the wood, the supporting power being lost. Timber will always bear a load best resting across the grain even when in first class condition; the cross-tie system also offers great advantages in renewals, over the longitudinal stringer system, vastly increasing facilities of replacing material without delay or interruption of traffic. Even on bridges where longitudinal stringers have been used for years, on account of advantages obtained in the details of construction of the floor-system, they are now being abandoned and a cross-tie system adopted. The rationale of the present almost universal method of timber cross-tie supports is therefore readily seen.

These ties are placed at frequent intervals, sufficient to properly support the rails, the latter being securely spiked to them, and the ties, in addition to giving the proper support, tie the rails together to gauge, and by their hold in the ballast below, keep the whole track in line. Hence thé American word "cross-tie," at once descriptive and appropriate. The cross tie should if possible be of what is technically termed "hardwood," and of all woods in America the best for this purpose is white oak. This is the case at least in the temperate zone. There may be some woods in the tropics, unknown to the author, that are better.

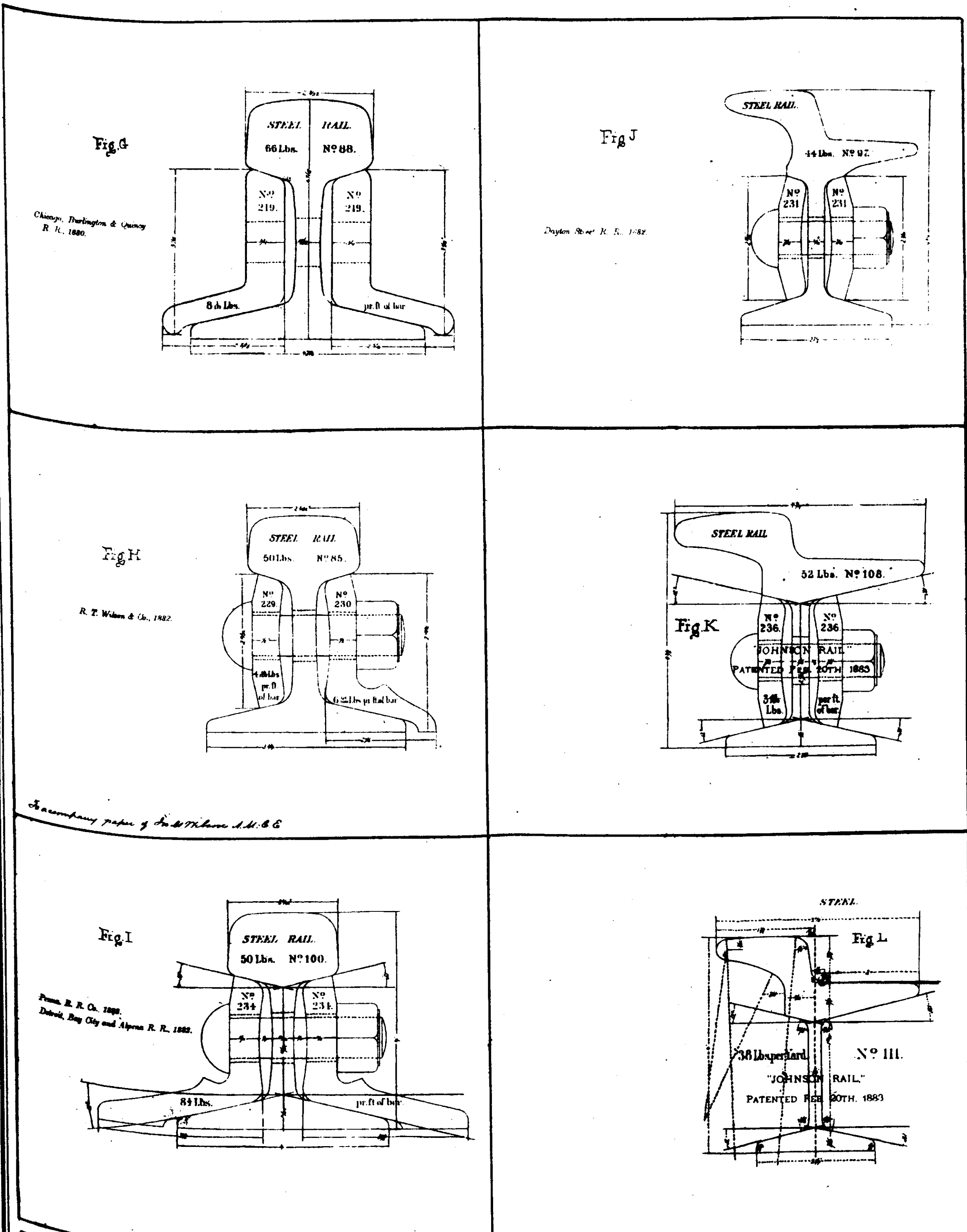
The more bearing surface ths rail has on the tie, and the more surface the tie has on the ballasting material below it, the better and more stable the track. Hence the ties should be flattened on the upper and lower sides, and a minimum width of the flat surface should be specified, less than which will not be allowed. The sides of the ties are only barked and left rounding. Sawed ties are sometimes used cut square on all sides, but hewn ties are by far the

AMERICAN PERMANENT WAY.



best, less liable to decay, and giving a better shape with the rounded sides. The length of the tie should be sufficient to give ample allowance outside of each rail and all the requisite bearing surface on the ballast below. Hard-wood ties not only carry the rails better than soft wood, but they will also hold the spikes two or three times as firmly. In soft wood, the spike bruises and breaks the fibres, while in hard wood, it tends to compress and push them back on themselves, increasing the pressure against the sides of the spike and holding it tighter.

AMERICAN PERMANENT WAY.



The great scarcity of hard woods in some sections necessitates, however, the use of softer and inferior material, hemlock, spruce, the various kinds of pine, etc., and hemlock, in particular, is used in large quantities, being very abundantly distributed over the country, notwithstanding that it is one of the poorest woods for the purpose, and liable to very rapid and deceptive decay, the interior going first, leaving only a hollow shell of good timber outside.

In Canada, tamarac and cedar are also used for ties. Tamarac can only be obtained in certain districts. It is a timber somewhat resembling larch, is higher priced than hemlock but lasts longer. Cedar and locust are both good woods in lasting properties, but are softer than desirable, particularly the former.

Uniformity in the size of cross-ties is important, especially iu cold latttudes, as in the spring of the year large ties hold the frost much longer than the smaller ones, and irregularity in line and surface of road occur under service.

The spikes which are used to secure the rails to the cross-ties should not be less than 5 inches in length, better 5½ inches, should be square in section 9-16th of an inch each side, and should have a flat head projecting to one side to catch the flange of the rail. The lower end of the spike should be flat or chisel-pointed in a direction to cut across the grain of the tie and not to split it. The spikes should be sound, smooth, well shaped, and of double refined iron, bending cold at least 90 degrees without sign of fracture. The length of spike necessitates the depth of cross-ties being at least 6 to 7 inches, and they should also be of this size to perform their other requirements. They should have not less than 6 inches across their flatted surface and ought to be at least 8, or better 8½ feet long for a 4 feet 8½ inches or 4 feet 9 inches gauge.

Some years ago the regular distance for laying cross-ties was 2 feet 6 inches centre to centre, and this may still be the custom on some of the lighter roads, but those with heavier service are now laying them much closer. They are usually placed 18 inches to centres under joints, and 2 feet to centres at other places, making for a 30 feet rail 2,640 ties to the mile of single track. Circumstances may however justify the Engineer increasing the distance. The question is governed by the width of tie, allowable carrying length of rail, and the space required between the ties to provide for proper tamping of ballast around them.

A true track requires, of course, that the ties should be laid to a uniform top surface. If the tie is twisted it should be made true on top by adzing, to give an even bearing to the rail for the whole width, but under no circumstances should a tie be notched. This only allows water to enter the pores and decay the timber, besides being a disfigurement to the track. The ends of the ties should be lined up parallel with the rail on one side, always the outside for double track, the ties should be well rammed into the ballast or bearing material below them and they must have a solid bearlng for their whole length. The rails must be spiked on the inside and outside at each tie, on straight lines as well as on curves, and the spikes must be driven so as to keep the ties at right angles to the rails. There are therefore 4 spikes to each tie. Those on opposite sides of the same rail should not be placed in line, as it increases the tendency of the tie to split, and this rule should be carried ont also at splices, the two spike notches in each splice being made unsymmetrical with the centre of splices so as to insure this result. Special ties are required under switches and crossings according to the standard diagrams of the special road for whicn they are intended.

The ordinary life of a tie is from 5 to 10 years, depending upon location, drainage, service, etc. White oak ties only last on the main line of the Pennsylvania Railroad from 5 to 6 years on an average, but they might have nearly double that life on a road with less and lighter traffic. Hemlock and spruce, in favorable locations, will last from 3 to 5 years and cedar 8 to 10 years, but the latter being so soft a wood will only stand light service on easy grades; Timber will last much longer in a severe climate where it is frozen up unifornly for many months in the year, than it will in a temperate climate exposed to alternate freezing and thawing.

The following is the standard specification of the Pennsylvania Railroad for cross-ties as adopted January 1st, 1879:—

1st.—"All ties must be made of green or " living timber, of good quality, and freed from " decayed knots or other unsound parts. White " Oak and Rock Oak will be the only kinds of " timber admitted.

2nd.—" Ties must be eight and a half feet " long, seven inches thick, and not less than " seven inches wide; to be hewn on two sides " with straight faces, of an even thickness, sawed " off square at each end, and stripped of the " bark.

3rd.—" No variation will be allowed in the " LENGTH AND THICKNESS given above.

4th.—" No sawed or split ties will be received.

5th.—" They must be delivered on the line " of the railroad, stacked up in neat square stacks " of fifty each, with alternate layers crossing each " other on ground which is as HIGH OR " HIGHER THAN THE GRADE OF THE " ROAD, and in such position as to admit of " being counted and inspected.

6th.—" Ties delivered at suitable and convenient places, will be inspected, and bills " made for all received and accepted to the 15th " of each month. The payments will be made " on or about the 15th of succeeding month."

The number of ties used for each 30 ft. rail are: for main running tracks, 16 ties, for branch roads and third tracks on main lines used exclusively for freight trains, 14 ties, and for sidings and tracks used for standing cars only, not exceeding 12 ties.

The Grand Trunk Railway of Canada uses ties 8 inches flatted face, by 6 inches thick and 8 feet long—2,640 to the mile. The material is White Oak, Hemlock or Tamarack, the former now becoming very scarce. White Oak lasts 10 to 12 years, and the other woods about 6 years.

The Atlantic and Pacific Railroad (Western Division) uses ties 8 inches by 6 inches by 8 feet long, mostly native pine, but on heavy grades and curves, oak ties are used, number to the mile 2616.

The Cincinnati Southern Railway specifies ties of "either white, post, burr or chestnut oak, "or other timber approved by the Engineer, cut "from sound live timber, free from rotten or "loose knots, worm holes, dry rot, wind shakes "or other imperfections affecting the strength "and durability of the wood. All bark must be "removed. They must be 8 feet in length, not "less than 6 or more than 6½ inches in thick-"ness, one-fourth the number must measure not "less than 10 inches face for the entire length of "the tie, and the remainder not less than 8 "inches; the faces must be parallel, not winding, "smooth, free from deep score-marks and "splinters. Ties must be cut square at the ends "and be straight in all directions. Not more "than one inch of sap will be allowed on the "face of sawed ties. 2,640 ties are used to the "mile of single track."

The standard hard wood ties of the Chicago & North Western Railway have the following order of value: White Oak, Burr Oak, Red Elm, Cherry, Black Ash and Butternut. They are 8 feet in length and 6 by 8 inches section if sawed, or 6 inches thick with 6 inches face if hewn.. The soft wood ties are Cedar and Hemlock, and have 7 inches depth by 7 inches face; 3,000 ties are used to the mile.

The Chicago, Burlington & Quincy Railroad use Oak ties entirely on main line, but cedar on some of the branches, the sizes being the same as for oak. The specifications for Oak ties require all to be hewn from sound live White, Burr, or Post Oak, 8 feet long when squared at the ends, not less than 6 inches and not more than 7 inches thick, at least 85 per cent. to have not less than 8 inches face and none less than 7 inches face,—3,000 ties are used to the mile on main line and down to 2,640 on the branches.

The cross ties are bedded in what is termed ballast. The embankment or cutting of the road is finished to a certain width depending upon the question of single or double track, and the class of road that is being built. In cuttings sufficient width must always be allowed for good drainage ditches on each side, and on embankments enough width to rightly sustain the ballast and ties. The road bed should then be sloped from the central portion to the sides to drain off properly. Embankments on single track are made from 14 to 16 feet wide at top, and 24 to 28 feet on double track. Cuttings on single track are from 16 to 21 feet wide, and on double track 26 to 32 feet. It may be necessary in some cuttings, depending upon the nature of the material and its liability to wash down on the track, to have very wide ditches, and these exceptional cases must be provided for. The road-bed being properly prepared, the ballast is laid upon it. This ballast is either broken stone, gravel, sand, burnt clay, cinders, shells, refuse coal siftings from the mines, etc., or simply earth, the latter being really no ballast at all, but merely the ties bedded in the earth, properly rammed, and surfaced with the right slope for drainage between the ties. The question of material for ballast depends altogether on what can be obtained at a reasonable price, and if inferior material is used of course so much the less perfect the road is.

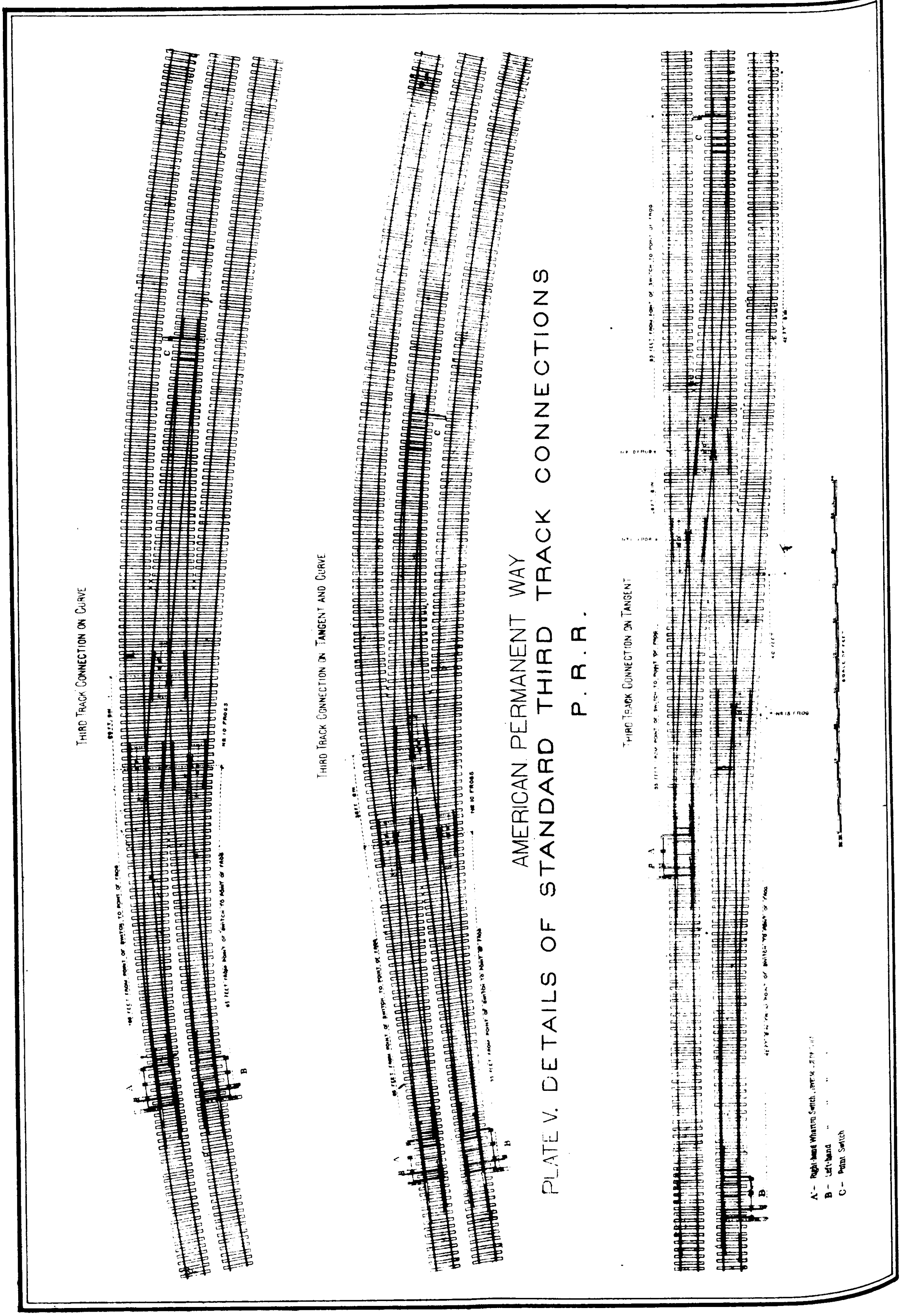
The ballast acts as an elastic bed, receiving the load from the moving train and spreading it out over a broad surface, and also serves as a drain to carry off the water from rain or snow to the ditches, and not allow it to freeze around the ties in winter, or to form wet holes in the road-bed, into which the ties and ballast will work and sink. First-class ballast material should be clean, hard and always of such consistency as will allow of the passage through it. The best ballast is a hard durable stone, not liable to decomposition or disintegration under the action of the weather, stones like limestone or trap, broken into angular fragments not larger than will pass through a two and a half inch ring. The amount placed under the ties is very variable, the question, unfortunately, not always being now much is best, but how much can the railroad company afford to use. For the best, or a first-class track, there should not be less than 12 inches, although many roads which are considered as high class, do not use over 9 inches.

On the Cincinnati Southern Railway, portions of the road through clay formation have 12 inches of ballast under the ties, other parts where the grading is light, have only 6 inches and the Engineer's estimates were made for the whoie line on an average of 9 ihches for main track and 6 inches for sidings (See Report of Dec. 1877, since which there may have been some modification of the standard). The ballast on this line is specified of gravel or broken stone: the gravel to be clean, free from clay, or boulders larger than two and a half inches in any direction, and must not contain more than one-third of sand; the broken stone to be of good durable and hard limestone or sandstone approved by the Engineer and not larger than two and a half inches in any direction.

The Chicago & North Western Railway Company uses as standard, one foot of ballast under ties, either gravel or broken stone.

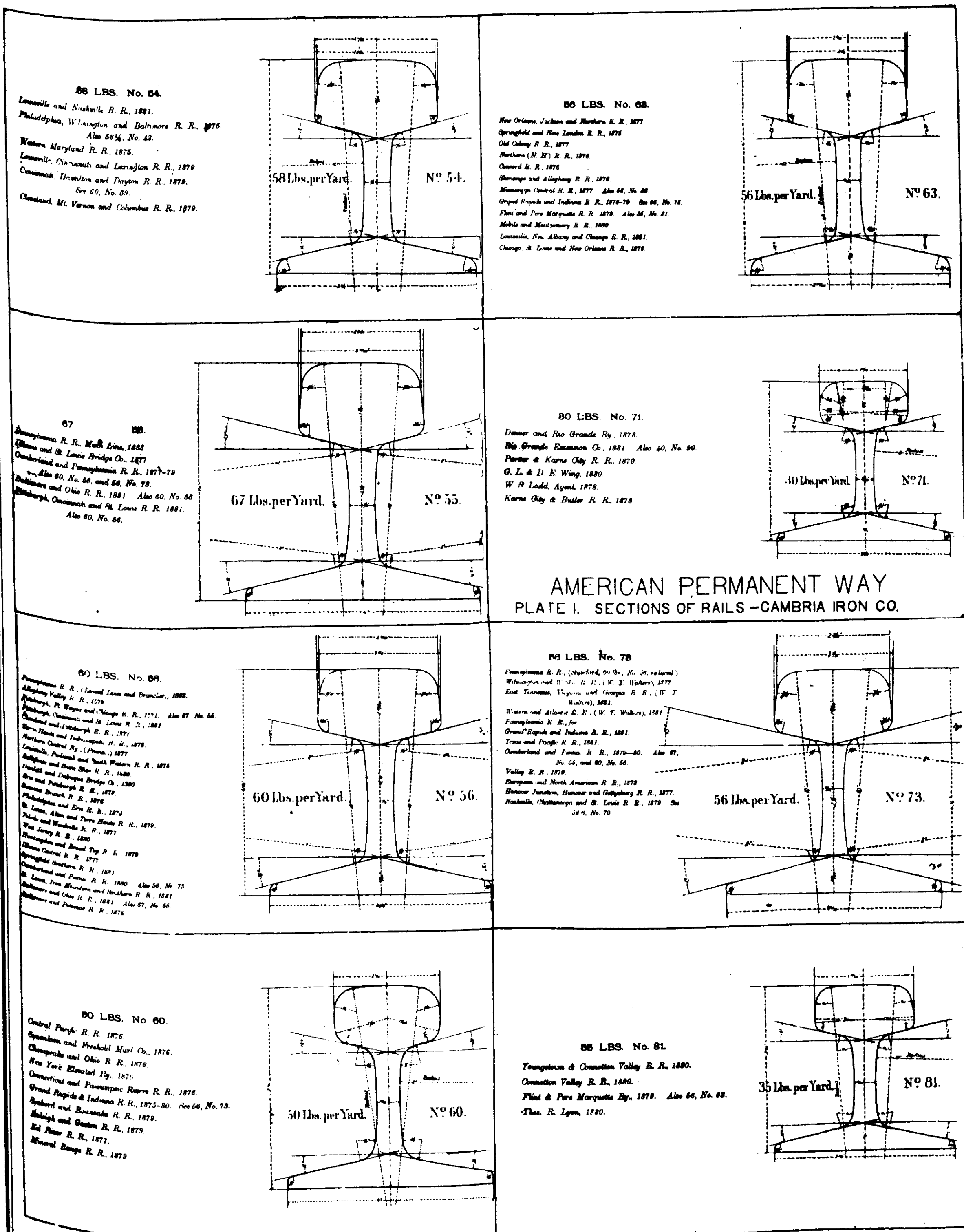
The Altantic & Pacific Railroad Company (Western Division) uses gravel, stone or earth ballast.

The Chicago, Burlington & Quincy Railroad Co. has been foo some time experimenting with burnt clay for ballast, having had two miles of


AMERICAN PERMANENT WAY
PLATE V. DETAILS OF STANDARD THIRD TRACK CONNECTIONS
P. R. R.
THIRD TRACK CONNECTION ON CURVE
THIRD TRACK CONNECTION ON TANGENT AND CURVE
THIRD TRACK CONNECTION ON TANGENT
A
B
C
A – Right-hand Wharton Switch
B – Left-hand
C – Point Switch

AMERICAN PERMANENT WAY.

(*See page* 258.)



this in use for two years, and it contemplates putting in about 15 miles additional this season. Where the road is not ballasted, it is surfaced up with the soil, filling in between rails about two inches above the tie, sloping each side so as to clear the bottom of the rail, and running down to the bottom of the tie at the ends. The Company possesses some excellent gravel beds in Illinois, has about 425 miles of its road ballasted with gravel in that state, and about 50 miles with broken stone. In Iowa, however, where the supply is deficient, it has only about 150 miles with gravel ballast and the same amount with broken stone. It is in Iowa that the burnt clay ballast will be used.

The Pennsylvania Railroad Company specifies that there must be a uniform depth of at least 12 inches of clean broken stone or gravel under the ties. The ballast must be filled up evenly between, but not above the top of the ties, and also between the main tracks and sidings where stone ballast is used. In filling up between the tracks, coarse large stones must be placed in the bottom in order to provide for drainage; but care should be taken to keep the coarse stone away from the ends of the ties. At the outer ends of the ties the ballast must be sloped off evenly to the sub-grade. When stone is used it must be broken evenly, and not larger than a cube that will pass through a two and one-half inch ring.

The Grand Trunk Railway Company of Canada uses gravel for ballast, from pits, taking the best the country affords, putting about six inches in depth under the ties, and filling in between the latter to their surface.

For good drainage the ditches must be ample, well made, with proper grades, and kept well cleaned out. The Pennsylvania Railroad Company has been sodding a great many of the slopes of its cuttings to prevent the material from washing into tne ditches, and the result has been very successful, saving the cost of maintenance and at the same time improving the appearance of the road. It has also had a number of gutters made with a concrete of Portland cement, two inches thick, laid on stone ballast four inches thick, having a granolithic top of one inch, and cut into flags of six feet long. These have given general satisfaction, and the use of them is being extended at various points. In its instructions to road foremen, the Pennsylvania Railroad Company specifies for ditches, "that the cross section at the highest point must be of the width and depth as shown on the standard drawing, and graded parallel with the track, so as to pass water freely during heavy rains and thoroughly drain the road-bed. The line of the bottom of the ditch must be made parallel with the rails, and well and neatly defined, at a distance of not less than 7 feet from the outside rail. All necessary cross drains must be put in at proper intervals. Earth taken from ditches or elsewhere must be dumped over the banks, and not left at or near the end of the ties, but distributed over the slope. Earth taken out of the ditches in cuts, must not be thrown on the slope. The channels or streams for a considerable distance above the road should be examined, and brush, drift, and other obstructions removed. Ditches, culverts and box drains should be cleaned of all obstructions, and the outlets and inlets of the same kept open to allow a free flow of water at all times."

All sidings should be kept in as good order as practicable, but it is not necessary that they be kept up to the standard of main tracks, second class rails and ties, or partly worn material from the main tracks being usually used for their construction.

In reference to turnouts and crossings from one track to another, the general arrangement is very well illustrated by the standard third track connections of the Pennsylvania Railroad, see Page 296. The switches shown on these plates are the Wharton and the Point switch. The old-fashioned stub switch is now entirely out of date. It will of course be found on many roads, but new switches of this kind are not being introduced anywhere in first-class work.

(To be continued.)

EXPERIMENTS UPON AUTOMATIC SPRINKLERS.*

BY G. J. H. WOODBURY.

Within the last five years, the protection of the more hazardous portions of textile mills, and other industrial establishments by means of automatic sprinklers, has become quite general in the eastern portion of the United States.

These sprinklers consist of a jet arranged to throw a spray of water, and ordinarily sealed, either by a metal cap which covers them and is secured by soldering with some of the alloys which melt at from 150° Fhr. and upwards, or the passage of water into the sprinkler is prevented by a valve held to its seat by levers which are sealed with this solder.

Before referring to a sprinkler system and its method of installation, reference will be made to the floor construction of an American mill.

Beams of southern pine, twelve by fourteen inches in section, run transversely across the mill in spans of about twenty-three feet, and eight to ten feet apart. Upon these beams three inch spruce plank are fastened; upon this is placed the top flooring, which consists of hard wood plank one and a quarter inches thick. This is the present method of floor construction, and on account of its solidity and economy is encouraged by engineers and underwriters, and forms an important element in what the latter term "slow-burning construction."

There are two methods of installing sprinkler systems dependent upon whether the sprinkler is designed to be placed in an upright or a pendent position.

For the upright sprinklers, pipes in communication with a water supply reach longitudinally with the mill, about sixteen feet from each other, and about fifteen inches below the ceil-

* A paper read before Section G of British Association at Montreal Meeting.

ing; at distances of eight feet branch pipes extend for about four feet in either direction, and sprinklers are attached at the ends of these branch pipes.

In the case of the pendent sprinklers, the pipes are placed against the floor plank forming the ceiling in the middle of each bay, and sprinklers connected directly to these pipes every eight feet.

With both systems of sprinklers the methods of supply are alike. The branch pipes extending along the ceiling of each room are connected to an upright pipe in the mill tower; at the upper end of the pipe is a large tank for furnishing a constant head of water upon the sprinkler system; and the lower end communicates with fire pumps, and a reservoir supply where it is available.

In order that the system shall have the benefit of the greatest head of water which communicates to the sprinklers, check valves are placed in the pipes leading from each of these several sources of supply, and *opening towards the sprinklers.* This arrangement causes the greatest water pressure to close the other check valves. Gate valves which are ordinarily kept open are situated at various places in the system for the purpose of diminishing the water damage after a fire.

The idea of using the heat of a fire to supply means for its extinction is very old; the earliest British patent upon that subject was issued to John Green, July 9, 1763, and consisted of a plan by which the fire should first burn a cord to release a valve which it held from opening. With slight modification this system of combustible cords is frequently re-invented, although the practical difficulties of insuring the combustion of the cord before the fire is under a dangerous headway, and the mechanical obstacles in the way of opening a valve after years of disuse, have prevented this system from ever reaching any practical value. In 1861, patents were issued for sprinklers sealed with fusible solder, but there does not seem to have been any general application of this principle, until Henry S. Par- Parmelee, of New Haven, Conn., made the sprinklers which were placed upon the market some twelve years later, Aug. 12, 1874.

The commercial progress of the matter was slow, until the results of the apparatus in promptly extinguishing fires in some of the few places where they had been installed developed a great demand for them for protecting hazardous property.

As a result of this success, a large number of automatic sprinklers have been invented, and about thirty-one different patterns have been in actual use, but the changes brought about by business combinations and the displacement of the earlier forms by improved devices leave only eleven different sprinklers now in the market.

At the conference of the executive officers of the Factory Mutual Insurance Companies of New England, the writer was directed to make an examination of the various automatic sprinklers in respect to their efficiency, for the purposes of mill protection, including their method of distribution and consumption of water when under various heads; to liability to accident and deterioration to their sensitiveness, and to all other matters pertaining to their practical operation. Four hundred sprinklers were purchased from the several manufacturers, and these in turn were exchanged at the mills for sprinklers which had been subjected to time pressure, and in some instances to corrosive vapors. The result of this work shows:

1st. That time and pressure has not affected the strength and fusion point of the solder during an experience of twelve years.

2nd. Portions of sprinklers where corrosion might interfere with prompt action should be protected, preferably by heavy mineral oil.

3rd. The distribution of water between three and thirty-six pounds' pressure is such that water is directed upon a smooth ceiling and upon each square foot of floor, with all of the sprinklers used in these experiments.

4th. The concentration of water at the beginning of a fire is greater than by any other form of inside apparatus.

5th. Where tanks are used for a first supply for sprinklers, the bottom of the tank ought not to be less than ten feet above the sprinklers.

6th. As a matter of practical application, sprinklers have worked at 141 mill fires in seven years without any known instance of their failure.

7th. The result of the experience in respect to automatic sprinklers demonstrate that their efficiency is not liable to become impaired by time, and prove the good judgement of those underwriters who advocated their introduction as a safeguard against loss,

8th. It is essential that valves be so arranged that the proper persons can readily know that a full-water pressure is upon the sprinklers. Valves with travelling stems are preferable on this account. Valves with stationary stems can be fitted to show their position by winding around the valve stem a line with a weighted tag at the end. When the valve is open or shut, the tag will hang in a corresponding extreme position of the line. Left-hand valves should not be used as sprinklers. It is well to secure the valves open with a riveted strap; if it is necessarry to shut the valves on account of mishap, anybody can cut it, but do not use a lock and chain, as the key will in the nature of things be lost, and the valve spindle bent in the efforts to sunder the chain.

One building fully equipped with automatic sprinklers has been destroyed. The sprinklers were inoperative because the valves in the feed-pipes were shut. This contingency of a want of water-supply or pressure does not militate against the sprinklers.

The facts upon which these conclusions are based are herewith submitted. No single characteristic defines the merit of a sprinkler; but, after consideration of all the facts, each one can assign due weight to the various items which constitute desirable elements in a sprinkler, and forms opinions which are, to a certain extent, applicable in each instance. It is easier to offer a criticism than to make a sprinkler which will resist the shocks of water hammer, and the broom of the small boy; or to devise a sprinkler whose mechanical operation will not be disabled by corrosion or sediment, and which will be ready for effective work when ever needed after the lapse of many years.

Reports that the Lehigh Valley Railway Company intends using the right of way of the Seaboard and Western Railroad Company, from Ashland to Pittsburgh, or building an independent line between these points, is emphatically denied by the Lehigh Valley railroad officials. They state they are entirely satisfied with the present traffic arrangement in that quarter.

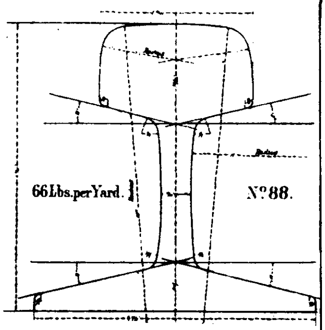
SAFETY CATCH FOR ELEVATORS.

From opposite sides of the cage floor rise two standards, whose upper ends are united by a beam. To each standard near its upper end is secured a cross beam, at the ends of which are vertical rods which have their lower ends attached to the corners of the floor. The standards have forked clips at the top and bottom, which embrace the two side guide beams in the elevator shaft. Hung on the ends of the cross beams are stirrup rods, on which rest the free ends of sheet iron tops, which are hinged on rods connecting the upper ends of the standards. Resting upon a rubber spring secured to the lower

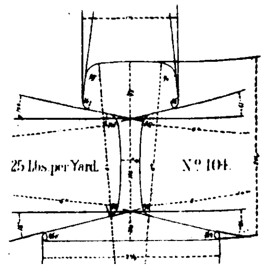
AMERICAN PERMANENT WAY.

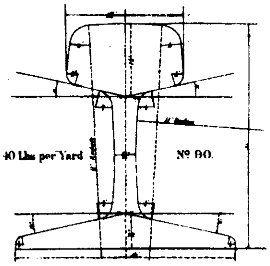
(*See page* 258.)

66 LBS. No. 88.
Chicago, Burlington and Quincy R. R., Main Line, 1881.



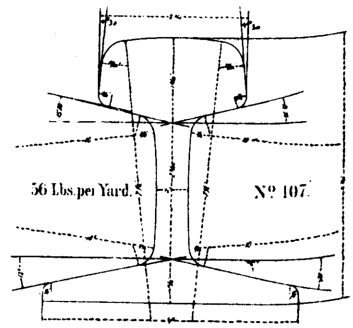
25 LBS. No. 104.
Morley Bros., 1883.



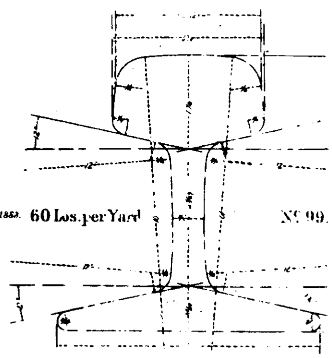


To accompany paper of Jas. M. Wilson, A.M.C.E.

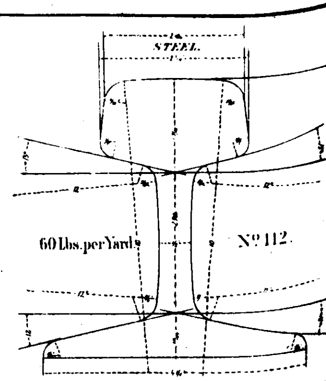
Illinois Central R. R., 1883.



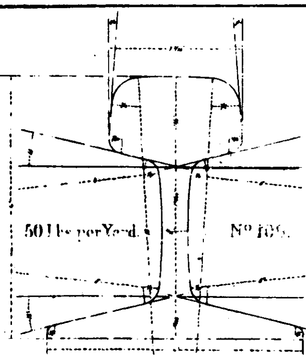
60 LBS. No. 99
Cin., New Orleans & Texas Pacific R. R., 1883.
Alabama & Great Southern, 1883.



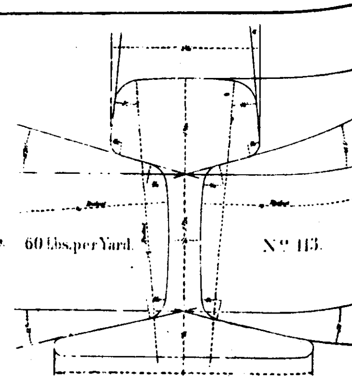
Chicago and North Western Ry. Co., 1883.
This Company uses 65 lbs. per yard on main lines



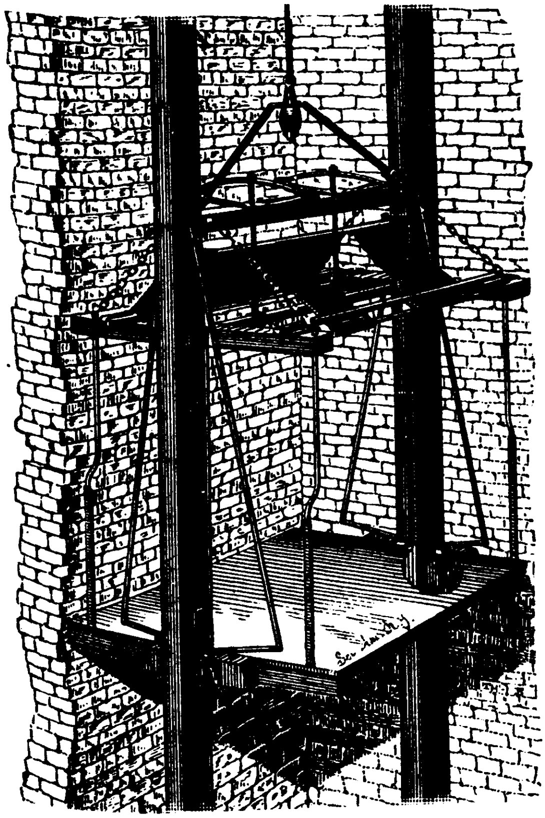
50 LBS. No. 100.
Penna. R. R., Branch Lines, 1883.
Cin., Van Wert & Mich. [illegible] Co., 1883.
Toledo, Cincinnati and St. Louis, 1883



60 LBS. No. 113
Illinois Central R. R. Co., 1883.



end of the hoisting cable is a V-shaped inverted hanger, upon the end of which are pivoted the ends of a bar carrying a beam. Between the ends of the beam and the bar are held clips which embrace the guide beams, and which are formed with outwardly projecting lugs. Chains are attached to clips upon the ends of this beam and to the upper ends of the corner rods. Passing through apertures in this beam are rods secured to the beam uniting the tops of the two standards; upon the upper ends of the rods are held elliptic springs. On each end of the floor a lever is pivoted, at each side of the standard, to the outer ends of which are pivoted rods whose upper ends are joined to the clips. To the inner ends of the levers are pivoted rods which



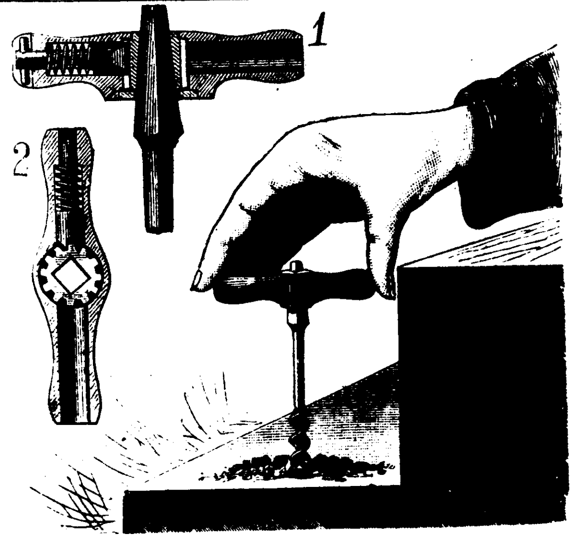
GILES' SAFETY CATCH FOR ELEVATORS.

pass through holes in wedge shaped blocks having transverse teeth formed in the faces towards the sides of the guide beams. Blocks are secured to the ends of the floor in such a manner that their beveled edges face the beveled edges of the lever blocks.

It will be seen that the cage is suspended from the spring rods, the springs being compressed. The beam carrying the springs keeps the outer end of the levers raised, and the blocks are held a short distance from the guide beams. When the cable breaks, the springs exert a downward pressure thereby forcing the beam downward, and through the rods and levers pressing the blocks against the sides of the guide beams, firmly locking the car in place.

RATCHET TOOL HANDLE.—(*Ex.*)

Fig. 1 is a sectional side elevation, and Fig. 2 a sectional plan view of a ratchet tool handle recently patented by Mr. Christian Hermann, of Bristol, R.I. The handle is a straight bar of suitable length formed with a recess in which is seated a ratchet sleeve having an angular aperture for passing upon the tool shank. The handle is bored lengthwise through both ends, and in one held is a sliding pawl that engages the ratchet sleeve. A spiral spring acts to move the pawl, the movement being limited by a cross pin through the outer end of the dog, than enters a groove in the handle to prevent the pawl from turning accidentally. The ratchet is held in the recess by a ring plate fitted to the under side of the handle in a manner to allow removal. The hole in the opposite end of the handle



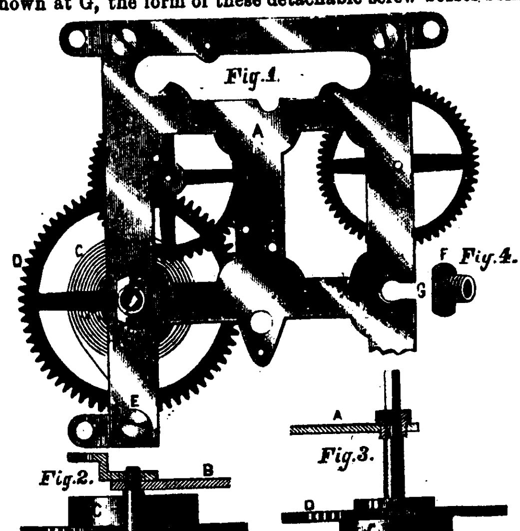
HERMANN'S RATCHET TOOL HANDLE.

permits the insertion of the dog, and can be used to receive a bar and to give greater leverage.

This handle can be readily applied to bits, screw drivers, and other tools, and by drawing back the pawl and giving it a half turn the ratchet mechanism is changed from right to left, so that the handle can be used to withdraw a boring tool or back out a screw.

AN IMPROVED CLOCK FRAME.—(*Sc. Am.*)

The invention herewith illustrated provides for the ready removal of the main spring or springs and main wheels of a clock without disturbing the rest of the movement, or taking it apart in case of breakage, or for necessary repair, and so they may be quickly and easily replaced. The front plate of the frame A, Fig. 1, is made with a peculiar slotted construction for a screw boss or front bearing for the arbor of the main wheel, as shown at G, the form of these detachable screw bosses being



WYKHUYSEN'S INPROVED CLOCK FRAME.

as represented by F, Fig. 4. One main spring, C, and wheel, D, are shown opposite, fixed in place in a similar bearing. E represents the pillar or bolt of the main frame, to which the main spring is attached, and this pillar has at its rear end a screw thread adapted to screw into the back plate of the movement B, as shown in Fig. 2, although the rear bosses may be permanent attachments, as in Fig. 3.

This invention has been patented by Mr. Hendrik Wykhuysen, of Holland, Mich.

THE CAUSES AND REMEDIES OF CORROSION IN MARINE BOILERS.*

Marine engineers are all striving in various ways to attain increased economy of fuel in steamers. Among other means of doing so, triple-expansion engines of high initial pressure are being introduced, which appear to be gaining much favor, and will no doubt in time supersede the ordinary two-cylinder type. The increased pressure of steam evidently renders it necessary to be still more guarded than hitherto as to the deterioration of boilers. Steel boilers are now in very general use, and there can be no doubt as to their efficiency ; but the writer's experience is that they are equally liable with iron boilers to corrosive influences. On careful scrutiny he has found in steel plates severe corrosions concealed by a very slight scale, upon the removal of which the plate has proved to be covered with a black substance, probably a black oxide of iron. In many cases a casual inspection may fail to detect this. Internal corrosion is well known to be most erratic in its action ; it attacks the metal in different parts of a boiler, in different ways, and from various causes. The principal sources of corrosion, however, may be discussed under the two heads of defective design and defective management ; which is equivalent to saying that an ordinary marine boiler will hardly be subject to corrosion at all, if well designed and well managed.

Design.—The most frequent fault of design which bears upon corrosion is the want of sufficient space for allowing a thorough examination to be made of every part of a boiler. The tubes are often placed so far out in the wings that it is impossible to get down to look at the sides of the furnaces, or so close to the furnace crowns that there is no room to get over these. It would be preferable to allow at least nine inches between each furnace crown and the bottom row of tubes, especially as this row is not useful as heating surface when placed so close down to the crown. The manholes are often inconveniently placed and made too small, which always affords an excuse for a want of proper attention on the part of the men in charge. Manholes should always be fitted in the wings if the size of boiler will allow. There can be no doubt that the best way to prolong the life of a boiler is to watch it carefully and constantly, so as to note the commencement of deterioration and take steps to check it. In any part which cannot be seen, it is impossible to know what is going on. Another fault of design, which easily escapes notice until too late, is the pitching of the steam-space stays, so that one or perhaps several of them come over a space, instead of over a tube, thus rendering the effective use of the scaling tool very difficult, or even impossible in that particular vertical space. With the object of securing the conventional 20 square feet of heating surface per horse-power, the tubes are sometimes too closely pitched, which causes bad circulation, besides rendering the spaces liable to become soon choked with scale. The tubes should never be less than 1¼ inch apart, both vertically and horizontally.

Management.—The first point to be looked to in the management of a boiler is the circulation. In an ordinary multibular marine boiler the circulation takes place by the water ascending from the furnace crowns, and from the sides, backs, and fronts of the combustion chambers, and descending at the wings ; the tubes do of course somewhat obstruct the upward current. There can be no doubt that the coolest places in the boiler are those where the circulation is most defective, as is naturally the case below the level of the fire-bars. The water in this part of the boiler always contains the greatest percentage of solid matter, and here the greatest deterioration may, therefore, be expected to be found. Double-ended boilers are not only subject to the same corrosive action as single-ended ones, but being longer they are also more prone to suffer from racking strains, due to the difference of temperature between their upper and lower parts. One method of reducing this difference as far as possible, is to fit the internal feed-pipe so that it is led along on a level with the upper tubes, so as first to warm the water inside it, and is thence carried down so as to discharge the warmed water in a horizontal direction at the bottom of the boiler. The scum pipe should be fitted with a pan, shaped like on inverted saucer, and placed just above the level of the water for the scum to collect under it ; and it should always be blown off upon raising steam, and also about once a day when under weigh. The blow-off cock should either be attached at the bottom of the boiler, or else an internal pipe should be fitted to it, reaching down to the very bottom. Salt is not deposited until the density of the water exceeds 4–32nds by the salinometer, that is, until there is no more pounds of salt in 32 pounds of water ; beyond this proportion the deposition of salt then begins upon the furnace crowns, etc. It is recommended that the opportunities occurring from time to time by the engines being stopped should be taken advantage of for pumping up the boiler to the top of the gauge glass, and then blowing it down to the bottom of the glass. This, repeated about twice or thrice on each occasion, will work wonders. The great usefulness of this plan arises from the fact that while the engines are stopped there is little or no steam being made, and therefore no solid matter is being deposited from the water ; so that the extra feed-water pumped in at that time does much more to freshen the boiler than it would if the engines were at work. When in charge of the engines of a steamer on a voyage from England to Rangoon, calling at several ports on the way, and thence to Venice, the writer kept water in the boilers continuously during the whole round, that is to say the boilers were never entirely run out and refilled, but were blown down from time to time as above described. They were under steam about seventy-two days and upon being opened out at the end of that time had only a slight scale upon them of uniform thickness, and no indication of pitting or corrosion.

The mode of treatment adopted by the writer for new boilers is to have them well washed out before filling, then to run them up, and when they are filled with water up to the normal height, to throw into each through the top manhole about a bucketful of common soda. When steam is raised to about 30 pounds per square inch, blow out a little through the scum cock. Before adding any more water, start the feed donkey, and let it deliver for some time over the side of the ship, so as to get rid of any dirt, etc., in the pump ; this is a very useful precaution to observe whenever the feed donkey is employed. After starting the main engines, let them run at first with the feed-water overflowing from the hot-well into the bilges ; this will clear the condenser. When under weigh, it is advisable to use the blow-down cocks sparingly. The appearance of the water in the gauge-glass shows at a glance the state of the water in the boiler ; if the glass is at all dirty inside, that is proof positive of the water not being clean enough ; and this can be cured by the use of scum cock. In a double-ended boiler a scum pipe should be fitted at each end. The scum pipes are sometimes so fitted that their position can be altered to suit the trim of the ship, which is a point of far more importance than is generally imagined. After a run, when steam is finished with, the water should be blown out from the bottom, and the boilers then kept thoroughly dry. Before refilling they should be carefully swept down inside, and washed out.

There is no doubt that one of the most active causes of deterioration in boilers is the want of proper care in their treatment. Cases have come under the author's notice of boilers being blown down as far only as the level of the bottom manholes, and refilled, without care being taken to draw the water out of the bottoms. This process having been frequently repeated, the waters at the bottoms became so impregnated that the heads of the rivets and the lower half of the compensating rings round the manholes were corroded away, while the other parts of the boiler were in good condition. Many good boilers are ruined through careless management and the makers are wrongly charged with allowing their work to come from the shop not properly finished. Another example, out of numerous cases met with, is that of a pair of boilers which were fitted some little time ago with hydro-kineters, or internal steam jet nozzles for stimulating the circulation of the water in the cooler spaces below the surface flues. Upon a recent examination the valves of these appliances were found to be hard and raising steam too quickly, and blowing out under too great a pressure, which cannot be too strongly condemned. Corrosion in the upper parts of the boiler is principally caused by the introduction of oil, tallow, and other greasy substances from the engines. In all the steamers with which the writer is connected he has discarded the use of all oil or other lubricant in the cylinders, with the most satisfactory results.

Various remedies have been suggested for preventing corrosion : among other, air extractors and circulating tubes. Zinc has been tried, both cast and rolled, and some engineers report favourably on its use ; but to make it effective, very large

* [A paper read at the Cardiff Meeting of the Institute of Mechanical Engineers, of London, August, 1884, by Mr. J. HARRY HALLETT, Cardiff.]

quantities must be used, as it so quickly oxidises, and thus loses its protective qualities. The electrogen of Mr. Hannay's invention, which is rapidly gaining favor, is a very simple little appliance, and, as far as the writer has experimented with it, is very effective. The principle upon which it works is the setting up of a small galvanic battery in the boiler, by means of a ball of zinc cast upon a copper bar, and then hammered, to make it more impervious to the action of water; on each end of the copper bar a wire is soldered, and the two wires are again soldered to different parts of the boiler, so as to obtain metallic contact. Boilers which had shown a tendency to corrosion looked quite healthy in a very short time after these appliances had been fitted to them. Marine boilers are not troubled with much external corrosion, especially modern boilers, because much more care is now taken in fitting them into the ships than was formerly the case. They are now properly coated, and are not fitted too close down the bottom of the ship, plenty of room being allowed for access to the seams. But that all the mischief to be contended with is not confined to the waterside of the boiler is shown by the following incident. Some four and a half years ago the writer was called in to survey a boiler that had exploded and killed the chief engineer and fireman. Upon examination it was found that the bridges had been built up close to the backs of the combustion chambers; the dirt, etc. had been allowed to accumulate for some time, and corrosion had been going on upon both sides of the plate without being noticed. After the accident, when all had been cleared away, the iron was found to have oxidised so much that in some parts it was barely 1-16th of an inch thick; hence the explosion. The backs had been so built for the express purpose of economizing fuel; but experience goes to prove that this is a fallacy, and many cases could be mentioned where similar bridges have been taken out without making any difference in consumption of fuel, except that, if anything, the economy has been in favor of their absence. There is nothing like cleanliness to prolong the life of a boiler. When a vessel is to be laid up, a good plan is to pump the boiler full up to the very top of the dome, and keep it so until it is again required. Another method of preserving a boiler not in use is to empty it and clean it thoroughly, then close all the manhole doors except one at the bottom, put in a small stove full of burning coke, and close up the bottom door quickly. The object of both these methods is, of course, to exclude air as thoroughly as possible.—THE LONDON *"Iron."*

Engineering Notes.

COAL DUST FUEL IN FRANCE.—The United States Commercial Agent at Nantes says that the coal dust, which was formerly rejected as worthless, is now consumed in immense quantities in France in the form of "patent fuel," or coal bricks. The natural supply of dust from the yards of the coal merchants being entirely insufficient for the needs of the brick works, the manufacturers, particularly in the Nantes district, import a large quantity of coal dust from Cardiff, Swansea, and Newport. The process of manufacture is very simple. The coal dust is mixed with pitch, and the mixture poured into cups attached to a belt, each cup containing just enough material for a brick of the size desired. The belt in its movement passes this material through a chamber where it is exposed to steam, which fuses the two substances into a homogeneous mass.

This is poured by the descent of the belt into moulds, where it is subjected to an enormous pressure by a hydraulic press or by machinery set in motion by a steam engine. The brick is square in form, its thickness being about one-third of its other dimensions, and it weighs five, ten, or fifteen pounds. Certain of the French railway companies refuse to accept fuel unless at least 10 per cent. of pitch has been used for its agglomeration. It is stated that briquettes are preferable to ordinary coal for exportation to the colonies and to warm climates on account of their compact storage and freedom from small fragments and dust, also for use on locomotives, both on account of economy of space and because firemen can always determine the amount of fuel they are employing in a given time, the weight of each brick being exactly known. The manufacturers claim that the "patent fuel" is more healthy for domestic use than ordinary coal, citing in support of this theory the declaration of certain well known physicians. At the present day a large number of bricks are made for domestic use, of small size, and perforated with circular or longitudinal openings.

TREES AND PLANTS AS PURIFIERS.—The beneficial effects which plants and trees may produce on dwelling-sites and on the air of habitations have been made the subject of a paper by Dr. James Evans, before the South Carolina Medical Association. The network of fine fibrous roots of trees and plants, traversing the soil in every direction, feed on the organic matter which would otherwise undergo decomposition, polluting the soil, air, and surface water. The vegetation also absorbs excess of moisture and drains the soil. This moisture is afterwards exhaled from the leaves, and there is no doubt that plants also exhale, with the moisture, some of their active and peculiar principles. The scent of mint and thyme is due to menthol and thymol, antiseptics of the highest value, and it is not improbable that their exhalations have the same property. The eucalyptus is remarkable as a prophylactic against malaria. Its leaves immersed in hot water are also said to be an efficient disinfectant in the sick room. By virtue of their power to generate ozone and to split up carbonic acid, absorbing the carbon and setting free the oxygen, plants remedy to some extent the evils of bad ventilation. In Pasteur's virus-culture experiments he found that, when they were conducted under a diminished supply of oxygen, the germs retained their primitive virulence, but, on the contrary, when they had access to oxygen the virus became weaker. It has been known for a long time, that marsh miasm is intercepted by a forest, and that persons living in a locality so screened are exempt from attacks of malarial fever. The explanation of this is probably to be found in this discovery of Pasteur. When a cloud of malarial germs are wafted from a marsh to the neighboring forest, they encounter a continuous stream of oxygen pouring forth from every leaf, attenuating the virus and rendering it innocuous.—*Sanitary Engineer.*

SETTING WATER WHEELS.—In preparing to set wheels first excavate wheel-pits (if there be none, or not of sufficient depth), put down mud-sills and shut them over with two inch plank (unless there be a rock bottom). These pits must be from two to five feet in depth, according to size of water wheel. It should always be borne in mind that too free a discharge can not be made. Wheels should always be set so that the draft tube or cylinder will set at least two inches in tail water when standing. The tail-race as well as the wheel-pit, should be both wide and deep, and, if possible, the level of bottom of wheel pit should be carried on the whole length of the tail race to the stream, which is easily done when the race is short. When the desired depth can not be given the whole length of the tail race, in should be made up in width, and in this case the bottom of tail race should slope gently to bottom of the wheel pit, in order to avoid an abrupt opposing surface. There should be, if possible, two feet in depth of dead water in the tail race when the wheel is not running, in order to avoid the raising of the water in the tail race and consequent loss of head. In placing the wheel, great care must be taken to see that the wheel sets perfectly level. No fastening is required to keep the wheel in position, as its own weight and the pressure of the water will hold it in water.

MARVELLOUS ENGINEERING —The London Inner Circle Railroad is a marvelous feat of engineering skill. It runs throughout its entire distance under the busiest centre of the largest city in the world, and the operations attending the excavation and construction have proceeded without injury to or interruption of business or traffic. Quicksands have had to be passed through, beds of old rivers spanned, lofty warehouses and massive buildings secured while their foundations have been undermined, and an intricate network of gas and water pipes sustained until supports had been applied to them from below. Added to this the six main sewers had several times to be reconstructed. Day and night the work has been carried on for 18 months, and now the engineers are able to announce that their tunnel is complete. The laying of the rails and the building of the stations are the only portions of the immense work that remain to be done, and in a very short time trains will be passing over the whole of this wonderful subterranean road.

POLISH FOR PINE WOOD.—A wash of one part nitric acid in ten parts of water will impart a stain resembling mahogany to pine wood that does not contain much resin. When the wood is thoroughly dry shellac varnish will impart a fine polish to the surface. A glaze of carmine or lake will produce a rosewood finish. A turpentine extract of alkanet root produces a beautiful stain which admits of French polishing. Asphaltum thinned with turpentine makes an excellent mahogany colour on new wood.

THE MOVEMENTS OF THE EARTH[1]

VI.

WE have now to consider some of the results of these Movements of the Earth—first round its own axis, its rotation; then round the sun, its revolution—which we have been considering, results to which of course a general interest attaches, and which there will be no difficulty in showing are of very great importance to us. Occasion was taken to point out that the different appearance presented by the sun and the stars was simply due to the fact that the sun was very near to us whilst the stars were very distant, the one, a sun which happens to be near to us, the others, also suns, but happening to be very far removed from us. Now suppose we have a globe in which we have an electric light, to represent the sun, and a little globe to represent the earth, then it will be obvious that that part of the earth which is turned towards the lamp will be bathed in light, while that half which is turned from it will be in darkness, being, so to speak, only under the light of the distant stars. This shows us the reason for that great difference which we call day and night, and we can quite understand how it is that we get the apparent rise of the sun which occurs when the part of the globe on which we live is carried from the darkness into the light, and sunset which of course occurs when the globe is being carried by its rotation from the light into the darkness. This phenomenon of day and night is thus one of the most obvious results of the rotatory movement of the earth, and one which might have been dismissed in two words had we so chosen, but we will dwell upon it for a few moments, because this fundamental difference between day and night furnishes us with a reason why we should discard that sidereal time to which up to the present reference has alone been made.

49.—Diagram showing how the difference between the lengths of the sidereal and mean day arises.

Fig. 49 will show how it is that under the circumstances in which we thus find ourselves, a new kind of time must take the place of sidereal time. In this diagram we have the earth represented at two positions in its orbit, 1 and 2. It travels in this orbit in the direction of the arrows, rotating on its axis the while in the direction also indicated by arrows. Now let us consider the start-point 1, and suppose that when the earth occupies this position a particular star is on the meridian at midnight. The earth it will be remembered rotates in twenty-four sidereal hours; it will therefore take twelve hours to turn half round, so that if we consider the sun to be directly opposite the star which is south at midnight it is obvious that they are twelve hours apart. Now consider the earth at position 2. Then remembering this fundamental fact, that the distance of the stars is so enormous that a string stretched from the observer to the star at one point of the earth's orbit would be practically parallel to a string stretched to the same star from any other part of the orbit; it is obvious that the star will have the same right ascension in both positions of the earth, and the line pointing to the star will be practically in the same direction. But the sun will no longer lie along the prolongation of the line joining earth and star as it did at 1, for in consequence of the earth's revolution round the sun we shall get a gradually increasing angle as the earth in its orbital course gets farther and farther from its initial position at 1. Now it is obvious if we are going to have our time regulated by the sun instead of by the stars—and that is what we must do for the purposes of civil life—we shall have to arrange our clock so that when we pass from 1 to 2 it must, if it showed 12 o'clock when the sun was due south in the former position, show 12 o'clock also when the sun is due south in the latter position. If this be so, and we have this angle made by the line joining sun and earth and star, we shall have to make our sun-clock go more slowly than our sidereal clock, for the reason that the sidereal clock will have gone round once in less time than the earth will have got round to the same place with regard to the sun. But if we choose, and we do choose, to say that we will have twenty-four hours from sun-southing to sun-southing, then these twenty-four hours and necessarily also their minutes and seconds, will be longer than the hours, minutes, and seconds of sidereal time. Let us take another illustration. Consider the case of the earth in three different positions, represented by three globes round a central lamp. Then suppose that in each of these globes a wire is put to represent the direction in which the transit instrument points at Greenwich when the same star is observed at three consecutive intervals of twenty-four hours of sidereal time. These three wires should therefore be placed parallel to each other. Now let us take the electric lamp to represent the sun, then we shall find that, when the transit instrument on each of the earths is brought round to point at the sun, the three wires which represent the instruments will not be parallel to each other but at some angle. At first sight it might seem that we could easily get a sun-time to replace the star-time, but unfortunately when we go a little deeper into it we find, as we often do in other cases, that it is not quite so easy—and for two reasons. We found, it will be remembered, when we came to consider the form of the earth's orbit, that it was not quite circular, that it was in fact what is called an ellipse, and that the radius vector, *i.e.* the imaginary line joining the centres of the sun and earth did not sweep through equal *arcs* in equal times but through equal *areas*, so that, if we want to invent a clock which will show twenty-four hours from the time of sun-southing one day to the time of sun-southing the next, that clock will require to be regulated differently for every day in the year, because the greater or less part of its orbit moved over by the earth will cause the greater or less angle between the lines joining sun, earth, and star.

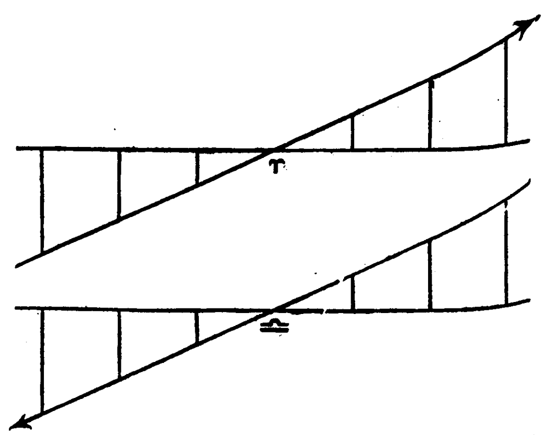


FIG. 50.—Diagram showing how the sun's apparent motion along the inclined lines representing the ecliptic in the direction indicated by the arrow-heads is represented by a smaller amount when referred to the earth's equator (the horizontal lines in the figure) at the spring (♈) and autumn (♎) equinoxes.

That I hope is clear. Thus then there is good reason why this arrangement of having a sun-time from noon to noon will not work. We should have to regulate our clock for every day in the year, or rather for every two opposite days. But there is another matter. We are now in full presence of the fact that the equator of the earth is inclined at an angle of about 23½° to the plane of the ecliptic. Fig. 50 will perhaps enable us to understand this matter more easily. Let the horizontal lines represent the plane of the equator and the inclined lines the

Continued

plane of the ecliptic. Now our clock and all measurements of time must depend upon the earth's rotation, the plane of which always remains parallel to itself, and we have seen that our start-point for geocentric and heliocentric longitude depended upon the fact that at a certain point in its revolution the earth passed through a node, and that the node at which the sun with its apparent motion crossed the equator northward was called the ascending node. In the diagram this is represented by ♈ in the upper figure, and the descending node is indicated by ♎ in the lower figure. It will be seen that if we have equal intervals along the ecliptic the motion along the equator is represented by bases of successive triangles, of which the hypothenuses lie along the ecliptic. Now the hypothenuse must be

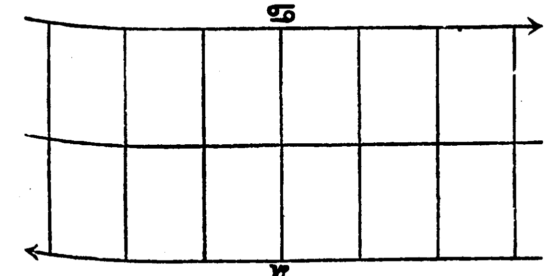


FIG. 51.—Diagram showing how the sun's apparent motion along the ecliptic, now parallel with the earth's equator (the central line of the figure) at the summer (♋) and winter (♑) solstices, is represented by equal intervals along the equator.

greater than the base, so that we have at the ascending node the motion of a body along the ecliptic represented only by the base of a triangle of which the motion itself represents the hypothenuse; and the same thing happens in the opposite manner at the descending node; whereas if we take the other positions shown in Fig. 51, for a short time at all events the motion will be parallel, and motion along the ecliptic will be represented by an equal amount along the equator.

These then are the difficulties we have to face when we come to fix our sun-time, first the unequal velocity of the earth round the sun; and secondly, those variations which are brought about by the fact that the two motions of the earth—its axial rotation and yearly revolution—take place in different planes. How are these difficulties got over? They are got over by pretending a sun, as a child would say. Astronomers pretend that there is a sun moving along the equator, or, in other words, they pretend that the earth's movement of revolution takes place in the same plane as its movement of rotation. It is further imagined that this imaginary sun travels at precisely that rate which it would if the average of all its rates along the ecliptic during a year were taken, so that we get something like this (see Fig. 52); first of all we have the curve B B B B, which shows the variation which would take place providing we only had to deal with the obliquity of the ecliptic. Where that curve crosses the horizontal line, we get at those moments (if we disregard the elliptic motion) the same time shown by the mean sun as we should get if the true sun had been taken; it will be seen this occurs four times during the year—on March 20, June 21, September 23, and December 22. Then there is another curve, C C C C, which represents another relation between the mean sun and the true sun. Providing that the two planes were coincident, and that the movement of the earth under these conditions were exactly the same as under the present conditions, namely, that she moved in an ellipse and that the radius vector swept over equal areas in equal times, then we should have the true and mean sun coincident on December 31 and July 1 only. Then the algebraic mean of these two curves, B B B B and C C C C, is taken, and we get as a result the lower curve D D D D, which is a compound of the two other curves, and as the result it will be seen that where we got the curve C. giving us a difference of nearly five minutes, and the curve B, giving a difference of about nine minutes in the same direction, we have a very great departure between the motions of the real and mean suns. Above and below the datum line, which is marked zero, we have 5, 10, and 15, which represent the difference in minutes at which the southings of our real and fictitious suns really take place. Early in the month of February we have a difference of very nearly fifteen minutes between the two suns, and it is at this time of the year of course that the sun dial is most in error. At other points where the effect of curve B is to cause a great difference, the effect of curve C will be to minimise that difference, and so in the compound curve D the difference is very slight. About the middle of June we get them together, then towards the end of July we get another separation, and about November 1 we come

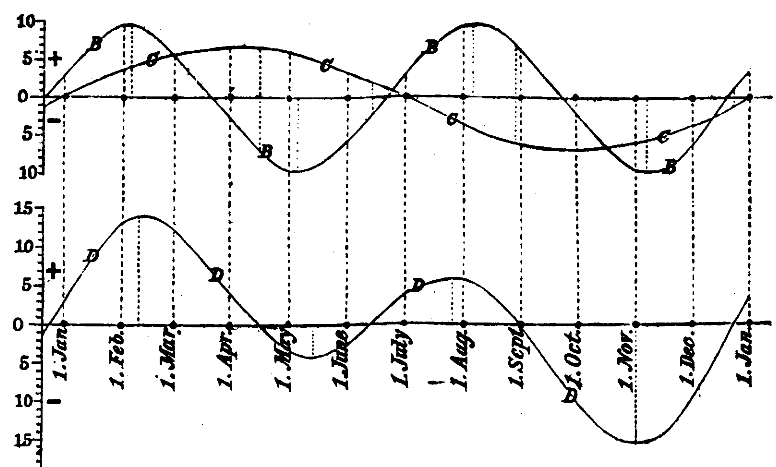


FIG. 52.—Diagram showing how the equation of time (curve D D D D) results rom the combination of curve B B B B representing the vairation due to tha obliquity of the ecliptic, and curve C C C C representing the difference between the mean and true suns.

to another difference even greater than that in February. In this way a correction has been introduced, which is known as the "equation of time," and this added to the motion of the true sun, or added to that of our imaginary sun, brings them together, and by this means the mean sun is kept as nearly as possible to the average position of the true sun throughout the year. Another diagram (Fig. 53) will enable us to understand some of the considerations which have brought this about. Let P represent the position of the sun in one of the foci of the ellipse, P e A, round which the earth is supposed to be travelling. Now while we have the real radius vector going from P to e, with its unequal motion along the orbit, we have a fictitious radius vector going with absolute constancy along the circle. We get what is called the true anomaly in the angle P F e, and the mean anomaly in P F e', and the difference e F e' is called the equation of the centre. This equation helps us to determine those curves to which reference has been made, and the chief object in calling attention to this diagram is to explain the meaning of the term anomalistic year, which it will be necessary to introduce presently. It has already been said that it is imperative, if we are to gain any advantage from it, that real sun-time and apparent sun-time should never be widely separated, because if so we might have contented ourselves simply with sidereal time, which would have at least the advantage of being constant, so that it is most necessary if any benefit is to be derived from this mean sun of ours that it should not differ very much from the true sun. The longitude of our mean sun is therefore made equal to the mean longitude of the true sun. This having been premised, the terms "mean time" and "mean noon" will now be clear without any explanation. "Greenwich mean time" of course means time referred to the meridian of Greenwich.

We thus finally discard our sidereal time, and replace it by mean solar time so arranged that the maximum departure of this from true solar time shall be fifteen minutes in the month of February and fifteen minutes at the beginning of November. We have seen that the sidereal day is shorter than a solar day, and that consequently the hours, minutes, and seconds which make up the sidereal day must be shorter than those which form the solar day. The relation between the seconds of solar and sidereal time may be thus shown.

One sidereal second = ·9973 of a mean-time second.

One mean-time second = 1·0027 of a sidereal second.

We have now got the results of the earth's revolution combined with its rotation, so far as day and night, considered in their more general aspects, are concerned; but we have not done with day and night yet. When we were considering the question of the inclination of the earth's axis, we went so far as to say that it was inclined $23\frac{1}{2}^{0}$ to the plane of the ecliptic, and that it always remained practically parallel to itself. Now suppose we arrange four globes in a circle, to represent the earth in different parts of its orbit, and we have in the centre an electric lamp to represent the sun. Then, if the earth's axis is thus inclined to its path round the sun, and always remains parallel to itself, it will be seen that at one position the north pole will be all in the light of the electric lamp (which represents the sun) during the entire revolution of the earth on its axis. At the point opposite this the reverse happens, for during the entire rotation of the earth the north pole will be in the dark. At the two remaining points the pole will be just on the boundary of light and darkness. We need not consider the case of the south pole; there exactly the reverse will happen to what occurs at the north pole—when the north pole is always in the light, the south pole will be always in the dark and *vice versâ*, as may be seen by looking at the globes. Now it should be clear that the fact of the earth's axis being inclined to its path causes different lengths of day and night throughout the year. It is simply that, and nothing else. At the poles, which, as we have seen, are sometimes entirely in the light and sometimes altogether in the dark, there will be six months of this light and six months of darkness. At the equator it will be readily understood the days and nights will be of twelve hours' duration at whatever part of her orbit the earth may be. If you take those positions of the earth where the boundary of light and darkness passes through both the poles, it is perfectly clear that the days and nights are of equal length all over the world, and a line drawn from those points through the sun is therefore called the "line of equinoxes." These points are respectively at the ascending and decending nodes of the orbit. The two other points where the North Pole is most in the light or in the dark during the whole of a rotation are known as the solstices, because it is at these times that the sun for some days appears to attain the same height at noon.

To sum up then, it will be seen that the earth's rotation and and the earth's revolution, in conjunction with the important fact of the non-coincidence of the planes in which they take place, give us not only our days and our nights, but cause the year. We have in this inclination of these planes to each other, too, the cause of the seasons, because when the northern hemisphere of the earth has been for a long time in that position with the sun longest above the horizon, the temperature will be very different to what it is when the earth is in the other position. In the former position we have summer in the northern hemisphere, in the latter winter. The conditions of life at two such points in the orbit will be vastly different. At the equator, where the days and nights are always of equal length, the course of nature will be very uniform. As the equator is receded from and the poles are approached, this uniformity begins to disappear until, as has been said, at the pole six months of perpetual daylight alternate with six months when there is no sun.

But even now when we have got our day and our year, we have not got all.

It must next be pointed out that, whilst the axis of the earth may be said to remain practically parallel to itself, yet that it does not absolutely remain so.

As a result of this and of the earth's movement round the sun, we get a very important outcome. Although the consideration of the dimensions of the earth has scarcely come within our subject, yet the earth's rotation may be used to bring in the dimensions of the body on which we dwell in just the same way as the velocity of light was used to refer to the dimensions of its orbit.

We need not, however, consider the question in detail, but we may state that the earth is a globe of something like 8000 miles in diameter, the equatorial diameter being longer than the diameter from pole to pole by some twenty-six miles, so that we have, as it were, round the equator a ring of matter some thirteen miles thick and eight thousand in diameter. Now this ring of matter, this equatorial protuberance, is presented to the sun at an angle to the line joining the centres of the sun and earth, as shown in Fig. 54, and the sun's attraction upon it can be resolved into two forces, one parallel to the line joining the centres of the sun and earth, and the other at right angles to this direction; and if we consider what will be the effect of this latter force upon such a ring, we can easily understand that it will result in an alteration of the inclination of the ring. In an arrangement for showing the effect of this attraction, the ring of matter on which the sun acts may be represented by an iron ring attached to a spinning top, and the resolved portion of the sun's pull may be imitated by the attraction of a magnet held in a nearly vertical position. As the ring rotates, the attraction of the magnet draws the ring out of the horizontal, and the poles revolves in a circle. This is what takes place with the earth's axis; hence it is not true to say that it always remains parallel to itself. This revolution is always slowly going on, being completed in a period of about 25,000 of our years. In consequence of this motion, what happens is this: the line of equinoxes which is at right angles to the line of solstices is constantly changing its position along the earth's orbit, producing what is called the procession of the equinoxes. We have to consider, therefore, not merely the sideral year, the time between which the earth is at one point with reference to the sun and a star, and the time when it is at that same point again; we have not merely to consider the fact that this line of solstices, with its conjoined line of equinoxes, varies with regard to what is called the apse line, that is, the line joining the perihelion and aphelion points of the orbit, or the axis-major of the ellipe—but we get from this another year which is called the tropical year, which, like our mean time, is the one most used, because it brings the year into relation with our seasons. Now that we have got our mean time and know exactly how and why we have got it, we may express the sideral year in mean time, and say that it consists of 365.256 solar days. The tropical year—the time which elapses between two successive passages through the vernal equinox—is shorter than the sidereal one, owing to the procession along the orbit of the equinoctial points, and consist of 365.242 mean solar days, and the difference between the lengths of this and the sideral year will of course give the annual amount of precession which takes place. Anomalistic year is the term applied to the period which elapses between two successive passages through the perihelion or aphelion points of the orbit; and as these points have a forward motion along the orbit, this year is longer than the sidereal one, being 365·259 mean solar days.

We may give the exact lengths of these years in days, hours, minutes, and seconds as follows:—

	Mean solar time. d.	h.	m.	s.
Mean sidereal year....	365	6	9	9.6
Mean tropical year....	365	5	48	46.054440
Mean anomalistic year	365	6	13	49.3

The Movements of the Earth are so important to us, and so interesting in themselves, that it is not possible in six lectures to exhaust all that may be said about them or learned from them. I trust however that I have left no point of the first importance untouched. The moral of these lectures is that astronomy has appealed to physics, and has not appealed in vain, for the demonstration of the physical reality of the movements in question.—*Nature.*

J. Norman Lockyer.

INFLUENCE OF THE EARTH'S ROTATION ON THE FLOW OF RIVERS.

Mr. G. K. Gilbert contributes a new element to the discussion of "the sufficiency of terrestrial rotation for the deflection of streams, in a paper read to the National Academy of Science in April, and recently published in the *American Journal of Science*, which is presented by *Science* as follows: Taking Ferrel's measure of the deflective force that comes from the earth's rotation, Mr. Gilbert shows, by a remarkably simple consideration, that its value is not so much in throwing the whole stream against its right bank, as in selecting the swifter threads of the current and carrying them against the bank; and, further, that this action will have especially well marked development in meandering streams, where it will aid the cutting on the meanders of right-hand convexity, and diminish it on those of left-hand convexity. For the Mississippi, the selective tendency thus determined toward the right bank is nearly nine per cent. greater than toward the left; but it is not stated that the valley form has been noticeably affected by this preference. On Long Island, however, the form of the valleys is clearly controlled by the earth's turning, as was first suggested by Mr. Elias Lewis some years ago, and recently confirmed by Mr. J. C. Russell.

The article by Mr. Gilbert advances the question not only by properly applying the law to rivers flowing in any direction, but further by giving it a more delicate analysis than it has yet received, with the conclusion that in a certain favorable case the form of a valley may be decidedly influenced by this hidden control. While the result is of interest to physical geographers, the method of analysis has a wider importance. The application of mathematics to terrestrial physics has too often been fruitless from dealing with problems in a simplified or idealized form that departs too widely from the complications of natural conditions. This was notably the case with the supposed demonstration obtained by Hopkins in his geological speculations. It is therefore gratifying to find that increased value of Von Baer's law, now found by Gilbert, comes essentially from a close consideration of the actual rather than of the ideal conditions of river-flow. It is an advance in the application of mathematics as well as in the explanation of facts.

The lateral tendency of rivers was first noticed in the case of the Volga, which undercuts its right bank, as it should in this hemisphere. Other examples are found in North Carolina, in the channels of the streams flowing eastward to the coast, where the southern banks are the steeper; again on Long Island, and on the plains of New Zealand. But the radical valleys of south-western France afford better illustrations than any of these, inasmuch as their forms are accurately shown on the great map of the army engineers. North of the Pyrenees, about the towns of Tarbes and Auch, there is an old sandy delta deposit spread out by the rivers from the mountains while this region was still under water; and since its elevation, the streams formed upon it all follow its gentle slopes, diverging like the ribs of a fan from the higher centre toward the lower margin, and cutting down their channels into the old delta plain. There is nothing here in the flat layers of unconsolidated sands to determine an unsymmetrical form in the valleys; and yet they all show most distinctly a gentle slope on the left, and a steeper slope on the right; longer lateral branches on the left, and shorter ones on the right; and many of the highways, constructed parallel to the streams on the as yet unbroken uplands, are clearly closer to the streams on their left than on their right. All this is a direct effect of the earth's rotation.

It is customary, in speaking of the deflective force that arises from the earth's rotation, to say that it acts to the right in the northern hemisphere, but to the left in the southern. The reason for this is not found in a change in the direction of the force, but only in a change in our way of looking at it. It is as if one should look at the face of a watch in the northern hemisphere, and say that the hands turn to the right, and then, on going to the southern hemisphere, look at the back of the watch, and say that the hands turn to the left. Let us therefore suggest that tne geographers of the southern hemisphere look at their winds and storms and streams from the upper side, just as they look at their watches; and, although this would involve them in the slight inconvenience of standing on their heads it would give them the moral satisfaction of seeing that the deflective forces of the earth's rotation, as well as the hands of their watches, "always make for the right."

HALF-HOUR WITH THE FLOWERS USED IN PERFUMERY.*

BY W. A. WRENN.

Allow me to claim your indulgence to deviate slightly from the literal translation of the title of this paper, as, in addition to flowers, I have added a short description of some substances used in the manufacture of perfumes and toilet essences, either for the purpose of fixing the odor, such as ambergris, or as is required in some cases to develop the scent of certain flowers susceptible to such influences, and to give them preponderance, such as musk; or, again, to make a distinctness of their own, such as that caused by the addition of acid benzoic.

Doubtless some may think such a paper as this rather out of place among pharmaceutical and chemical data. What right has the pharmacist to engage in the compounding of perfumes —why not leave it to the coiffeur or perfumer proper? is a question which has been asked more than once, and opinions have been much diversified. I myself regard the manufacture of perfumes as a very suitable adjunct to the varied duties of the pharmacist. A sensitive nose is a very useful appendage to a chemist's physiognomy; and what can be a more crucial test than the continual intercourse with essential oils and their varied aroma to detect the numerous admixtures and sophistications which are of every-day occurrence?

Again, the peculiar odor of a pharmacy, so attractive to feminine whimsicalities, is due in the main to the excess of the odor of the perfumes and essential oils over the more nauseous aroma of drugs proper; while in the matter of £ s. d. I think a unanimous opinion exists.

With these preliminary remarks I will ask the attention of those who, perhaps, have passed over in recollection the interesting and varied metamorphoses between the time flowers are seen in the fields and their ultimate deposition as concentrated extracts in a toilet bottle.

A half-hour is such a limited space of time to treat such an interesting subject that I have decided to mention only those flowers, fruits, etc., which are more largely used. These are bergamot, cassie, cloves, heliotrope, jasmin, lavender, lemon, mignonette, narcissus, orange, patchouli, pelargonium, rose, rosemary, thyme, tuberose, verbena, and violet; and briefly note ambergris, gum benzoin, musk, orris, tonquin, and vanilloes.

Bergamot, the essential oil obtained from the fruit of *Citrus bergamia*. It is very similar to the lemon, being golden yellow in colour externally, smooth peel, and pale yellow pulp. The flowers, however, resemble those of the bitter orange. The tree *Citrus bergamia* is cultivated in Sicily, and more especially in the neighborhood of Reggio. The oil is obtained by expression, though formerly by the sponge process, from the fruit in a partly unripe state, gathered in the end of the year —November and December. The quantity of oil obtained is about 3 oz. from 100 fruits. The oil, when newly prepared, deposits a albuminoid substance, and in a month or so a white fat, called "bergaptene" or "bergamot" camphor. The green tint is due to chlorophyll, which, in a very minute quantity, may be coagulated by heat and separated by filtration, leaving the oil with a brownish tint.

The sp. gr. is about .830 to .890 in genuine samples. Hanbury gives .860 to .880; some samples gave sp. gr. .858 and .865. These were found to be adulterated, probably with turpentine and ess. of lemon, the spr. gr. of the former being as low as .823, and of the latter .832 to .880. The quantity of oil used in perfumery is very great, and the shipments, which are made principally from Palermo and Messina, are still on the increase.

By mixing together—

Ess. bergamot	40	cubic centimetres.
Spirits of wine	5	"
Nitric acid, sp. gr. 1,200	10	"
Water	45	"

and allowing this to stand for two months, shaking about twice a week, I obtained a fine crop of crystals (sample of which I place before you this evening). They resemble those of terpin hydrate as obtained by Mr. R. H. Parker from oil of turpentine.

Essence of bergamot is a feature in the perfume Ess. Bouquet, said to be a favorite scent of George IV.

CLOVES, the flower-buds from the evergreen *Caryophyllus*

*A Paper read before the Chemists' Assistants' Association.

MOVEMENTS OF THE EARTH.

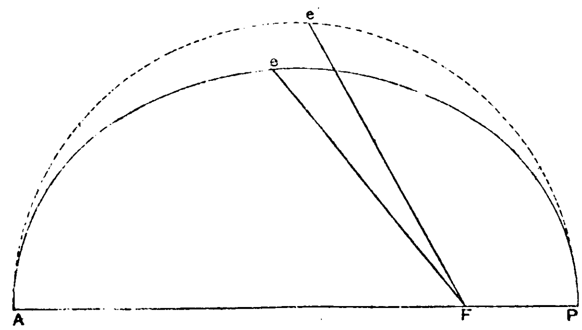


FIG. 53.—Diagram explaining mean anomaly and true anomaly.

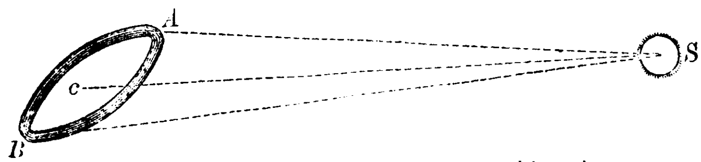


FIG. 54.—The attraction of the sun on the earth's equatorial protuberance.

aromaticus, are so well known that I will not dwell upon them. Suffice it to say that the oil to be used in compounding perfumes snould always be the finest English drawn, and re-distilled.

The crude oil, and also that known as oil of clove stems, can be detected by the dark color, and by giving a "paon" blue color when shaken up with three times its volume of alcoholic solution of ferric perchloride, and also a deep violet if shaken up with some reduced metallic iron Oil of pimento might be used instead of oil of cloves, and when the latter is given in a recipe, using half oil of cloves and half pimento, a very good blend is the result I may also mention that I find an addition of 2 per cent. of ammoniated alcohol to all the spice oils resists their volatilization.

HELIOTROPE.—This well-known perfume is often prepared from the flowers of *Heliotropium Peruvianum*, or from the British variety, as one would suppose, considering the powerful odor these flowers emit; a combination of vanilla and violet being the most common substitute

JASMIN, obtained from two species of Jasminum, *J. officinale* and *J. Grandiflorum*, of the natural order of Jasminaceæ, which also supplies the lilac (*Syringa*). The jasmin, or jessamine, is a small bush cultivated in the garden and flower farms of Grasse, to an extent greater than any other flower, although it is the most difficult to bring to perfection, being very sensitive to changes of temperature and soil. The perfume is greatly increased by the heat of the sun, and a rainy and dull summer between the months of June and October, when the shrub flowers, is as great a disaster to the Grasse perfumer as a wet harvest is to the English farmer. The essence obtained from jasmin is used as a basis for almost every compound scent, and I always form an idea of the status of the Grasse manufacturer by the quality of his jasmin pomade and essence, for, unles very carefully prepared, rancidity will quickly take place.

LAVENDER.—The natural order Labiatæ embraces several shrubs which yield very powerful volatile oils used for perfumery and flavoring, and also possessing medicinal properties in the forms of stimulants, carminatives, aromatics, etc There are three distinct qualities of the oil; two distilled from *Lavandula vera*—Mitcham, or English, and French, principally from Les Alpes Maritimes; and that from *Lavandula spicata*—a very inferior sample, called "oil of spike." The first named—the Mitcham—at the present time, commands a very high price—about as many shillings an oz. as the French oil is worth per lb.—and there is every prospect of still higher prices, as year by year, when passing through Mitcham and the adjoining villages of Wallington, Carshalton, Beddington, Waddon, Cheam, and Sutton, I have noticed fields once under lavender and mint cultivation fallen prey to the ever-increasing inroad of the speculating builder. Ten years ago there were about 350 acres of lavender; now, I believe, there are not 150 acres. It is also grown at Market Deeping and a few other places—to what extent I am not prepared to say; and I should certainly consider it would pay any speculator to direct his attention to lavender cultivation.

In England the flowers are collected in July and August, when in full bloom, and are generally distilled with the stalks as gathered, the yield being about 20 oz. for every 100 lbs. Take this for granted, and an average crop of 800 lbs. per acre gives 160 oz., or 10 lbs. Now, suppose the increased cultivation should bring down the price of English oils to 100s. per lb.; this shows a value of £50 an acre, and at the rate of 50 per cent. for working expenses, stilling, rent, etc., I believe a very good return could be made. A friend of mine who some five years ago laid down about a quarter of an acre of garden ground has been fully satisfied by the amount realized by the sale of the flowers, even from so small a plantation.

The exotic oil is obtained principally from the south of France, also from Northern Italy, Sicily, and Algeria. The department of Les Alpes Maritimes produces the finest samples. The highest hill-slopes grow the nearest approach to the Mitcham.

The different qualities exported by the Grasse manufacturers are almost as numerous as the letters of the alphabet, and are distinguished by such terms as essence de lavande cultivée, lavande du Piedmont, lavande des fleurs mondées, lavande éperle, lavande fine, lavande 1re qualité, 2me qualité, etc. In the neighborhood of Avignon I noticed some lavender growing, and was told the product was of rather inferior quality, the country being low and flat, and the soil poor. Mont Ventoux, in the same vicinity, which I traversed in my holiday tour, grows lavender of very fair quality; the altitude is about 400 feet above sea level.

Lavender oil is used in perfumery largely as lavender water, combined with orange and rose water, and in essences best combined with oil of cloves and benzoic acid.

Essence d'aspic is the distillate of the wild flowery plant *Lavandula spica*, and is rarely found free from adulteration, a certain quantity of prepared turpentine being added in accordance with the price wished for. Camphor is also added to conceal this addition. Oil of spike is used in the arts and also in veterinary practice. It is not produced in Britain, the climate being too cold.

THYME.—Another plant of this natural order Labiatæ is *Thymus vulgaris*, which yields an oil used in perfumery. It is imported into this country from France; it grows also in the Western Peninsula, Lombardy, and the mountainous shores of the Adriatic and Greece, and is to be found in almost every English country garden for culinary purposes.

The distillation in Southern France is made from June to September, and the two samples of oil of thyme—red and white—are obtained from the same plant, the redistilling keeping back the coloring matter, but at the same time destroying some of the aroma. I should recommend the red oil in preference to the white, and if the color (which is often intensified by alkanet) is not desired, animal charcoal will remove it very considerably.

ROSEMARY (*Rosmarinus officinale*) may be now added as belonging to the same natural order, growing in the same localities and under similar circumstances. It is also grown in Britain, and a small quantity of oil is distilled, but, owing to the small amount used, quite a fancy price is the rule.

The last three oils—lavande d'aspice, thyme, and rosemary—are used mostly for soap-scenting, their terebinthinate odor excluding them from the category of the more delicate perfumes.

OIL OF PATCHOULI, from the plant *Pogostemon patchouli*, which is grown in the Malayan archipelago. The oil is much used in perfumery, though, owing to circumstances, not to such an extent as formerly. Chiefly used in conjunction with otto de rose. Owing to its lasting odor a very small quantity only should be used in proportion to other ingredients.

LILY OF THE VALLEY *Convallaria majalis*), with its pure white, bell-shaped, and delicately-scented flowers, is made into essence and pomade in the Grasse manufactories, and found of great use for perfume compounding. The plant flowers in early spring, February and March being the best months for manufacturing the essence.

DAFFODIL. (*Narcissus pseudonarcissus*)—Daffy-down-dilly—which is found in almost every country in Europe, yields a pleasant perfume. It flowers in Grasse about April, and a little later in England. When once planted in a garden the yield will soon be found greatly in excess of the wishes of the cultivator.

ESSENCE OF LEMON.—This oil, so largely used in flavoring, etc., is also employed in perfumery. Like oil of orange, it is very uncertain in its results, owing to changes in composition consequent on keeping for any length of time. Essence of lemon is prepared in the same manner as essence of bergamot, but there is a variety termed "essence de citron zeste," which is prepared by simply puncturing the oil-vessels and allowing the oil to run out, collecting it in a receiver, and filtering. This is the best article for use in perfumery, as commercial essence of lemon is generally contaminated with very inferior distillates, or with rectified oil of turpentine, which can be detected by adding some liquor potassæ to a sample and applying heat.

OIL OF ORANGE (*Citrus vulgaris, Citrus aurantium*, and *Citrus bigaradia*).—From the fruits are obtained the oils of bitter and sweet orange. This perfume is not very extensively used in perfumery in the shape of oil. The water obtained from the flowers, distilled during the month of May, is imported in large quantities from the south of France.

From the flowers is also obtained an essential oil termed "oil of neroli." The best test to ascertain its purity is to shake up a small quantity with a saturated solution of sodium bisulphite, when a permanent crimson color will be produced. The sp. gr. is .890, and the oil is neutral to test-paper. There are two varieties of oil—essence de neroli bigaradia, and essence de neroli Portugal.

Oil of petit grain is obtained from the leaves and shoots of the above-mentioned varieties, and called "essence de petit grain bigaradia et Portugal."

A mixture of oil of orange and oil of neroli, with other essences, makes a very good substitute for essence of ylang ylang (a sample prepared from a formula by myself is on the table for your inspection). Oil of petit grain is used extensively in the manufacture of eau de Cologne.

MIGNONETTE (*Reseda odorota*) is well known and is much esteemed for its fragrance. Flowering in March and April, it is then prepared for use in perfumery. The cold March winds sometimes spoil the crops for the season. Several imitations are in use, and are very similar to the genuine perfume.

PELARGONIUM ROSEUM.—Rose geranium is grown for perfumery in Provence, and there is an Algerian product known as "essence de geranium d'Afric," inferior to that distilled at Grasse. This oil is used to adulterate otto de rose. Owing to the small yield—viz., 1 lb. from 1000 lbs.—it is expensive, and its characteristic odor is greatly esteemed as an addendum to the numerous items in millifleur essence. Ol. geranii E. I. is not to be confounded with pelargonium, but is obtained from several species of the genus Andropogon, and termed "ginger-grass oil."

ROSE.—First, the species *Rosa Gallica*, cultivated in Southern Europe, Asia Minor, and Britain. The petals of this flower are obtained in their most perfect state for druggists' use from Mitcham. The quantity there obtained is very small, and Mitcham rose petals therefore command a high price; the same remark applies to all English-cultivated rose leaves. The dried Continental leaves are often dyed with aniline, which may be detected by macerating in spirit to which is added a few drops of ammonia. The true state of the leaves can soon be seen.

Rosa Damascena.—From this is obtained the much-prized otto, or attar, of roses, which now rules at a high price. When first incroduced into this country it was subject to duty about 10s. per oz.; this was greatly reduced, and in 1880 was taken off altogether.

Otto of roses is imported from Bulgaria and Turkey, principally from the southern side of the Balkan range—from Kizanlik and Philippopolis—and from Smyrna (Asia Minor). It is also made in India, in the valley of the Ganges, but is never exported thence. There is also a little manufactured in France, but the quality will not bear comparison with Kizanlik. Otto is largety adulterated, as I mentioned previously, with oil of rose geranium (pelargonium), and also with oil of *Andropogon schœnanthus*, a grass grown in India, which is exported to Turkey solely for the purpose of adulterating otto.

The best tests for genuine otto are the degree at which it congeals, which should be 55° Fahr., and the appearance of the mass The crystals, or laminæ, should be shiny, feathery, and nearly transparent. When thick and milky, and more deposited at the bottom of the bottle than at the top, spermaceti is present, and perhaps paraffin wax, which latter is hardly so readily detected as spermaceti.

Rose-water is also prepared from *Rosa Damascena*, together with the essence and pomade, and imported from Grasse, Cannes, and Nismes.

TUBEREUSE.—Tuberose grows in the neighborhood of Grasse, and is a bulb which requires to be replanted each spring, not being of sufficient hardiness to stand the winter. It blooms from July to October, and is not very extensively cultivated. Being a very delicate perfume, it is prepared by the cold "enfleurage process."

VIOLET (*Viola odorata*) is the most esteemed of all perfumes. It is cultivated over a large expanse of country, extending as far west as Avignon; in fact, wherever the olive is grown, being planted chiefly in olive orchards, which protect the plants from the cold winds, to which they are very susceptible. The flowers are gathered in February and March. The crop is often a failure, the result being a considerable increase in the price of the pomade and essence, in addition to bad quality.

VERBENA.—That variety which is used in perfumery il *Lippia citriodora*—lemon-grass plant—and is prepared at Tras vancore and Singapore, in the Straits Settlements. The oi- should be redistilled before use for compounding.

AMBERGRIS.—A very useful adjunct to a toilet essence. When preparing essence of ambergris macerate in hot water, to which is added the same quantity, by weight, of liquor potassæ as the ambergris; spirit to be added after a day or two, and maceration continued for two months before using.

MUSK.—The same remarks apply here. Always rub down the grain with sand or pumice-stone before using. The addition of one pint of any simple essence made from pomade—jasmin preferred—increases the permanence of musk. A few drops of acetic acid prevents the accumulation of ammoniacal aroma.

Orris.—Use only the finest Florentine; exhaust by maceration and percolation.

Tonquin and Vanilloes should be both selected from good samples, and care should be taken to remove the fixed oil, which may be done by adding ½ pint of water to each gallon of the essences, when the oil will float on the surface. If not separated when compounded the essences will require a second filtration.

Acid Benzoic.—This I have found a valuable addition to essences which are made from essential oils, and not from pomades. It is needless to add that only the English resublimed and that prepared from gum benzoin should be used.

The preparation of pomades and essences in the south of France has been so ably and minutely described in Piesse's "Art of Perfumery" that I cannot do better than advise you to study the book yourselves. I may add that the cold "enfleurage process," which is performed by strewing layers of flowers over thin layers of fat, the flowers being renewed daily until a good perfume is obtained, is more used than formerly, and it is the desire of manufacturers to export what are termed extra-saturated pomades in place of the well-known No. 24 strength.

Methyl Chloride has been suggested as a good menstruum to exhaust flowers of their perfumes, and a manufactory on this principle was established at Cannes. I do not know if it has turned out a success. The chief difficulty at first was to have a pure methyl chloride which was obtained by treating the ordinary methyl chloride with sulphuric acid, which absorbed the greater portion of the impurities. The extract has to be concentrated in vacuo—another source of difficulty—so I doubt if the old process of fat maceration can be beaten.

SUN-SPOT INEQUALITIES.

ABSTRACT OF REPORT BY B. STEWART AND W. L. CARPENTER COMMUNICATED TO ROYAL SOCIETY BY REQUEST OF THE SOLAR PHYSICS COMMITTEE.

It has been known for some time that there is a close connexion between the inequalities in the state of the sun's surface as denoted by sun-spot areas and those in terrestrial magnetism as denoted by the diurnal ranges of oscillation of the declination magnet; and moreover the observations of various meteorologists have induced us to suspect that there may likewise be a connexion between solar Inequalities and those in terrestrial meteorology.

This latter connexion, however (assuming it to exist), is not so well established as the former, at least if we compare together Inequalities of long period. It has been attempted to explain this by imagining that for long periods the state of the atmosphere as regards absorption may change in such a manner as to cloak or diminish the effects of solar variation by increasing absorption when the sun is strongest and diminishing absorption when the sun is weakest.

On this account it seemed desirable to the authors to make a comparison of this kind between short-period Inequalities, since for these the length of period could not so easily be deemed sufficient to produce a great alteration of the above nature in the state of the atmosphere.

The meteorological element selected for comparison with sun-spots was the diurnal range of atmospheric temperature, an element which presents in its variations a very strong analogy to diurnal declination-ranges.

There are two ways in which a comparison may be made between solar and terrestrial Inequalities. We may take each individual oscillation in sun-spot areas, and find the value of the terrestrial element corresponding in time to the maximum and the minimum of the solar wave. If we were to perform this operation for every individual solar Inequality, and add together the results, we might probably find that the magnetic declination-range was largest when there were most sun-spots. If, however, we were to make a similar comparison between sun-spot daily areas and diurnal temperature-stations, such as Toronto, it is suspected (the verification or disproval of this suspicion being one of the objects of this paper) that there are two maxima and two minima of temperature-range for one of sun-spots. The effect of this might be that in such a comparison the temperature-range corresponding to a maximum of sun-spots might be equal in value to that corresponding to a minimum, or, in other words, we should get no apparent result, while, however, by some other process proofs of a real connexion might be obtained. But if we can get evidences of apparent periodicity in sun-spots fluctuations when dealt with in a particular manner, we have at once a method which will afford as a definite means of comparison. And here, as Professor Stokes has pointed out, it is not necessary for our present purpose to discuss the question whether these sun-spot Inequalities have a *real* or only an *apparent* periodicity. All that is needful is to treat the terrestrial phenomena in a similar manner, or in a manner as nearly similar as the observations will allow, and then see whether they also exhibit periodicities (apparent or real) having virtually the same times as those of sun-spots, the phases of the two sets of phenomena being likewise allied to one another in a constant manner.

It is such a comparison that the authors have made, their method of analysis being one which enables them to detect the existence of unknown Inequalties having apparent periodicity in a mass of observations. A description of this method has already been published in the "Proceedings of the Royal Society" for May 15th, 1879. The comparison was made by this method between sun-spot observations extending from 1832 to 1867 inclusive, Toronto temperature-range observations extending from 1844 to 1879 inclusive, and Kew temperature-range observations extending from 1856 to 1879 inclusive. The following conclusions were obtained from this comparison.

(1.) Sun-spot Inequalities around 24 and 26 days, whether apparent or real, seem to have periods very nearly the same as those of terrestrial meteorological Inequalities as exhibited by the daily temperature-ranges at Toronto and at Kew.

(2.) While the sun-spots and the Kew temperature-range Inequalities present evidence of a single oscillation, the corresponding Toronto temperature-range Inequalties present evidence of a double oscillation.

(3.) Setting the celestial and terrestrial members of each individual Inequality, so as to start together from the same absolute time, it is found that the solar maximum occurs about 8 or 9 days after one of the Toronto maxima, and the Kew temperature range maximum about 7 days after the same Toronto maximum.

(4.) The proportional oscillation exhibited by the temperature-range Inequalities is much less than the proportional oscillation exhibited by the corresponding solar Inequalities.

COST OF THE ELECTRIC LIGHT IN FRANCE.

A paper recently read by M. Ph. Delahaye before the Société Technique de l'Industrie du Gaz en France, gave an account of the progress made by the electric light during 1883. He commenced by a brief account of the inventions of the year, and then turned to the question of expense, as compared with that of gas, founding his conclusions upon figures derived from typical installations. He stated that among manufacturing establishments the installation at the Cail workshops was among the most interesting, as it comprised both arc and incandescence lamps. The total superficial area illuminated is 251,880 square feet, and the number of lights 177, of which 94 are arc lamps and 88 incandescence lamps. The cost, without land and buildings, was £4900, and the maintenance per hour is 1.07d, for the arcs and .10d. for the incandescence lamps, the power required being 1.38 horse-power for the former, and 10 kilogrammetres for the second. The total working expense is 19s. 2d., or .003d. per carcel hour (one carcel=9.5 standard candles). The amortisation and interest on capital, and the maintenance, taken together at 15 per cent., represent £736. Assuming a mean of 500 hours lighting per annum there must be added on this account .0046d. per carcel hour, which will bring the total cost to .0076d. The total expense is £2.44 per hour, or equal to the cost of 7167 cubic feet of gas at 6s. 9d. per 1000 ft., a quantity of gas which M. Delahaye does not think will even be brought to yield the same amount of light as is furnished by the electricity. He next takes the case of the Grand Magasin du Printemps. The lights burn five hours per day for 300 days in the year, with the exception of thirty Jablochkoff candles in the basement, which are in use nine hours per day. The annual cost for candles, carbons, and electric lamps is 60,900 francs (£2436); the cost of the motive power (490,065 horse-power hours) is 39,200 francs (£1568); the expenses of the staff are

33,000 francs (£1320); the amortisation and interest, at 10 per cent., 68,400 francs (£2736); and the maintenance, at 5 per cent., 29,200 francs (£1168.) The total expense is thus 230,700 francs (£9228). M. Delahaye institutes two comparisons between this and gas lighting. First, he estimates what would be the price of a gas installation, and what it would cost per year; and second, what consumption of gas corresponds to the light furnished by the electricity. In the former case, assuming that there would be 3000 gas burners, giving 9.5 candles each, and taking the price of gas at 6s. 9d. per thousand, and adding thereto 33 per cent. for amortisation interest, supervision, &c, the yearly expense is 221,625 francs (£8865), or almost the same as electricity. According to the latter mode of investigation, the consumption would be 69,509,760 cubic feet. At the price given above, the cost would be £31,015 or three and a half times as much as electricity. Of course such an amount of gas could not be burnt, as it would render the place uninhabitable. M. Delahaye did not adduce any precise instance of incandescence lighting, but he gave a detailed estimate of its cost, and came to the conclusion that in an important installation it need not be dearer then gas at Paris rates, a result that will meet with very general acceptance in this country, where some have been bold enough to argue that it might compete with gas at half the price at which it is supplied in Paris. The paper is chiefly interesting in showing how favourably situated the electric light is in France, and how slow its progress is there even with the odds in its favour.—*Engineering.*

Another electrical railroad experiment.—A practical trial was made at Cleveland, Ohio, on the 20th ult., of an electric motor for street cars, the Brush Electric Works, in connection with the East Cleveland Railway Company having fitted up about two miles of track and attached a motor to the car. The general scheme is much like that of a railroad, the electricity being conducted through rods laid in a trough in the center of the tracks. A lever reaches down in the center of the track into this trough and attaches to the electrically charged rods. The experiment was considered a success, the car moving off at the first swing of the lever. There seemed to be some stiffness in the machinery, but this, it is claimed, will be overcome. The railroad company state that they expect to at once apply the motor to the whole line. It is claimed that the road can be operated with electricity at one fourth the cost of working it with horses.

Transmission of power by electricity.—One of the most remarkable instances of the transmission of power by electricity is that presented by the electric railway in one of the main cross-cuts of the Oppel colliery, Saxony. This cross-cut is 2,365 feet long, and is the outlet for the coal mined in the vein, the quantity delivered to it being 600 mine-cars per day of 16 hours, each car weighing, loaded, 1,594 pounds. A train of 15 cars is moved at a speed of from 7 to 10 feet a second, the steam-engine at the mouth of the shaft making from 225 to 250 revolutions during the run, lasting from three and one-half to four and one-half minutes through the cross-cut. When doing this amount of work, the steam-engine delivered 11.2 horse-power; or, assuming the friction of the engine's gearing to have occasioned a loss of twenty-five per cent, the power actually transmitted by the electric current to the locomotive was 5.22 horse-power, or 46.6 per cent.

The Electrical Transmission of Power.—We read in the *Journal du Gaz et de L'Electricité*, that a new application of the electrical transmission of energy was installed a few months ago in a coal mine in the neighborhood of Vienna, Austria, and works regularly, and with great success. Both the machines are Gramme dynamos; the generator furnishing a current of 15 ampères at 500 volts. The receiver, says our contemporary, produces about 8 H. P. at a distance of 1,900 metres, and actuates a pump which delivers 300 litres of water per minute at a height of 60 metres, and through a conduit 800 metres long. This was formerly worked by a steam engine, which rendered the temperature of the gallery uncomfortably high. The employment of the dynamos has caused a lowering of temperature of 14°; it appears, also, that the consumption of fuel is considerably reduced. We fancy that the return claimed for the receiver would bear a considerable amount of reduction.

About ten years ago Mr. Krupp of Essen borrowed £1,500,000 to be repaid in yearly instalments extending to 1897; arrangements have just been made, however, for repaying within a short time the whole of the sum still remaining undischarged. These great steel-works, employ 19,000 hands.

THE ENTOMOLOGY OF A POND.—(*Knowledge.*)

(*Continued from page* 282.)

The *Ranatra linearis* is a creature of three elements, though, of course, its proper sphere is the water. It can manage to progress on land better than most aquatic insects, carrying its body high up on its stilt-like second and third pairs of legs; still, its movements are, at best, but slow and awkward. It will also, sometimes, take to the air, and on returning to its pond, finds occasionally a little difficulty in re-entering the water, on account of its own slight specific gravity and the dryness of its tail filaments, so that quite a struggle is necessary before it is completely immersed. It is a sluggish insect, and will often remain motionless amongst the pond weeds for a long time together, only rising to the surface to breathe, and this, as one might expect in so inactive an insect, it needs to do very infrequently. It makes its way through the water, either by the help of aquatic plants, or by the movements of its two hind pairs of legs; but these are worked somewhat peculiarly, the third pair being driven backwards at the same time that the second are moved forwards, and *vice versa*, all the movements being performed in a leisurely manner. But when we come to the front legs, the case is altogether different; all the celerity of which the insect is capable seems to be concentrated here. Ranatra, indeed, is more of a living trap than a hunter, lying in wait for, more frequently than pursuing, its prey, which consists of other aquatic insects, especially the larvæ of Mayflies, and even small fishes. With fore-legs extended, it patiently waits till some unwary and unsuspicious being, on pleasure only bent, approaches within the charmed circle guarded by these long-handled sickles, and then, with a rapid and forcible stroke and with unerring aim, down come the powerful limbs and seize the hapless pleasure-seeker as between a pair of pincers. Dragged to the cruel beak of its thirsty foe, its juices are gradually extracted, and the grasp is not relaxed till the dregs have been drained and nothing but the skin is left; the useless pellicle is then rejected and the lanky tyrant brings itself into position for another attack. It is said sometimes to regale itself on fish spawn, a proceeding which naturally excites the ire of pisciculturists. It holds its prey with astonishing tenacity, of which the following instance, recorded in the "Entomologist," by Mr. A. G. Laker, may serve as an example. He says: "I placed some sticklebacks in the glass with a Ranatra, when one of them, about an inch long, was seized (the total length of the Ranatra, exclusive of its anal filaments, being only eighteen lines), and, notwithstanding the fish's repeated and vigorous struggles, it was held fast. I then took hold of the stickleback and raised it out of the water; the Ranatra, however, would not let go, and was drawn out of the water with the fish. I forcibly separated the two, replaced the insect, and immediately afterwards the fish; but the latter was again seized in a very short time, and the insect continued its meal." Ranatra is an exceedingly bold and fearless insect, manifesting surprising readiness to attack any foe, let its size be what it may. In fact, under ordinary circumstances, there are probably but few enemies that it has any need to fear. It is the giant of the insect population of the pond, and can hold its own against all comers. The great Dytisci are probably the only insects of which it has any need to stand in awe; and these, if hard pressed by hunger, would probably have no hesitation in attacking it, and protected by the invulnerable nature of their chitinous armature, would soon make mincemeat of the slim and long-legged bug. The hard integument of beetles, however, does not always baffle Ranatra, not even when it seems to offer an insurmountable obstacle. There is a little oval, reddish-brown beetle, *Hyphydrus ovatus* by name, about the size of a small pea, and not unlike a somewhat flattened one in shape, which is about as unmanageable a morsel as could well fall to the lot of any insect; but even this Ranatra will not refuse, turning and twisting it about with its pincers in vain efforts to find a soft spot in which to plunge its beak, till at last it lights upon the extremity of the abdomen, as being a little less hard than the rest, and manages to extract even thence at least enough nutriment to whet its appetite and make it long for more.

The Dragon-flies, insects of the family *Libellulidæ*, are stingers, and in Scotland go by the name of "devil's darning-needles," and in America by that of "mosquito hawks," will detain us later on, when we speak of the fauna of the aerial regions just above the pond. Suffice it here to say, that they have four large glassy-looking wings, reticulated with a multitude of nervures, and usually a long, slender body, which has suggested to our Highland brethren the diabolical connection above mentioned. For brilliancy of coloration they easily take a prominent position in the insect world; but their beauty pertains wholly to the adult form. In their aquatic stages they are the dingiest of the dingy, and in many cases are hideously ugly. When you have brought yourself to perform the disagreeable task of hauling out of a dirty pond a mass of slimy weeds and fetid mud, and have deposited it on the bank, you see the mass here and there heaving with the struggles of these ugly brutes as they gradually work their way into daylight and drag their grimy bodies out of the tenacious and unsavoury mess. What a contrast between this sordid life and the gay and brilliant existence of the shiny-winged adult, as it dashes about, glistening in the sunbeams! There are two principal types of these larvæ; one a broad, thickset, clumsy creature, which yields the larger and stouter-bodied dragon-flies, the other slender and carrying some leaf-like appendages at the tail, the immature condition of the most slender and graceful members of the group. Taking first the former of these (Fig. 1), we see a creature with six

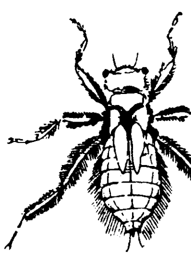


Fig. 1.—Larva of Dragon Fly.

straggling legs, which, sprawling out at the sides, would, were it not for their number, be strongly suggestive of affinities to the spider class. The head, when viewed from above, is surprisingly like that of a kitten, the prominent ears of the latter being represented by the equally prominent eyes of the insect; the two short antennæ, too, are suggestive of the kitten's whiskers. Then comes the thorax, with curious ridges like rough bark, and carrying the six sprawling legs and the rudimentary wings, and then the abdomen, broadest a little behind the middle, and exhibiting, especially in its hinder part, periodical contractions and dilatations, the length being lessened at the expense of the breadth. This motion, as might be expected, is a respiratory one. The breathing is performed in a manner as wonderful as it is unique. It is most marvellous what a variety of contrivances there are to enable aquatic insects to perform this important function; we have already referred to the diving-bell arrangement of the water-beetles, the anal spiracle of some of their larvæ, and the lateral leaf-like appendages of others, the long tail-filaments of the water scorpions, and the feathery stars and tubes of the gnat larvæ and pupæ, and now we come to an arrangement totally distinct from all of these. At the extremity of the body there are some stout, spine-like processes, surrounding the terminal orifice of the digestive tube, which is guarded by a valvular apparatus. By muscular effort these spines, which are movable at their base, can be opened out like the parts of a wire egg-whisk, the capacity of the abdomen being at the same time increased; the valves are thus opened, and water rushes in and fills the terminal part of the intestinal canal, and after remaining there a short time, is forcibly ejected by a reversal of these operations. The lining of the last part of the intestine is produced into six double series of folds, whereby its surface is enormously increased. In the interior of these thin folds, great numbers of minute tracheal tubes are distributed. The water, of course, as usual, contains air dissolved in it; and, as it passes over these tracheal tubes, the fresh air with which it is charged can be exchanged for the contaminated supply contained in the tubes, by simple transfusion of the gases through the thin walls of these. As soon as this has been effected, the now useless water is got rid of in the manner above described, but its expulsion frequently serves the additional purpose of effecting locomotion. When the insect is calm and undisturbed, the water is passed out gently, but should it be disturbed or alarmed, a forcible ejection of the liquid follows, and just as a rocket mounts in the air while the gases into which its contents are being transformed by the process of combustion, rush out in the other direction, so the larval dragon-fly is shot swiftly forward as the jet passes out from behind. The jet can be readily observed: if there are particles of matter in suspension in the water, their movements as they are carried along with the stream make the current perceptible; or if the creatures are in a shallow vessel with only just enough water to cover them, the surface will be seen to be violently disturbed at every expiration. The force with which the water can be projected is quite surprising; the most astonishing record comes from over the sea. A lady states in the *American Naturalist* that a larva of a large species, when disturbed, sent out a fine stream of water to the distance of from two to three feet, and continued doing so indefinitely!

These curious beings then progress by a series of jerks or leaps, though, of course, they can crawl as well. Some kinds while jerking themselves forward, assist their efforts by a sharp backward stroke of the legs (though these are not modified for swimming purposes), and finish the stroke by bringing the legs close alongside the body, an action by no means inelegant.

The more slender kinds have an elongated body, which they can move pretty vigorously from side to side as a fish does its tail. They have also three external leaf-like appendages at the tail, which are thin, and are each supplied with a tracheal tube and its branches, the exchange of gases taking place here externally in the same way as in the others internally. These caudal leaves, too, are used to assist locomotion.

But we have yet to consider one of the most remarkable peculiarities of these creatures. If we take a front view of the head, we see the lower part of the face rounded and smooth, with a vertical zigzag line down the centre, and showing no traces of great jaws such as one would expect in so voracious an insect. This is simply because they are concealed by a very curious modification of that part of the mouth which, in insects generally, is called the labium, or lower lip. To examine this structure it is best to take a freshly-killed specimen; this is easily obtained by plunging the creature into *boiling* water, which produces instantaneous death. By aid of a pin or needle we can now easily open out the "mask," as it is called (Fig. 2), and when fully extended, we see that it looks something like a broad-handled ladle, attached by the handle underneath the head. It consists of several joints, the basal one of which is attached to the lower part of the head, or, as we might say, under the chin. Succeeding this is another piece, at the outer angles of which are attached two curved triangular jaw-like pieces articulated to it by one of their angles, and capable of folding inwards till their saw-like edges exactly meet, when the front part of the apparatus forms the bowl of the ladle. When closed, the basal joint is bent backwards, showing as a bluntly-pointed projection, reaching to the base of the

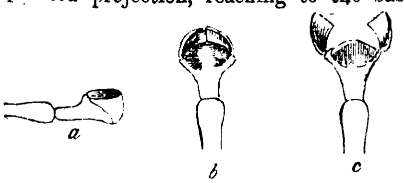


Fig. 2.—Mask of Dragon Fly. *a.* Side View. *b.* Viewed from Above. *c.* The Same, with Jaws Open.

second pair of legs; the next piece is folded back upon this, and the bowl-like part is thus brought close up to the face, which fits into the hollow. When the mask is extended, the real jaws are seen beneath in the usual position. The mask is used somewhat like the raptorial legs of the water-scorpions—viz., to seize a passing insect at a little distance. To accomplish this, it is very rapidly unfolded, darted out with unerring aim, and brought back again into position, thus holding the prey close up to the true jaws.

Dragon-flies do not alter much during their earlier stages. The traces of wings soon appear, even after the first moult or two. When a moult is about to take place, the creature fixes its claws into some support to obtain leverage for its coming struggle, and then, by strong muscular effort, the back of the thorax is split, and the insect crawls out of its case. The cast skins may frequently be seen floating about in ponds. The insects are very voracious, and when other food fails, will not scruple to adopt cannibalism.

(*To be continued.*)

IMPROVED SAWS.

An account of a new kind of saw for cutting stone, originally described in *La Semaine des Constructeurs*, which seems to have advantages over those now commonly in use, appeared in a recent issue of the *American Architect*. In place of the ordinary long steel blades, supplied with sand to enable them to grind their way into the stone, the new machine presents only a slender endless cord, composed of three steel wires twisted together, which is stretched over pulleys in such a way as to bring the lower portion horizontally over the stone to be cut. The frame carrying the pulleys is movable, so that the cord can be brought into contact with the stone or lifted away from it at pleasure, and the whole is kept in rapid motion, while water falling in drops from a reservoir above serves to moisten the stone. The three wires which form the saw differ form the ordinary kind in being square in section, and by twisting into a cord they are so turned as to present a succession of oblique cutting edges, which act, when set in motion, in nearly the same way as so many small chisels, while the rapidity with which the blows follow each other probably adds to their effect. It is not said what proportion the work accomplished by the new machine bears to that effected by the expenditure of the same amount of energy in the old form of apparatus, and the invention is probably in too rudimentary, a stage to make such comparisons practicable; but the idea seems to be a good one, and with wire of suitable temper and form the cutting effect should be very considerable; while, as every one will observe, the wire saw ought to be available for use in a verticle line, like a hand-saw for cutting wood, and, if operated in this way, could be made to saw mouldings of the most difficult sections as readily as the same forms are cut in wood.

Again, too much care cannot be taken to give each saw its proper amount of lead. This, like speeding the saw, must be done to conform to the adaptability of the same. After once getting the proper lead there are difficulties, often very troublesome, that have to be overcome in some way. A saw is seldom filed and put in order twice alike. After it is first regulated any deviation or alternation in filing is equivalent to a change in the running of a saw. Of course, a sawyer that is apt at the business will make less deviation than an inexperienced one, and will correct the defect with the guide-pins without any perceptible difference in the running of the saw. Where there is a want of experience in handling the saw, the better way is to correct the lead by throwing the mandrel back or forth as the case may require. In no case should there be an attempt to make a saw run with the guide-pins where it is not inclined to. The attempt will not only be futile, but an everlasting vexation, to say nothing of the loss of time waste of power, and badly cut lumber. It never pays a man to attempt to run unless things are in proper condition. Better shut down and put things in order, and then go head.

To be a successful sawyer it is also necessary to be a good judge of different classes of wood. Some kinds are of very firm hard grain, and require to be cut on a much slower speed than others. Other kinds may not appear so hard, yet there is a tendency to spring, causing the saw to heat, which sometimes leads to the conclusion that the saw is at fault.

There are always new difficulties arising that must be met, understandingly, or otherwise. They are stubborn, everyday facts, that have to be dealt with.

THE ANTHRACITE BURNING LOCOMOTIVE OF AMERICA.

Anthracite coal, used for locomotive purposes since 1838 with increased success, is now burned exclusively on water grates formed of wrought iron tube, 2 in. external and 1½ in. internal diameter, spaced so as to give a maximum clearance between water tubes of 1 in. to 1½ in., set longitudinally with the fire-box, and having a rising inclination backwards, varying from ¾ in. to 1½ in. per foot of length. This sloping of grate is chiefly to secure the perfect and rapid circulation of water, thus preventing accumulation of mud and scale in the tube, keeping it cool and lengthening its effective life.

Transversely to fire-box, the water tubes are usually set in a horizontal line, but there is a tendency to lift the side tubes a little higher, giving the cross section a basket form, removing the fire further above the solid foundation bar and slightly increasing the area of air opening through the grate.

To increase the amount of air opening without increasing the space between each water tube, the transverse setting of them in corrugated or rigid outline (thus *₊*₊*₊*₊*₊*) has been tried, but with partial success, as the fire naturally got then at high points and all the air supply passing through such thin spots, the fire became dead and steam pressure fell too low.

To clear the fire, two (and in case of wide gates three) of the water tubes are replaced by long 2 in. wrought iron bars, carried by ferrule through the water space out and beyond back of fire-box, so that the fireman can withdraw them—in whole or in part—leaving an opening four inches wide through which all foreign matter is raked into hopper ash-pans having a depth of from 2 to 2½ feet, this depth preventing the accumulation on ash-pan from burning out the grates from underside.

It is often found advisable to line these hoppers with scrap plate, the narrow air space left between the plates saving the hopper from being warped or otherwise injured from the hot ashes.

Compared with fire-boxes burning bituminous coal, excessive grate surface is required, and each engine bar-frame (and such frames are found best suited to the condition of our road-bed, &c.) being from 3 in. to 3½ in. wide, the available space between them is found too narrow, and it has resulted in fire-boxes being stopped off short of the top of the frame and made as wide as will just clear driving wheel flanges ; in fact, fire-boxes designed to burn Anthracite "dirt" are stopped off short of the wheels, and thus being free from side control are made three or four feet wider than rail gauge. The length of grate has in powerful freight (goods) engines reached a maximum of 11½ feet, necessitating an intermediate support for the water tubes and movable solid bars.

An equal and perfect distribution of the total weights available for adhesion on the coupled driving wheels is possible when the fire-box is made so shallow as not to come within the frames in a manner rarely obtained when deep fire-box is used, as it often outwardly controls the relative position of the coupled axles.

A further constructive peculiarity caused by the width of the fire-box, is that instead of springs being placed directly over or under axle-boxes, and the spring ends connected by compensating or equalizing levers, deep narrow levers are passed over and bear upon the axle boxes, and the lever ends are coupled to the springs, or, in other words, the springs lie horizontally between and about in line with the axles, instead of above or below them. So arranged, the engine rides smoothly and easily.

To sustain the weight at rear end of boiler, the fire-box is carried upon four massive reversed pendulum links from lower part of engine bar-frame, which, without limiting the expansion and freedom of movement longitudinally holds it in designed position firmly.

Shallow depth of fire-box, being, as hereafter explained, a necessity of economic combustion, it is obtained by quickly sloping downwards from tube sheet the crown plate of inside fire-box, so that at the back the effective depth of box is but about 2 feet 8 inches, and not only is the inside crown inclined, but, to avoid excessive weight and keep centre of gravity low, the outer crown is also sloped longitudinally and the two sheets secured together by screwed rod stays; thus anticipating that form of crown sheet known under the name of its Continental patentee "Belpaire." The distance apart of the two crown plates much increases as they come towards the barrel, thus providing freer circulation.

The firing is done from tender, and necessarily the fire hole is of rather more than ordinary width to give freedom of firing over so large a surface, and it is quite close to crown sheet, so as to give with shallow fire-box 14 in. to 16 in. depth of fire on grate without fuel standing above the level of fire hole. The so-called "Combustion Chamber," occasionally provided forward of fire-box, is not to secure more perfect combustion, but is due to the grate being so high that a bridge is necessary to keep fuel on sloping grate, from travelling bodily into and choking the boiler tubes, and, space being required forward of bridge, so that passage be left for gases to enter the lower tubes, the chamber or partial extension of fire-box into barrel becomes a necessity, although it has the defect of shortening the boiler tubes by its own length.

The shallow fire-box secured in part by sloping grate up, and crown sheet down, and used certainly as early as 1848 9, is not only a convenience in constructive design, but for effective combustion a necessity, as this fuel, due to the absence of hydrogen, is only slightly inflammable, when burnt openly and freely, and to secure as much flame and as large a portion of radient heat as possible, an artificial current that will lift the fine incandescent particles and keep them in suspended motion and contact with the hot gases is desired. This lifting and suspension, the exhaust blast with shallow fire-box and large grate surface accomplishes, securing a full body of short, light-coloured flame, and therefore securing radient heat: and the crown sheet—the best absorbing surface—being close to the flame, is made the more effective. A close parallel can here be drawn between the behaviour of Anthracite in a reheating and in a puddling furnace. In the latter, with the same air pressure and grate surface serviceable flame cannot be obtained; whereas, with no other change than a low roof, the reheating furnace produces a white flame and intense radiant heat, bring the iron up to a welding heat rapidly and economically.

The P. & R. R.—a large user of this fuel—give me as the result of their experience with locomotives, that one pound of Anthracite evaporates 6.1 pounds of water, and one pound of Bituminous 7 pounds of water, under similar and average conditions of railway work—in other words, Anthracite has an evaporative efficiency of .87 per cwt., and Bituminous of 1.14 per cent.—in each case taking the other fuel as the unit of comparison. With their market prices at tidewater as in June, Anthracite per gross ton at $3 50 (14 shillings), and Bituminous at $3.05 (12 shillings), the cost of evaporating one pound of water is, Anthracite, .0255 of a cent, and Bituminous .0194; thus Anthracite has an *economy* efficiency of .76 per cent., and Bituminous of 1.31 per cent., in each case the other fuel being taken as the unit of comparison.

The Pennsylvania Railway gives me the consumption in pounds of coal per passenger car mile for four months under conditions so similar as to make a reliable comparison. The market value of coal being, Bituminous per net ton $2.73 and Anthracite $3.82 per gross ton, or per 100 lbs. Bituminous costs $13.65 cts. and Anthracite $17.05 cts. Anthracite being per pound fully 25 per cent. the dearer fuel.

On *Local* passenger runs the consumption per passenger car mile was 10.44 lbs of Bituminous against 13.85 lbs. of Anthracite—a difference of 3 41 lbs., their relative percentage values (comparison as before) being 1.32 per cent. and .76 per cent. or multiplying the amount by the cost, the items stand in cents per car mile 1.425 for Bituminous and 2.363 for Anthracite, a difference of .938 cts., their relative economy percentages being 1.66 per ct. and .60 per ct.

For the same period on through or continuous passenger train runs the figures in pounds per car mile are 8.64 Bituminous against 11.55 per Anthracite, a difference of 2.91 lbs. their relative evaporative percentages being 1.25 per cent. and .80 per cent., on multiplying this weight by the cost, the expense per car mile in cents is 1.179 for Bituminous and 1.969 for Anthracite, a difference of .79 cents per car mile; thus their relative economic percentages are 1.67 per cent. and .59 per cent.

The through run with but few stops and making continuous demands on the full uses per car mile, 1.80 lbs. less of Bituminous and 2.30 lbs of Anthracite, but as these differences bear to each other the percentage proportions of 1.27 per cent. and .80 per cent., it seems as if Anthrcaite could be used as advantageously where the stops are frequent as in through runs under ordinary conditions. Although it is Mr. Wooten's opinion, that where stops are frequent, or work intermittent and the maximum power is called immediately after such intermission less Bituminous coal need be used because of its ready ignition.

The reason of Anthracite having a less evaporative efficiency is in part due to its density, the heat of combustion being greater in proportion as molecular condensation of fuel is less advanced—the better control permissible through the air dampers of the combustion of fuel possessing free carbon or volatile gases, and to the large mass of fuel on grates at the end of each trip which cannot be utilized; also as a depth of 14 in. to 16 in. of live coal is kept on the grate, it is highly probable (although I have not been able to test and prove it by the analysis of the escaping gases) that this depth of white hot carbon converts in its upward course through it a large portion of carbonic acid into carbonic oxide, in which form it escapes from the chimney, no provision being made to supply oxygen above the grate except by throwing open the fire-hole door.

The limits of this paper will not permit of any full comparison of the chemical constituents of Americal and Welsh Anthracite, but this table shows that the percentage of fixed carbon is practically the same, and that the only marked difference is, that American averages 3.61 per cent of ash, or more than three times the amount found in Welsh.

	Welsh.				Pennsylvania.			
	Pembrokeshire Lower Vein.	Kilgetty Vein.	Aman Valley Big Vein.	Swansea Valley Brass Vein.	Beaver Meadow.	Shenoweth Vein.	Black Spring Gap.	Nealeys Tunnel.
Carbon . .	94.18	93.27	92.55	91.11	92.30	94.10	80.57	89.90
Ash . . .	.98	1.21	.42	1.51	1.28	4.50	3.28	5.40
Hydrogen .	2.99	2.72	2.10	3.58 }	6.42	1.40	7.15	5.40
Oxy. & Nit. .	1.26	2.65	4.07	3.24 }				
Sulphur .	.59	.15	.12	.59				
Moisture. .			.10					
Total	100.	100.	100.	100.	100.	100.	100.	100.

The lower evaporative duty of American is probably explained by its extreme density. A comparison averaged from the detailed figures given by Crookes and Rohrig shews the following results :—

	No. of specimens.	Specific Gravity.	Weight of a cubic yard in lbs,
American......	18	1.541	2.623
Welsh..........	3	1.318	2.223
Difference		.223	400

I do not find that any attempt has yet been made on American locomotives to carry out the neat and apparently effective contrivance described by Mr. C. H. Perkins in his paper on Anthracite at the Swansea Meeting,—viz.: the use for grates of hollow perforated tubes, through which the air required for combustion is forced under pressure of pan or steam jet. It is probable if applied by fan or blower to locomotive service and the exhaust steam, not then required for producing blast, otherwise utilised, a more economic result would be achieved than yet obtained in the use of Anthracite as a locomotive fuel.

The ash pans not being provided with air dampers it may be mentioned that the mechanical means for controlling the rate of combustion commonly in use, are, 1st. By variable exhaust pipe nozzle which is only partially successful as it demands from engineer-men more attention and judgment than can be ordinarily secured. 2nd. The free opening of the large fire-hole door which is not provided with damper or deflecting plate, and, 3rd. In same case the admission of air into smoke box at front end door through a movable grid plate, thus neutralizing the effect of the blast.

The life of a steel fire box burning Anthracite on the P. & R. Ry. averages 200,000 miles or only about 80 per cent of a steel box burning Bituminous, which under similar conditions averages 250,000 miles ; whereas the P. Ry says the difference is .60 per cent or a life respectively of six and ten years, and as the first cost of an Anthracite boiler is from 8 to 15 per cent in excess and cost of repairs heavier, rising in extreme cases to 33 per cent in excess, and the market price of the Anthracite being higher and its evaporative duty being less than Bituminous, a very natural query is—Why should it be used ?

The answer is—1st. Its complete freedom from smoke, its small amount of dust and the cleanliness of the dust are strong points in its favor for passenger train service. 2nd. It is but slightly, if at all, used by any railway not owning and working mines, and by them over a very limited geographical area, and, 3rd. As two-thirds of this fuel brought to market, is sold by by three railway companies, the so-called market price (controlled by a pool) is no indication of the actual cost of the fuel.

Ignoring the question of interest in capital invested, and accepted as data for comparison, Bituminous coal at $3.00 (12 shillings) per ton with a yearly consumption of 1,250 tons, Anthracite boilers costing 17 per cent in excess, having 40 per cent. less length of life, with 33 per cent. increase in cost of running repairs, and Anthracite having an evaporative efficiency of but .80 per cent. it would have to cost barely $2.49 (10 shillings) per ton to justify its use as a fuel of equal economy. In other words the comparative cost by weight of Anthracite must be not only .80 per cent. less than the cost of Bituminous, but in addition 7.7 cents per ton lower, so as on the average yearly consumption to leave on "fuel-sheet" an unspent balance of at least $112.00 to the credit of renewals and repairs of boiler.

My thanks are due to Mr. J. E. Wooten, General Manager of the Pennsylvania and Reading Ry., and Mr. Theo. N. Ely, Supt. Motive Power, Pennsylvania Ry. for information supplied by them embodied in this paper.—*Section G British Association, Montreal.*

J. DAVIS BARNETT.

A COMMISSION of five French medical men have reported on their investigations as to the real nature and action of the cholera poison. The substance of their report as it appears in the *Times* is as follows :—"The initial lesion of cholera takes place in the blood. It essentially consists in the softening of the hæmoglobin, which makes some globules lose first their clear shape, the fixity of their form, and the faculty of being indented. These globules adhere together, lengthen out—*en olive*—stick together, and in fulminating cases especially some are are seen which are quite abnormal, while others appear quite healthy. The entire loss of elasticity of the globule (which is shown by the preservation of the elliptic form when it has been stretched out) is, in our view, a certain right of the patient's death. To stretch out a globule you have merely to alter the inclination of a plate on which a sanguineous current has been established in the field of the microscope. The fluid column stops at one point, whereas the rest continues to flow. An elongation of the intermediary globules results, and then a rupture of the column. In the gap thus formed are some scattered globules. If these revert to their primitive form, the patient may recover. If they keep the elliptic form, we have seen death in every case, even if the patient's symptoms were not serious at the time of the examination of the blood."

A NEW perfect-combustion stove for domestic use has been invented by Mr. Henry Thompson, of Canonbury, England. Externally it resembles the ordinary register-stove, but in its internal construction it differs widely from it. A recess at the back of the Thompson stove is filled with coal at starting ; and behind the coal is a vertical hinged plate, which is so arranged as always to exert a gentle pressure on the coal and the body of the fire, tending to push the coal forward toward the bars. A slight stirring of the fire causes it to be loosened, and the fuel to be pressed forward to the front to replenish the fire. When the coal has been consumed, the vertical plate is pushed back, and a fresh charge of coal inserted. It will thus be seen that the coal at the back is undergoing a process of coking before being pushed forward. The gases evolved from it, instead of passing up the chimney and into the air in the form of solid carbon, are carried downwards by the draught produced by an ingenious but simple arrangement at the back of the stove, and are delivered beneath the grate. At this point they are drawn upwards through the incandescent fire, in which every particle of smoke is consumed. The waste products of combustion pass up the chimney in the usual way, but without the usual attendant results of smoke and soot.

JAPANESE STUDIES OF NATURAL FORMS—I.

JAPANESE STUDIES OF NATURAL FORMS—II.

THE ELECTRIC LIGHT IN THE MECHERNICH MINES.

The electric light installation at the Mechernich Mines in its once volcanic Eifel district in Rhenish-Prussia, has now had a fair trial for more than three years and has proved a complete success. The expectation that it would both facilitate the operations and increase their security, has fully been realised, and an extension of the plant is now being carried out. Messrs. Siemens and Halske, of Berlin, undertook the work, which was superintended on their behalf by Mr. Boeddinghaus. An open working 2,000 ft. long, 1,000 ft. wide, and over 300 ft. deep, in which 300 men and 20 horses are continually occupied, was first to be supplied with the electric light. This part of the mine is excavated in steps, the horizontal terraces being provided with rails. Ordinary lamps in globes on poles were out of the question, as blasting operations continue throughout the day and the shots would soon have made havoc of the lamps. After several trials two powerful lamps, of 3,000 candles each, were erected at the upper margin of the pit where they were fairly out of the reach of the projected stones; and reflectors were fixed to throw the light down upon the steps. To find the proper positions for these powerful lamps and to avoid too dark shadows caused some difficulty. But the illumination was finally rendered most efficient, and the open pit with the light playing on the whitish grey rock affords a fine spectacle. As any interruptions, even for short periods, such as those occupied in renewing the lamp carbons, would be dangerous, the whole plant is double; each lamp receiving its current from a D2 dynamo. No hitch of any kind has occurred, and the safety of the miners has decidedly been augmented. It was formerly not always possible for the superintendents to see whether the loose mass resulting from the blasting operations had been properly removed, and frequent minor accidents arose from the débris falling down upon the miners engaged on the step next below. The work can now be controlled much better than before when petroleum lamps and hand lamps were in use. The cost shows a saving of about 4d. per hour in favour of the electric illumination. The satisfactory results obtained in the open working induced the company to introduce the electric light down in the subterranean galleries. The ore forms little concretions of sand and galena scattered all through the rock; the whole mass has therefore to be brought to day to be disintegrated and sifted, and the mining proceeds in parallel and cross galleries which are constantly being widened until they become 90 ft. in width, and 70 ft. in height, by sometimes 300 ft. in length. The operations in themselves would not require much light if there was not always danger threatening from loosened pieces of rock. Pitch torches were formerly employed to examine the bore holes and fissures round them after each explosion. It was a question whether the arc lamp would answer for this purpose in the smoky atmosphere. For the first experiments, arc lamps of 3,000 and 1,000 candles were used, with the positive carbon in the lower holder. The effect was brilliant, yet the light did not penetrate the white smoke cloud which collects at the upper wall immediately after the shot. But as the smoke settles within ten minutes, it was thought advisable to acquiesce in this interruption of a few minutes, and to use smaller lamps of 350 candles, which proved quite efficient. Of these, there are ten in use, with about 10,000 ft. of lead cable, the cable being partially elastic, as the lamps with their wires have to be removed when the blasting is to take place. The lamps were originally supplied with hexagonal lanterns with obscured glass to protect the eyes of the miners. The glasses were of course soon broken, but no complaints are said to have been made about the naked electric lights. The proprietors of the mine have decided upon an extension of the installations.—*Engineering.*

Miscellaneous Notes.

HEATING EFFECTS OF ELECTRIC CURRENTS.—An interesting paper on this subject has been communicated to the Royal Society by Mr. W. H. Preece. With bare platinum wires of small diameter, the general law governing the ratio between the current strength and the diameter of the wire, when the latter is raised to a definite temperature, and where radiation is free, appears from Joule's law to be that the current should vary as the diameter × $\sqrt{\text{diameter}}$ or $c=d\sqrt{d}$. Both the results of Mr. Preece's experiments tend to show that the current varies as the diameter. Platinum wires are however liable to flaws which practically reduce their effective diameter. Mr. Preece has also determined the strength of currents which produce self-luminosity in wires of different kinds and sizes. These currents were measured by finding the difference of potential at the ends of a thick German silver wire, whose resistance was .0157 ohms inserted in the circuits. The results with copper, Swedish wrought iron, German silver and platinum wires, showed that the law $c=d\sqrt{d}$ held very well for all these wires, except with those of platinum, the point of low red heat being taken as the fiducial point. The temperature of a wire which becomes self-luminous has been given by Draper as 977 deg. Fahr., and by Daniell as 980 deg. Fahr. The exception in the case of platinum may account for its exception to the law in the former experiments. Mr. Preece infers from his experiments that electric light wires should be made large enough to avoid the possibility of heating them above normal temperatures, otherwise points of danger are easily reached by increments of currents.

THE WORLD'S TELEGRAPHS.—The telegraph appears to have made more progress in the United States than in any other country. The number of American telegraph offices in 1882 was 12,917, and the number of telegrams forwarded during the year was 40,581,177. The number of telegraph offices in Great Britain and Ireland in 1882 was 5,747, the number of telegrams forwarded being 32,965,029. Germany had 10,803 offices, the number of telegrams forwarded being 18,362,173. France had 6,319 offices, the number of telegrams forwarded being 26,260,124. Russia had 2,819 offices, the number of telegrams forwarded being 9,800,201. Belgium had 835 offices, the number of telegrams forwarded being 4,066,843. Spain had 647 offices, the number of telegrams forwarded being 2,830,186 British India had 1,025 offices, the number of telegrams forwarded being 2,032,603. Switzerland had 1,160 offices, Italy 2,590, and Austria 2,696. The number of telegrams forwarded in these three last-mentioned countries was 3,046,182, 7,026,287, and 6,626,203 respectively.

MAGNETISM OF THIN STEEL PLATES.—A curious and instructive experiment has just been made by M. Duter, who took a number of very thin plates or discs of tempered steel, about a millimetre thick, and from five millimetres to forty centimetres wide, and built them into piles, the adjacent plates being sometimes in contact, and sometimes separated by a sheet of paper or cardboard. These piles were then inserted in a very powerful magnetic field, and withdrawn. It was then found that they had become powerful permanent magnets; but when the individual plates were separated they seemed to have lost their magnetism. On building up the pile again the original magnetism was restored to it. It appears then that the thin plates have not really lost their polarity on being withdrawn from the exciting field. Some of Professor D. E. Hughes's recent experiments have a great similarity to M. Duter's.

A NEW CARBON BATTERY.—A new voltaic battery has been brought out by M. Tommasi and M. Radiguet, in which peroxide of lead surrounds the carbon plate as it lies on the bottom of the cell. The other plate is also of carbon, covered with fragments of retort carbon platinised. The two plates are placed one above the other, but separated by a sheet of parchment paper which divides the containing vessel into two compartments. A saturated solution of chloride of sodium or common salt is filled into both compartments until the upper carbon fragments are partly immersed in it. The electromotive force is 0.6 volt. The negative pole is that carbon plate which is not in contact with the peroxide of lead. If other saline solutions, such as sulphate of ammonia, sulphate of soda, chlorhydrate of ammonia, or even dilute sulphuric acid, be used instead of the solution of salt, the electromotive force does not sensibly vary.

THE RADIATING POWER OF METALS.—M. Walter Meunier has, according to the *Revue Industrielle*, been experimenting on the comparative loss of heat from cast iron, and copper tubes. The experiment were carried out in a room having a uniform temperature, and were made simultaneously with the three materials in question. The tubes were all 2.5 meters long, and 155 mm. in diameter, connected at one end with a steam supply, and at the other end with a worm condenser in water. Observations showed that the weight of water condensed, per square meter of heating surface per hour, was, with naked pipes, 3·484 kilos for the cast iron, 3·906 kilos for the wrought iron, and 2·816 kilos for the copper. The non-radiating power of copper, in comparison with iron is thus manifest. It is not stated, however, whether the pipes were all of equal thickness, and similarly polished, or left with their natural surfaces. It is to be understood, perhaps, that identical conditions were, as far as possible, preserved.

PURIFYING ZINC.—M. Heôte, the well-known French chemist, has recently been occupied with the question of purifying zinc from the arsenic and antimony which it usually contains. The process which he finds most effectual is to melt the zinc with chloride of magnesium. All the arsenic then takes the form of chloride of arsenic, and the antimony, when it is present, is also disengaged with it.

MELTED LEAD IN THE EYE.—A curious case of accident from a fragment of melted lead solidifying on the surface of the eye without injuring it, was recently brought before the Bordeaux Society of Anatomy and Physiology by Dr. Perrier, who showed that the immunity of the eye from burning was really due to the "spheroidal state." The melted jet of lead was at a higher temperature than 171 deg. Cent., the temperature necessary to produce the spheroidal state, hence when it arrived at the surface of the eye it vaporised the moisture of the latter. When it had cooled below 171 deg. Cent. the lachrymal secretion prevented the metal from scorching the ball.

HEAT OF COMBUSTION OF WOOD.—Mr. Ernest Gottlieb, says the *Revue Industrielle*, has made several analyses of different woods after drying them at a temperature of 115 °C., and has compared the figures obtained with the amount of heat that would be developed in their combustion. The carbon and hydrogen were determined directly by combustion, by weighing the carbonic acid and vapor of water formed, the remainder, after deducting the ashes, giving the oxygen and nitrogen. The results were found to be in excess of those deduced by applying the formula of Dulong. The wood containing 40.03 per cent. of carbon and 6.06 per cent. of hydrogen by combustion produced 4785 calories, which number, according to the formula, should have been only 4139.

THE LARGEST SKY-LIGHT.—The sky-light in the new building of the Board of Trade in Chicago, will be the largest in the United States, and will be constructed by a manufacturer of that city. Its dimensions will be 60 by 68 feet, divided into 225 parts 46 inches square. It contains very little color, the problem presented to the artist being the greatest possible amount of light combined with the highest ornamentation. The figures are rich in colouring, but slender and serpentine, the ground being nearly white. The glass is partly Venetian, partly cathedral, and partly opalescent, one-eight and one-sixteenth of an inch in thickness. The sky-light will be finished by October 15th, and will cost about $5,000.

SILVERING IRON.—A manufacturer in Vienna employs the following process for silvering iron. He first covers the iron with mercury, and silvers by the galvanic process. By heating to 300 °C., the mercury evaporates and the silver layer is fixed. Ironware is first heated with diluted hydrochloric acid, and then dipped in a solution of nitrate of mercury, being at the same time in communication with the zinc pole of an electric battery, a piece of gas carbon or platinum being used as an anode for the other pole. The metal is soon covered with a layer of quicksilver; is then taken out and well washed and silvered in a silver solution. To save silver the iron can be first covered with a layer of tin; one part of cream of tartar is dissolved in eight parts of boiling water and one or more tin anodes are joined with the carbon pole of a Bunsen element. The zinc pole communicates with a well-cleaned piece of copper, and the battery is made to act till enough tin has been deposited on the copper, when this is taken out and the ironware put in its place. The wire thus covered with tin chemically pure and silvered is much cheaper than any other silvered metals.

NEW PROCESS FOR PRESERVING MEAT.—Mr. Richard Jones' new process for the preservation of meat, to promote which, and carry it into practice, a limited company has just been floated, seems not unlikely to put manufacturers of refrigerating machinery upon their mettle. By means of Mr. Jones' process no mechanical refrigeration is necessary, and the cost of an installation of refrigerating machinery on board ship, bound with dead meat from, say, the Antipodes, is avoided. The principle Mr. Jones has adopted is the injection of a fluid preparation of boracic acid into the blood of an animal immediately after it has been stunned, and before the heart has ceased to beat, the whole operation, including the removal of all the blood and chemical fluid from the body of the animal, only taking a few minutes. The quantity of boracic acid used is very small, and though that little is almost immediately drawn out again with the blood, the preservation of the flesh is said to be thoroughly effected. The quantity of the chemical left in the flesh must, therefore, be very small, and can scarcely be injurious to the human system; for, as Professor Barff has proved by experiment, living animals, either of the human or other species, do not seem to be injured in any way by its consumption. This new process, which is a great advance upon Mr. Jones' original vacuum theory, is stated to be perfectly satisfactory in its results. A demonstration of the effects of the process has been given at the Adelphi Hotel, when the joints cut from a sheep, which had been hanging for more than seven weeks at the House of the Society of Arts, were cooked in various ways, and those present agreed that the meat was equal to ordinary butcher's meat.

A GERM FILTER FOR WATER.—The tendency of research is to show that the germs believed to cause so many diseases are not found in the air except under exceptional circumstances, but exist chiefly in water. This is probably due to the fact that rain and filtration eventually bring the products of fermentation and decomposition into the watercourses. Water may, therefore, be considered as one of the principal agents in the propagation of such diseases; and M. Chamberland has recently turned his attention to the production of a microbe filter, which would purify water not only from its mineral but its animal impurities. M. Pasteur has employed a porous vase of baked porcelain to separate microbes from the medium in which they are generated, and this is the basis of M. Chamberland's filter. The latter has observed that water filtered through one of these vases contains neither microbes nor their germs; and the proof of it is that such water can be added in any proportion to susceptible liquids without causing any change in them. The apparatus of M. Chamberland, which was recently brought before the French Academy of Sciences, can be fitted directly to any water pipe, and acts by the pressure existing in the latter. Under a pressure of about two atmospheres, which is the pressures in M. Pasteur's laboratory, M. Chamberland obtains with a single porous tube or "filtering candle" (as he calls it) 20 centimetres long, and 25 millimetres in diameter, some 20 litres (about 4 gallons) of pure water per day, that is to say, a sufficient quantity for the uses of an ordinary household. By multiplying the number of candles or filter pipes, so as to form sets or "batteries" of them, a supply of pure water sufficient for a school, hospital, works, or barracks, can be obtained. The filter, therefore, is of a practical kind, and being simple and inexpensive, will supply a much-felt want. The filter is cleaned by brushing its external surface, and plunging it into boiling water, or by heating it directly in a fire to destroy the organic matter lodged in it; and properly cleaned, the same tube will last indefinitely. While upon this subject we may mention that electricity has been suggested as a means of ridding water of microbes, and a filter which electrifies the water has actually been designed and constructed.—*Engineering*.

A FIXED ASTRONOMICAL TELESCOPE.—A modification of Lœwig's great telescope has been devised by M. Hermite, and submitted to the French Academy of Sciences. The instrument mounted as an equatorial comprises two parts, one movable the other immovable. The immovable part is a telescope tube directed parallel to the axis of the world. The movable part comprises the objective and divers accessories which allow the observation of all parts of the celestial vault by aid of two movements communicated to them at will by toothed wheels; one of these wheels receives the parallactic movement. The objective is placed, not perpendicularly to the axis of the tube as in the ordinary telescope, but parallel to that axis and in a box of triangular section with the tube of the telescope entering one of its walls with gentle friction. The wall perpendicular to the latter carries the objective, and the third wall inclined at an angle of 45 deg. carries a plane mirror on it which receives the rays coming from the objective and reflects them up the interior of the telescope tube to the ocular lens. The box is closed laterally to forbid the introduction of outside rays. It follows from this construction that by turning the box round the tube of the lunettes or telescope tube, the observer can see all points of the sky situated on the celestial equator.

This movement of rotation corresponds, therefore, to that of an equatorial round the axis of right ascension. To obtain the second movement of rotation corresponding to that of an equatorial round the axis of declination, a new box carrying a mirror inclined at 45 deg. to the objective can be moved circularly round the latter. This box is open in front of the mirror; consequently the first or interior mirror and the objective can move in a plane perpendicular to the tube of the lunette, while the second or external mirror which receives all the rays before they are sent to the observer possesses two movements, one in a plane also perpendicular to the tube of the lunette, the other in a plance at right angles to this latter movement. As in M. Lœwig's instrument the observer can be comfortably seated at his work, the tube of the lunette can be constructed in masonry if necessary, and as only the movable part, which is very small, requiring protection, the expense of a dome is saved.—*Engineering.*

THE AGE OF THE EARTH.—Richard A. Proctor says that the age of the earth is placed by some at 500,000,000 years; and still others of later time, among them the Duke of Argyll, place it at 10,000,000 years. None place it lower than 10,000,000, knowing what processes have been gone through. The earth must have become old. Newton surmised, although he could give no reason for it, that the earth would at one time lose all its water and become perfectly dry. Since then it has been found that Newton was correct. As the earth keeps cooling it will become porous, and great cavities will be formed in the interior which will take in the water. It is estimated that this process is now progressing so fast that the water diminises at the rate of the thickness of a sheet of writing paper a year. At this rate in 9,000,000 years the water will have sunk a mile, and in 15,000,000 years every trace of water will have disappeared from the face of the globe.

THE ANTIGNITY MERCURY.—A recent writer in the North China *Herald* discusses the part played by mercury in the alchemy and materia medica of of the Chinese. Cinnabar was known to them in the seventh century before the Christian era, and its occurrence on the surface of the earth was said to indicate gold beneath. Their views on the transformation of metals into ores and ores into metals by heat and other means took the form of chemical doctrine about a century before Christ, and there is now no reasonable doubt that the Arabian Geber and others)as stated by Dr. Gladstone in his inaugural address to the Chemical Society) derived their ideas on the transmutation of metals into gold and the belief in immunity from death by the use of the philosopher's stone from China. Among all the metals with which the alchemist worked mercury was pre-eminent, and this is stated to be really the philosopher's stone, of which Geber, Kalid, and others spoke in the times of the early Caliphs. In China it was employed excessively as a medicine. On nights when dew was falling a sufficient amount was collected to mix with the powder of cinnabar, and this was taken habitually till it led to serious disturbance of the bodily functions. In the ninth century an emperor, and in the tenth a prime minister, died from overdoses of mercury. Chinese medical books say it takes two hundred years to produce cinnabar; in three hundred years it becomes lead; in two hundred years more it becomes silver, and then by obtaining a transforming substance called "vapor of harmony" it becomes gold. This doctrine of the transformation of mercury into other metals is 2,000 years old in China. The Chinese hold that it not only prolongs life, but expels bad vapors, poison, and the gloom of an uneasy mind.

VEGETABLE SILK.—A German technical journal gives some details as to a vegetable substance, somewhat resembling silk, to which attention has lately been drawn by its having been exhibited in Greece. It is stated that this substance is a silky haired portion of a tree-like shrub, which came originally from America, but is found in Syria and the south of Europe (*Asclepias Syriæ*), of the family of Asclepiades. It is also known as the Syria silk plant. The substance in question is used for stuffing very soft cushions. When mixed with silk and wool, the Syrian silk is said to be used in different tissues. The milky juice of the plant is poisonous, and the tough stalks can be used in the same manner as the corresponding portions of the hemp plant. An English exchange, which has seen a specimen of this fibre, says: "It is certainly very beautiful, soft to the touch, and very silky in appearance. Whether it is likely to be used largely for manufactures is quite another matter, and upon which no off-hand opinion would be worth much.

A NEW EXPLANATION OF MENTAL AND NERVOUS DISORDERS.—Dr. B. W. Richardson has offered a new and plausible explanation for the occurrence of various forms of mental and nervous disorders, namely: that they depend for their development on the presence in the body of certain organic compounds, formed by certain unnatural or abnormal chemical processes carried on within the body itself. He has proved that the substance amylene—an organic product that is sometimes formed in the body—produces phenomena identical with somnambulism. He believes from his researches upon the action of lactic acid, that the presence of this substances in the body will account for certain forms of heart disease and rheumatism. Similarly he advances other suggestions as to the probable effect of other chemical compounds of poisonous nature which he believes may be developed in the body by abnormal processes, and discusses their possible relation to the causation of special forms of disease.

LENGTH OF OUR LIVES INCREASING.—At a recent international health exhibition held in London, Sir James Paget delivered an address before the association, the Prince of Wales being present. The learned physician asserted that people live longer than formerly, and that less sickness prevails among the mass of people, and he then gives the following reasons for the decrease of mortality during the last few years: "There is less from intemperance, less from immorality; we have better, cheaper and more various food, far more and cheaper clothing, far more and healthier recreations. We have, on the whole, better houses and better drains, better water and air, and better ways of using them. The care and skill with which the sick are treated in hospitals, infirmaries, and even in private houses, are far greater than they were; the improvement and extension of nursing are more than can be described; the care which the rich bestow on the poor when they visit them in their own homes, is every day saving health and life; and even more effectual than any of these is the work done by the medical officers of health and all the sanitary authorities now active and influential in every part of the kingdom. But we want," adds the lecturer in closing, "more ambition for health—a personal ambition for renown in health as keen as is that for bravery or for beauty, or for success in our athletic games and field sports."

THERMAL COLOURED RINGS.—M. Decharme, whose experiments on the flow of currents in pipes and their hydro-dynamic analogy to electric currents have attracted much attention, has also recently drawn attention to the fact that thermal coloured rings bear a striking resemblance to electro-chemical coloured rings. When a copper plate is exposed to the flame of a spirit lamp or a Bunsen burner, an irisated or rainbow coloured corona is produced about the heated point. Under good conditions these colours are fixed and unalterable in the air. These rings are, according to M. Decharme, quite similar to Nobili's electro-chemical rings; like the latter they succeed each other in waves, the colours being in the same order, namely, that of Newton's rings viewed by transmission.

SUBMARINE CABLES.—The Faraday is now engaged in laying the second Bennet-Mackay Atlantic cable from Kenmare Bay in Ireland to Canso in America. Dr. Muirhead is at present at the Irish station fitting up his duplex system on the cable already laid, and we understand that he will shortly proceed to America to complete the work there. With both the new cables duplexed, the company will have practically four cables at their disposal to compete with the existing lines, and we believe that arrangements have been made with an American telegraph company to give them a land continental system of lines, as well as a sub-Atlantic system. The combination may therefore prove a formidable rival to the Western Union Telegraph Company if it can keep out of the hands of the present powerful monopolies. While upon this subject we may mention the singular case of a living whale, 70 ft. long, being recently caught in one of the West Coast of America Telegraph Company's cables by Captain Morton, of the company's repairing ship. The whale was hauled up to the ship's bows in the cable while being repaired, and the wire cutting into its flesh caused the entrails to escape. The whale drifted to windward dead after the cable parted with the strain. The supposition is that the whale produced the faults in the cable, which was being repaired, by getting entangled in the latter. If so, it must have been caught seven days.