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Contents

Table of Contents

Page 1

V. ELECTRICITY, LIGHT, HEAT. ETC.—The Temperature of the Earth as shown by Deep Mines.

New Arrangement of the Bichromate of Potash Pile.—3 figures.

The Distribution of Electricity by Induction.—1 figure.

Electricity Applied to the study of Seismic Movements.—Apparatus for the study of horizontal and vertical seismic movements, *etc*.—8 figures.

New Accumulators.—3 figures.

Industrial Model of the Reynier Zinc Accumulator.

The History of a Lightning Flash.—By W. SLINGO.

Researches on Magnetism.

VI. Natural history.—The Giraffe.—With engraving.

VII. *Medicine*, *and Hygiene*.—The Treatment of Cholera—By Dr. H.A. *Rawlins*.

Temperature. Moisture, and Pressure, in their Relations to Health.—London deaths under 1 year in July, August, and part of September.

Consumption Spread by Chickens.

New Method of Reducing Fever.

VIII. *Miscellaneous*.—The Crown Diamonds of France at the Exhibition of Industrial Arts.

A New Mode of Testing the Economy of the Expenses of Management in Life Insurance.—By *Walter* C. *Wright*.

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THE GIRAFFE.

The spirited view herewith presented, representing the “Fall of the Giraffe” before the rifle of a sportsman, we take from the *Illustrated London News*. Hunting the giraffe has long been a favorite sport among the more adventurous of British sportsmen, its natural range being all the wooded parts of eastern, central, and southern Africa, though of late years it has been greatly thinned out before the settlements advancing from the Cape of Good Hope.

[Illustration: *The fall of the giraffe*.]

The characteristics of this singular animal are in some particulars those of the camel, the ox, and the antelope. Its eyes are beautiful, extremely large, and so placed that the animal can see much of what is passing on all sides, and even behind it, so that it is approached with the greatest difficulty. The animal when full grown attains sometimes a height of fifteen to seventeen feet. It feeds on the leaves and twigs of trees principally, its immense length of legs and height at the withers rendering it difficult for the animal to graze on an even surface. It is not easily overtaken except by a swift horse, but when surprised or run down it can defend itself with considerable vigor by kicking, thus, it is said, often tiring out and beating off the lion. It was formerly almost universally believed that the fore legs were longer than the hinder ones, but in

Page 2

fact the hind legs are the longer by about one inch, the error having been caused by the great development and height of the withers, to give a proper base to the long neck and towering head. The color varies a good deal, the head being generally a reddish brown, and the neck, back, and sides marked with tessellated, rust colored spots with narrow white divisions. Many specimens have been brought to this country, the animal being extremely docile in confinement, feeding from the hand, and being very friendly to those who are kind to it.

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An experiment has been made in Vienna which proves that even with incandescent lights special precautions must be taken to avoid any risk of fire. A lamp having been enveloped with paper and lighted by a current, the heat generated was sufficient to set fire to the paper, which burnt out and caused the lamp to explode.

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THE TEMPERATURE OF THE EARTH AS SHOWN BY DEEP MINES.

At a recent meeting of the American Society of Civil Engineers, observations on the temperature of the earth, as shown by deep mines, were presented by Messrs. Hamilton Smith, Jr., and Edward B Dorsey. Mr. Smith said that the temperature of the earth varies very greatly at different localities and in different geological formations. There are decided exceptions to the general law that the temperature increased with the depth. At the New Almaden quicksilver mine, in California, at a depth of about 600 feet the temperature was very high—some 115 degrees; but in the deepest part of the same mine, 1,800 feet below the surface and 500 feet below sea level, the temperature is very pleasant, probably less than 80 degrees. At the Eureka mines, in California, the air 1,200 feet below the surface appears nearly as cool as 100 feet below the surface. The normal temperature of the earth at a depth of 50 or 60 feet is probably near the mean annual temperature of the air at the particular place. At the Comstock mines, some years since, the miners could remain but a few moments at a time, on account of the heat. Ice water was given them as an experiment; it produced no ill effects, but the men worked to much better advantage; and since that time, ice water is furnished in all these mines, and drunk with apparently no bad results.

Mr. E.B. Dorsey said that the mines on the Comstock vein, Nevada, were exceptionally hot. At depths of from 1,500 to 2,000 feet, the thermometer placed in a freshly drilled hole will show 130 degrees. Very large bodies of water have run for years at 155 degrees, and smaller bodies at 170 degrees. The temperature of the air is kept down to 110 degrees by forcing in fresh air cooled over ice.

Captain Wheeler, U.S. Engineers, estimated the heat extracted annually from the Comstock by means of the water pumped out and cold air forced in, as equal to that generated by the combustion of 55,560 tons of anthracite coal or 97,700 cords of wood. Observations were then given upon temperature at every 100 feet in the Forman shaft of the Overman mine, running from 53 degrees at a depth of 100 feet to 121.2 degrees at a depth of 2,300 feet. The temperature increased:

Page 3

100 to 1,000 feet deep, increase 1 degree in 29 feet.
100 to 1,800 feet deep, increase 1 degree in 30.5 feet.
100 to 2,300 feet deep, increase 1 degree in 32.3 feet.

A table was presented giving the temperatures of a large number of deep mines, tunnels, and artesian wells. The two coolest mines or tunnels are in limestone, namely, Chanarcillo mines and Mont Cenis tunnel; and the two hottest are in trachyte and the "coal measures," namely, the Comstock mines in trachyte and the South Balgray in the "coal measures." Mr. Dorsey considered that experience showed that limestone was the coolest formation.

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GALLISIN, AN UNFERMENTABLE SUBSTANCE IN STARCH SUGAR.

C. Schmitt and A. Coblenzl have made a careful investigation of the unfermentable substances found in commercial starch sugars, and have succeeded in isolating a definite compound, to which they give the name gallisin. The method of separation and purification which they made use of is as follows: 5 kilogrammes of commercial starch sugar were allowed to ferment. At a temperature of 18-20 deg. C. and with a solution containing 20 per cent. the fermentation was complete in five to six days. It was filtered; the perfectly clear, almost colorless, liquid evaporated as far as possible on the water-bath, and the sirup while still warm brought into a good-sized flask. The sirup was then well shaken with a large excess of absolute alcohol, when it became viscous, but did not mix with the alcohol. The latter was poured off, replaced by fresh alcohol, and again shaken. When this shaking with alcohol has been repeated several times, the sirup is finally changed to a yellowish-gray mass. This is now brought into a large mortar, and rubbed up under a mixture of alcohol and ether. After some time the whole mass is transformed into a gray powder. It is quickly filtered off with the aid of an aspirator, washed with alcohol and then with ether, and brought under a desiccator with concentrated sulphuric acid. In order to purify the substance, it is dissolved in water and treated with bone-black. The solution is then evaporated to a sirup, and this poured into a mixture of equal parts of anhydrous alcohol and ether. In this way the new compound is obtained as a very fine, pure white powder which rapidly settles. It has much the appearance of starch. Under the microscope it is perfectly amorphous. In the air it deliquesces much more rapidly than ignited calcium chloride.

Treated with dilute mineral acids or oxalic acid on the water-bath gallisin is transformed into dextrose. It does not ferment when treated in water solution with fresh yeast. The analyses led to the formula C_{12}H_{24}O_{10}. When treated under pressure with three times its weight of acetic anhydride at 130-140 deg. it dissolves perfectly. From the solution a product was separated which on analysis gave results agreeing with the formula $C_{12}H_{18}O_{10}(C_2H_3O)_6$. The substance appears therefore to be hexacetylgallisin.

Page 4

Physiological experiments on lower animals and human beings demonstrated clearly that gallisin has neither directly nor indirectly any injurious effect on the health.—-*Berichte der Deutschen Chemischen Gesellschaft, 17, 1000; Amer. Chem. Jour.*

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THE COMBINING WEIGHTS, VOLUMES, AND SPECIFIC GRAVITIES OF ELEMENTS AND COMPOUNDS.

Under the title of “Figures Worth Studying,” Mr. William Farmer, of New York, read a paper before a recent meeting of the Society of Gas Lighting, from which the *American Gas Light Journal* gives the following:

I have prepared the following table, which contains some of the elements and compounds, with their combining weights, volumes, and specific gravities. When the combining weight of any of these elements and compounds is taken in pounds, then the gas or vapor therefrom will always occupy about 377.07 cubic feet of space, at 60 deg. Fahr. and 30 inches barometer. If we divide this constant 377.07 by the combining weight of any of the substances, then the quotient will be the number of cubic feet per pound of the same. If we divide the combining weight of any of the substances given in the table by 2, then the quotient will give the density of the same, as compared with hydrogen. If we divide the combining weight of any of the substances by the constant 28.87, then the quotient will be the specific gravity of the gas or vapor therefrom, as compared with air. All the calculations are based on the atomic weights which are now generally adopted by the majority of chemists.

	Combining Weight.	Cub. Ft. per Pound.	Cub. Ft. per Combining Weight.	Specific Gravity Air = 1.
Hydrogen (H_{2})	2.00	188.53	377.07	0.0692
Carbon vapour (C_{2})	23.94	15.75	377.07	0.8292
Nitrogen (N_{2})	28.06	13.43	377.07	0.9719
Oxygen (O_{2})	31.92	11.81	377.07	1.1056
Chlorine (Cl_{2})	71.00	5.31	377.07	2.4593
Bromine (Br_{2})	160.00	2.35	377.07	5.5420
Flourine (F_{2})	38.00	9.92	377.07	1.3162
Iodine (I_{2})	253.20	1.48	377.07	8.7703

Sulphur (S_2)	63.96	5.89	377.07	2.2154
Phosphorus (P_4)	123.84	3.04	377.07	4.2895
Carbonic oxide (Co)	27.03	13.50	377.07	0.9674
Carbonic acid (Co_2)	48.89	8.59	377.07	1.5202
Water vapour (H_2O)	17.06	20.99	377.07	0.6221
Hydrogen sulphide (H_2S)	33.08	11.09	377.07	1.1770
Ammonia (H_2N)	17.03	22.14	377.07	0.5898

Page 5

Sulphurous oxide (so_{2})	63.90	5.90	377.07	2.2133
Sulphuric oxide (so_{3})	79.86	4.72	377.07	2.7662
Cyanogen ($C_{2}N_{2}$)	52.00	7.25	377.07	1.8011
Bisulphide of carbon (CS_{2})	75.93	4.96	377.07	2.6300
Ethyl alcohol ($C_{2}H_{6}O$)	45.90	8.21	377.07	1.5898
Ethyl ether ($C_{4}H_{10}O$)	73.84	5.10	377.07	2.5576
Methyl alcohol ($CH_{4}O$)	31.93	11.81	377.07	1.1059
Methyl chloride ($CH_{3}Cl$)	50.47	7.47	377.07	1.7482
Carbonyl chloride ($COCl_{2}$)	98.93	3.81	377.07	3.4267
Phosphine gas (Ph_{3})	33.96	11.10	377.07	1.1769
Hydrochloric acid (HCl)	36.50	10.33	377.07	1.2642
Methane (CH_{4})	15.98	26.61	377.07	0.5531
Ethane ($C_{2}H_{6}$)	29.94	12.50	377.07	1.0370
Propane ($C_{3}H_{8}$)	43.91	8.58	377.07	1.5209
Butane ($C_{4}H_{10}$)	57.88	6.51	377.07	2.0048
Ethene ($C_{2}H_{4}$)	27.94	13.49	377.07	0.9677
Propene ($C_{3}H_{6}$)	41.91	8.99	377.07	1.4516
Butene ($C_{4}H_{8}$)	55.88	6.74	377.07	1.9355
Ethine ($C_{2}H_{2}$)	25.94	14.53	377.07	0.8985
Propine ($C_{3}H_{4}$)	39.91	9.44	377.07	1.3824
Butine ($C_{4}H_{6}$)	53.88	6.98	377.07	1.8662
Quintone ($C_{5}H_{6}$)	65.85	5.72	377.07	2.2809
Benzene ($C_{6}H_{6}$)	77.82	4.84	377.07	2.6955
Styrolene ($C_{8}H_{8}$)	103.75	3.63	377.07	3.5936
Naphtalene ($C_{10}H_{8}$)	127.70	2.95	377.07	4.4232
Turpentine ($C_{10}H_{16}$)	135.70	2.77	377.07	4.7003
Dry air	28.87	13.06	--	1.0000

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EMERALD-GREEN: ITS PROPERTIES AND MANUFACTURE.[1]

[Footnote 1: This substance is also known by the name Schweinfurt green.]

By *Robert Galloway*, M.R.I.A.

The poisonous effects of wall-paper stained with emerald-green (aceto-arsenite of copper) appears to be a very favorite topic in many journals; it is continually reappearing in one form or another in different publications, especially medical ones; there has recently appeared a short reference to it under the title, “The Poisonous Effect of Wall-paper.” As some years ago I became practically acquainted with its properties and manufacture, a few observations on these subjects may not be without interest.

Page 6

In the paragraph referred to, it is stated that the poisonous effect of this pigment cannot be *entirely* due to its mere mechanical detachment from the paper. This writer therefore attributes the poisonous effects to the formation of the hydrogen compound of arsenic, *viz*., arseniureted hydrogen (AsH_{3}); the hydrogen, for the formation of this compound, being generated, the writer thinks probable, “by the joint action of moisture and organic matters, *viz*., of substances used in fixing to walls papers impregnated with arsenic.” In some of our chemical manuals, Dr. Kolbe’s “Inorganic Chemistry,” for example, it is also stated that arseniureted hydrogen is formed by the *fermentation* of the starch-paste employed for fastening the paper to the walls. It is perfectly obvious that the fermentation of the starch-paste must cease after a time, and therefore the poisonous effects of the paper must likewise cease if its injurious effects are caused by the fermentation. I do not think that arseniureted hydrogen could be formed under the *conditions*, for the oxygen compound of arsenic is in a state of combination, and the compound is in a dry solid state and not in solution and the affinities of the two elements—arsenic and hydrogen—for each other are so exceedingly weak that they cannot be made to unite directly except they are both set free at the same moment in presence of each other. Further, for the formation of this hydrogen compound by the fermentation of the starch, or by the growth of minute fungi, the *entire* compound must be broken up, and therefore the pigment would become discolored; but aceto-arsenite of copper

$$(3CuAs_{2}O_{4}+Cu(C_{2}H_{3}O_{2})_{2})$$

is a very stable compound, not readily undergoing decomposition, and is consequently a very permanent color. It has also been not unfrequently stated that the injurious effects of this pigment are due to the arsenious oxide volatilizing from the other constituents of the compound. This volatilization would likewise cause a breaking up of the entire compound, and would consequently cause a discoloration of the paper; but the volatilization of this arsenic compound is in every respect most improbable.

The injurious effects, if any, of this pigment must therefore be due to its mechanical detachment from the paper; but has it ever been conclusively proved that persons who inhabit rooms the wall-paper of which is stained with emerald-green suffer from arsenical poisoning? If it does occur, then the effects of what may be termed homoeopathic doses of this substance are totally different from the effects which arise from larger doses. During the packing of this substance in its dry state in the factory, clouds of its dust ascend in the air, and during the time I had to do with its manufacture I never heard that any of the factory hands suffered, nor did I suffer, from arsenical poisoning. If there is any abrasion of the skin the dust produces a sore, and also the delicate lining of the nostrils is apt to be affected. It is in this way it acts in large doses; I am therefore very skeptical as to its supposed poisonous effects when wall-paper is stained with it.

Page 7

Different methods are given in works on chemistry for the manufacture of this pigment, but as they do not agree in every respect with the method which was followed in English color factories some years ago, it will be as well, for the full elucidation of the manufacture of this substance, to briefly recite some of these methods before describing the one that was, and probably is still, in use; and I will afterward describe a method which I invented, and which is practically superior to any other, both in the rapidity with which the color can be formed, and for producing it at a less cost.

It is stated in Watts' "Dictionary of Chemistry" that it is "prepared on a large scale by mixing arsenious acid with cupric acetate and water. Five parts of verdigris are made up to a thin paste, and added to a boiling solution of 4 parts or rather more of arsenious acid in 50 parts of water. The boiling must be well kept up, otherwise the precipitate assumes a yellow-green color, from the formation of copper arsenite; in that case acetic acid must be added, and the boiling continued a few minutes longer. The precipitate then becomes crystalline, and acquires the fine green color peculiar to the aceto-arsenite." I do not know from personal knowledge, but I have always understood that the copper salt employed in its manufacture in France is the acetate. This would account, in my opinion, for the larger crystalline flakes in which it is obtained in France than can be produced by the English method of manufacturing it. Cupric acetate is never employed, I believe, in England—the much cheaper copper salt, the sulphate, being always employed.

In "Miller's Chemistry" it is stated it "may be obtained by *boiling* solutions of arsenious anhydride and cupric acetate, and adding to the mixture an equal bulk of *cold* water." Why it should be recommended to add *cold water*, I am at a loss to understand.

In Drs. Roscoe and Schorlemmer's large work on "Chemistry," and in the English edition of "Wagner's Handbook of Chemical Technology," edited by Mr. Crookes, the process as described by Dr. Ehrmann in the "Ann. Pharm.," xii., 92, is given. It is thus stated in Wagner's work: "This pigment is prepared by first separately dissolving equal parts by weight of arsenious acid and neutral acetate of copper in boiling water, and next mixing these solutions while boiling. There is immediately formed a flocculent olive-green colored precipitate of arsenite of copper, while the supernatant liquid contains free acetic acid. After a while the precipitate becomes gradually crystalline, at the same time forming a beautiful green pigment, which is separated from the liquid by filtration, and after washing and carefully drying is ready for use. The mode of preparing this pigment on a large scale was originally devised by M. Braconnot, as follows: 15 kilos. of sulphate of copper are dissolved in the smallest quantity of boiling water, and mixed with a boiling and concentrated solution of arsenite of soda or potassa, so prepared as to contain 20 kilos. of arsenious acid. There is immediately formed a dirty greenish-colored precipitate which is converted into Schweinfurt green by the addition of some 15 liters of concentrated wood-vinegar. This having been done, the precipitate is immediately filtered off and washed."

Page 8

As I have already stated, the copper salt used in the manufacture of this pigment in England is the sulphate, and it is carried out pretty much according to Braconnot's method as described by Dr Ehrmann; but any one would infer, from reading his description of the manufacturing process, that the compound, aceto-arsenite of copper, was formed almost immediately after the addition of the acetic acid, a higher or lower atmospheric temperature having no effect in hastening or retarding the formation. Furthermore, it is not stated whether the compound forms more readily in an acid or neutral solution, or whether it can or cannot be formed in a neutral one; now both these points are important to notice in describing its manufacture. As regards the former I shall notice it presently, and, as far as my knowledge extends, the pigment will not form when the solution is neutral.

The operation is conducted in the following manner in the factory: The requisite quantity of sulphate of copper is placed in a large wooden vat, and hot water added to dissolve it; the requisite quantity of arsenic (arsenious anhydride) and carbonate of soda, the latter not in quantity quite sufficient to neutralize the whole of the sulphuric acid set free from the sulphate of copper on the precipitation of the copper as arsenite, are placed in another wooden vessel; water is then added, and the formation of the arsenite of soda and its solution are aided by the introduction of steam into the liquid. When complete solution has been effected the arsenic solution is run off into the vat containing the solution of the sulphate of copper, arsenite of copper being at once precipitated. The necessary quantity of acetic acid is afterward added. In *warm* weather the formation of the aceto-arsenite soon commences after the addition of the vinegar; but, even in that case, it takes a week or more to have the whole of a big batch of arsenite converted into the aceto-arsenite; and perfect conversion is necessary, as the presence of a very minute quantity of unchanged arsenite lowers very much the price of the emerald pigment, and a by no means large quantity renders the pigment unsalable, owing to its dirty yellowish-green color. In cold weather a much longer time is required for its complete conversion; even at the end of a fortnight or three weeks there frequently remains sufficient unconverted arsenite to affect seriously the selling price of the color; when this occurs the manufacturer generally removes these last traces by a most wasteful method viz, by adding a quantity of free sulphuric acid. The acid of course dissolves the arsenite, but it dissolves in very much larger quantities the aceto-arsenite; and this costly solution is not utilized, but is run into the factory sewer.

By my method of manufacturing it, it can be produced in winter as well as in summer in one or two hours, and the quantity of free acid required for its formation is reduced to the lowest amount. I proceed as follows: After having dissolved in hot water the requisite quantity of cupric sulphate, I decompose one-fourth of this salt by adding just sufficient of a solution of carbonate of soda to precipitate the copper, in that quantity of the sulphate, as carbonate. I then add just sufficient acetic acid to convert the carbonate into acetate. I have now got in solution—

Page 9

$3CuSO_{4} + Cu(C_{2}H_{3}O_{2})_{2}$,

and I have to transform it into—

$3CuAs_{2}O_{4} + Cu(C_{2}H_{3}O_{2})_{2}$.

It is at once seen that I have got the requisite quantity of acetate formed. I next dissolve the requisite quantity of arsenious anhydride in an amount of carbonate of soda *rather less* than is sufficient to neutralize the acid in the remaining cupric sulphate, and I then bring the solution to or near the boiling-point by introducing steam into it; the arsenic is dissolved not in the same vessel as the copper salt, but in a separate one. When the arsenic solution is fully heated, a small current of it is allowed to flow into the vat containing the copper salts, and brisk stirring is kept up in the vat. The emerald green is at once formed; but if there should be the slightest formation of any arsenite, the flow of the arsenic solution is at once stopped until every trace of the arsenite has been converted; the arsenic solution is then allowed to flow in again, with the same precautions as before; in this way a large batch of emerald-green can he formed in one or two hours, without containing the slightest trace of the arsenite. I keep the arsenic solution near the boiling-point during the whole of the time it is flowing into the other vessel. By varying the proportions of water I could either make it coarse or fine, as I wished, which is an important matter to have complete control over in its manufacture.

Two points of interest occurred to me during the time I was occupied with the research, which I had not time to complete; one was whether the aceto-arsenite can be formed, adopting the old method for its formation, if there is more than a certain quantity of water; from some experiments I made in this direction I was inclined to the opinion it could not. I have already stated that emerald-green is soluble to a certain extent in acids, and that it is formed in a more or less acid solution; consequently a varying amount of the pigment is always lost by being dissolved in the supernatant liquid. To prevent to a certain extent this loss I precipitated the copper from it as arsenite; but I was not successful in the few experiments I had time to make on this part of the subject of reconverting the copper arsenite thus obtained into the aceto-arsenite by the addition of acetic acid.—*Jour. of Science.*

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ANALYSIS OF ZINC ASH AND CALCINED PYRITES BY MEANS OF AMMONIUM CARBONATE.

In a recent issue of the *Chemiker Zeitung* Dr. Kosmann has reported an analytical method for the examination of zinciferous products; according to this report, the ash and flue dust produced by the extraction of zinc from its ore comprise:

1. Zinc dust, from the distillation of zinc,
2. Flue dust, condensed in chambers of zinc furnaces with Kleemann’s receivers,

Page 10

3. Zinc ash, of various assortments, from iron blast furnaces.

Of these, zinc dust is the only ready product which is, as color or reducing agent, employed in analytical and technical processes. Its value, when serving the latter purpose, is determined by the percentage of finely divided metallic zinc and cadmium contained therein; of equal reducing power is cadmium, generally associating zinc; injurious, and therefore uneffective, are zinc oxide and oxides of other metals, also metallic lead.

Flue dust, condensed in chambers of zinc furnaces with Kleemann's receivers, is employed with zinc ores in the extraction of zinc, and in small quantities as substitute for zinc white; its commercial value is similarly estimated as that of zinc ores.

The various modifications of zinciferous flue ashes from blast furnaces are an object for continual demand, being both a valuable material for the production of zinc and, in its superior qualities, a desirable pigment. In the regeneration of zinc the presence of foreign substances is of some concern; detrimental are lead, sulphur, and sulphuric acid in form of lead, zinc, and lime sulphate.

The chemico-technical analysis of these products has until recently been confined to the volumetric determination of zinc by means of sodium sulphide (Schaffner's method). But as a remnant of sulphur, as sulphuric acid, in roasted blende causes a material loss during distillation, and otherwise being induced to produce a zinc free of lead, the estimation of sulphur, sulphuric acid, and lead became necessary. These impurities are determined by well-known methods; sulphur is oxidized and precipitated with barium chloride, lead by sulphuric acid and alcohol. The examination of zinc dust, when used for the regeneration of metal, determines the quantity of zinc resident therein, and employed as reducing agent, the quantity of metal which causes the generation of hydrogen. Cadmium, showing the same deportment, must also be considered as well as lead and arsenic.

A most complete and rapidly working method for the examination of zinciferous products has originated with the application of neutral ammonium carbonate as solvent. A solution of this preparation is made, according to H. Rose, by dissolving 230 grm. commercial ammon carbonate in 180 c.c. ammoniacal liquor of 0.92 s.g., and, by addition of water, augmenting it to one liter.

This solution dissolves the metallic components, their oxides, and basic zinc sulphate, and transfers cadmium and lead oxide, also lead, magnesium, and lime sulphate, into insoluble carbonates. Iron and manganese, when present as protoxide, are dissolved; of iron sesquioxide but traces, and of cadmium oxide *in statu nascendi* a small portion enter into solution. The solution of ammonium carbonate contains in each 10 c.c. 1 grm. ammonia, which dissolves 1.5 grm. zinc.

Page 11

The sample for examination is moistened with water and mixed with an adequate volume of the solvent, is digested at 50-60 deg. C. until complete decomposition is effected. The heating of the liquid prevents the solution of iron, manganese, and cadmium. The content, sediment and liquid, is thrown on a filter and washed with hot water to which a small quantity of the solvent has been added. When the solution contains iron and manganese, it is separated by decantation from the sediment and oxidized with bromine (according to the method of Nic-Wolff) until a flocculent precipitate of iron sesquioxide and manganese dioxide becomes visible; it is united with the original residue and filtered.

The filtrate is diluted till it appears cloudy, boiled to expel ammonia, tested with sodium sulphide upon the presence of zinc, and, when freed of all zinc, decanted. The precipitate of zinc carbonate is filtered, exhausted with water, transferred into zinc oxide by ignition, and weighed. The gravimetric method can be substituted by the volumetric by introducing a solution of sodium sulphide of known strength into the ammoniacal filtrate. On dividing the filtered liquid into various equal portions other substances, arsenic and sulphuric acid, can be determined from the same sample. For this purpose the filtrate is concentrated; divided into two equal portions, one of which is acidified and treated with hydrogen sulphide for the determination of arsenic, the other is acidified and used for the estimation of sulphuric acid by means of barium chloride. The original residue is dissolved in muriatic or acetic acid and filtered. The lead of the filtered liquid is thrown down by sulphuric acid, and alcohol, and cadmium, after dissipation of alcohol into gas, precipitated by hydrogen sulphide. Iron, manganese, alumina, and other substances present in the solution are determined by known methods.

It is manifest that the determination of substances—zinc, lead, and sulphuric acid—-which are of importance in technical analysis of zinc ash, can be executed by this method within a comparatively short time. The application of ammonium carbonate as solvent has the advantage, over the application of ammonia, that it is a far better solvent, that it decomposes insoluble basic sulphates, and that the remaining carbonates are readily dissolved by acids.

The decomposition of zinc dust is accompanied by a lively evolution of gas; it is therefore necessary to continue the digestion of the sample till no more hydrogen is given off. Zinc dust contains both metals and their oxides, and methods which, from the volume of hydrogen generated, determine indirectly the percentage of metallic zinc do not give the real composition of the zinc dust. For the determination of the metallic components the material is digested with a solution of copper sulphate, which dissolves zinc and cadmium; the liquid is filtered, acidified, and decomposed with hydrogen sulphide, or treated

Page 12

with a solution of ammonium carbonate. The use of cupric chloride is not advisable, as it corrodes lead, and gives rise to the formation of soluble chloride of lead, which complicates the separation of zinc from cadmium. The best mode of operation is the following: Both copper sulphate and zinc dust are weighed separately, the former is dissolved in water and the latter introduced into the solution of copper sulphate in small portions until it appears colorless. During the operation the vessel is freely shaken, lumps are comminuted with a glass rod, and a few drops of the liquid are ultimately tested with hydrogen sulphide or ammonia. The remainder of zinc dust is then weighed, and its value deducted from the original weight. Zinc and cadmium of the filtrate are determined as above. On repeating this method several times most satisfactory results are obtained.

Another mode of operating is to employ an excess of copper sulphate and to determine the copper dissolved in the filtrate. The separation of copper from cadmium being difficult and laborious, and the volumetric estimation with potassium cyanide not practicable, it is not prudent to apply this method.

When calcined zinciferous pyrites have to be examined, the estimation of zinc is similar to that employed in the analysis of zinc ore. The sample is exhausted with water, filtered, and, to eliminate calcium sulphate and basic iron sulphate, evaporated to dryness. It is then dissolved in a small quantity of alcohol and water, refiltered, and the filtrate decomposed with ammonium carbonate. The original residue is treated with a solution of ammonium carbonate, which dissolves arsenious acid and basic zinc sulphate, filtered, and united with the first filtrate. When iron and manganese are present, the filtrates are treated with bromine. The united filtrates are boiled or examined volumetrically with sodium sulphide.

* * * * *

PETROLEUM AS FUEL IN LOCOMOTIVE ENGINES.[2]

[Footnote 2: Abstract of paper read before the Institution of Mechanical Engineers.]

By Mr. THOMAS URQUHART.

Comparing naphtha refuse and anthracite, the former has a theoretical evaporative power of 16.2 lb. of water per lb. of fuel, and the latter of 12.2 lb., at a pressure of 8 atm. or 120 lb. per square inch; hence petroleum has, weight for weight, 33 per cent. higher evaporative value than anthracite. Now in locomotive practice a mean evaporation of from 7 lb. to 71/2 lb. of water per lb. of anthracite is about what is generally obtained, thus giving about 60 per cent. efficiency, while 40 per cent. of the heating power is unavoidably lost. But with petroleum an evaporation of 12.25 lb. is practically obtained, giving 12.25/16.2 = 75 per cent. efficiency. Thus in the first place petroleum is theoretically 33 per cent. superior to anthracite in evaporative power; and secondly, its useful effect is 25 per cent. greater, being 75 percent. instead of 60 percent.; while, thirdly, weight for weight, the practical evaporative value of petroleum must be reckoned as at least from (12.25 — 7.50)/7.50 = 63 per cent. to (12.25 — 7.00)/7.00 = 75 per cent. higher than that of anthracite.

Page 13

Spray injector.—Steam not superheated, being the most convenient for injecting the spray of liquid fuel into the furnace, it remains to be proved how far superheated steam or compressed air is really superior to ordinary saturated steam, taken from the highest point inside the boiler by a special internal pipe. In using several systems of spray injectors for locomotives, the author invariably noticed the impossibility of preventing leakage of tubes, accumulation of soot, and inequality of heating of the fire box. The work of a locomotive boiler is very different from that of a marine or stationary boiler, owing to the frequent changes of gradient on the line, and the frequent stoppages at stations. These conditions render firing with petroleum very difficult; and were it not for the part played by properly arranged brickwork inside the fire box, the spray jet alone would be quite inadequate. Hitherto the efforts of engineers have been mainly directed toward arriving at the best kind of "spray injector," for so minutely subdividing a jet of petroleum into a fine spray, by the aid of steam or compressed air, as to render it inflammable and of easy ignition. For this object nearly all the known spray injectors have very long and narrow orifices for petroleum as well as for steam; the width of the orifices does not exceed from 1/2 mm. to 2 mm. or 0.02 in. to 0.08 in., and in many instances is capable of adjustment. With such narrow orifices it is clear that any small solid particles which may find their way into the spray injector along with the petroleum will foul the nozzle and check the fire. Hence in many of the steamboats on the Caspian Sea, although a single spray injector suffices for one furnace, two are used, in order that when one gets fouled the other may still work; but, of course, the fouled orifices require incessant cleaning out.

Locomotives.—In arranging a locomotive for burning petroleum, several details are required to be added in order to render the application convenient. In the first place, for getting up steam to begin with, a gas pipe of 1 inch internal diameter is fixed along the outside of the boiler, and at about the middle of its length it is fitted with a three-way cock having a screw nipple and cap. The front end of the longitudinal pipe is connected to the blower in the chimney, and the back end is attached to the spray injector. Then by connecting to the nipple a pipe from a shunting locomotive under steam, the spray jet is immediately started by the borrowed steam, by which at the same time a draught is also maintained in the chimney. In a fully equipped engine shed the borrowed steam would be obtained from a fixed boiler conveniently placed and specially arranged for the purpose of raising steam. In practice steam can be raised from cold water to 3 atm. pressure—45 lb. per square inch—in twenty minutes. The use of auxiliary steam is then dispensed with, and the spray jet is worked by steam from its own boiler; a pressure

Page 14

of 8 atm.—120 lb.—is thus obtained in fifty to fifty-five minutes from the time the spray jet was first started. In daily practice, when it is only necessary to raise steam in boilers already full of hot water, the full pressure of 7 to 8 atm. is obtained in from twenty to twenty-five minutes. While experimenting with liquid fuel for locomotives, a separate tank was placed on the tender for carrying the petroleum, having a capacity of about 3 tons. But to have a separate tank on the tender, even though fixed in place, would be a source of danger from the possibility of its moving forward in case of collision. It was therefore decided, as soon as petroleum firing was permanently introduced, to place the tank for fuel in the tender between the two side compartments of the water tank, utilizing the original coal space. For a six-wheeled locomotive the capacity of the tank is 3-1/2 tons of oil—a quantity sufficient for 250 miles, with a train of 480 tons gross exclusive of engine and tender. In charging the tender tank with petroleum, it is of great importance to have strainers of wire cloth in the manhole of two different meshes, the outer one having openings, say, of 1/4 in., the inner, say 1/8 in.; these strainers are occasionally taken out and cleaned. If care be taken to prevent any solid particles from entering with the petroleum, no fouling of the spray injector is likely to occur; and even if an obstruction should arise, the obstacle being of small size can easily be blown through by screwing back the steam cone in the spray injector far enough to let the solid particles pass and be blown out into the fire-box by the steam. This expedient is easily resorted to even when running; and no more inconvenience arises than an extra puff of dense smoke for a moment, in consequence of the sudden admission of too much fuel. Besides the two strainers in the manhole of the petroleum tank on the tender, there should be another strainer at the outlet valve inside the tank, having a mesh of 1/3 in. holes.

Driving locomotives.—In lighting up, certain precise rules have to be followed, in order to prevent explosion of any gas that may have accumulated in the fire box. Such explosions do often take place through negligence; but they amount simply to a puff of gas, driving smoke out through the ash-pan dampers, without any disagreeably loud report. This is all prevented by adhering to the following simple rules: First clear the spray nozzle of water by letting a small quantity of steam blow through, with the ash-pan doors open; at the same time start the blower in the chimney for a few seconds, and the gas, if any, will be immediately drawn up the chimney. Next place on the bottom of the combustion chamber a piece of cotton waste, or a handful of shavings saturated with petroleum and burning with a flame. Then by opening first the steam valve of the spray injector, and next the petroleum valve gently, the very first spray of oil coming on the

Page 15

flaming waste immediately ignites without any explosion whatever; after which the quantity of fuel can be increased at pleasure. By looking at the top of the chimney, the supply of petroleum can be regulated by observing the smoke. The general rule is to allow a transparent light smoke to escape, thus showing that neither too much air is being admitted nor too little. The combustion is quite under the control of the driver, and the regulation can be so effected as to prevent smoke altogether. While running, it is indispensable that the driver and fireman should act together, the latter having at his side of the engine the four handles for regulating the fire, namely, the steam wheel and the petroleum wheel for the spray injector, and the two ash-pan door handles in which there are notches for regulating the air admission. Each alteration in the position of the reversing lever or screw, as well as in the degree of opening of the steam regulator or the blast pipe, requires a corresponding alteration of the fire. Generally the driver generally passes the word when he intends shutting off steam, so that the alteration in the firing can be effected before the steam is actually shut off; and in this way the regulation of the fire and that of the steam are virtually done together. All this care is necessary to prevent smoke, which is nothing less than a waste of fuel. When, for instance, the train arrives at the top of a bank, which it has to go down with the brakes on, exactly at the moment of the driver shutting off the steam and shifting the reversing lever into full forward gear, the petroleum and steam are shut off from the spray injector, the ash-pan doors are closed, and if the incline be a long one, the revolving iron damper over the chimney top is moved into position, closing the chimney, though not hermetically. The accumulated heat is thereby retained in the fire-box; and the steam even rises in pressure, from the action of the accumulated heat alone. As soon as the train reaches the bottom of the incline and steam is again required, the first thing done is to uncover the chimney top; then the steam is turned on to the spray injector, and next a small quantity of petroleum is admitted, but without opening the ash-pan doors, a small fire being rendered possible by the entrance of air around the spray injector, as well as by possible leakage past the ash-pan doors. The spray immediately coming in contact with the hot chamber ignites without any audible explosion; and the ash-pan doors are finally opened, when considerable power is required, or when the air otherwise admitted is not sufficient to support complete combustion. By looking at the fire through the sight hole it can always be seen at night whether the fire is white or dusky; in fact, with altogether inexperienced men it was found that after a few trips they could become quite expert in firing with petroleum. The better men contrive to burn less fuel than others, simply by greater care in attending to all the points

Page 16

essential to success. At present seventy-two locomotives are running with petroleum firing; ten of them are passenger engines, seventeen are eight-wheel coupled goods engines, and forty-five are six-wheel coupled. As might be expected, several points have arisen which must be dealt with in order to insure success. For instance, the distance ring between the plates around the firing door is apt to leak, in consequence of the intense heat driven against it, and the absence of water circulation; it is therefore either protected by having the brick arch built up against it, or, better still, it is taken out altogether when the engines are in for repairs, and a flange joint is substituted, similar to what is now used in the engines of the London and Northwestern Railway. This arrangement gives better results, and occasions no trouble whatever.

Storage of petroleum.—The length of line now worked with petroleum is from Tsaritsin to Burnack, 291 miles. There is a main iron reservoir for petroleum at each of the four engine sheds, namely at Tsaritsin, Archeda, Filonoff, and Borisoglebsk. Each reservoir is 66 ft. internal diameter and 24 ft. high, and when full holds about 2,050 tons. The method of charging the reservoir, which stands a good way from the line, and is situated at a convenient distance from all dwelling houses and buildings, is as follows: On a siding specially prepared for the purpose are placed ten cistern cars full of oil, the capacity of each being about ten tons. From each of these cars a connection is made by a flexible India rubber pipe to one of ten stand pipes which project 1 ft. above the ground line. Parallel with the rails is laid a main pipe, with which the ten stand pipes are all connected, thus forming one general suction main. About the middle of the length of the main, which is laid underground and covered with sawdust or other non-conducting material, is fixed a Blake steam pump. As soon as all the ten connections are made with the cistern cars, the pump is set to work, and in about one hour the whole of the cars are discharged into the main reservoir, the time depending of course upon the capacity of the pump. All the pipes used are of malleable iron, lap-welded, and of 5 in. internal diameter, having screwed coupling muffs for making the connections. At each engine shed, in addition to the main storage reservoir, there is a smaller distributing tank, which is erected at a sufficient height to supply the tenders, and very much resembles the ordinary water tanks. These distributing tanks are circular, about 81/2 ft. diameter and 6 ft. high, and of 1/4 in. plates; their inside mean area is calculated exactly, and a scale graduated in inches stands in the middle of the tank; a glass with scale is used outside in summer time. Each inch in height on the scale is converted into cubic feet, and then by means of a table is converted into Russian poods, according to the specific gravity at various temperatures. As it would be superfluous

Page 17

to graduate the table for each separate degree of temperature, the columns in the table show the weights for every 8 degrees Reaumur, which is quite sufficient: namely, from 24 deg. to 17 deg., from 16 deg. to 9 deg., and so on, down to -24 deg.; the equivalent Fahrenheit range being from 86 deg. down to -22 deg. Suppose the filling of a tender tank draws off a height of 27 in. from the distributing tank, at a temperature of say -20 deg. R., these figures are shown by the table to correspond with 200.61 poods = 7,245 lb., or 3.23 tons, of petroleum. This arrangement does very well in practice; both the quantity and the temperature are entered on the driver’s fuel bill at the time of his taking in his supply.

Engines.—The engines used in the trials were built by Borsig, of Berlin, Schneider, of Creusot, and the Russian Mechanical and Mining Company, of St. Petersburg. Their main dimensions and weights were about the same, as follows, all of them having six wheels coupled, and 36 tons adhesive weight; as originally constructed they had ordinary fire boxes for burning anthracite or wood; cylinders 18-1/8 in. diameter and 24 in. stroke; slide valves, outside lap 1-1/16 in., inside lap 3/32 in., maximum travel, 4-9/16 in.; Stephenson link motion; boiler pressure, 120 lb. per square inch; six wheels, all coupled, 4 ft. 3 in. in diameter; distance between centers of leading and middle wheels, 6 ft. 2-3/4 in.; between middle and trailing, 4 ft. 9-1/4 in.; total length of wheel base, 11 ft.; weight empty, on leading wheels, 12.041 tons; middle, 10.782 tons; trailing, 10.685 tons; total weight, 33.508 tons empty; weight in running order, on leading wheels, 12.563 tons; middle, 11.885 tons; trailing 12.790 tons; total weight, 37.238 tons in running order. Tubes number 151; outside diameter, 2-1/8 in.; length between tube plates, 13 ft. 10-1/8 in.; outside heating surface, 1,166 square feet; fire box heating surface, 82 square feet; total heating surface, 1,248 square feet; fire grate area, 17 square feet; tractive power = 65 per cent. of boiler pressure x (cyl. diam.) squared x stroke / diameter of wheels = 0.65 x 120 x (18.125) squared x 24 / 51 = 5.383 tons. Ratio of tractive power to adhesion weight = 5.383 / 37.238 = 1 / 6.9.

Tender.—Contents: water, 310 cubic feet, or 1,933 gallons, or 81/2 tons; anthracite, 600 poods, or 10 tons; or wood, 11/2 cubic sajene, or 514 cubic feet; weight empty, 13.477 tons; weight in running order, 28.665 tons; six wheels.

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Petroleum Refuse—Comparative Trials with Petroleum, Anthracite, Bituminous Coal, and Wood, between Archeda and Tsaritsin on Grazi and Tsaritsin Railway, in Winter Time.

Page 18

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-----+---+-----+------+---+-----+------+----------+---
----------+------+-----------
| L |     |         |     |      |          |           |      |
| o |     |  Train    |     |      |          | Consumption |      |
| c |     |  alone.  |     |      |          |  Including  |      |
Date.| o |     |          |     |      |          | Lighting up.|      |
1883.| m |     |----+-----|     |      |          |           | Cost |
| o |Train|Num-|     | Dis-| Car  |          |           |  of  |Atmospheric
| t |     |ber |Gross|tance|miles.|  Fuel.    |-------+-----| fuel |temperature
| i |     | of |load.| run.|      |          |       | Per | per  |   and
| v |     |Loa-|     |     |      |          | Total |train| train| weather.
| e |     |ded |     |     |      |          |       |mile.| mile.|
| . |     |cars|     |     |      |          |       |     |      |
-----+---+-----+----+-----+-----+------+----------+-------+
-----+------+-----------
|  |     | No.| Tons|Miles|      |          |       |     |Pence.|
-----+---+-----+----+-----+-----+------+----------+-------+
-----+------+-----------
|  8|32-23| 25 | 400 | 388 | 9,700|Anthracite.| 31799 |81.90|11.957|-17 deg.
to -18 deg.
|  |32-23|    |     |     |      |          |  lb.  | lb. |      |  Reau.,
Feb.|  |     |    |     |     |      |          |       |     |      | equiv. to
8  |  |24-21|    |     |     |      |          |       |     |      |-6 deg. to -81/2 deg.
| 14|24-21| 25 | 400 | 388 | 9,700|Bituminous |37557.5|96.53|14.093|   Fah.
|  |     |    |     |     |      | Coal.     |  lb.  | lb. |      |
|  7|26-29| 25 | 400 | 194 | 4,830|Petroleum  | 9462  |48.77| 5.487|   Strong
|  |     |         |     |      | refuse.   |  lb.  | lb. |      | side wind.
-----+---+-----+----+-----+-----+------+----------+-------+
-----+------+-----------
| 24|32-23| 25 | 400 | 194 | 4,850|Anthracite.|12639.5|65.15| 9.512|-5 deg.
to -9 deg.
March|  |     |    |     |     |      |          |  lb.  | lb. |      |  Reau.,
6  | 21|24-21| 25 | 400 | 194 | 4,850|Wood, in   | 1071.8| 5.52| 8.5  | equiv. to
|  |     |    |     |     |      | billets.  | c. ft.|c. ft|      | 21 deg. to 12 deg.
|  |     |         |     |      |          |           |      |   Fah.
| 23|26-27| 25 | 400 | 194 | 4,850|Petroleum  | 7228  |37.28| 4.188|   Light
|  |     |         |     |      | refuse.   |  lb.  | lb. |      | side wind.
-----+---+-----+----+-----+-----+------+----------+-------+
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Prices of fuel:
Petroleum refuse, 21s. per ton; Anthracite and bituminous coal, 27s. 3d. per ton;
Wood, in billets, 42s. per cubic sajene = 343 cubic feet;
equivalent to 1.47d. per cubic foot.

Dimensions of locomotives:
Cylinders, 18 1/8 in. diam. and 24 in. stroke; Wheels, 4 feet 3 in. diam.;
Total heating surface, 1,248 sq. feet: Total adhesion weight, 36 tons;
Boiler pressure, 8 to 9 atm.

Page 19

The preceding table shows the results of comparative trials made in winter with different sorts of fuel, under exactly similar conditions as to type of engine, profile of line, and load of train. Two sets of comparative trials were made, both of them in winter. The three engines used were some of those built by Schneider. In comparison with anthracite, the economy in favor of petroleum refuse was 41 per cent. in weight, and 55 per cent. in cost. With bituminous coal there was a difference of 49 per cent. in favor of petroleum as to weight and 61 per cent. as to cost. As compared with wood petroleum was 50 per cent. cheaper. At a speed of fourteen miles an hour up an incline of 1 in 125 the steam pressure was easily kept up at 9 to 91/2 atm. with a No. 9 injector feeding the boiler all the time.

Up to the present time the author has altered seventy-two locomotives to burn petroleum; and from his own personal observations made on the foot plate with considerable frost he is satisfied that no other fuel can compare with petroleum either for locomotives or for other purposes. In illustration of its safety in case of accident, a photograph was exhibited of an accident that occurred on the author’s line on 30th December, 1883, when a locomotive fired with petroleum ran down the side of an embankment, taking the train after it; no explosion or conflagration of any kind took place under such trying circumstances, thus affording some proof of the safety of the petroleum refuse in this mode of firing. Although it is scarcely possible that petroleum firing will ever be of use for locomotives on the ordinary railways of coal-bearing England, yet the author is convinced chat, even in such a country, its employment would be an enormous boon on underground lines.

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CHARCOAL KILNS.

[Illustration: KILN FOR BURNING CHARCOAL.]

In answer to the inquiry of a correspondent about charcoal making, we offer two illustrations that show a method of manufacture differing from that usually adopted, which is that of burning on the bare ground, and covering with soil or sods to exclude the air. These kilns are made of brick, one course being sufficient, bands of iron or timber framework being added to strengthen the brickwork with greater economy. The usual style is conical, and the size is 24 feet in diameter, with an equal height, holding about 40 cords of wood. The difference in price is 1-1/8 d. per bushel in favor of these kilns as compared with the usual mounds, the burner being furnished with the use of the kilns, and the timber standing, the kiln burning costing 2-1/8 d., and the other 3-1/4 d. The kilns must be lined to about halfway up with fire-brick, the cost of which will vary with the locality, but will be about L200, and as 40 to 50 bushels of coal have been made per cord the extra yield on good charcoal and the lessening of the cost of making soon covers any

Page 20

extra outlay on the cost of the kilns. The wall of the kiln is carried up nearly straight for 6 feet, when it is drawn in, so as to become bluntly conical. Upon the top a plate of iron is fastened in the manner of the keystone of an arch, and bands of iron are passed round the kiln and drawn tight with screw bolts and nuts to strengthen it. Double doors of sheet-iron are made at the bottom and near the tops, by which it is either filled or emptied, and a few air-holes (B), which may be stopped with loose bricks, left in the bottom. The second figure shows a kiln of another shape made to burn 3,000 bushels of charcoal, or about 80 cords of wood. The shape is a parallelogram, having an arched roof, and it is strengthened by a framework of timber 10 inches square. As the pressure of the gas is sometimes very great, the walls must be built a brick and a half thick to prevent their bursting. The usual size is 16 feet wide and high, and 40 feet in length, outside measure. The time occupied in filling, burning, and emptying a small cone is about three weeks, and four weeks is required for the larger ones.—*The Gardeners' Chronicle.*

[Illustration: KILN FOR BURNING CHARCOAL.]

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ENTRANCE, TIDDINGTON HOUSE, OXON.

Our illustration is a view of the entrance facade to Tiddington House, Oxfordshire, the residence of the Rev. Joshua Bennett. The house is an old building of the Georgian period, and though originally plain and unpretentious, its bold coved cornices under the eaves, its rubbed and shaped arches, moulded strings, and thick sash bars, made it of considerable interest to the admirers of the "Queen Anne" school of architecture, and led to the adoption of that style in the alterations and additions made last year, of which the work shown in our illustration formed a small part. Between the "entrance facade" and the wall of the house there is a space of some twenty feet in length, which is inclosed by a substantially built conservatory-like erection of Queen Anne design, forming an outer hall.

[Illustration: ENTRANCE TIDDINGTON HOUSE OXON.—Morris & Stallwood—-Architects.]

The works were executed by Messrs. Holly & Butler, of Nettlebed. The brick carving was beautifully done by the late Mr. Finlay; and the architects were Messrs. Morris & Stallwood, of Reading.—*The Architect.*

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NEW ARRANGEMENT OF THE BICHROMATE OF POTASH PILE.

Page 21

Since Poggendorff in 1842 thought of substituting in the Bunsen battery a solution of bichromate of potash and sulphuric acid for nitric acid, and of thus making a single liquid pile of it, in suppressing the porous vessel, his idea has been taken up a considerable number of times. Some rediscovered it simply, while others, who were better posted in regard to the work of their predecessors, took Poggendorff's pile as he conceived it, and, considering the future that was in store for it, thought only of modifying it in order to render it better. Among these, Mr. Grenet was one of the first to present the bichromate of potash pile under a truly practical form. As long ago as 1856, in fact, he gave it the form that is still in use, and that is known as the bottle pile. Thus constructed, this pile, as is well known, presents a feeble internal resistance, and a greater electro-motive power than the Bunsen element. Unfortunately, its energy rapidly decreases, and the alteration of the liquid, as well as the large deposit of oxide of chromium that occurs on the positive electrode, prevents its being employed in experiments of quite long duration. Mr. Grenet, it is true, obviated these two defects by first renewing the liquid slowly and continuously, and causing a current of air to bubble up in the pile so as to detach the oxide of chromium in measure as the deposit formed. Thus improved, the bichromate pile was employed on a large scale in the lighting of the Comptoir d'Escompte. In an extensive application like this latter, the use of compressed air for renewing the liquid can be easily adapted to the bichromate pile, as the number of elements is great enough to allow of the putting in of all the piping necessary; but when it is only desired to use this pile for laboratory purposes, and when there is need of but a small number of elements, it is impossible to adopt Mr. Grenet's elements in the form required by an electric lighting installation. It becomes absolutely necessary, then, to come back to a simpler form, and attempt at the same time to obviate the defects which are inherent to its very principle. In accordance with this idea, it will be well to point out the arrangement adopted by Mr. Courtot for his bichromate of potash piles—an arrangement that is very simple, but, sufficiently well worked out to render the use of it convenient in a laboratory.

[Illustration: Fig. 1.—COURTOT'S ARRANGEMENT OF THE BICHROMATE PILE.]

Fig. 1 gives the most elementary form. It consists of an earthen vessel into which dip four carbon plates connected with each other by a copper ring which carries one of the terminals. In the center there is a cylindrical porous vessel that contains a very dilute and feebly acidulated solution of bichromate of potash into which dips a prism of zinc, which may be lifted by means of a rod when the pile ceases to operate. It is true that the presence of the porous vessel in the bichromate of potash element increases the internal resistance, but, as an offset, although it decreases the discharge, it secures constancy and quite a long duration for it.

Page 22

[Illustration: Fig. 2.—COURTOT'S ARRANGEMENT OF THE BICHROMATE PILE.]

The elements thus constituted may be grouped, to the number of six, in a frame analogous to that shown in the engraving, and, sum total, form a small sized battery adapted to the current experiments of the laboratory, and capable of supplying two small four volt lamps for ten or twelve hours. We have had occasion to make use of these elements for the graduation of galvanometers, and, after ascertaining the constancy of the discharge, have found that the internal resistance of each couple is nearly 0.175 ohm, with an electro-motive force of two volts. As may be seen, these elements should, in general, all be mounted for tension, as they are in the figure, inasmuch as the mobility of the zincs permits, according to circumstances, of employing a variable number of them without changing anything. Moreover, with zincs amalgamated in a special manner, the attack is imperceptible, and the work in open circuit need scarcely to be taken into consideration.

Yet, despite the qualities inherent to the arrangement that we have just described, that defect common to all bichromate of potash piles—the deposit of oxide of chromium upon the carbon—is not here avoided. It occurs quite slowly, to be sure, but it does occur, and, from this point of view, the arrangement shown in Fig. 2 is preferable. The elements here are composed of prismatic porcelain vessels containing, as before, the solution and porous vessel.

[Illustration: Fig. 3.—COURTOT'S ARRANGEMENT OF THE BICHROMATE PILE.]

The whole is covered with a sheet of ebonite connected with the zinc and the two carbon plates in such a way that when the pile is not in operation the whole can be lifted from the liquid. Under such circumstances the deposit of oxide is notably diminished, and the duration of the discharge is consequently greatly increased.

Fig. 3 shows the details of a windlass that permits of lifting, according to circumstances, all the elements of the same trough or only a part of them. To effect this, the drum around which the chain winds that carries the carbons is mounted upon a sleeve fixed upon the axle. This latter is actuated by a winch; and a ratchet wheel, R, joined to a click which is actuated by a spiral spring, prevents the ebonite plates from falling back when it is desired to place the bolt under the button, B, of the spring.

When it is desired to put an element out of the circuit, it is only necessary to act with the finger upon the extremity of the lever, D. Under the action of the latter, the piece, *s*, which carries a groove for the passage of the screws that fix it to the upper cross-piece, takes on a longitudinal motion and consequently gears with the drum through the toothed sleeve, E. When an experiment is finished the zinc may thus be lifted from the liquid, and the deposit of oxide be prevented from forming upon the carbon. As may

Page 23

be seen, the arrangements which we have just described exhibit nothing that is particularly original. The windlasses used for removing the elements from a pile when the circuit is open have been employed for a long time; the bichromate pile is itself old, and, as we said in the beginning, it has been modified in its details a number of times. In spite of this, we have thought it well to point out the mode of construction adopted by Mr. Courtot, since, owing to the simplicity of the arrangements, it renders convenient and easily manageable a pile of very great constancy that may be utilized for supplying incandescent lamps, as well as for the most varied experiments of the laboratory.—*La Lumiere Electrique.*

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THE DISTRIBUTION OF ELECTRICITY BY INDUCTION.

There has been much said in recent times about the distribution of electricity by means of induction coils, and the use of this process has given rise to several systems that differ but little from one another in principle.

The following are a few details in regard to a system due to a Dutch engineer:

In the month of December, 1881, a patent relating to the distribution of electricity was taken out in Germany and other countries by Mr. B. Haitzema Enuma, whose system is based upon a series of successive inductions. The primary current developed by a dynamo-electric machine gives rise to secondary, tertiary, *etc*., currents. The principal line runs through the streets parallel with their axes, and, when the arrangement of the places is adapted thereto, it is closed upon the generator itself. In those frequent cases where it is necessary to cause the line to return over a path that it has already traversed, it is more advantageous to effect the return through the earth or to utilize the street water mains or gas pipes as conductors. This return arrangement may likewise be applied to the lines of secondary, tertiary, *etc*., order, as may easily be seen.

The induction is effected by the aid of bobbins whose interior consists of a bundle of soft iron. The wire of the inducting current is wound directly around this core. The wire of the induced current is superposed upon the first and presents a large number of spirals. It is useless to say that these wires must be perfectly insulated from each other, as well as from the soft iron core. We shall call primary bobbins those which are interposed in the principal line, and secondary bobbins those in which the inducting current is a secondary one, and so on.

It will be at once seen that this arrangement permits of continuing the distribution of electricity to the interior of buildings by the simple adjunction of one or several bobbins. Each electric apparatus, whether it be a lamp or other mechanism, is furnished with a special current. If the number of these apparatus be increased, it is only necessary to increase the number of bobbins in the same ratio, on condition, be it understood, that the intensity of the currents remain sufficient to secure a proper working of the apparatus in question. When such intensity diminishes to too great a degree, the bobbin must be replaced by a stronger one.

Page 24

[Illustration: DISTRIBUTION OF ELECTRICITY BY INDUCTION.]

It results from what precedes that each apparatus must be put in in such a way as to permit, of the opening and closing of the corresponding circuit. This arrangement, moreover, has no need of being dependent upon the apparatus, and may just as well be transferred to any part of this same circuit. As regards lighting, it is preferable to employ alternating current dynamo machines; yet there is nothing to prevent the use of continuous current ones, provided that there is an arrangement that permits of constantly opening and closing this same circuit. That portion of the line which is placed under ground is insulated in the ordinary way at the places where it is necessary. As for the underground circuit and the induction coils connected therewith, these are protected against all external influence, and are at the same time insulated very economically by covering them with a coat of very fine silicious sand mixed with asphalt.

It is only necessary to inspect the annexed figure to get an accurate idea of this system of distribution. C represents the building in which the generator of electricity, D, is placed; B, the public street, and Q the house of a subscriber. The principal line, E, starts from the terminals, *a, b*, of the machine, passes through the primary bobbins, G, and is closed through the earth at F. It will be seen that the primary current communicates through *d* and *c* with the internal winding of the bobbins, G, while the secondary currents, H, are connected through *e* and *f* with the external winding. The same arrangement is repeated for the tertiary currents, M, and the quaternary ones, *o, p*. In the annexed example all the lines that run parallel with the axis of the streets are closed through the earth, while those that have a direction perpendicular thereto enter the houses of subscribers and form a closed circuit. In the interior of these houses the wires, as well as the induction coils, are insulated and applied to the walls. At Q is represented the arrangement that would have to be adopted in the case of a structure consisting of a vestibule, *r*, and two rooms, *s*, lighted by two electric lamps, R. In the portion of the figure situated to the left it is easy to see the process employed for insulating the line. A commencement is made by digging a ditch in the street and paving the bottom of it with bricks. Upon these latter there is laid a mixture of sand and asphalt, and then the wires and bobbins are put in, and the whole is finally covered with a new insulating layer.

Page 25

It is a simple statement that we make here, and it is therefore not for us to discuss the advantages and disadvantages of the system. If we are to believe Mr. Enuma, the advantages are very numerous, to wit: (1) The cables have no need of being of large size; (2) the intensity is the same through the entire extent of the primary circuit, secondary one, *etc*.; (3) the resistance is invariable in all portions of the line; (4) the apparatus are independent of each other, and consequently there may be a disturbance in one or several of them without the others suffering therefrom; (5) either a strong or weak luminous intensity may be produced, since, that depends only upon the size of the coil employed; (6) there is no style of lamp that may not be used, since each lamp is mounted upon a special circuit; (7) any number of lamps may be lighted or extinguished without the others being influenced thereby; (8) when a fire or other accident happens in a house, it in no wise interferes with the service in the rest of the line; (9) the system could, were it required, be connected with any other kind of existing line; and (10) the cost of installation is infinitely less than that of a system of gas pipes embracing the same extent of ground.—*La Lumiere Electrique.*

* * * * *

ELECTRICITY APPLIED TO THE STUDY OF SEISMIC MOVEMENTS.

Italy, with her volcanic nature, has very naturally made a specialty of movements of the ground, or seismic perturbations. So the larger part of the apparatus designed for such study are due to Italians. Several of these instruments have already been, described in this journal, and on the present occasion we shall make known a few others that will serve to give an idea of the methods employed.

For the observation of the vertical and horizontal motions of the ground, different apparatus are required. The following is a description of those constructed for each of such purposes by the Brassart Brothers.

[Illustration: FIG. 1.—APPARATUS FOR THE STUDY OF HORIZONTAL SEISMIC MOVEMENTS.]

Apparatus for Studying Horizontal Movements.—A lever, (Fig. 1), movable about a horizontal axis, carries a corrugated funnel, *i*, at one of its extremities. At the other extremity it is provided with a counterpoise which permits of its being exactly balanced, while not interfering with its sensitiveness.

[Illustration: FIGS. 2 AND 3.—DETAILS OF THE APPARATUS.]

The opening of the funnel passes freely around a column, *v* (Fig. 2), upon which is placed in equilibrium a rod that terminates in a weight, P. The corrugations of the funnel carry letters indicating the four cardinal points, and the funnel itself is capable of revolving in such a way that the marked indications shall always correspond to the real position of the cardinal points. When a horizontal shock occurs, the weight, P, falls

Page 26

in a direction opposite thereto, and into one of the corrugations, where it rests, so that the direction of the shock is indicated. But, in falling, it causes the lever, F, to tilt, and this brings about an electric contact between the screw, *h*, and the column, *n*, which sends a current into the electro, E, so that the armature of the latter is attracted. In its position of rest this armature holds a series of parts, S, A, L, which have the effect of stopping the pendulum of a clock placed upon the same apparatus. At the moment, then, that the armature is attracted the pendulum is set free and the clockwork is started. As the current, at the same time, sets a bell ringing, the observer comes and arranges the apparatus again to await a new shock. Knowing the hour at which the hand of the clock was stopped, he sees how long it has been in motion again and deduces therefrom the precise moment of the shock.

The small rod, *f*, which is seen at the extremity of F, is for the purpose of allowing electricity to be dispensed with, if need be. In this case the screw, *h*, is so regulated that F descends farther, and that *f* may depress the armature of the magnet just as the current would have done.

[Illustration: FIG. 4.—APPARATUS FOR THE STUDY OF VERTICAL MOVEMENTS.]

Apparatus for the Study of Vertical Movements.—In this apparatus (Fig. 4), the contact is formed between a mercury cup, T, and a weight, D. The cup is capable of being raised and lowered by means of a screw, so that the two parts approach each other very closely without touching. At the moment of a vertical shock a contact occurs between the mercury and weight, and there results a current which, acting upon the electro, E, frees the pendulum of the clock as in the preceding apparatus. In this case, in order that the contact may be continuous and that the bell may be rung, the piece, A, upon falling, sets up a permanent contact with the part, *a* (Fig. 3).

[Illustration: FIG. 5.—BRASSART'S SEISMIC CLOCK.]

Brassart's Seismic Clock.—This apparatus is designed for being put in connection at a distance with an indicator like the ones just described. It is a simple clock to which a few special devices have been added. Seismic clocks may be classed in two categories, according as they are stopped by the effect of a shock or are set running at the very instant one occurs. The Messrs. Brassart have always given preference to those of the second category, because there is no need of watching them during a seismic calm, and because they are much more easily constructed. It is to this class, then, that their seismic clock belongs. It is capable of being used for domestic purposes in place of any other clock, and of becoming a seismoscopic clock as soon as it is put in electric communication with the seismic telltales.

Page 27

To the cross-piece that holds the axle of the drums the inventors have added (Fig. 5) a support formed of a strip of brass, S, with whose extremity is jointed (at the lower part) a double lever, A. This latter is held in a horizontal position by a small counterpoise, *i*, so that the finger at the opposite extremity shall prevent the pendulum, P, from swinging. To keep the latter in a position of rest a bent lever, *n n'*, is jointed to the upper part of the support, S. The longer arm, *n'*, of this lever is bent forward at right angles, so that it may come into contact with and repel the small rod of the pendulum as soon as the lever has been lifted by means of a small cord which is connected with the larger arm, *n*, and runs up to a small hook, from whence it descends and makes its exit under the clock-case.

In order to stop the clock, then, it is only necessary to pull on this cord slightly, when, by moving the pendulum to the left, it will thrust it against the inclined plane of the finger of the lever arm, A. It is clear that the extremity of the pendulum, upon striking against the finger, will depress it slightly and go beyond the projection against which it remains fixed owing to the counterpoise, *i*. The fever, *n n'*, is brought back to its position of rest by means of a small counterpoise at the extremity of the arm, *n*. When the lever, A, is depressed, the pendulum escapes and sets the clock running. This depression is effected by means of an electro-magnet, E, whose armature, which is connected with the rod, *t, t*, lifts the arm, *i*, of the lever, and depresses A. The wires of the two bobbins of the electro-magnet end in two clamps, 1 and 2. The second of these latter is insulated from the clock-case. Both communicate with the extremities of the circuit in which is interposed the seismic telltale that brings about a closing of the current. Having noted the position of the hands on the dial when the clock was running, one can deduce therefrom the moment at which the shock occurred that set the clock in motion.

In addition to the parts that we have described, there are other accessory ones, R R_r_, and a third clamp, 3, which constitute a sort of rheotome that is designed to keep the circuit closed after the momentary closing that is produced by the telltale has occurred. This little mechanism is indispensable when the disturbed telltale has also to act upon an electric bell. This rheotome, which is very simple, is constructed as follows: A small brass rod, R, which is screwed to the support, S, carries at its left extremity a brass axis, X, which is insulated from the rod, R, by means of an ivory piece. Toward the center of this small rod, the bent lever, *r*, carries a small arm that is bent forward, and against which abuts the axis of the pendulum, thus causing it to be thrust toward the left when the pendulum is arrested by the projection of the finger, A. As soon as the pendulum is set free, the lever, *r*, redescends and places itself against the axis, X. This latter communicates with clamp 3, which is insulated, while the rod, R, communicates with clamp 1. The external communications are so arranged that the circuit in which the bell is interposed remains definitely closed when the lever, *r*, is in contact with the rod, X.

Page 28

[Illustration: FIG. 6.—ROSSI'S TREMITOSCOPE.]

Rossi's Tremitoscope.—This instrument (Fig. 6) unites, upon the same stone base, three different arrangements for showing evidences of trepidations of the earth. On one side we find (protected by a glass tube) a weight suspended over a mercury cup by a spring, and designed to show vertical motions. The two other parts of the apparatus are designed for registering horizontal motions. The first is a pendulum which causes a contact with four distinct springs, and whose movements are watched with a spy-glass. The second is a steel spring which carries at its upper part a heavy ball that vibrates at the least shock. This ball is provided with a point which is movable within a second ball, so that its motion produces a contact. All these different contacts are signaled or registered electrically.

[Illustration: FIG. 7.—SCATENI'S SEISMOGRAPH.]

Scateni's Registering Seismograph.—This apparatus, which is shown in Figs. 7 and 8, consists of two parts—of a transmitter and of a registering device.

[Illustration: FIG. 8.—REGISTERING APPARATUS.]

The transmitter consists of a glass vessel supported upon a steel point and provided beneath with a platinum circle connected with a pile. All around this circle are four strips of platinum, against one of which abuts the circle at every movement of the glass. Each strip of platinum communicates, through a special wire, with one of the electro-magnets of the registering device (Fig. 8). This latter consists of an ordinary clock that carries three concentric dials—one for minutes, one for hours, and one for seconds. In a direction with the radii of these dials there are four superposed levers, each of which is actuated by one of the electros. On another hand, each dial is divided into four zones that correspond to the four cardinal points. When a shock coming from the north, for example, produces a contact, the corresponding electro is affected, and its lever falls and marks upon each of the dials a point in its north zone. We thus obtain the exact hour of the shock, as well as its direction. As may be seen, the apparatus, as regards principle, is one of the simplest of its kind.—*La Lumiere Electrique.*

* * * * *

NEW ACCUMULATORS.

[Illustration: FIG. 1.—ARNOULD & TAMINE'S ACCUMULATOR.]

In Messrs. Arnould and Tamine's accumulators, shown in Fig. 1, the formation is effected directly by the current, as in the Plante pile, but the plates are formed of wires connected horizontally at their extremities by soldering. These plates are held apart either by setting them into paraffined wooden grooves at the ends of the trough or by interposing between them pieces of paraffined wood.

[Illustration: FIG. 2.—BARRIER & TOURVIELLE’S ELECTRODOCK.]

Page 29

In Messrs. Barrier and Tourville's *Electrodock* (Fig. 2) the plates are formed of concentric leaden tubes fixed into a wooden cover. These tubes are threaded internally and externally, and the grooves thus produced are filled with a peculiar cement composed of litharge, powdered charcoal, and permanganate of potash, triturated together, sifted, and then mixed with glucose or sugar sirup so as to make a paste of them. This mixture forms a cement that is very adhesive after, as well as before, the electrolytic action.

[Illustration: FIG. 3.—KORNBLUH'S ACCUMULATOR.]

In Kornbluh's accumulators the plates consist of ribbed leaden gratings between which is compressed red lead prepared in a peculiar manner, and constituting, 48 hours after formation, a compact mass with the lead. The tangs of the plates are widened so as to touch one another while leaving a proper distance between the plates themselves, and are hollowed out for the reception of a rod provided at its extremities with a winged nut and jam nut for passing them up close to one another. The plates, properly so called, are held apart by rubber bauds. The glass vessels are placed in osier baskets.—*La Lumiere Electrique.*

* * * * *

INDUSTRIAL MODEL OF THE REYNIER ZINC ACCUMULATOR.

The three models of a secondary battery that I recently made known to the readers of this journal have been the object of continuous experiment. Conformably to the provisions of theory, the zinc accumulator has shown itself practically superior to the two others, and I have therefore chosen this type for getting up an industrial model, which is shown in the annexed cut. The accumulator contains four Plante positives, having a wide surface, and three negatives constructed of smooth sheets of lead covered with zinc by the electrolysis of the acidulated solution of zinc sulphate in which the couple is immersed. Accidental contact with the interior of the pile is prevented by glass tubes fixed to the negatives by means of leaden bands. The seven electrodes are carried by as many distinct crosspieces of paraffined wood, which rest upon the edges of the trough and hold the plates at a certain distance from the bottom. These various crosspieces, which touch one another, take the place of a cover. Each plate is provided with a terminal. The four positive terminals are all on the same side, and the three negatives are on the opposite side. Two brass rods ending in a wire-clamp connect the respective terminals of the same name. The trough consists of two oblong wooden receptacles, one within the other, and having a play of several millimeters. This space is lined with a tight, elastic, insulating cement having tar for a base.

[Illustration: REYNIER'S ZINC ACCUMULATOR. (One-fifth actual size.)]

The careful insulation of the trough and all parts of the apparatus, and the purity of the metal and its amalgamation, reduce the local attack of the zinc to almost nothing. So the coefficient of restitution is now comparable with that of accumulators of the Plante type.

Page 30

The following are the principal numerical data of the new zinc accumulator.

PHYSICAL DATA.

E. Electromotive force. 2.36 volts. R. Mean resistance. 0.02 ohm. I. Normal intensity of the discharge current. 25 amperes. i. Intensity of the charge current. 5 to 10 amperes. Q. Capacity of accumulation after 200 hours' formation. 550,000 couples.

DATA CONCERNING CONSTRUCTION.

Efficient surface of the 4 positive electrodes. 200 square dec.
Efficient surface of the 3 negative electrodes. 15 square dec.
Weight of the positive electrodes. 8.2 kilogrammes.
Weight of the negative electrodes. 1.4 kilogrammes.
Weight of the trough. 2.7 kilogrammes.
Weight of the liquid. 4.4 kilogrammes.
Weight of the attachments. 0.46 kilogrammes.
Weight, total. 17.16 kilogrammes.

The total electric work stored up is 130,000 kilogrammeters, or 7,600 kilogrammeters per kilogramme of accumulator. Theory indicates that a zinc accumulator might store up as much as 15,600 kilogrammeters per kilogramme. If the present model gives half less, it is because I have purposely exaggerated the solidity of the trough and the mass of the electrodes.

It should be remarked that this capacity of 7,600 kilogrammeters per kilogramme is much greater than that of any other accumulator constructed in France. The new model possesses, then, despite the size of the positives and the box, a relative lightness that will permit it to take a place upon electric locomotives as well as in fixed installations.

Independently of their use as accumulators, secondary zinc batteries may be utilized as regulating voltameters in lighting by incandescence, for deadening piston strokes, attenuating the irregularities in speed, and covering accidental stoppages.—*E. Reynier, in La Nature.*

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THE HISTORY OF A LIGHTNING FLASH.

By W. SLINGO.

Lately we have all felt, I doubt not, a considerable amount of interest in the various phenomena attending this summer's unusually heavy thunderstorms, accompanied, as they have been, by vivid lightning discharges of a more or less hurtful nature. The list of disasters published in *Knowledge*, No. 143, might be very materially augmented were we to record such damage as has been wrought since that list was compiled.

There is not, I suppose, in the mind of any intelligent man at the present day a doubt as to the electrical origin of a lightning flash. The questions to be considered are rather whence comes the electricity, and in what way is the thunderstorm brought about. In attempting to answer these questions, sight must not be lost of the fact that the very nature of electricity is in itself almost sufficient to baffle any effort put forth to ascertain from lightning, as such, its whence and its whither.

Page 31

It is possible, however, with the aid of our knowledge of static electricity, to arrive at hypotheses of a more than chimerical nature. In the first place, that our sphere is a more or less electrified body is generally admitted. More than this, it is demonstrated that the different parts of the earth’s surface and its enveloping atmosphere are variously charged. As a consequence of these varying charges, there is a constant series of currents flowing through the various parts of the earth, which show themselves in such telegraph wires as may lie in the direction followed by the currents. Such currents are known as earth currents, and present phenomena of a highly interesting nature. But, apart from these electrical manifestations, there is generally a difference of electrical condition between the various parts of the earth’s surface and those portions of the atmosphere adjacent to or above them. Inasmuch as air is one of the very best insulators, this difference of condition (or potential) in any particular region is in most cases incapable of being neutralized or equilibrated by an electric flow. Consequently the air remains more or less continually charged. With these points admitted as facts, the question arises, Whence this electricity? There have been very many and various opinions expressed as to the cause of terrestrial electricity, but far the greater portion of such theories lack fundamental probability, and indicate causes which cannot be regarded as sufficiently extensive or operative to produce such tremendous effects as are occasionally witnessed. I take it that we may safely regard the evolution of electricity as one of the ways in which force exhibits itself, that, in other words, when work is performed electricity may result. When two bodies are rubbed together, electricity is produced, so also is it when two connected metals are immersed in water and one of them is dissolved, or when one of the junctions of two metals is raised to a higher temperature than the other junction. I will go further than this, so far, in fact, as to maintain that there is a reasonable ground for supposing that every movement, whether it be of the mass or among the constituent particles, is attended by a change of electrical distribution; and if this is true, it may easily be conceived that inasmuch as motion is the rule of the universe, there must be a constant series of electrical changes. Now, these changes do not all operate in one direction, nor are they all of similar character, whence it is that not only are there earth currents of feeble electro-motive force, but that this E.M.F. is constantly varying, and that, furthermore, electricity of high E.M.F. is to be met with in various parts of the atmosphere.

Page 32

With earth currents we have here very little to do. The rotation of the earth is in itself sufficient to generate small currents, and the fact that they vary in strength at regular periods of the day and of the year enforces the suggestion that the sun exerts considerable electrical influence on the earth. Letting it be granted, however, that the earth is variously charged, how comes it that the air is also charged, and with electricity of greater tension than that of the earth itself? It was pointed out by Sir W. Grove that if the extremities of a piece of platinum wire be placed in a candle flame, one at the bottom and the other near the top, an electric current will flow through the wire, indicating the presence of electricity. If an electrified body be heated, the electricity escapes more rapidly as the temperature rises. If a vessel of water be electrified, and the water then converted into steam, the electric charge will be rapidly dissipated. If a vessel containing water be electrified, and the water allowed to escape drop by drop, electricity will escape with each drop, and the vessel will soon be discharged.

We regard it as an established fact that the earth has always a greater or less charge; whence it is safe to assume that in the process of evaporation which is going on all over the surface of the globe, more particularly in equatorial regions, every particle of water, as it rises into the air, carries with it its portion, however minute that portion may be, of the earth's electric charge. This small charge distributes itself over the surface of the aqueous particle, and the vapor rises higher and higher until it reaches that point above which the air is too rare to support it. It then flows away laterally, and as it approaches colder regions gets denser, sinking lower and nearer to the earth's surface. The aqueous particles becoming reduced in size, the extent of their surfaces is proportionately reduced. It follows that as the particles and their surfaces are reduced, the charge is confined to a smaller surface, and attains, therefore, a greater "surface density," or in simpler language, a greater amount of electricity per unit of surface.

Electricity, as above set forth, is in what is known as the "static" condition (to distinguish it from electricity which is being transferred in the form of a current), when it has the property of "repelling itself" to the utmost limits of any conductor upon which it may be confined. This will account for the charge finding its way to the surface of the water particles, and will furthermore account for the greater density of the charge as the particle gets smaller and has the extent of its surface rapidly diminished. It may be mentioned that the surface of a sphere varies as the cube of its radius.

Page 33

Returning to the discussion of the state of affairs existing when the particles have reached their highest position in the atmosphere, we may imagine that they set themselves off on journeys toward either the north or the south pole. As they pass from the hotter to the colder regions, a number of particles coalesce; these again combine with others on the road until the vapor becomes visible as cloud. The increased density implies increased weight, and the cloud particles, as they sail poleward, descend toward the surface of the earth. Assuming that a spherical form is maintained throughout, the condensation of a number of particles implies a considerable reduction of surface. Thus, the contents of two spheres vary as the cubes of their radii, or eight (the cube of 2) drops on combining will form a drop twice the radius of one of the original drops. We may safely conceive hundreds and thousands of such combinations to take place until a cloud mass is formed, in which the constituent parts are more or less in contact, and, therefore, behave electrically as a single conductor of irregular surface, upon which is accumulated all the electricity that was previously distributed over the surfaces of the millions of particles that now compose it.

The tendency of an electric charge upon the surface of a conductor is to take upon itself a position in which it may approach nearest to an equal and opposite charge; or, if possible, to attain neutrality. If, then, a cloud has a charge, and there is no other cloud above or near it, the charge *induces* on the adjacent earth surface electricity of the opposite kind. Thus, assuming the cloud to be charged with positive electricity, the subjacent earth will be in the negative state. The two electricities[3] exert a strong tendency to combine or to produce neutrality, whence there is a species of stress applied to the intervening air. Possibly the cloud will be drawn bodily toward the earth more or less rapidly, according as the charge is great or small. Or, on the other hand, the cloud may roll on for leagues, carrying its influence with it, so that the various portions of the earth underneath become successively charged and discharged as the cloud progresses on its journey.

[Footnote 3: We may speak of two electricities or two electric states without necessarily implying adherence either to the single or the double “fluid” theory. Whether electricity be of two kinds or no, the fact remains that there are two conditions, and all the features of this paper may be explained with equal facility by the supporters of either hypothesis.]

Should the cloud be near the earth, or should it be very highly charged, the tension of the two electricities may be so great as to overcome the resistance of the intervening air; and if this resistance should prove too weak, what happens? How does the discharge show itself? It takes place in the form of a lightning flash, and passing from the one surface to the other—or, maybe, simultaneously from both—produces neutrality more or less complete.

Page 34

There has recently been a little discussion in these pages on the subject of lightning, some having stated that they discerned the discharge to take place upward—that is, from the earth toward the cloud. I will not venture so far as to say whether or not the direction of the discharge is discernible; possibly the flash may sometimes be long enough to enable one to tell; but I have never so seen it, and have always looked upon the eye as a deceitful member—very. “The lightning flash itself never lasts more than 1/100000 of a second.” It is, however, just as likely that a discharge may travel upward as downward. What controls the discharge? Does the quality of the charge?—that is to say, is the positive or the negative more prone to break disruptively through the insulating medium? Investigations with Geissler’s and other tubes containing highly rarefied gases have made it tolerably clear that there is a greater “tearing away” influence at the negative than at the positive pole, and if two equal balls, containing one a positive and the other a negative charge, be equally heated, the negative is more readily dissipated than the positive. But, so far as we at present know, this question enters into the discussion scarcely, if at all. Our knowledge seems rather to point to the substances upon which the charges are collected. The self-repellent nature of electricity compels it to manifest itself at the more prominent parts of the surface, the level being forsaken for the point. The tension of the charge, or its tendency to fly off, is proportionately increased. And if at a given moment the tension attains a certain intensity, the discharge follows, emanating from the surface which offers the greatest facilities for escape. The earth is generally flatter than the cloud, whence, in all probability, the discharge more frequently originates with the cloud.

Should a lightning flash strike the earth and produce direct neutrality, it is possible that no damage will result, although this again is not always certain, because when the cloud charge acts inductively on the earth it produces the opposite (say negative) charge on the nearer parts, the similar (or positive) state is also produced at some place more or less distant. Sometimes this “freed” positive (which, by the way, accumulates gradually and physiologically imperceptibly) is collected at some portion of the earth’s surface. When the negative is neutralized by the discharge, the freed positive is no longer confined to a particular region, but tends to dissipate itself, and a shock may be felt more or less severely by any person within the region. Or, again, a similar shock may be experienced by a person standing within the negative zone on the neutralization of the charge.

Page 35

I may take the opportunity here to mention a highly interesting and instructive incident observed on local telegraph circuits during a thunderstorm. The storm may be taking place at some distance from the point of observation. The electrified cloud induces the opposite charge beneath it, the similar charge being repelled. It is noticeable that the needle of a galvanometer, starting from the middle position, goes gradually over to one side, eventually indicating a considerable deflection. Suddenly, owing apparently to a lightning discharge some distance away, the force which caused the deflection is withdrawn, and the needle rebounds with great violence to the opposite side. In a short time, the cloud becoming again charged on its under surface, and recommencing its inductive effect upon the adjacent earth, the needle starts again, and goes through the same series of movements, a violent counterthrow following every flash of lightning.

If we can so far control our imagination, we may conceive the earth to be one large insulated conductor, susceptible to every influence around it. If then the earth, as a mass of matter, behaves as above indicated, there is no plausible reason for declining to regard any other large conducting mass in a similar light, and as a body capable of being subjected more or less completely to the various impulses affecting the earth. In other words, a large mass of conducting material, partially or perfectly insulated, is, during a thunderstorm, in considerable danger. With this portion of the subject I shall, however, deal more fully when discussing the merits of lightning protectors.

Lightning discharges do not take place between cloud and earth only, but also, and perhaps more frequently, between too oppositely charged clouds. We then get atmospheric lightning, the flash often extending for miles. This form of lightning is harmless, and in all probability what we see is only a reflection of the discharge. The oft-told tale of the lightning flying in at the window, across the room, and out of the door, or up the chimney, is all moonshine, and before dealing with lightning protectors I intend to expose some of the fallacies concerning lightning. Were the discharge to pass through a house, it would infallibly leave more decided traces and do more damage than simply scaring a superstitious old lady now and again. Many people are often and unnecessarily frightened during a thunderstorm, but it may be safely predicted that a person under a roof is infinitely safer than one who is standing alone on level ground, and making himself a prominence inviting a discharge. Rain almost invariably accompanies the discharge, and the roof and sides of the house being wet, they form a more or less perfect channel of escape should a flash strike the building.—*Knowledge.*

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RESEARCHES ON MAGNETISM.

Page 36

By M. DUTER.

If we place a thin plate of steel in a uniform magnetic field, so that the lines of force of the field may be normal to the surface of the plate, we have a very flat magnet, the two faces of which are the two polar surfaces. The magnetic distribution thus obtained seems to disappear when the plate is no longer in the field. The following experiments show that this disappearance is not complete. I made use of plates of tempered steel of 1 millimeter in thickness, and varying in diameter from 0.040 to 0.005 meter. With these plates I formed cylindrical batteries. In some of these batteries the plates are directly in contact, and in others they were separated by leaves of pasteboard, the thickness of which varied from that of the thinnest paper to 0.001 meter. The batteries were placed in the central portion of a very powerful magnetic field, and after they have been taken out they formed perfectly regular permanent magnets. The supporting power of these magnets was the greater the nearer its constituent plates were to each other. In a battery of 100 plates, touching each other directly, and strongly pressed into a brass cylinder, the portative force at each extremity rose to 30 grammes. This first result having been obtained, I dismounted the batteries, plate by plate, taking care to mark the upper and under side of each. I found then that each plate retained only an excessively slight magnetism. Yet each of them still constituted a flat magnet, of which the two faces are the polar surfaces; for on rebuilding the battery it gave again a perfectly regular magnet, though weaker than it was at first. The separation of the magnet into its constituent plates, and its reconstruction, maybe repeated indefinitely.—*Comptes Rendus.*

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Dr. T. Tommasi (*Cosmos les Mondes*) notes that the thermic constant of thallium is exactly the mean of the thermic constants of potassium and lead, the two metals which it most resembles in its chemical character.

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IMPROVED GAS LIGHT BUOY.

[Illustration: GAS LIGHT BUOY.]

The accompanying engravings represent a light buoy made by the Pintsch’s Patent Lighting Company for the river Humber. The chief dimensions of the buoy are given in the engraving, which also shows that the gas holder is placed within the boat in such a way as to be protected from blows likely to cause any leakage. The buoy has a special form to meet its requirements as a lightship, and the conditions of its employment is the fast tidal current of the river. It was designed by Mr. C. Berthon, of Westminster, and is intended to carry a six months’ supply of gas, the burner, regulator, and lamp being on the well known Pintsch system. The hull is formed of 3/8 inch plate, 24 feet 3 inches total length, and 9 feet beam at the line of flotation. The laps

Page 37

of the plates are 4 inches wide, and riveted with 3/4 inch rivets, spaced 2-1/4 inch apart center to center. The keel and stem are both in one piece, as shown, and to this the garboard strake is to be fastened. The bilge pieces are riveted on to the bilge, and made of 9 inches by 4-1/2 inches by 9/16 inch T-iron. A wooden fender, 4 inches by 4 inches wood, is fitted on both sides of hull, running from stern to stern, by 3 inches by 3-1/2 inches by 7/16 inch L-iron top and bottom with the sheer as shown. The hull from water line falls in as shown, so as to describe at midships an arc of 4 feet 6 inches, and a circular deck of 1/8 inch plate is riveted on the hull. There are two man-holes, each 16 inches diameter in the clear, placed in end plates of the circular deck as shown, and provided with covers 3/8 inch thick, secured by twenty screws 3/4 inch diameter. The edge of each manhole is stiffened by a welded iron ring. The surface of the mooring link that comes in contact with the shackle and mooring chain is steeled. The gas holder rests upon a plate bent up on each side, and riveted to the keelson, and is prevented from rolling by four gusset plates, with two short pieces of angle iron riveted thereto at the ends and coming in contact with the holder, and at the ends by angular plates, and angle iron riveted on each side and riveted to the keelson. The superstructure consists of four legs of angle iron 2-1/2 inches by 2-1/2 inches by 5/16 inch, the upper ends of the legs being attached to a square flanged plate for supporting the lighting apparatus. Four wooden battens of pitch pine, 4 inches by 1-1/2 inches, and bolted on to each cant of the angle iron superstructure, with 7/8 inch galvanized iron bolts and nuts.

[Illustration: GAS LIGHT BUOY.]

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PROJECT FOR A ROADSTEAD AT HAVRE.

The present port of Havre is absolutely insufficient to answer the ever increasing requirements of commerce. Its entrance, which is too narrow and not deep enough, does not permit steamers to go in, come out, and perform their evolutions with the rapidity required by our epoch. So they are gradually abandoning our port, and going to load and unload at Anvers and elsewhere. A large number of wise heads, who are anxious about the future of this port and our national interests, have devoted themselves to finding a means of enlarging it, not by dredging *new* basins, which would prove ruinous to the budget and useless in twenty years, but by installing a true roadstead at the entrance to the present basins.

[Illustration: FIG 1.—PLAN OF THE PROJECTED ROADSTEAD AT HAVRE.]

Upon the maps of the hydrographic service may be seen, under the name of the Little Roadstead, a vast extent of sea nearly two kilometers wide by three to four in length, bounded upon one side by the heights of Heve and St. Adresse, and upon the other by the rocky line of Eclat and of the heights of the roadstead (Fig. 1). This Little Roadstead, so called, in order to become a genuine one, would have to be protected against the great waves of the open sea. To thus protect it, to close it as quickly and as cheaply as possible—that is the problem.

Page 38

In 1838, Charles de Massas presented a project (the first in order of date), which consisted in constructing upon the Eclat reef a semi-lunate dike, and a breakwater at Cape Heve. Moreover, upon the emergent parts of the Eclat reef and heights of the roadstead he proposed to erect two forts.

[Illustration: FIG. 2.—LEWIS' FLOATING BREAKWATER.]

The defense of the port of Havre is a very important question, and one that appears to be completely abandoned. Since Engineer Degaulle in 1808 advised the erection of a fort upon the Eclat, and requests have periodically been made and projects drawn. The requests are forgotten, but the drawings are in the Ministers' portfolios, and if France should to-morrow have a war with a maritime power our great northern port might be destroyed and burned by the smallest squadron.

Some years after Massas' project, two officers, Deloffre and Bleve, and an engineer named Renaud, received a commission to search for a means of closing a portion of Seine Bay. These gentlemen advised the erection of two dikes, one on the Eclat shoal in the very axis of this reef, and the other at Heve. Between these two masonry dikes was to be placed a floating breakwater. This project, which was submitted to Admiral de Hell in 1845, had a favorable reception, and the Admiral especially applauded the trial of breakwaters, "which were much talked of in England, although the effects that they might produce were not well known." Deloffre, Bleve, and Renauds' project comprised two forts—one to the north and the other to the south of the roadstead. For a long time nothing more was said about it, and it is only during recent years, when the peril has become imminent for Havre (threatened as it is of being abandoned even by the French transatlantics), that the question has again became the order of the day.

[Illustration: FIG. 3.—FROIDEVILLE'S FLOATING BREAKWATER.—END VIEW.]

Mr. Bert, a merchant, would protect the Little Roadstead by means of two jetties, 1,000 and 1,600 meters in length, built, one of them upon the Eclat and the other upon the eminences of the roadstead. These would be constructed by forming a foundation of loose rocks, and using earth and brick above the level of the water. Mr. Vial has likewise proposed a rockwork of 2,000 meters in length, to form a dike 10 meters in height and width, whose platform would be on a level with the highest tides.

Next comes the more recent project of Mr. Coulon. Seeing that it is the deposits of the ocean and not those of the Seine that accumulate upon the estuary, Mr. Coulon advises the construction of a dike about 2,000 meters in length, starting from the Havre jetty, and ending at the southwest extremity of the shoals at the roadstead heights, and a second one returning toward the northwest, of from 500 to 1,000 meters. A third and very long one of not less than 8 kilometers would be built from Honfleur to the Ratier shoals.

Page 39

This latter one, in contracting the bay, would contribute to increase the force of the current, which, throwing back at the ocean its mud and pebbles, would give us the depths of 15 and 20 meters indicated on the map of Beautemps-Beaupre.

This year, again, two projects have arisen; one of them due to Mr. Thuillard-Froideville, and the other to Mr. Hersent.

According to Mr. Hersent, it would be necessary to surround the Little Roadstead with an insubmersible dike built upon the rocky shoals, which would begin at Cape Heve (which it would consolidate) and end opposite the entrance to the port at 1,600 meters from the jetties. Through it there would be five passages. Afterward another dike would be constructed, starting from the shore and running to meet the jetty designed to inclose the Little Roadstead. On turning the angle at which it met the jetty it would be continued as far as to Berville. Finally, a third dike, running from Honfleur to Berville, would complete the system.

Mr. Hersent’s project, which is one of the most remarkable of those that have been proposed, has one fault, and that is that it would require twelve years of work, and cost 158 million francs.

Mr. Thuillard-Froideville, completely renouncing masonry dikes as being too costly and taking too long to construct, proposes to inclose the Havre roadstead by means of floating breakwaters. As we have already seen, the use of these between Cape Heve and the Eclat shoals had already been proposed in 1845. As the project was abandoned, the models of these breakwaters are rare.

In Bouniceau’s “Marine Constructions” we find a curious figure, a sort of open framework of clumsy form anchored in a singular manner, and surmounted by rooms for watchmen, semaphores, posts for the shipwrecked, *etc*. It is, indeed, the most complicated and most impracticable type that could be imagined.

Mr. Lewis’ model, which was exhibited last year at the International Fisheries Exhibition, was, on the contrary, one of the simplest. It consisted of a strong piece of wood of nearly triangular section, the sharpest angle of which, being turned oceanward, was designed to cut the waves and cause them to break over it (Fig. 2). If, by favor of divine Providence, this breakwater, which presents absolutely plane surfaces to the shock and pressure of the waves, is not broken to fragments in the first tempest, it will certainly acquit itself of the *role* for which the inventor destined it. When we have a system of resistance to the sea, anchored and facing a certain direction, and consequently not being able to revolve around its axis as vessels do, care must be taken not to give it entire surfaces.

[Illustration: FIG. 4.—FROIDEVILLE’S BREAKWATER.—MODE OF JOINING THE PARTS.]

Page 40

Mr. Froideville's breakwater consists of a framework 25 meters in length, and 9 in height and width, and having the form of an irregular 5-sided prism (Fig. 3). The smallest side of the prism is designed to serve as a flat keel. The axis is formed of a metallic float, from whence start radii that form the skeleton of the framework, and that are designed for connecting the center with five long spruce beams that form the angles of the prism. To these beams are affixed the cross pieces that form the openwork sides. Five long pieces of wood parallel with the beams, but not so strong as they, protect the cross pieces and secure them against breakage in the middle. All the angles of the breakwater and all points of juncture of the pieces are protected with iron, and it is in order to counterbalance the weight of all this iron that the central float is used. Parallel with this first breakwater, there are two other and smaller ones, which are designed for reducing the effect of rolling as much as possible. Reduced to a single float, the breakwater might remain under the waves too long, but, owing to the two others, it rights itself, warps around, and always presents the spur of its sharp roof to the wave.

In order to prevent the breakwaters from clashing against each other, they are united end to end in a very simple and ingenious manner. From each of them there starts a deeply inserted iron bar which terminates in a journal that permits the breakwater to oscillate. Between these two bars there is a sort of swivel, whose pieces, in playing upon one another, give the breakwaters elasticity, while always holding them apart (Fig. 4). From each side of the swivel start the branches of a stirrup iron to which the anchorage chain is attached. This latter is of steel, without solderings, and it is so perfectly constructed that no breakage need be feared. To the other extremity of the chain is attached an anchor having two flukes, which both engage with the bottom.

Mr. Froideville proposes to set up two lines of these breakwaters, for a length of about 71/2 kilometers, starting at the north from Cape Heve, taking in depths of 15 meters (the best that are found in the Little Roadstead), passing in front of the Eclat shoal and the heights, and ending opposite the entrance of the present port.

The first row is designed for breaking the force of the waves, and the second for lending its aid in times of high tempests, and stopping the surge that has escaped from the first.

The extreme simplicity of this project has permitted its promoter to affirm that in a few months, and with nine millions, he can inclose the Havre roadstead.

The Little Roadstead, being thenceforward protected, will become an excellent port of refuge in bad weather. In addition, a system of lighters, or, better, a few floats connected with the shore and forming a rock, will permit vessels to take on their cargoes with great rapidity.

Page 41

Mr. Froideville's project presents the further advantage of rendering it easier to put the port of Havre quickly in defense. A certain number of floating batteries, anchored behind the breakwaters and protecting the advances of torpedo boats by means of their firing, would make a formidable defense. Not having to perform any evolutions, they might without danger be invested with armor plate thicker than that of ordinary ironclads. In order to complete the system, there might be erected upon the Eclat shoal an ironclad fort like that which defends the entrance of Portsmouth.

An English chronicler of the fourteenth century, in speaking of his country, places it above all others, and declares that men are handsomer, whiter, and purer blooded there than elsewhere, and he says that this is so "because it is so." We would not like to imitate his naive reasoning, and yet, for defending the very original system proposed by Mr. Froideville, we have only our conviction, which we share, moreover, with a large number of sea-faring men and engineers. Mathematics are powerless to predict to us with accuracy the manner in which the floating breakwaters will behave, but experiment remains. Let the promoter of the project, then, be given authority to inclose a few hundred meters, and if, as we suppose, the breakwaters shall remain immovable in a northwester, a maritime revolution will have been brought about.—*La Nature.*

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IMPROVED CATCH BASIN.

In 1882, M. Bacle published in *Le Genie Civil* a study of the sewer systems in some of the large foreign cities. There may be found there a description of the Liernur system at Amsterdam, Leyden, and Dordrecht, in Holland, and in certain cities of Germany and the United States.

[Illustration: IMPROVED CATCH BASIN.]

This system consists in the employment of two distinct systems of ducts, one for the discharges from water-closets and the other for household wastes, rain water, and the discharges from factories when sufficiently purified. This arrangement allows the employment of sewers of small section, provided that it shall be unnecessary to enter them for the purpose of cleansing them. It has been necessary, therefore, to provide inlets with a separating apparatus called "gully" or "catch basin," which retains as completely as possible all solid matter, mud, excrement, and *debris* of every kind which maybe floated in by street washing or by rain-water, and which may be capable of causing stoppages in the sewers, the choking up being followed by fermentation and the emanation of noxious vapors.

M.C. Pieper of Berlin suggests a device for a catch basin, which appears to meet the requirements. It is in the form of a cylindrical metal box, enlarged in its upper section to receive a filtering cylinder of perforated sheet iron, which occupies almost the upper half of the device and rests upon the smaller lower part. The entire apparatus is covered by a movable funnel, through which enter water and any rubbish which it may carry with it. From one side a tube allows the liquid to be discharged, while a siphon placed on the opposite side serves the same purpose under certain circumstances, as will be explained.

Page 42

Figure 1 represents the apparatus discharging under normal conditions. The heavy matter, sand, stones, *etc*., falls to the bottom into a receptacle which can be lifted out from time to time and emptied. The lighter buoyant matters, straw, vegetable *debris*, paper, *etc*., remain at the surface, and are retained by the filter; the water passing through the holes in the sheet iron rushes in a filtered condition through the annular space which exists in the upper part between the two cylinders, and escapes by the waste-pipe when the water reaches a proper level. If at a given moment the quantity of water flowing in is too much to be discharged through this waste-pipe, the level of the water mounts in the cylinder until it reaches the top of the siphon. Immediately the siphon comes into play and empties the upper part of the apparatus, and the filtered water contained in the annular space already mentioned quickly re-enters the cylinder through the perforated sheet iron, and in so doing cleans out the perforations with considerable energy. This second period is represented in the second figure.

The mouth of the siphon being placed above the movable basket, the heavy matters contained in the latter are not in the least disturbed, and the metallic screen placed over the mouth prevents the entrance of any floating matters. When siphonic action ceases, the water in the short arm of the siphon empties itself into the main receptacle, and by so doing cleanses the screen. During a rain or the washing of the streets, the siphon can work in concurrence with the ordinary discharge-pipe. It is evident of course that these two—pipes can be placed on the same side of the apparatus, if this prove the most convenient arrangement.

We will add that this apparatus can be applied not only to the Liernur system, but also can be used for preventing the entrance of obstructions into sewers of the ordinary type, where the grade is small or where the quantity of water is insufficient; and if we adopt the system of “everything to the sewer,” can we not find in the employment of this apparatus an element for the realization of the famous formula, “Always in circulation, and never in stagnation?”—*Le Genie Civil.*

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[Concluded from SUPPLEMENT No. 454, page 7249.]

WATER-POWER WITH HIGH PRESSURES AND WROUGHT-IRON WATER-PIPE.

By HAMILTON SMITH, JR., M. Am. Soc. C.E.

METHODS OF CONDUCTING WATER AND TRANSMITTING POWER.

A description of the mode of using water-power for driving the North Bloomfield tunnel in California, some years since, will give a good illustration of some of the advantages of the hurdy-gurdy. This tunnel was originally about 8,000 feet long, through a slate highly metamorphosed, with its general line passing under a good-sized stream, at a depth of about 190 feet. There were eight working-shafts, each

Page 43

about 200 feet deep, which, with the lower entrance or portal, gave sixteen working faces. Diamond drills were used at the lower heading requiring power; the other fifteen headings were driven by hand-work. It was uncertain how much water would be encountered; but from the location, it was evident that a large quantity might be struck in any shaft, and hence it became necessary to have ample power at hand at each opening, in readiness for such an emergency. A pipe main was laid along the general line of the tunnel, with its pen-stock 285 feet vertical above the surface at the upper shaft, and 549 feet above the lowest shaft. It was made of single riveted sheet-iron, of No. 14 (Birmingham) gauge, in lengths of 20 feet, put together stove-pipe fashion, with the joints made tight by cloth tarred strips and pine wedges. This pipe had a diameter of 15 inches at the pen-stock, diminishing from this to 13, 11, and 7 inches at its lower end. From it, short branches, 7 inches in diameter, were extended to the several shafts. It was in one place carried across the stream by a light suspension bridge, some 150 feet long, the trunk of a tree on each side forming a convenient tower. The aggregate length of the main and branches was 9,960 feet, with some 2,500 feet additional, for the branch to the diamond drills. The pipe was laid on the surface of the ground, its only protection being in places a couple of 11/2-inch planks tacked together, and placed over it; the range of temperature was from 10 degrees to 107 degrees Fahr. (in the shade). It was inspected by the foreman of the tunnel-work as he daily walked over the line; besides the occasional driving of a few wedges and putting on a band or two, it gave no trouble from leakage, which probably for its entire length did not amount to more than an average of 3 or 4 cubic feet a minute; from time to time, a little sawdust was put into the pen-stock. Three stop-gates were placed on the main, and a separate stop-gate at each shaft, operated by a fine-threaded screw, so that the water could be cut off when desired.

[Illustration: FIG. 13.]

Fig. 13 shows the arrangement of the machinery for hoisting and pumping, which was identical at the several shafts, except that the hurdy-gurdies varied from 161/2 feet in diameter at the upper shaft to 21 feet at the lowest shaft. The water-wheel moved only in one direction; the pinion on the wheel-shaft drove the spur-wheel, to which the pitman of the pump-bob was attached. On the spur-wheel shaft was a friction-gear, driving the hoisting-reel; this reel was mounted on sliding blocks, so that hoisting was done by putting it in gear, the empty load being dropped by a friction-band. Changing the size of the water-wheel as the pressure increased permitted the use of the same pattern of machinery at the different shafts. The water was brought to the wheel by a discharge-pipe, some nine feet long, having a vertical movement by ball-and-socket

Page 44

joint, so that at pleasure, by dropping the pipe, the machinery could be run at various speeds, or entirely stopped. At the end of this discharge-pipe was a cast tapered nozzle, about 31/2 inches in diameter, in which was inserted a ring of saw-plate steel having the desired diameter, and which was held in place by an annular screw-cap. By changing the ring, which only required a few moments' time, any desired amount of water, up to 3 or 4 cubic feet a second, could be discharged against the wheel. The stop-gate was left wide open while the machinery was running. The pumping was done by eighteen pumps, of Cornish pattern; the largest amount of water pumped from any one shaft was something over 30 cubic feet a minute; the power at hand, however, was ample to pump more than twice that quantity. It was rather curious at, this shaft to see more water coming from the pumps than was used on the wheel. The two diamond drills were driven by a small hurdy-gurdy set on the rear of the drill carriage. This, but at another tunnel, was afterward modified by placing a separate hurdy-gurdy on a sleeve on each drill-rod; the advance movement of the drill being given by hydrostatic pressure on an annular piston, thus doing away with all gearing. These eight sets of machinery were run for nearly 21/2 years' time; the only break being that of a spur-wheel, doubtless caused by the careless dropping of a steel bar between it and its pinion. Aside from this accident, practically not a dollar was spent for repairs, and the machinery, including the pipe, was in about as good order when the tunnel was finished as when it was first erected. One man, on a twelve hour shift, operated the machinery at each shaft, besides dumping the cars; two men kept the 18 pumps on the line in order, the principal work being in keeping the suction-pipes for the down-grade headings tight; thus a force of 18 men was only required for the eight shafts. The cost of the pipe, gates, *etc*., when put in place, was $14,631, and of the machinery about $60,000.

[Illustration: FIG. 14.]

At the Idaho gold quartz mine, situated near Grass Valley, California, water-power has been introduced during the past year (1883), taking the place of steam. The supply main is of wrought-iron, 22 inches in diameter, 8,764 feet long, buried in the ground below frost-line. The joints, as a rule, are riveted together, with occasional lead joints to admit of slight movements in the pipe.[4] The pipe was coated by placing each joint in a bath of boiling tar and asphaltum; to insure the most thorough coating, it is necessary to keep the pipe for ten or fifteen minutes in the boiling mixture. A cast-iron stop-gate is placed at the lower end of the main, and also one at each of the branches. Cast-iron man-holes are attached to the main, which, although they have given no trouble in this particular case, are very objectionable for high pressures, as it is difficult to avoid ruptures with cast and wrought-iron combined, owing to the great difference in the elasticity of the two metals. The long seams of this pipe are double-riveted, and the round seams single riveted; at the lower end, iron of No. 6 gauge is used. From the end of the main, the water is led to the several wheels by branches of smaller diameter.

Page 45

[Footnote 4: With buried wrought-iron pipe this precaution is unnecessary, as the elasticity of the iron will admit of the movement due to changes of temperature, without injury to the rivets.]

The water is delivered at the hoisting-wheel with a total head of 542.6 feet. For power and for mill uses, *etc*., the required supply is about 8 cubic feet a second; this draught reduces the effective head to say 523 feet.

The work done consists in driving the following described machinery:

A large air-compressor—2 cylinders, double acting, air compressed to 75 pounds—-requiring about 140 horse-power.

A line of Cornish pumps, forcing the water from a depth of 1,450 feet vertical; 12-inch plungers for upper 800 feet, 6-inch plungers for lower 650 feet, with 6-foot stroke, requiring from 55 to 70 horse-power.

Hoisting from a double-compartment shaft—two connected winding reels, moving separate cages—requiring 35 horse-power, or more.

A few small machine-tools and smithy forges, requiring 3 or 4 horse-power.

A 35-stamp mill, with concentrating apparatus, *etc*., requiring about 70 horse-power.

The total amount of power required being say 320 horse-power, for which seven Pelton hurdy-gurdy wheels are employed.

The power in all cases is transmitted by systems of Manila rope belting; the rope is 2 inches in diameter; the grooves in the sheaves or pulleys are slightly oval, so that the rope does not go quite to the bottom; the ropes are horizontal, and run very slack (no tighteners), with no appreciable slip; the splices are made very long, to obtain uniformity in diameter.

[Illustration: FIG. 15.]

This method of transmitting power appears to work most perfectly and has given excellent satisfaction. It is thought, at the Idaho, to be greatly preferable to the gearing formerly in use when the works were driven by steam (for such work as pumping or hoisting, leather or rubber belting is never used), besides being much cheaper in first cost.

The wheel driving the air-compressor is 6 feet in diameter, running 300 turns[5] per minute, with 1-15/18-inch nozzle; three ropes are used from the wheel shaft to the counter-shaft, and six ropes from the latter to the fly-wheel shaft.

[Footnote 5: The revolutions per minute, of these wheels, as here given, are only approximate, as the design was to have the bucket speed $=1/2\ 2(gh)^{1/2}$.]

For driving the pumps, there are two water-wheels, set on the same shaft, one 5 feet and the other 7 feet in diameter, either of which can be used at will, thus permitting different rates of speed; two nozzles are placed on each wheel, so that if necessary the power can at any time be doubled. The smaller wheel has a 1-1/4 inch nozzle, and runs 360 turns a minute; the larger has 1-1/8-inch nozzle, and makes 270 turns a minute. There are two ropes from the wheel-shaft to a counter-shaft, and four ropes

Page 46

to the fly-wheel shaft, on which is the pinion driving the spur-wheel attached to the pitman of the pump-bob. Hoisting is done by two wheels placed side by side on the same shaft, the buckets and nozzle of each wheel being placed in opposite directions. Both wheels are 8 feet in diameter, with 15/16-inch nozzles, and make at full speed about 225 turns a minute. Reversing the movement of the shaft is done by shutting off water from one wheel, and turning water on the other wheel; the two water-gates for these nozzles are quickly opened or closed by hydrostatic pressure, afforded from the water main. In addition to the usual brakes on the winding-reels, a brake is placed on the wheel-shaft, so that it can be stopped in a very short period of time.

The shock to the pipe by the almost instantaneous cutting off the water at these hoisting-wheels (nearly one cubic foot per second) has not apparently had any injurious, effect. To lessen this shock, a compensating balance was designed, but which is not now in use. A wheel, of small diameter, is used for the smithy, *etc*., running at a very high velocity. The wheel driving the stamp-mill is 6 feet in diameter, makes 300 revolutions a minute, and is supplied through a 1-3/16 inch nozzle. The head of water at this point is a few feet greater than at the other wheels. Power is transmitted from the hoisting and mill-wheel shafts by two and four ropes, the same as with the pumping rig. The amount of work done, or of water used, has not been carefully determined; judging from the indicator cards taken from the old steam-engines, the managers of the Idaho believe that an efficiency of fully 80 per cent. of the theoretic power of the water is obtained on the main driving-shafts of the machinery. The substitution of water for steam-power has resulted in a large saving of expense. Although the hills near by are covered with fine forests, thus making wood cheap, and although a round price is charged for water by the company furnishing it, the cost of the water is considerably less than that of the wood formerly used as fuel. The cost of attendance is altogether in favor of the water-wheels, which hardly require any attention. The cost of the change from steam to water-power was $46,496.32.

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TEXAS CREEK PIPE AND AQUEDUCT.

A description of this work will be of interest in showing the general practice followed in California for carrying water across deep mountain gorges. In order to augment its water supply, the North Bloomfield Gravel Mining Company desired to conduct water from a stream known as Texas Creek, in Nevada County, California, across the Big Canon branch of the South Yuba River into the main Bloomfield flume or aqueduct, which was located on the side of Big Canon Creek, at a vertical elevation of 620 feet above the bed of the latter stream. The quantity of water to be carried was

Page 47

about 32 cubic feet a second (1,250 miner’s inches), which could be diverted from Texas Creek at a point 480 feet vertical above the Bloomfield flume. An aqueduct about 4,000 feet long, partly of ditch and partly of flume, was needed to bring the water from the catchment dam on the creek to the brow of the gorge. The vertical head for the pipe could therefore be from a maximum of 460 feet down to any lesser head; with a head of 460 feet, the pipe would be 4,790 feet long; and with a head of 220 feet, the length would be 4,290 feet. Assuming a maximum tensile strain upon the iron of 16,500 pounds per square inch, with the formula for the greatest head of about

$$d = (.359\ l/h)^{1/5}, \text{ [or, } v = 68\ (dh/l)^{1/2}, \text{ and } Q = 32],$$

and a lower value of the coefficient in the last equation for the lesser heads, it was found, by calculation, that the least cost could be obtained with a head from 300 to 350 feet. The head fixed upon was 303.6 feet, with a length of 4,438.7 feet. A profile of the pipe, with nearly the same horizontal and vertical scales (horizontal scale, showing slope lengths), is given in Fig. 14; details are given in Figs. 15 and 16. The pipe was of double riveted sheet iron, made in lengths of about 20 feet, and of the following thicknesses:

1,349	linear feet,	0.083	inch thick.
220	"	0.095	"
240	"	0.109	"
250	"	0.120	"
320	"	0.134	"
610	"	0.148	"
1,450	"	0.165	"

Some of the iron was of the very poorest quality; the pipe was made by contract in San Francisco, without the supervision of an inspector, as the contractors were a firm of good reputation; the bad quality of the iron was not detected until too late to have it corrected. Since then, the writer has always had such pipes—the mines of which he has been the manager using large quantities—made directly on the ground where they are to be used; the pipe makers, in the latter case, always reject such sheets as are too much below in thickness the standard gauge, and those which show in passing through the rolls the bad quality of iron; tests of each joint by hydrostatic pressure would add too much to the cost.

[Illustration: FIG. 16.]

The maximum tensile strain upon each of the seven thicknesses of iron used was intended to be 16,500 pounds per square inch. Some of the sheets were below the standard gauge, so that, in reality, the tensile strain is sometimes as high as 18,000 pounds. The mean diameter of the pipe was 1.416 feet. The entrance into the pen-stock was tapered, so that the coefficient of contraction was about 0.92. For pressures not exceeding say 380 feet, the joints were put together stove-pipe fashion. For greater pressures, the joints were made by an inner sleeve riveted on one end of the joint, with an outer lap-welded band, as shown by Fig. 15; lead was run into the space between the outer band and the pipe, and then tightly

Page 48

driven up by calking-irons. The pipe was laid under the bed of the Big Canon Creek, a large stream when in freshet, where the head below the hydraulic grade line was 760 feet. Some of the lead joints leaked slightly at first, but this was soon remedied by more careful calking. No man-holes or escape-gates were used. The pipe for the larger part of the year is not filled at its upper end; when such is the case, the water at the inlet carries down the pipe a great quantity of air, for which escapes must be provided to prevent a jarring or throbbing, which would soon destroy the pipe. The escape air-valves used are shown by Fig. 16. They consist simply of a heavy flap valve of cast-iron, with recess for lead filling to give greater weight set on top the pipe, seating on a vulcanized rubber cushion, and swinging on a loose hinge. When the pipe is only partly filled with water, the valves drop down by their own weight, allowing the air to freely escape; when the water rises above the level of a valve, it is tightly closed by the resulting pressure. There are fourteen of these valves, those on the lower end being designed to allow air to freely enter the pipe in case it should burst in the deeper portion, and thus prevent any collapse from atmospheric pressure. The valves have answered the desired purposes most effectually. The pipe was hauled over a road built to the inlet end, and shot down the mountain side by means of a V-shaped trough of wood. For the lower end, the joints were hauled up the cliff side into place by a crab worked by horse-power. On steep inclinations, the pipe was held firmly in place by wire ropes fastened to iron pins in the solid rock, as shown by the sketch. The covering of earth and stone was 1 foot to 2 feet in depth; with steep slopes, the earth was kept from sliding by rough dry walls, or by cedar plank placed crosswise. The pipe was laid in 1878; the first year it broke twice, owing to the wretched quality of the iron; since then, it has given no trouble, and has required practically no attention. The cost of this work—-ditch and flume 4,000 feet, and pipe 4,440 feet—was $23,779.53.

A comparison of the relative values of n, in the formula v = n (r s)^{1/2}, for the foregoing ditch, flume, and pipe will be instructive. The ditch has a width on the bottom of 3 feet, on the top of 6 feet, with a depth of 3 feet, and an inclination of 20 feet per mile; its sides are rough, being cut in part through the rock and with sharp curves, although fairly regular; with a flow of about 1,300 miner's inches (32.8 cubic feet per second) the ditch runs about full.

Therefore:

```
6 + 3
a = ----- x 3 = 13.5 ;
2
```

[TEX: a = \frac{6+3}{2} \times 3 = 13.5;]

a
r = ------------- = 1.41 ;
3.3 + 3 + 3.3

[TEX: r = \frac{a}{3.3 + 3 + 3.3} = 1.41;]

20 1
s = ------ = ----- ;
5280 264

[TEX: s = \frac{20}{5280} = \frac{1}{264};]

Page 49

Q = 32.8, hence

$$v = \frac{Q}{a} = 2.43;$$

[TEX: v = \frac{Q}{a} = 2.43;]

and

$$n\ \left(\text{in}\ v = n\ (r\ s)^{1/2}\right) = 33.$$

[TEX: n\ (\text{in}\ v = n (r s)^\frac{1}{2}) = 33.]

The flume is of unplaned boards, rectangular, 2.67 wide x 2.83 deep, with an inclination of 32 feet per mile. There are sharp curves, although these were made as regular as practicable; the boiling action of the water passing around these curves brought the flow line (Q = 32.8) nearly up to the top of the sides; with a straight flume of the same size, the water would have doubtless stood several inches lower.

Therefore:

a = 2.67 x 2.83 = 7.56 ;

$$r = \frac{a}{2.83 + 2.67 + 2.83} = 0.908 ;$$

[TEX: r = \frac{a}{2.83 + 2.67 + 2.83} = 0.908;]

$$s = \frac{32}{5280} = \frac{1}{165} ;$$

[TEX: s = \frac{32}{5280} = \frac{1}{165};]

Q = 32.8, hence

$$v = \frac{Q}{a} = 4.34;$$

[TEX: v = \frac{Q}{a} = 4.34;]

and n = 59.

With the pipe,[6] 1.416 diameter,

$$r = \frac{d}{4} = 0.354;\ Q = 31.69;\ v = 20.13.$$

[TEX: r = \frac{d}{4} = 0.354;\ Q = 31.69;\ v = 20.13.]

[Footnote 6: *Vide* pages 120-122, Transactions American Society of Civil Engineers for 1883.]

Allowing for loss of head due to imparting velocity to water, and for contraction,

$$s = \frac{296.1}{4438.7};\ \text{and}\ n = 131.$$

[TEX: s = \frac{296.1}{4438.7};\ \text{and}\ n = 131.]

We hence have the following values of n, in v = n (r s)^{1/2}, Q being constant:

Rough ditch, with sharp curves. 33 Rectangular flume, with sharp curves. 59 Wrought-iron pipe, with easy curves, coated with asphalt, but with rivet-heads forming noteworthy obstructions (m = 65.5, and 2m = n) 131

* * * * *

PARACHUTE HYDRAULIC MOTOR.

The very singular and simple hydraulic motor which we illustrate herewith is the invention of a Russian engineer, Mr. Jagn. It is scarcely as yet known in Western Europe, where, however, something will probably be heard of it ere long. Its true field would seem to be Egypt, India, or any country where canals or rivers are used for irrigation, and where it is desired to draw water from them at particular spots in the simplest and cheapest manner. At present in nearly all such cases water is raised by hand or steam power; nevertheless it must be obvious that the current of the canal itself, slow though it may be, is quite sufficient to raise a small portion of the discharge to the very moderate height generally needed to lift it over the banks into the adjoining fields. Why then is it not employed for the purpose?

Page 50

The answer is obvious, when we consider the various hydraulic motors at present in use. Of course, motors worked by water pressure must here be excluded; and we are left with scarcely anything but the undershot wheel, the turbine, and the screw pump. All these require expensive buildings and erections to set them to work, present but a very small fraction of their surface to the water at any one time, and must be very large and costly if they are to draw even a very moderate amount of power from such a source. There is no possibility of adjusting them readily to suit variations in the speed of the current or in the quantity of water required, nor of moving them from place to place should this be convenient.

[Illustration: PARACHUTE HYDRAULIC MOTOR.]

The motor of Mr. Jagn is on a totally different principle. Its essential features consist, as shown, of an endless rope made of hemp or aloe fiber, which takes a turn or two round a pair of drums mounted on a barge or pontoon, and then passes down the channel to return over a pulley hung from a floating punt, at such a depth that the whole of the rope is immersed in the water. Along this rope are suspended at equal intervals a number of parachutes made of sail cloth. The rope passes through the center of each of these, and to it are attached a series of strings, the other ends of which are connected to the outside edge of the parachute. Thus they act like the spokes of an umbrella to prevent the parachute from opening too far under the pressure of the current. The parachutes must be placed so far apart that the current may act fairly on each, and the sum of the pressures forms the force which draws the rope through the water. The moment, however, that any parachute has passed round the return pulley, the current acts upon it in the opposite direction. It then shuts up like an umbrella, and assumes a volume so small that its resistance on the return journey is insignificant. After passing round the drum at the upper end, it at once opens afresh of its own accord, and once more becomes part of the moving power of the whole system. The parachutes are formed by first cutting out a complete circle of cloth, and then taking from this a sector equal to one-fifth or one-sixth of the total area. Such parachutes are found to keep their form when stretched by the water better than a surface originally spherical, although the latter would be theoretically more correct. The motion of the drum is transmitted by spur, gear, or otherwise as may be required, to give the requisite speed.

It will be seen that the advantages of the system are as follows: First, the facility it offers for obtaining a large working area, which may be increased or diminished at will, according to the requirements of the moment, by lengthening or shortening the rope. Secondly, the ease with which it is erected and set to work. Thirdly, the small part of the river section which it occupies, so as to present no obstacle to navigation. Fourthly, the ease with which it can be mounted on a barge of any kind, and carried wherever it may be needed. Fifthly, it is not stopped, like all other hydraulic motors, by the appearance

BOOKRAGS

of ice—it has, in fact, already been worked under ice in the Neva. At the same time, winds and waves have no influence upon it.

Page 51

The principle of the apparatus is not altogether new. In 1872 there was tried on the Ohio River an arrangement termed the Brooks motor. It was composed of two drums, placed horizontally and parallel to each other. Round these there passed endless chains at equal spaces apart on the length of the drums, and to these chains were fixed wooden blades or arms of a curved form, and so jointed to the frames that they opened when moving in one direction, and closed down on the chain when moving in the other. In this machine the weight of the chains was a serious obstacle to obtaining any large amount of power. The whole apparatus was mounted on a heavy wooden scaffold, which proved an impediment to the flow of the river. Again, the resistance due to the surface of the returning blades and to their stiffness was found to be far from insignificant.

In the present system Mr. Jagn has found, after many experiments, that the best effect was obtained when the parachutes were spaced apart at twice their diameter, and when the rope made an angle of 8 degrees to 10 degrees with the current. It is found that when open and in motion the parachutes never touch the bottom. This was the case with a rope containing 180 parachutes of 4 feet diameter, and working in a depth of only 6 feet. This is easily explained by the fact that the velocity of a current always diminishes as it approaches the bottom. Hence the pressure on the lower part of the parachute will be less than that on the upper part; but the former pressure tends to draw the parachute downward, while the latter tends to raise it to the top of the water. Thus, the latter being the larger, the parachute will always have a tendency to rise. In fact, it is necessary to sink the return pulley sufficiently deep to make sure that the parachutes will not emerge from the surface. For the same reason no intermediate supports are needed over the driving span; if any are needed it is for the return span, on which the parachutes are closed. Of course, if metal were used instead of hemp, the case would be entirely different, and intermediate supports would have to be used for anything but very moderate lengths.

In practice, Mr. Jagn has employed two ropes wound upon the same pair of drums, which are mounted upon a pontoon. The ropes are spread out from each other, as in Fig. 1, making an angle of about 10 degrees. The low specific gravity of the system enables ropes to be employed of as great a length as 450 yards, each of them carrying 350 parachutes of 17.2 square feet area. As half of these are in action at the same time, the total working area for the two cables is 5,860 square feet. This immense area furnishes a considerable amount of power even in a river of feeble current. Comparing this with a floating water wheel of the type sometimes employed, and supposing this to have only 172 square feet of working area, such a wheel must have a length of 46 feet, a diameter of 23 feet, and seventy-two floats, each 21/2 feet wide. The enormous dimensions thus required for a comparatively small working area point sufficiently clearly to the advantage which remains on the side of the parachute motor.

Page 52

The general arrangement of the system is shown in the engraving. Behind the return pulleys, D D, are attached cords, A A, with some parachutes strung upon them. These present their openings to the current and preserve the tension of the connecting ropes. At the further end of each cord is a board, B, which is kept in a vertical plane, but lying at a slight angle to the direction of the current; and this acts to keep the two moving ropes apart from each other. The two return pulleys are, however, connected by a line, E, which can be shortened or lengthened from the pontoon, and in this way the angle of inclination between the two ropes can be varied if required. A grooved pulley presses upon the trailing span at the moment before it reaches the circumference of the drum. It is mounted on a screwed spindle, which is depressed by a nut, and thus makes the wet rope grip the outside of the drum in a thoroughly efficacious manner.

The author has made a theoretical investigation of the power which may be developed by the system, and has worked out tables by which, when the velocity of the current and the other elements of the problem are known, the power developed by any given number of parachutes can be at once determined. We do not reproduce this investigation, which takes account of the resistance of the returning parachutes and other circumstances, but will content ourselves with quoting the final equation, which is as follows: T = 0.328 S V cubed. Here T is the work done in H.P., S is the total working area in sq. m., and V is the velocity of the current in m. per sec. Taking V = 1, and S = 1 sq. m., which is by no means an impracticable quantity, we have T = 0.328 H.P. per sq. m. We may check this result by the equation given, in English measures, by Rankine—“Applied Mechanics,” p. 398—for the pressure of a current upon a solid body immersed in it. This equation, F = 1.8 m A v squared / 2g, where m is the weight of a unit of volume of the fluid—say 62 lb.—A is the area exposed, and v the relative velocity of the current. Mr. Jagn finds that the maximum of efficiency is obtained when the rope moves at one-third the velocity of the stream. If this velocity be 3 feet per second, we shall have v = 2. and we then get F = 7 lb. per sq. ft. very nearly. Now 1 sq. meter = 10.76 sq. ft., and a speed of 1 ft. per second (which is that of the rope) is 60 ft. per minute. Hence the H.P. realized in the same case as that taken above will be 7 x 10.76 x 60 / 33,000 = 0.137 H.P. The difference between the two values is very large, but Rankine, of course, depends entirely on the value of the constant 1.8, which is quite empirical, and is for a flat band instead of a hollow parachute. Taking, however, his smaller figure, and an area of 544 square inches, which Mr. Jagn has actually employed, we get a gross power of = 0.137 x 544 = 7.43 H.P. Hence it will be seen that the amount of power which can be realized by the system is far from being inconsiderable.

Page 53

Lastly, we may point out that the durability of the apparatus will be considerable. There is no wear except at the moment when the rope is passing round the drum, and even then there need be no slipping or grinding. The apparatus worked in the Neva was in very good condition after running for four months day and night. After five months about one-fifth of the parachutes had to be replaced, but after seven months the hemp rope still showed no signs of wear. We think we have said enough to show that for certain purposes, and especially, as we have, already mentioned, for irrigation purposes, the new motor is well worthy of a careful and extended trial. It may be questioned even whether we have not here the germ of an idea which may hereafter enable us to solve one of the most interesting and important of engineering problems, *viz*., the utilization of the great store of power provided for us twice daily in the ebb and flow of the tide.—*The Engineer.*

* * * * *

IMPROVED SHAFTING LATHE.

Our engraving represents a new departure in shaft turning lathes, and is the result of thirty years' experience in the manufacture of shafting, with many years' study, to perfect a machine of the greatest practical capacity and efficiency.

[Illustration: IMPROVED SHAFTING LATHE.]

The principal points of difference from a common engine lathe are readily distinguished, among which may be mentioned the absence of centers and tail stock, a traveling head with hollow driving spindle, and a stationary tool rest and water tank. By dispensing with a tail stock a much shorter bed may be used, and the hollow driving spindle enables any length shaft to be turned, with one setting of the tools. The tool rest is so arranged as to allow of perfect lubrication of the tools, keeping the shaft cool, and at the same time holding it perfectly rigid and strong; the operator is not required to travel the length of the bed, but remains near the driving belt, feed gearing, *etc*. Power is communicated to the driving spindle by means of a sliding pinion on a splined rod inside the bed, the driving belt and gears being at the end.

The driving head, after having traveled the length of the bed and turned a shaft, is returned by a quick feed, and stops automatically, allowing nearly time enough for the operator to grind tools and be ready with another shaft, thus economizing the time completely.

Wood, Jennison & Co., Worcester, Mass., are the makers, and they say that with a good quality of iron they have turned three hundred feet of two inch iron in ten hours.

* * * * *

POWER STRAIGHTENING MACHINE.

Page 54

The machine is provided with a pair of rolls at each end of the bed, which are adjustable for different lengths of shaft, and are made to revolve by power applied through suitable gearing and a splined rod inside the bed; the bar of iron being placed on the periphery of the rolls receives a rotary motion by friction, and shows the crooked places in the same way and with the same ease as though rotating on centers in the usual manner; vertically adjustable blocks are arranged in the base of the press to support the iron; power is applied by means of gearing to a splined rod at the back of the machine, on which is a sliding clutch connecting, at the will of the operator, with an eccentric; the eccentric conveys motion and power through a link to the elbow joint at the front of the press, which forces a plunger down against the iron.

[Illustration: POWER STRAIGHTENING MACHINE.]

Sufficient adjustment is provided for different sizes of iron by turning a nut at the top of the press.

Any point in the length of the bar can be reached by moving the press on the bed. Any length of iron can be straightened, and the most laborious and disagreeable work in the process of making shafting is rendered easy and rapid. Made by Wood, Jennison & Co., Worcester, Mass.

* * * * *

HYDRAULIC MINING IN CALIFORNIA.

By GEORGE O’BRIEN.

Our knowledge of the primitive operations of the aboriginal inhabitants of the globe in pursuit of gold is barely traditional, as we are only aware that from very early times the precious metal was collected and highly prized by them, and that they chiefly extracted the visible gold, which existed in prodigious quantities on or closely beneath the surface of the earth, and of its being particularly abundant in Asia and Africa. But we can draw more positive conclusions as we survey remains of the rude but effective contrivances used by them in later, but still remote, periods, with full evidence as to the extent of their operations, in the numerous perpendicular shafts located at short distances from each other, over large areas of auriferous gravel in India, as well as from precisely similar memorials of ancient workings which remain also further demonstrations, in the abandoned “hill diggings,” and shifted beds, and beds of rivers, in Peru South America, flowing between the sea and coast ranges of the Andes, descending in a northeasterly direction to the river Amazon, and that their much coveted and enormous productions were the accumulated riches of the Incas, transferred as spoils of war to their Spanish conquerors in the sixteenth century. And for similar explorations in the same class of depositions we have the experiences of our own times, and which explain by comparison all the previous operations alluded to.

Page 55

Thus in the year 1849, after the cession of the northern portion of Mexico to the United States of North America, the rich mineral district of California was at once invaded by hardy and intelligent bands of mining adventurers from all parts of the world, who, with little other means at their disposal but pick, shovel, and pan, soon fell on the productive bars of rivers and rich ravines where the gold was trapped, derived from its original birthplaces, where it had been sparsely disseminated, to be dispersed by the subsequent disintegrations and denudations of the mountains themselves, and deposited in a disengaged form for the first comer; and so perfect were sometimes these concentrations, in certain localities where water once streamed, that, divested of its earthy matrix, the cleansed pure metal was found deposited, detained by its superior specific gravity, on the bare rock, and only hidden from vision by a slight covering of vegetable mould. In this manner, as an example of such concentration, a “pot” or “find” (in mining parlance) to the value of L10,000 was collected in a space of 15 square yards, or within the limits of a particular “mining claim,” at the foot of Mokulumne Hill, in a southern county of California, soon after the territorial transfer from Mexico. And in search of such locations we must account for the numberless shafts which still exist both in India and Peru, and sometimes sunk within a few feet of each other, passing through the alluvium to a depth of 40 feet to the bed rock.

These mining adventurers soon extended their explorations over the other recently acquired territories, and built Virginia City, the capital of Montana, with the gold derived from the alluvium of a river channel which they excavated; and its inhabitants were the founders of an institution called the Vigilance Committee, with “Lynch law,” and by it ruled supremely for many years. But their surface diggings, by the manual operations alone of multitudes, were soon exhausted in every direction, and then their energies and powers of invention were dedicated to discover and explore deeper and more permanent depositions, along the western slopes of the Sierra Nevada, the Andes of the Western Territories, and which originally were without doubt several miles higher than they are at the present time—probably 20,000 feet above the sea-level—and of which, or whatever superior elevation they formerly had, the greater portion of it has already been removed, by the continuous natural action of centuries, to form there, as elsewhere, the plains and prairies of the earth, burying and diverting by the mutation the ancient river system, whose sources of supply were consequently extinguished by the removal of these altitudes. These denudations and subsequent depositions have been caused by alternations of temperature and combined action of air, water, and time since the creation of the world; and powerful demonstrations of these transformations instruct us

Page 56

in all directions, if we care to observe them. Thus in “Little Cottonwood” ravine, in the Wahsatch range of mountains in Utah Territory, lie isolated in the center of the valley huge masses of metamorphic granite, some blocks of which weigh individually thousands of tons, and were dislodged from the hills—which on either side are of limestone formation—with no visible granite in them, having been undermined by the removal of their pulverized basis by denudation, and which is the material now forming the tablelands, the foundation, of Salt Lake City. The blocks of granite, having alone resisted the atmospheric changes, were precipitated into the valley beneath, and the Mormons are now constructing their cathedral church from these granitic remains.

The melting of the snow which formerly capped all these ranges of mountains furnished the water that once flowed in the extinguished channels of ancient rivers, and whose now diverted waters were also the powerful agent to assist in causing these marvelous alternations; and by the means of hydraulic mining we can advance our feeble knowledge on the subject.

These mighty changes have gradually been accomplished, and the accumulated denudations of the mineral zones have defended themselves by strata of crystallized silicates of quartz of various thicknesses, and thus in places beneath such system of defense, or by their own concretion, have preserved in many localities a thickness of from 500 to 600 feet of conglomerate, but without this necessary cementation its further removal is very certain when again attacked by water. An example of this continuous process is very observable in “Death Valley,” Lower California, where a width of about 100 miles has been filled up from the hills to the gulf of same name, invading and occupying its former bed; and this activity is still proceeding, and a temporary formation of tableland above it is in course of removal, although already overgrown with forest trees, which are toppling over the side which is being attacked. But eternal snow now only covers a small portion of these Sierras, and a period of comparative repose may be expected, as the distribution has already been far advanced by the excessive reduction of the mountains.

The deep and extensive depositions which I now attempt to describe attracted the early attention of the mining adventurers, and were called “hill diggings,” but not being properly understood were therefore not immediately operated upon, and remained in abeyance, while the lower, richer, and more manifest alluvials endured. They were designated “blue gravel,” the color being due to the action of sulphuret of iron and other salts, the cementing auxiliaries requisite to form the hard conglomerate, and on exposure to the atmosphere changes color to yellow and violet, losing also its firmness by oxidation.

The “great blue lead” is another important mining term and designates the alluvium found reposing in a well-defined channel on the bed rock, being the well-worn path of an ancient river; and it is obvious that the material in these channels should be richer than the general mass beyond their limits.

Page 57

“Rim rock” is the boundary line of the banks of the old channel, and, like the bottom, is well worn and corrugated by the running water into cavities and “pot holes,” where the force of the stream eddied. The width of these channels varies from 60 to 400 feet, and the cement near the rim and bottom is always richer than elsewhere. The wider and deeper channels generally course from N. to N.W. The richest and most explored belt of gold-bearing alluvium in California lies between the South and Middle Yuba Rivers, commencing near Eureka, in Nevada county, and extends downwards to Smartsville and Timbuctoo, in Yuba county, a distance of 40 miles; and from among snowy mountains the country falls gradually from where the ravines or canons are cut by the actual rivers, which are 2,000 feet beneath the auriferous gravel and region near Smartsville, and 2,000 feet above the Yuba River, where snow is unknown, and near its terminus the ancient river bed courses more westerly than it does above it, and crosses Yuba below Timbuctoo, where the auriferous depositions disappear. The whole distance of 40 miles has been ransacked by the earlier adventurers, and around the village of Timbuctoo was a center famed for its wonderful yield of gold, obtained chiefly in the ravines, in holes, and depressions in the bed rock. These hollows detained the concentrations of the denudated alluvium from the altitudes, and were generally closely beneath the surface, and by such guidance and means of discovery the miners traced the gold up the ravines to their sources in the lofty mounds and deposits, or hills of cemented conglomerate, near Eureka in Nevada county; and by constructing canals from a higher level began the new system of “hydraulic mining” and washing, and gradually extended their operations over the area of the metallic zone mentioned, of 40 miles long by 20 wide, using the Yuba River below Timbuctoo to receive and discharge the tailings, or refuse from their operations. The result in gold was considerable, but the system is from its violent nature difficult to control, by presuming to handle and remove such huge depositions in order to collect the richest material. The idea was bold, being an anticipation of Nature’s operations; but the equitable disposal of the “tailings” in a cultivated country is impossible, as the silt runs down the rivers, creating banks and bars in their channels, obstructing navigation and agricultural arrangements.

General Description of Hydraulic Mining.

The first work to be accomplished, after calculating that the amount or value of the material to be operated upon is sufficient to guarantee the cost of the undertaking in general, is the construction of a canal or canals, to convey the requisite volume of water from the fountain-head, and of sufficient elevation to command the ground to be worked upon, having also in view the levels of the necessary tunnels and shafts as outlets for the discharge of the gravel through them, these being engineering operations requiring much skill and labor to avoid useless after-cost.

Page 58

Aqueducts of considerable elevation have to be constructed across deep valleys, and the speculation is at all times problematical, as the ground cannot be properly tested until the water arrives upon it, and disputes may arise between the shareholders of the canal and the mining company, ending frequently in the one devouring the other, unless the two interests be quickly amalgamated.

The starting point should be the lowest level, or "bed rock," on the white cement in the ancient channel, which is probably the original silt collected in it, and is harder than the conglomerate above it, which is more easily removed. The courses of these beds can be easily traced by landmarks and undulations, and occasional exposures of the bed rock at low levels; also trial shafts are sunk in various places in search of it, to a depth of 100 feet, passing through blue gravel. The grades of these beds are not steep, being from 10 to 40 feet per mile as of an ordinary river, and the calculated thickness of the alluvial conglomerate is about 600 feet in many places across the ridge between the South and Middle Yuba River across the Columbia.

The power of the water for the operation is dependent on a given volume deposited in a reservoir, and at sufficient elevation above the points of discharge, as on this depends effectivity to tear down the gravel. It is delivered to the miner by huge pipes made of wrought iron, and laid down to follow the curvatures of the surface of the ground; and the pipe I now treat of, belonging to the Excelsior Water Company, has a diameter of 40 inches on a length of 6,000 feet, and 20 inches on the rest of its length of 8,000 feet, being 9,000 feet in all; and this large pipe forms an inverted siphon across a valley, following on the gravel, to the top of the hill into the reservoir.

These pipes offer advantages over wooden aqueducts for spanning chasms, and also to avoid coursing the sides of valleys; being also cheaper to construct in general, and less liable to accidents from fire and storms, and have the convenience for conveying the water from point to point, as the work of excavation advances, necessitating the removal of portions of the aqueduct forward. The watershed, or reservoir, of the Excelsior Company embraces the valley of the South Yuba and its affluents, and the entire cost of its eight amalgamated canals was 750,000 dollars.

The rainfall during three years in the mountains averaged 49 inches annually, while the medium in the same period did not exceed 20 inches in the plains beneath. The height of the reservoir above the tailing, or Yuba River, is 393 feet: and the height of the head above the floor, or outlet sluice-tunnel, of the Blue Gravel Mining Company was 197 feet.

Page 59

The exact quantity of water required to wash every class of gravel is difficult to estimate, but no quantity or pressure would be excessive if properly arranged. The measurement of water is effected by miner's inches, by allowing it to flow from the reservoir of the seller to the purchaser through a box 10 or 12 feet square, with divisions to obtain a quiet head, with a slide or opening capable of adjustment to any required measure; thus an opening of 25 inches by 2 inches, with a quiet head of 6 inches above the middle of the orifice, would give 50 inches, or about 89,259 cubic feet of water, flowing during ten hours per day, being an amount necessary for a first-class operation. The capability of the Excelsior Canal in rainy seasons reached to a delivery in twenty-four hours, to the various mining companies, of 21,120,000 cubic feet of water, or 8,000 miner's inches, and the value of the water paid for by the Blue Gravel Company in forty-three months ending November 9, 1867, was 157,261 dollars, being at the rate of 15 cents of a dollar per miner's inch; and the proportion of water used to wash down 989,165 cubic yards of gravel was 17,074,758 cubic yards, or 171/4 cubic yards of water to 1 cubic yard of gravel; and when at work the quantity of gravel daily moved was 1,298 cubic yards, and the estimated cost to move one cubic yard of gravel was 5 and 7/10 cents of a dollar. But in the face of contingencies the Blue Gravel Company moved 1,000,000 cubic yards of gravel in four years, or at the rate of 250,000 cubic yards per annum, and the cost of washing each cubic yard stands thus:

Cents.
Cost of water, at 15 cents per miner's inch 5.77
Cost of labor, gunpowder, sluices, and
superintendence 16.10

21.87
Or 213/4 cents of a dollar per cubic yard.

Thus the gravel should contain gold to the value of 22 cents of a dollar per cubic yard to cover cost, and the value of the gravel referred to ranged from 20 to 45 cents per cubic yard; and the cost of work done in shafts and tunnels, in the said Blue Gravel Company's Mining claim, reached 100,000 dollars. But with the cost of the necessary canals paid for by the Excelsior Water Company apart, the total cost amounted to about 1,000,000 dollars, and we must note that the latter company sold water to other mining companies.

The gross yield in gold of the Blue Gravel Company in four years was 837,399 dollars, and in the year 1866 the returns from the Blue Gravel Company paid all the costs of the developments; but in 1867 assessments were paid by the owners to meet the deficiency arising from the cost of sinking two new shafts, and driving fresh tunnels on the lowest levels, which evidently contain on the bed rock the richest concentrations.

In smaller mining adventures of this description, involving less capital, large profits have been made in the gold-bearing zone treated of, by also not having invested in costly canals, which would not have repaid the latter investment; and thus it is evident that the water companies are dependent blindly on the prosperity of the miners.

Page 60

I will now more minutely describe the actual mining operations. The mining ground being selected, a tunnel is projected from the nearest and most convenient ravine, so that the starting-point on the bed rock toward the face of the ravine shall approach the center of the material to be removed at a gradient of 1 in 10 to 1 in 30. The dimensions of such tunnels are usually 6 feet in width by 7 in height, and continuing in contact with the hard river-bed, for the greater ease of excavation, collection of gold, and conservation of quicksilver amalgam.

These tunnels vary in length from a few hundred feet to a mile, and some of the longer ones occupying from one to seven years in execution, at a cost of from 10 to 60 dollars per foot of frontage. The tunnel of the Blue Gravel Company, with length of 1,358 feet, cost in labor alone 70,000 dollars, but it could now be driven for 35,000 dollars, as skilled labor is cheaper now than then. The grade in this tunnel is about 12 per cent., and the end of the tunnel is designed to be 170 feet of elevation, and reaching to a point beneath the surface of the gravel which is being operated upon, and where a shaft or incline is sunk to or through the bed rock or gravel, until it intersects the tunnel.

The object of this laborious operation is obvious, as the long tunnel becomes a sluiceway, and through the whole length of which sluice boxes are laid, for the double motive of carrying off the material and saving the gold, and for this purpose a trough of strong planks is placed in the tunnel, 21/2 feet wide, and with sides high enough to contain the stream. The pavement of the trough is generally laid of blocks of wood 6 inches in thickness, cut across the grain, and placed on their ends, to the width of the sluiceway. The wooden blocks are usually alternated with sections of stone pavement, the stones being set endwise, and in the interstices between the stones and wooden blocks quicksilver is distributed, and as much as 2 tons of this metal is required to charge a long sluice. The water in the canal is brought by aqueducts, or other means, to the head of the mining ground, having an elevation of 100 to 200 ft. above the lowest level of the mining ground, and is finally conveyed to it by iron pipes, sometimes sustained on a strong incline of timber.

These pipes are of sheet iron, of adequate strength, riveted at the joints, and measure from 12 to 20 inches in diameter, and communicate at the bottom with a strong prismatic box of cast-iron, on the top and sides of which are openings for the adaptation of flexible tubes, made of very strong fabric of canvas, strengthened by cording, and terminating in nozzles of metal of 21/2 to 3 inches in diameter. From these nozzles the streams of water are directed against the face of the gravel to be washed, exercising incredible effectivity.

The volume of water employed varies of course with the work to be done; but it is not uncommon to see four such streams acting simultaneously on the same bank, each conveying from 100 to 600 inches of water per hour—1,000 miner’s inches being equal to 106,600 cubic feet of water per hour, constantly exerting its force under a pressure of 90 to 200 pounds to the square inch, varying with the height of the column.

Page 61

Under the continuous action of this enormous force, aided by the softening power of the water, large sections of the gravelly mass are dislodged, and fall with great violence, the *debris* speedily disintegrating and disappearing under the resistless force of the water, and is hurried forward in the sluices to the mouth of the shaft, down which it is precipitated with the whole volume of turbid water. Bowlders of 100 to 200 lb. in weight are dislodged and shot forward by the impetuous stream, accompanied by masses of the harder cement which meet in the fall, and by the concussion from the great bowlders the crushing and pulverizing agency required is found to disintegrate it. The heavy banks, of 80 feet and upward, are usually worked in two benches, the upper never being so rich as the lower, and also less firm, and therefore worked away with greater rapidity.

The lower section is much the more compact, as this stratum on the bed rock being strongly cemented resists great pressure, and even sometimes the full force of the streams of water, until it has been loosened by gunpowder or other explosives. For this purpose adits are driven in on its foundation-point of from 40 to 70 feet and more from the face of the bank, and drifts are extended at right angles therefrom to a short distance on each side of the adit, and in these drifts a large quantity of gunpowder is placed (from 1 to 3 tons), and fired at one blast, having been previously built in with masonry. And in this manner the compact conglomerate is broken up, and then the water easily completes its work. Sometimes in the soft, upper strata the systems of tunnel is extended, as in a coal-mine, by cross alleys, leaving blocks which are afterward washed away, and then the whole mass settles, and is disintegrated under the influence of water. The wooden sluices in the tunnels already described are often made double for the convenience of “cleaning up” one of them, while the other remains in action. The process of cleaning up is performed according to the quantity and richness of the material worked upon, at intervals of twenty to forty days, and consists in removing the pavement and blocks from the bed of the sluice, and then gathering all the amalgam of gold and rich dirt collected, and replacing the locks in the same way as at first. Advantage is taken on this occasion to reverse the position of the blocks and stones when they are worn irregularly, or substitute new ones for those which are worn through. The mechanical action of the washing process on the blocks is of course very rapid and severe, requiring complete renewal of them once in eight to ten weeks. Some miners prefer a pavement of egg-shaped stones set like a cobble-stone flooring, the gold being deposited in the interstices. Most of the sluiceways are, however, paved with rectangular wooden blocks, with or without stones as described. Standing at the mouth of one of the long tunnels in full action, any

Page 62

person unaccustomed to the process is struck with astonishment, amounting almost to terror, as the muddy mass sweeps onward, bearing in its course the great rolling bowlders, which add their din to the roar of the water, the whole being precipitated down a series of falls, at each of which it is caught up again by new sluices of timber, lined like the first, and so onward and downward many hundreds of feet until the level of the river is reached, at a distance of about a half mile or more from the mouth of the first tunnel.

At each of these new falls of 25 to 50 feet the process of comminution begun in the first shaft is carried on, and a fresh portion of gold obtained. Rude as this plan of saving gold appears to be, more gold is procured by it than by any other method of washing yet devised for this process of work, and the economical advantages obtained by it cannot be surpassed, as it would be impossible to handle such vast quantities of material in any other way, and we can compare the cost of washing and handling a cubic yard of auriferous gravel by it as follows:

	Dollars.
By manual labor with the pan	15.00
" " with rocker	3.75
" " with the long tom	.75
By the hydraulic process	.15

But this process, even if effective or profitable as a mining operation, may be prejudicial to the interests of the general public, if conducted on a large scale, as the vast quantity of material which it so suddenly removes is merely shifted into the shallows beneath, to be redistributed by every freshet to points lower and lower down until it reaches the sea-coast, creating bars at the mouths of rivers in its course, and changing the hydrography of harbors—as it has done with the Bay of San Francisco by its silt.

The hills behind, torn up and washed by the gold miner, are abandoned as desolate and irredeemable; and the costly canals, constructed with peculiar conveniences for mining purposes, eventually fall into disuse from being too expensive to maintain or alter for general agricultural uses.—*Journal of Science.*

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THE TREATMENT OF CHOLERA.

From the host of remedies and suggestions that are now deluging the European medical press, we select the following from Dr. Henry A. Rawlins, in the *London Med. Times*, July 12. 1884:

The man suffering from cholera has been suddenly deprived by diarrhoea of an enormous quantity of the fluid part of his blood. This loss is one of simple transudation, increasing as the powers of life decrease. This *sudden* loss produces intense prostration, and renders the heart powerless to perfect the circulation. The body, thus deprived of oxygen, speedily runs into decomposition, even before life is extinct. Have we any agent by which we can collect and press forward

Page 63

these scattered and lethargic drops of blood to the heart, and enable it to renew the circulation, and with it the blessings of oxygen to the body? My reply is emphatically—-Yes! Flannel bandages from the toes to the trunk, around the abdomen, and from the fingers to the body, will effect this object perfectly. Remark that the effect is gradual, increasing with every turn of the roller, but would be in full force in about twenty minutes. By thus exposing the blood in the lungs to the action of oxygen in its diluted form, as it is in the air, instead of pure oxygen, the reaction would neither be too rapid nor too dangerous. In confirmation of my views, I have this day learned that it is the custom in India to wear a double roll of flannel around the abdomen, as a preventive to cholera. The other advantages resulting from the use of the flannel bandages are:

1. That they prevent the escape of heat from the body of the poor creature who is already in a state of refrigeration.

2. By their firmly and equally grasping both flexor and extensor muscles alike, they are steadied, and rendered much less likely to be affected with spasmodic action or cramp.

3. By their steady *elastic* pressure and support of about 160 pounds, they persistently keep up and sustain the circulation of the blood, which they had previously restored.

4. That the oxygen thus well secured to the blood will, I believe, prove quite sufficient to neutralize the original poison, and also destroy its effects.

5. That this much can at least be claimed for their use—that they remove from nature a stumbling-block, which prevented her from exercising her marvelous recuperative powers. Diluted sulphuric acid is the best medicine to arrest the flux from the bowels, acting also as a tonic. It should be given in five-minim doses about every half hour, with rice gruel. By adopting this plan, the natural process is brought about, that of the starch being converted into grape sugar. Plenty of white of egg, well whipped up, so as to nourish the body and convey oxygen into the stomach, which it will appropriate, should be given. Opium, in small quantities, and other stimulants, should be given according to the necessities of the case. May it not be well, through the medium of wet sponge over the thorax, to apply a continuous but gentle current of galvanism, so as to stimulate the heart's action, keep alive the respiratory movements, and thereby assist in the maintenance of the functions of the body?

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TEMPERATURE, MOISTURE, AND PRESSURE IN THEIR RELATIONS TO HEALTH.

At the recent meteorological conference held at the Health Exhibition, Dr. J.W. Tripe read a paper of much interest on some relations of meteorological phenomena to health.

Page 64

In ages long past these relations excited much attention, but the knowledge concerning them was of the vaguest kind; and indeed, even now, no very great advance has been made, because it is only quite recently that we have been able to compare a fairly accurate record of deaths with observations taken at a number of reliable meteorological stations. The more useful and searching comparison between cases of sickness, instead of deaths, and meteorological phenomena has yet to be accomplished on a large scale in this country, and especially as regards zymotic diseases. In Belgium there is a Society of Medical Practitioners, embracing nearly the whole country, that publishes a monthly record of cases of sickness, of deaths, and of meteorological observations; but the only attempt on a large scale in this country, which was started by the Society of Medical Officers of Health for the whole of London, failed partly from want of funds, and partly from irregularity in the returns. My remarks, which must necessarily be very brief, will refer to the relations between (1) meteorological phenomena and the bodily functions of man, and (2) between varying meteorological conditions and death-rates from certain diseases.

As regards the first, I will commence with a few brief remarks on the effects of varying barometric pressures. A great deal too much attention is paid to the barometer if we regard it as indicating only, as it really does, variations in the weight of the column of air pressing upon our bodies, because, except at considerable elevations, where the barometer is always much lower than at sea level, these variations produce but little effect on health. At considerable elevations the diminished pressure frequently causes a great feeling of malaise, giddiness, loss of strength, palpitation, and even nausea; and at greater heights, as was noticed by Mr. Glaisher in a very lofty balloon ascent, loss of sight, feeling, and consciousness. These were caused by a want of a sufficient supply of oxygen to remove effete matters from the system, and to carry on the organic functions necessary for the maintenance of life. On elevated mountain plateaus, or even in high residences among the Alps, an increased rapidity in the number of respirations and of the pulse, as well as increased evaporation from the lungs and skin, occur.

For some years past, many persons suffering from consumption, gout, rheumatism, and anaemic affections have gone to mountain stations, chiefly in Switzerland, for relief, and many have derived much benefit from the change. It must not, however, be supposed that diminished atmospheric pressure was the chief cause of the improvement in health, as its concomitants, *viz*., a diminution in the quantity of oxygen and moisture contained in each cubic foot of air, probably the low temperature, with a total change in the daily habits of life, have assisted in the beneficial results. The diminution in the quantity of air, and consequently

Page 65

of oxygen, taken in at each breath is to a certain extent counterbalanced by an increased frequency and depth of the respirations, and a greater capacity of the chest. In this country, alterations in the barometric pressure are chiefly valuable as indicating an approaching change in the wind, and as well as of the amount of moisture in the air; hence the instrument is often called “the weather glass.” A sudden diminution in the atmospheric pressure is likely to be attended with an escape of ground air from the soil, and therefore to cause injury to health, especially among the occupants of basement rooms, unless the whole interior of the building be covered with concrete.

Temperature.—Experience has shown that man can bear greater variations of temperature than any other animal, as in the Arctic regions a temperature of -70 degrees Fahrenheit, or more than 100 degrees below freezing point, can be safely borne; that he can not only live but work, and remain in good health, in these regions provided that he be supplied with suitable clothing and plenty of proper food. On the other hand, man has existed and taken exercise in the interior of Australia when the thermometer showed a temperature of 120 degrees Fahrenheit, or nearly 90 degrees above freezing point, so that he can live and be in fairly good health within a range of nearly 200 degrees Fahrenheit.

The effects of a high temperature vary very much according to the amount of moisture in the air, as when the air is nearly saturated in hot climates, or even in summer in our own, more or less languor and malaise are felt, with great indisposition to bodily labor. With a dry air these are not so noticeable. The cause is evident; in the former case but little evaporation occurs from the skin, and the normal amount of moisture is not given off from the lungs, so that the body is not cooled down to such an extent as by dry air. Sunstroke is probably the result, not only of the direct action of the sun’s rays, but partly from diminished cooling of the blood by want of evaporation from the lungs and skin.

The effects of temperature on man do not depend so much on the mean for the day, month, or year, as on the extremes, as, when the days are hot and the nights comparatively cool, the energy of the system becomes partially restored, so that a residence near the sea, or in the vicinity of high mountains, in hot climates is, other things being equal, less enervating than in the plains, as the night air is generally cooler. It is commonly believed that hot climates are *necessarily* injurious to Europeans, by causing frequent liver derangements and diseases, dysentery, cholera, and fevers. This, however, is, to a certain extent, a mistake, as the recent medical statistical returns of our army in India show that in the new barracks, with more careful supervision as regards diet and clothing, the sickness and death-rates are much reduced. Planters and others, who ride about a good deal, as

Page 66

a rule keep in fairly good health; but the children of Europeans certainly degenerate, and after two or three generations die out, unless they intermarry with natives, and make frequent visits to colder climates. This fact shows that hot climates, probably by interfering with the due performance of the various processes concerned in the formation and destruction of the bodily tissues, eventually sap the foundations of life among Europeans; but how far this result has been caused by bad habits as regards food, exercise, and self-indulgence, I cannot say. Rapid changes of temperature in this country are often very injurious to the young and old, causing diarrhoea and derangements of the liver when great heat occurs, and inflammatory diseases of the lungs, colds, *etc*., when the air becomes suddenly colder, even in summer.

The *direct* influence of rain on man is not very marked in this country, except by giving moisture to the air by evaporation from the ground and from vegetable life, and by altering the level of ground water. This is a subject almost overlooked by the public, and it is therefore as well that it should be known that when ground water has a level persistently less than five feet from the surface of the soil, the locality is usually unhealthy, and should not, if possible, be selected for a residence. Fluctuations in the level of ground water, especially if great and sudden, generally cause ill-health among the residents. Thus, Dr. Buchanan in his reports to the Privy Council in 1866-1867, showed that consumption (using the word in its most extended sense) is more prevalent in damp than on dry soils, and numerous reports of medical officers of health, and others, which have been published since then, show that an effective drainage of the land, and consequent carrying away of the ground water, has been followed by a diminution of these diseases.

Varying amounts of moisture in the air materially affect the health and comfort of man. In this country, however, it is not only the absolute but the relative proportions of aerial moisture which materially influence mankind. The quantity of aqueous vapor that a cubic foot of air can hold in suspension, when it is saturated, varies very much with the temperature. Thus at 40 degrees Fahr. it will hold 2.86 grains of water; at 50 degrees, 4.10 grains; at 60 degrees, 5.77 grains; at 70 degrees, 8.01 grains; and at 90 degrees as much as 14.85 grains. If saturation be represented by 100, more rapid evaporation from the skin will take place at 70 degrees, and 75 per cent. of saturation, than at 60 degrees when saturated, although the absolute quantity of moisture in the air is greater at the first named temperature than at the latter. As regards the lungs, however, the case is different, as the air breathed out is, if the respirations be regular and fairly deep, completely saturated with moisture at the temperature of the body. In cold climates the amount of moisture

Page 67

and of the effete matters given off from the lungs in the expired air is much greater than in hot climates, and the body is also cooled by the evaporation of water in the form of aqueous vapor. Moist air is a better conductor of heat than dry air, which accounts for much of the discomfort felt in winter when a thaw takes place as compared with the feeling of elasticity when the air is dry. In cold weather, therefore, moist air cools down the skin and lungs more rapidly than dry air, and colds consequently result. London fogs are injurious, not only on account of the various vapors given off by the combustion of coal, but in consequence of the air being in winter generally saturated with moisture at a low temperature. The injuriousness of fogs and low temperatures will be presently dwelt upon at greater length.

Variations in the pressure and temperature of the atmosphere exert a considerable influence on the circulation of air contained in the soil, which is called ground air. As all the interstices of the ground are filled with air or water, the more porous the soil, the greater is the bulk of air. The quantity of air contained in soil varies very much according to the material of which the soil is composed, as it is evident that in a gravelly or sandy soil it must be greater than when the ground consists of loam or clay. The estimates vary from 3 to 30 per cent., but the latter is probably too high. If, therefore, a cesspool leak into the ground, the offensive effluvia, if in large quantities, will escape into the soil, and are given off at the surface of the ground, or are drawn into a house by the fire; but, if small, they are rendered innocuous by oxidation. The distance to which injurious gases and suspended or dissolved organic matters may travel through a porous soil is sometimes considerable, as I have known it pass for 130 feet along a disused drain, and above 30 feet through loose soil.

Winds exercise a great effect on health both directly and indirectly. Directly, by promoting evaporation from the skin, and abstracting heat from the body in proportion to their dryness and rapidity of motion. Their indirect action is more important, as the temperature and pressure of the air depend to a great extent on their direction. Thus winds from the north in this country are usually concomitant with a high barometer and dry weather; in summer with a pleasant feeling, but in winter with much cold. Southwest winds are the most frequent here of any, as about 24 per cent. of the winds come from this quarter against 161/2 from the west, 111/2 from the east, and the same from the northeast; 101/2 from the south, 8 from the north, and a smaller number from the other quarters. Southwest winds are also those which are most frequently accompanied by rain, as about 30 per cent. of the rainy days are coincident with southwest winds. Another set of observations give precisely the same order, but a considerable difference in their prevalence, *viz*., southwest 31 per cent., west 141/2, and northeast 111/2 per cent. Easterly winds are the most unpleasant, as well as the most injurious to man of all that occur in this country.

Page 68

I now propose discussing very briefly the known relations between meteorological phenomena and disease. I say the known relations, because it is evident that there are many unknown relations of which at present we have had the merest glimpse. For instance, small-pox, while of an ordinary type, and producing only a comparatively small proportion of deaths to those attacked, will sometimes suddenly assume an epidemic form, and spread with great rapidity at a time of year and under the meteorological conditions when it usually declines in frequency. There are, however, in this country known relations between the temperature and, I may say, almost all diseases. As far back as 1847 I began a series of elaborate investigations on the mortality from scarlet fever at different periods of the year, and the relations between this disease and the heat, moisture, and electricity of the air. I then showed that a mean monthly temperature below 44.6 deg. F. was adverse to the spread of this disease, that the greatest relative decrease took place when the mean temperature was below 40 deg., and that the greatest number of deaths occurred in the months having a mean temperature of between 45 deg. and 57 deg. F. Diseases of the lungs, excluding consumption, are fatal in proportion to the lowness of the temperature and the presence of excess of moisture and fog. Thus, in January, 1882, the mean weekly temperature fell from 43.9 deg. F. in the second week to 36.2 deg. in the third, with fog and mist. The number of deaths registered in London during the third week, which may be taken as corresponding with the meteorological conditions of the second week, was 1,700, and in the next week 1,971. Unusual cold, with frequent fogs and little sunshine, continued for four weeks, the weekly number of deaths rising from 1,700 to 1,971, 2,023, 2,632, and 2,188. The deaths from acute diseases of the lungs in these weeks were respectively 279, 481, 566, 881, and 689, showing that a large proportion of the excessive mortality was caused by these diseases. At the end of November and in December of the same year there was a rapid fall of temperature, when the number of deaths from acute diseases of the lungs rose from 297 to 358, 350, 387, 541, 553, and 389 in the respective weeks. From November 29 to December 9 the sun was seen only on two days for 41/2 hours, and from December 9 to the 18th also on two other days for less than 4 hours, making the total amount of sunshine 8.1 hours only in 20 days. In January and February the excess of weekly mortality from all diseases reached the large number of 504 deaths; in December it was less, the fogs not having been so dense, but the excess equaled 246 deaths per week.

Page 69

The relations between a high summer temperature and excessive mortality from diarrhoea have long been well known, but the immediate cause of the disease as an epidemic is not known. Summer diarrhoea prevails to a greater extent in certain localities, notably in Leicester (and has done so for years); and the cause has been carefully sought for, but has not been found out. Recent researches, however, point to a kind of bacillus as the immediate cause, as it has been found in the air of water-closets, in the traps under the pans, and in the discharges from infants and young children. In order to indicate more readily how intimately the mortality from diarrhoea depends on temperature, I now lay before you a table showing the mean temperature for ten weeks in summer, of seven cold and hot summers, the temperature of Thames water, and the death-rates of infants under one year per million population of London:

London.—Deaths under 1 Year, in July, August, and part of September, from Diarrhoea per 1,000,000 Population Living at all Ages, arranged in the Order of Mortality.

Age 0-1 year.
Mean Temperature Deaths from Diarrhoea
Years. temperature, of Thames per 1,000,000
10 weeks. water. population living at
all ages.
1860 58.1 deg. 60.6 deg. 151
1862 59.0 62.0 189
1879 58.7 60.7 228
1877 61.2 63.3 347
1874 61.7 63.8 447
1878 63.7 64.1 576
1876 64.4 64.9 643

As may be seen, the deaths of infants under 1 year of age from diarrhoea per 1,000,000 population was only 151; while the mean summer temperature was only 58.1 deg. F. against 189 in 1862, when the mean temperature was 59.0 deg.. In 1879, when the mean temperature was 58.7 deg., the deaths from diarrhoea rose to 228 per million, but a few days were unusually hot. In 1877 the mean temperature of the air was 61.2 deg., of the Thames water 63.3 deg., and the mortality of infants from diarrhoea 347 per million population. In 1874, when the mean temperature of the air was 61.7 deg., the mortality rose to 447 per million; and in the hot summers of 1878 and 1876, when the mean air temperatures were 64.1 deg. and 64.9 deg. respectively, the death-rates of infants were 576 and 642 per million population. The relations, therefore, between a high summer temperature and the mortality from diarrhoea in infants are very intimate. I have selected the mortality among infants in preference to that at all ages, as the deaths occur more quickly, and because young children suffer in greater proportion than other persons.

Page 70

The proportionate number of deaths at *all ages* from diarrhoea corresponds pretty closely with those of infants. To prove this, I made calculations for three years, and ascertained that only 3.9 per cent. of all the deaths from this disease were registered in the weeks having a temperature of less than 50 deg.; 11.9 per cent. in the weeks having a temperature between 50 deg. and 60 deg.; while in the comparatively few weeks in which the temperature exceeded 60 deg. F., as many as 84.2 per cent. of the total number of deaths was registered. In the sixteen years, 1840-56, for which many years ago I made a special inquiry, only 18.9 per cent. of all the deaths from diarrhoea occurred in winter and spring, against 81.1 per cent. in summer and autumn. In the twenty years, 1860-79, there were seven years in which the summer temperature was in defect when the mortality per 100,000 inhabitants of London was 200; while in ten summers, during which the temperature was in excess by 2 deg. or less, the mortality was 317 per 100,000. The mean temperature was largely in excess, that is to say, more than 2 deg. plus in three of these summers, when the mortality reached 339 per 100,000 inhabitants.

These figures show that great care should be taken in hot weather to prevent diarrhoea, especially among young children; by frequent washing with soap and water to insure cleanliness, and proper action of the skin; by great attention to the food, especially of infants fed from the bottle; free ventilation of living rooms, and especially of bedrooms; and by protection, as far as possible, being afforded from a hot sun, as well as by avoiding excessive exercise. All animal and vegetable matter should be removed from the vicinity of dwelling-houses as quickly as possible (indeed, these should be burnt instead of being put in the dust-bin), the drains should be frequently disinfected and well flushed out, especially when the mean daily temperature of the air is above 60 deg. F.

Time will not admit of more than a mere mention of the relations between meteorological phenomena and the mortality from many other diseases and affections, such as apoplexy from heat, sunstroke, liver diseases, yellow fever, cholera, whooping-cough, measles, *etc*., especially as the state of our knowledge on the subject is so very limited. A comparison between the mortality from several diseases in this and other countries shows that certain of these do not prevail under closely corresponding conditions. Thus the curves of mortality from whooping-cough, typhoid fever, and scarlet fever do not correspond with the curves of temperature in both London and New York, and the same may be said of diarrhoea in India. It is therefore evident that some other cause or causes than a varying temperature must be concerned in the production of an increased death-rate from these diseases. The subject is of great importance, and I do not despair of our obtaining some day a knowledge of the agents through which meteorological phenomena act in the production of increased and decreased death rates from certain diseases, and the means by which, to a certain extent, these injurious effects on man may be presented.

Page 71

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P. Rosenbach has found experimentally that potassium bromide diminishes the sensibility of the cortical substance of the cerebrum to electric excitement, while, the excitability of the underlying white substance remains unaltered.

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CONSUMPTION SPREAD BY CHICKENS.

In a village, C., near Weimar, where for many years no case of tubercular phthisis had taken place, two years ago several families suddenly discovered one of their members to be suffering from the disease. After a long inquiry, it was discovered by accident that all these families had been buying their spring chickens from one and the same place, *viz*., from a private hospital in the neighborhood. A medical student brought the livers of two such chickens to Prof. Johne, in Dresden. The student, whose own sister had become affected with consumption, had lived during his vacation at home with his parents, in C., and he had there at dinner observed the peculiar appearance of the liver of the chickens.

On examination, both organs were found to be full of tubercular bacilli. A thorough investigation was at once instituted, and it was then that the fact came to light that the chickens eaten by the families, members of which had been affected with tuberculosis, had all been brought from the institution mentioned. On further inquiry at the latter place the following facts were elicited:

At about the time when the first case of consumption occurred in the village, an inmate or the hospital, Mrs. R., had died of the disease. Before her death, Mrs. R. used to feed the chickens raised there; she was often seen first to chew the meat before she gave it to the chickens. Further, the spittoons were emptied on a place in the yard where the chickens generally came to pick up any stray corn.

As none of the chickens ever came in contact with any animals in the neighborhood—-the hospital being situated at a considerable distance from the village—as no disease had happened among them until the arrival of Mrs. R., when soon after an epidemic seemed to break out among them, and many died, there is no doubt that they contracted the disease from Mrs. R., and in return infected those who ate their flesh.

The case is very interesting, first, as it proves how such animals may become affected, then how they may spread the disease, and lastly, that some kind of a disposition must exist in the person infected; for here, of many who had eaten of the diseased flesh, only a few contracted the malady. The whole report teaches us how careful we have to be, and how necessary is the appointment of skillful experts by the State to inspect all food offered for sale.—*Med. and Surg. Reporter.*

* * * * *

NEW METHOD OF REDUCING FEVER.

Page 72

For many years eminent medical savants have sought earnestly through the vegetable and mineral worlds for some substance by means of which the high temperature often prevailing in typhoid, malarial, and other fevers might be reduced with rapidity and safety to the patient. A few substances have been found which produce a decline in temperature when administered in enormous and frequently repeated doses; but such administration has often been found to be decidedly detrimental to the patient, producing not infrequently serious injury to the stomach, kidneys, and sometimes the nervous system. So great is the danger of such injurious results, few careful practitioners have cared to adopt the heroic “antipyretic” medication recommended by experimenters, preferring to allow their patients to burn with fever, mitigated only by such simple means as are commonly employed by nurses, than to require them to combat the poisonous influences of a drug in addition to the morbid element of the disease.

Happily, however, it is not necessary to leave the patient to the unaided efforts of nature. By cool sponging of the surface, persistently and thoroughly applied; by large, cool compresses placed over the abdomen and chest, or even the whole front of the body, and changed as often as warm, or every three to five minutes; by frequently repeated cool packs; by cold water drinking; by ice-packs to the spine; by constant application of ice or frozen compresses to the head; by forcing perspiration by copious hot drinks and a warm blanket pack—by any or all of these means the temperature may be reduced with promptness in nearly every case. However, cases will now and then occur in which the temperature remains dangerously high, notwithstanding the thorough application of the above means. What shall be done?

Several years ago our attention was called to a series of experiments made by Dr. Winternitz, Professor of Hydropathy in the Medical University of Vienna, for the purpose of determining the influence upon temperature of enemas of water of different temperature in cases of fever. The results claimed by Prof. Winternitz were so striking that we improved the first opportunity to repeat his experiments, and with such results as have justified the continued use of this means of lowering temperatures in fever, in cases in which the ordinary measures were not efficient. The only objection we have found to the method has been the inconvenience to the patient occasioned by the frequent use of the bed-pan. In a recent case in which we found it necessary to resort to this method, the nurse observed that if the tin can of the fountain syringe used in administering the enema happened to be lowered below the level of the bed on which the patient lay, water which had previously been introduced into the rectum returned readily through the tube into the can. On learning this fact, the attendants were instructed to employ the enema in this way. From one to two pints of water, of 70 deg. or 75 deg.

Page 73

F. temperature, were allowed to pass into the bowels; and after being retained for five or ten minutes, or until the patient experienced uncomfortable sensations, it was made to pass out through the tube by simply lowering the reservoir to the level of the floor. A new supply of water of a proper temperature being introduced into the reservoir, it was again raised to the proper height, and the operation so continued until six quarts of water had been used. Then the patient was allowed to rest half an hour or an hour, according to the height of the fever, and the same process was repeated. Careful record was made of the temperature of the patient just before the treatment and immediately after. It was found to be invariably reduced from one to one and a half degrees by each treatment. The temperature, which had been exceedingly obstinate previous to the employment of this method, ranging from 104 deg. to 105 deg., during the intervals between the treatments would, of course, rise somewhat; but each time it stopped short of the point reached during the previous interval, so that in the course of a few hours the fever was brought down to very nearly a normal temperature. The temperature of the water, when taken after passing through the bowels, was found to have risen each time from 10 deg. to 13 deg..

The great capacity of water for absorbing heat renders it one of the most useful of all substances for lowering the temperature; and it is readily apparent that, by the means described, heat may be abstracted from the body almost *ad libitum*, and the temperature may thus be controlled with a rapidity and a degree of certainty which cannot be approached by any other method. In a still more recent case, in which the same treatment was employed, the temperature of the patient had reached 106 deg. F., in spite of the vigorous application of ordinary measures of treatment, such as cold compresses, *etc*.; but it was, in four or five hours, brought down to nearly 100 deg. by the use of the cold enemas.

The advantages of this method are: 1. It may be employed without wetting or moving the patient; very frequently a patient will sleep continuously during the administration of the treatment. 2. It seldom causes chilliness, which is frequently a disturbing symptom, especially in fevers of a low type, and even, when the temperature is alarmingly high, causing the patient to dread the employment of sponging with cool or tepid water. 3. It is not necessary to employ cold water, a temperature of 80 deg. or even 85 deg. being thoroughly efficient. In the majority of cases, however, water of 70 deg. or even 60 deg. may be employed without danger. The water comes in such immediate contact with surfaces filled with large blood-vessels that a temperature but a few degrees below that of the body is more effective than very much colder water applied to the surface.

In cases in which the use of the cool enema is attended by chilliness, this uncomfortable symptom may usually be relieved by the application of a hot bag or fomentations to the spine or to the pit of the stomach.

Page 74

The simple measures of treatment we have described will be found more effective in lowering the temperature than any or all other remedies which have ever been recommended for this purpose.—*Good Health.*

* * * * *

THE CROWN DIAMONDS OF FRANCE.

[Illustration: FIG 1.—THE CROWN DIAMONDS OF FRANCE AT THE EXHIBITION OF INDUSTRIAL ARTS.]

According to a recent law of Parliament, a large part of the crown jewels of France is destined to be sold. The exhibit that has been made of these riches for the last two months at the National Exhibition of the Industrial Arts, in the State Hall of the Louvre, has excited a lively interest among the visitors. Here are to be seen, heaped up in a large octagonal show-case, incomparable treasures, whose value exceeds quite a number of millions. According to the inventory of 1818, the 52,000 precious stones of the crown of France were estimated as worth more than 20 million francs ($4,000,000); but since that epoch the stones have increased in number, and money has singularly diminished in value, so that the total at present would be much less.

[Illustration: FIG. 2.—THE REGENT. (Actual Size.)]

In order to publicly exhibit so valuable treasures it was necessary to take precautions against thieves and fire, and this was done in a very sure and ingenious manner. The collection of crown jewels is distributed over the eight faces of an octagonal truncated cone, which is supported by a framework about three feet in height at the lower part. The stand is exhibited every day, at ten o’clock in the morning and six in the evening, under an elegant octagonal show-case surmounted by a high bronze statue of Fortune by Barbedienne. The whole is covered with a canopy, as shown in Fig. 1.

A force of guardians of the Treasury is detailed to watch over the crown jewels, and it is to them that is confided the care of operating in the morning and evening the safety mechanism that we shall describe. The object of this mechanism is to lower into and lift out of the strong-box the entire stand with all its jewels.

A winch, shown at A to the right of the engraving, sets in motion a system of gear wheels keyed at an angle, at B and C, upon intermediate shafts that transmit motion to the four vertical threaded rods of the frame, D. All these shaftings are 11/2 inch in diameter, and the cog-wheels, twenty in number, are about 5 inches in diameter.

The well is formed of an octagonal wall of fire-brick, and is 20 inches thick and 6 feet high. In the center of this masonry is embedded very thick iron plate. The bottom of the well is isolated from the flooring of the Exhibition hall by a thickness of boiler plate, by a filling of tire bricks, and finally by a second thickness of boiler plate. The well is closed by means of a large plate of iron 6 inches thick, 10 feet in length, and 88 feet in width. The winch which maneuvers this mass is placed at E. It actuates a system of bevel wheels, keyed at F, which transmit motion to two horizontal screws (hidden under the stage) that actuate the plate, H. This latter is provided with two parallel series of five rollers each that revolve over long and strong pieces of wood covered with rails. Electric alarms are located near the winches.

Page 75

A fire-engine station is located at within twelve or fifteen feet of the exhibition building.

A committee composed of competent jewelers and mineralogists has been appointed to make an appraisement of the diamonds and to indicate such as should be withheld from sale on account of their scientific, artistic, or historic interest. The members of the committee propose to preserve the following objects:

1. The “Regent” (Fig. 2), by reason of its mineralogical value, the perfection of its cutting, the purity of its water, its incomparable luster, and its great size, it being the largest brilliant as yet known.

2. The military sword of Charles the Tenth’s coronation, the hilt of which is entirely of brilliants mounted by Bapst with wonderful art.

3. The jewel called the “Reliquary,” of the 15th century.

To these riches must be added the following interesting objects: the Dey of Algiers’ watch; the Elephant of Denmark; the decorations, *etc*., of foreign orders; crowns and diadems of sapphire; rubies; pearls that afford curious specimens of French art at the beginning of our century; one of the Mazarins bequeathed by the celebrated Cardinal; and lots of colored stones destined for our national museums.

The same exhibition alluded to above contains a number of other collections of great interest that it would be unjust to pass over in silence, such as the exhibit of the French diamond mines of the Cape, where one may see all the details of this prosperous exploitation by means of photographs and specimens. The art bronzes, the objects of jewelry, of goldsmith’s work, and of morocco work, the music boxes, Trouve’s and Aboilard’s electric jewelry, and the retrospective art collections especially attracted the attention of the public.—*La Nature.*

* * * * *

A NEW MODE OF TESTING THE ECONOMY OF THE EXPENSES OF MANAGEMENT IN LIFE INSURANCE.

How to determine the general ratios of the expenses of management of life insurance companies has hitherto been an unsettled question, and I think no serious attempt has been made before my own to study this question exhaustively, and reach a scientific conclusion.

Believing that, one is contained in the following statement, I respectfully submit it to the criticism of others.

It has generally been taken for granted that the measure of economy of life insurance expenses may be expressed by the single ratio of expenses to one feature of the business, such as the premium income, or the total income (premium and interest), or the mean amount of all policies outstanding. But this is not the case. No exhaustive reason has been shown for preferring one of these bases of ratio to another, and, indeed, no reason well supported by argument has been shown for employing either. On the other hand, no better evidence is needed of the importance of establishing a uniform and demonstrably sound basis, than the fact that it is common for companies to refute one another's claims to superior economy, and totally confuse the public, by opposing ratios found in one way by ratios found in another—that one of two companies which appears the most economical according to one test being apparently the least so according to another.

Page 76

The economy of the expense of any transaction, or work, can only be intelligently judged by the value of the *result*. This truth is too well recognized to need illustration, and it only needs to be called to mind, to perceive both the error of ratios of expense based on premium, which is not the result but the *raw material*, so to speak, of insurance transactions; and what, on the contrary, the true basis is.

It is thus clear that in insurance the economy of expense must be judged, not by comparison with the premiums paid, but by comparison specifically with the resulting advantages in fact secured by such payments. Now these are of two kinds: which may be called the *insurance advantage* and the *investment advantage*.

(1) Each death claim paid is an insurance advantage, though it is so only to the extent of the excess of the amount of the policy which has become a claim over its premium reserve, or value, for the latter being the balance (with interest) of the policy holder's own premium money, could have been left or secured to his representatives without the intervention of the policy and company.

It is true that the advantage or benefit of insurance does not consist in adding anything to the wealth of a company, but only consists in drawing from the premiums paid into its treasury by the policy holders generally, to meet each death claim which arises; or can only be called an *advantage of distribution*, or process of collecting aid from the living members, to assist the representatives or dependents of the deceased ones; but it is not the less on this account an advantage worth *same expense* in securing.

(2) Interest realized by the investment of premium while it is in the keeping of a company is an advantage; in every sense so, since it comes wholly from outside sources, and accrues proportionally to all members; it may be called, as above, the investment advantage, and of course justifies some *expense* to secure it.

Hence the expenses incurred by any company in a given; time must be divided into two parts, one being the expense incidental to insurance, and the other that incidental to investment, which parts are to be compared respectively with the insurance claims met, and interest receipts of the company for the same time; or what is equivalent in the latter case, the net rate of interest earned after deducting the incidental investment expense may be found.

When this process shows that one company has earned a higher rate of interest than another, at the same time that its insurance expenses bear a lower ratio to its insurance claims paid, *there is no escape from the conclusion that during the period under observation it has served its policy-holders more economically*, and the test is therefore scientific. Though, if one company shows a higher rate of interest, while the other shows a lower ratio of insurance expense, it will still be necessary, to complete the test, to equate either the rates of interest or the ratios of insurance expense (it does not practically matter which), and note how this affects the relation of the duly corrected ratios on the other score.

Page 77

To be exact, if the average vitality of the members of the two companies differ (other things being equal, it is always cheapest to belong to that company which has the lowest death rate), the ratios of insurance expense to expected, as well as actual, claims of each must be found, and equated.

The science of this procedure, or mode of testing expenses, and also its practical simplicity, may be more clearly perceived by reference to its practical application in the following table:

Table Exhibiting Ratio of Expense, Determined by the New Mode, of Companies Doing Business in Massachusetts during the Year 1883.

```
| | | | | | | | |
| | | | | |Expense | | |Net Rate
| | | | | |per $100 | | | of
| | | | | |of claims| | |interest
| | Death |Estimated |Difference |Expense |paid. | Interest | Expense |
earned.
Name of Company. |Loca-| claims |Premiums. | or Net | on the |---------| Receipts. | on
the |--------
|tion.| paid. | Reserve |Insurance |score of | R | R | | score of | R | R
| | | thereon. |furnished. |Insurance. | a | a | |investment.| a | a
| | | | | | | t | n | | | t | n
| | | | | | | e. | k.| | | e. | k.
-------------------+-----+-----------+----------+-----------
+-----------+-----+---+-----------+-----------|----|---
Berkshire |Mass.| $208,147| $46,605| $161,524| $122,779| 75.4| 14| $194,067| $15,809|
5.25| 16
[1]John Hancock | " | 169,604| 25,117| 144,487| [8]228,566|158.2| 24| 135,597| 11,686|
3.65| 26
Mass.  Mutual | " | 426,995| 86,215| 340,780| 232,400| 68.2| 10| 428,255| 33,176|6.03| 7
N. England Mutual | " | 1,039,694| 235,630| 804,064| 311,879| 38.8| 3| 995,883| 69,908|
6.40| 4
State Mutual | " | 121,969| 22,493| 99,476| 98,839| 99.4| 19| 143,751| 13,057|4.51| 24
AEtna |Conn.| 1,302,807| 364,510| 938,297| 460,014| 49.0| 6| 1,760,372| 118,962|6.22|
5
Connecticut General| " | 87,639| 15,624| 72,015| 46,113| 64.0| 9| 95,580| 5,407|7.03| 1
    " Mutual | " | 2,867,489| 881,600| 1,985,889| 622,941| 31.4|
```

Page 78

1| 3,041,125| 238,944|5.70| 10
Equitable | N.Y.| 3,072,232| 483,950| 2,588,282| 1,884,108| 72.8| 12| 2,743,024| 216,725|5.42| 12
Germania | " | 606,072| 149,950| 456,122| 325,662| 71.4| 11| 508,702| 47,193|4.85| 22
Home | " | 205,921| 48,603| 157,318| 155,192| 98.6| 18| 260,506| 19,917|4.86| 21
Homoeopathic | " | 35,610| 6,340| 29,270| 48,734|166.5| 25| 42,814| 2,935|6.20| 6
Manhattan | " | 687,171| 183,450| 503,721| 266,305| 44.9| 5| 627,628| 44,081|5.82| 8
[7]Metropolitan | " | 638,639| 18,322| 620,317| 1,161,893|187.3| 26| 106,916| 9,098| 4.90| 20
Mutual Life | " | 5,172,275| 1,407,700| 3,764,575| 1,480,198| 39.3| 4| 5,042,964| 466,739|5.01| 19
Mutual Benefit | N.J.| 2,160,991| 550,890| 1,610,101| 521,829| 32.4| 2| 2,072,629| 169,913|5.61| 11
National | Vt. | 174,767| 29,127| 145,640| 77,861| 53.5| 7| 149,010| 10,100|5.26| 15
New York Life | N.Y.| 2,408,636| 574,150| 1,834,484| 1,995,102|108.8| 21| 2,676,592| 236,884|5.03| 18
Northwest'n Mutual | Wis.| 990,692| 190,500| 800,192| 630,582| 78.8| 15| 1,200,001| 88,527|5.80| 9
Penn. Mutual |Penn.| 601,625| 107,600| 494,025| 309,858| 62.7| 8| 463,567| 37,131| 5.38| 13
Provident Life and | | | | | | | | | | |
Trust | " | 280,817| 49,865| 230,952| 222,665| 96.4| 17| 340,115| 33,294|4.26| 25
Provident Savings | N.Y.| 24,875| 1,828| 23,047| 51,608|233.9| 27| 4,955| 2,579|1.70| 27
Travelers' |Conn.| 235,001| 42,243| 192,758| 144,621| 75.0| 13| 331,623| 22,476|6.42| 3
Union Mutual |Maine| 377,547| 88,520| 289,027| 237,913| 82.3| 16| 301,499| 28,754| 4.66| 23
United States | N.Y.| 283,304| 69,245| 214,059| 277,919|129.8| 23| 271,594| 23,460| 5.09| 17
Vermont | Vt. | 13,000| 1,542| 11,458| 13,613|118.8| 22| 12,917| 822|5.33| 14
Washington | N.Y.| 356,289| 71,820| 284,469| 289,461|101.8| 20| 446,998| 32,249|6.78| 2
| | | | | | | | | | |

+-----+-----------+----------+-----------+-----------+-----+---+-----------+-----------+----+---
Totals | |$24,549,808|$5,753,439|$18,796,369|$12,177,655| 64.8| |$24,398,684| $1,999,826|5.42|

Collective Business of Assessment Societies Doing Business in the State (excepting Secret Societies).

46 Societies | | $735,383| | | $237,770| 32.3| | |

| |

[Footnote 7: Including industrial business.]

Page 79

[Footnote 8: Includes $18.867 depreciation.]

The figures given in this table are drawn from the last annual report of the Insurance Commissioner of Massachusetts, excepting the premium reserve on death claims, which, as well as the division of the total expenses of each company into insurance and investment expenses, I have estimated on a uniform rule. This was for lack of the actual data in these particulars, which the report did not give, as it is desirable that future ones may.

This, however, does not injure the value of the table for illustrating the mode of procedure, for which purpose mainly it is presented. The companies whose figures I have used, moreover, have no occasion to complain of this, as my estimate certainly gives all ratios of insurance expense lower than they would appear if I had known, and used, the exact actual premium reserve on death claims, and all probably bear nearly the same ratio to each other as they would in that case.

As the object of this statement is to explain the new method, and not to defend my particular estimates in applying it, I forbear to state on what rules I have made them. Expense which is not ascribed to insurance must be ascribed to investment, and as in comparing any two companies, their two ratios of one kind or the other must be equated, to decide the question of economy between them, it may well be left to any company to say what the fair division of its own expenses is.

Moreover, there can be but little motive to make a false division; for to successfully compete for business, a company having large investments has as much need to show a high net rate of interest earned as a low rate of insurance expense. Again, it is not my purpose to pass judgment on the economy or extravagance of any ratio of expense shown in the table. It is not a fact exhibited for the first time by my figures, that the ratios of some companies are more than double those of others. The same fact would be displayed in about as high a degree by ratios based on premium income, or any other incorrect basis. Custom, the balance of opinions, and competition may well be left to decide what ratios of expense are high, and what are average, or low. And their decision is to be gathered only from *statistics*.

What I do claim is that the mode of determining ratios herein explained is the only intelligible and scientific one, and the only one proper to employ in *statistical tabulations* and *investigations*.

As such, it calls attention to the fact that the amount of insurance claims met, and of interest receipts, *are limits* which the corresponding expenses cannot exceed, certainly for a series of years together, without making the *expense* more than the *advantage* of the business. To keep this fact in view, *as a preventive of extravagance*, is not the least valuable service the new mode may render. It may be seen that there are eight cases in the table, in

Page 80

which the ratio of insurance expense points to expenses exceeding the insurance claims met in the same time, yet the reader need not hasten to conclude that the same companies will permanently show similar ratios, or have no good reasons to give for the ones which now appear. I may remark, however, that it is an evidence of the scientific mode in which the figures are presented, that it facilitates such explanations as are pertinent of any of the ratios.

For instance, some of the ratios are undoubtedly affected by the fact that the claims for the year of the company in question have been exceptionally high or low, or that the company (being of recent organization perhaps) has just incurred exceptional expense to increase its business, the advantage of which will appear later, *etc*. But I leave to the companies themselves to show to what extent such circumstances have affected their ratios; except that, in regard to the several net rates of interest earned, it is proper to say that in all cases in which they considerably exceed the average of 5.42 per cent. it will be found, by referring to the details of interest receipts reported to the Commissioner, that the excess is owing to the fact of exceptional profits by the sale of stocks, or recovery on investments previously reckoned as loss.

WALTER C. WRIGHT.

Medford, Mass., Sept., 1884.

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PATENTS.

Page 81

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