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THE SCIENTIFIC AMERICAN SUPPLEMENT

No. 180,

For the Week ending June 14, 1879.

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OPENING OF THE NORTHEAST PASSAGE.

Another great geographical problem has been settled by the successful passage of Professor Nordenskjold's expedition through the Arctic Sea to the north of Siberia. A telegraphic dispatch from St. Petersburg, dated May 27, states that the Governor of Yakutsk, Eastern Siberia, has received intelligence from the Vega to May 3, and a later dispatch from Irkutsk reports the safe arrival of the vessel in Behring's Straits. All the members of the expedition were well. Before this account reaches the reader the Vega will be on her way to Europe by way of the Suez Canal.

This expedition, which has thus crowned with successful accomplishment the belief of Professor Nordenskjold that a route to Asia might be found to the north of Siberia, sailed from Gothenburg, July 4, 1878, and arrived at Port Dixon, near the mouth of the Yenisei, August 6. This part of the course had already been proved to be passable at midsummer by Professor Nordenskjold's previous expeditions. The next important achievement was the rounding of the north cape of Asia, a feat never before accomplished, and on the 27th the expedition reached the mouth of the Lena. Here the two vessels parted company, the little steamer bearing the name of the Lena ascending that river, the Vega proceeding eastward, hoping to reach Behring's Straits before the autumn ice drifts should bar the passage. In this Professor Nordenskjold was disappointed, for the Vega became ice bound when within forty miles of East Cape, and was obliged to spend the winter there.

It is safe to anticipate a considerable addition to our knowledge of the Siberian seas when the results of Professor Nordenskjold's observations are made public; the plucky explorer has won a name that will rank with those of the greatest navigators; but there are grave reasons for doubting the fulfillment of his hopes of making known a practicable commercial route through the Arctic Sea from Europe to Asia. The season of open water along the Siberian coast is too brief and uncertain, and the risks are too great, to tempt many to undertake the northern passage, notwithstanding the saving in distance.

ANOTHER OBJECTION TO THE LICENSE SYSTEM.

One of the worst features of the recently defeated bill for the destruction of the American patent system was that introducing the compulsory license system or its equivalent. The unconstitutional nature of the proposed invasion of the inventor's exclusive right to control a patented invention was sufficiently exhibited in these columns last winter. The matter might be allowed to rest with the victory gained at that time, did not the opponents of inventors' rights threaten to bring it again before Congress at the earliest opportunity. In view of this fact it will pay to make a note of an objection to the license system recently urged by an English writer against a similar provision in the bill now before an English Parliamentary committee—an objection which we do not remember to have seen before. It may be useful some time.

The bill referred to contains a section which compels the patentee to grant licenses to manufacture or use his invention on such terms as the Lord Chancellor for the time being may consider fair. To this provision there can be urged no constitutional objection, as there might in this country; accordingly it is attacked solely on the score of bad policy. It is shown that it puts it entirely within the power of the Lord Chancellor to fix the value of patents of whose intrinsic value he is likely to know nothing. But worse than that, it puts it within the power of wealthy manufacturers to kill any invention that they may fear. Thus the moment a threatening improvement appears—threatening, that is, to inferior manufactures—the makers of the latter may demand a license to manufacture the new article, which they will proceed to do in the worst possible way, placing the new invention upon the market beside their own better made but intrinsically inferior products.

The public, finding the new invention inferior to the old, will be prejudiced against it, and the poor inventor will be unable to counteract the injustice. The products made in accordance with his invention may be the vilest caricatures of what he would make, yet they will bear his name and make it infamous, while he is unable to help himself. The chances are that where one inventor would willfully suppress or ask an exorbitant price for his invention or its products under the present system, a score of useful improvements or radically new additions to the world's resources would be stamped out of existence under the license system. The proposed change is as obnoxious on the score of public policy as on the score of abstract justice.

HOW COFFEE IS CLEANED.

When coffee was retailed in its natural condition, and roasted in small lots over the kitchen fire, imperfect beans and impurities were picked out by hand. With wholesale roasting more expeditious methods were necessary, and machines were invented to do the work with greater economy and dispatch. From this necessary operation, to the invention of processes for polishing and coloring inferior goods, to make them look like prime coffees, was but a step. The poorer grades of coffee were washed in colored water, and then treated to a course of polishing with powdered soapstone, which gave the beans the glossy and flinty appearance of first rate coffee and covered up all defects. The natural result was to make all honest dealers suspicious of polished coffees, though the need of machine cleaning was in no way diminished. It is possible, however, to have coffee cleaned and polished by machinery and at the same time be honest.

By this process the coffee is put into a large cylinder capable of holding eight or nine hundred pounds, the cylinder being lined with heavy linen and provided with cleats to increase the friction, when the beans are set in motion by the rapid revolution of the cylinder. At one end of the cylinder are a number of holes to admit air, and at the other a suction fan making about two thousand revolutions a minute. The friction loosens the dust and the outer covering of the coffee, which impurities are carried away by the air current set in motion by the fan. After ten or fifteen minutes of this treatment the coffee is wet with pure water and the machine again set in motion. The coffee is thus washed, and after half an hour's scouring comes out entirely clean and much improved in appearance by the polishing it has received. Coffees which contain much loose dirt and many broken beans are subjected to a preliminary process in which the perfect beans are winnowed clean, after which they are treated as already described.

ROBERT CRAWSHAY.

Robert Crawshay, the iron king of Merthyr Tydfil, Wales, died at Cheltenham, England, May 10. The London correspondent of the *Times* tells at great length the story of the foundation and wonderful development of the vast establishment which grew up under the wise management of Robert Crawshay, his father, William Crawshay, and his uncle, Richard Crawshay.

The last named had already acquired a fortune in the hardware business in London, when he purchased the controlling interest in the iron works at Cyfarthfa, in the vale of Merthyr Tydfil. Soon after, by the retirement of one partner and the death of the other, Mr. Crawshay became sole proprietor. This was about the time of the American Revolution and the beginning of England's rapid industrial development.

While Richard Crawshay was pushing his works along, he heard that a certain Henry Cort was working a new process of puddling iron, at some small foundry near Gosport. Crawshay went there, approved of the method, returned to Cyfarthfa, and built works both for puddling and rolling on Cort's plan, paying the patentee 10 shillings for every ton of iron turned out under his process. Among other improvements and extensions of the works, Richard Crawshay erected a water wheel 50 feet in diameter, 80½ feet in breadth, with a weight of gudgeon of 100 tons. The magazines and scientific papers of the time described the wheel as one of the modern wonders of the world. It was made by a local engineer named Watkin George. It used 25 tons of water per minute. The remains of this giant of the past may still be seen on the Taff. Crawshay gave this Watkin George a share in the works—a partnership in those days was more easily managed than it is now, when money is considered more than brains—to extend over a period. When George went out, some dozen years afterward, in addition to salary, he received his share of $500,000 profits. Mr. Crawshay took in other partners at various times, and at his death the disposition of the Cyfarthfa Works was three-eighths to Benjamin Hall, two-eighths to Joseph Bailey. Richard Crawshay died worth £1,500,000, a fortune far short of that made by his nephew, who, besides his Cyfarthfa interests, had vast iron properties in Monmouthshire. When Richard Crawshay died, Hall and Bailey retired, and the works came into the possession of William Crawshay, who, with Sir Joseph Bailey, had practically managed them for several years.

Under this new iron king, who had a genius for invention, Cyfarthfa advanced with gigantic strides. In 1819 it numbered 6 blast furnaces, and in that year produced 11,000 tons of pig iron and 612,000 tons of bars. In 1821 it turned out more of these manufactures than the three kingdoms put together had done between the years 1740 and 1750, and fully half the total yield of all Great Britain so late as 1788. From 1817 to 1840, the Glanmorganshire Canal, which the first Crawshay had started, carried from Cyfarthfa 613,144 tons of puddled iron. The most important of the rolling mills was erected in 1846, designed by William Williams. Attached were 18 boiling furnaces and 20 puddling furnaces, which, in March, 1847, turned out 6,144 tons of rails, and in the same month the largest bar of iron possibly ever made. It measured 27 feet long and 6¼ in diameter, and weighed 2,941 tons. In his old age, William Crawshay retired to his seat at Caversham Park, near Reading, on the Thames, having, however, built Cyfarthfa Castle, a magnificent residence near the works. He left his son, Robert, in charge, and dying in 1867, bequeathed him all his property, which, besides other valuables in lands and gold, including Cyfarthfa, with its 11 furnaces—7 at Cyfarthfa proper and 4 at Ynysfach—7 ironstone pits, and 8 coal pits. The estimated fortune of William Crawshay was £35,000,000. When the last great strike in the iron and coal trades of South Wales took place, Robert Crawshay closed his works, declaring that he would close his furnaces forever sooner than submit to the dictation of his men, and they have only been partially reopened since. At one time the works employed 5,000 men.

TRIUMPHS OF MODERN ENGINEERING.

In an address on the Past, Present, and Future of Engineering before a recent meeting of the Engineering Society of the School of Mines, Columbia College, Prof. W. P. Trowbridge said it was a remarkable fact that nearly all of the great achievements in engineering had been accomplished during the present generation, and it made him feel very old when he reflected that the first locomotive was constructed within his own time and memory. He well remembered his first trip from Detroit to Buffalo by steam. At that time there were no railroads beyond Buffalo, but a steamboat made the trip from Detroit to Buffalo in three days, which was considered to be "remarkably fast time."

The first trip by steamboat up the Hudson to Albany was made by the Clermont in 1807, the time being twenty-five hours. Four years later the Comet, a vessel 40 feet long, was built in England for the navigation of the Clyde. At that time the railroad and the locomotive were as much beyond human conjecture as any unknown achievement of the future was beyond our thoughts to-day. It seemed almost impossible that in those recent times tallow candles and whale oil furnished our lights, and that waterworks and other sanitary aids were unknown luxuries. The carpenter, the millwright, the stonemason, and the government surveyor were the engineers of the day. Steam navigation on the ocean was a problem of the future. The changes which had taken place during the past thirty-five years had been as rapid as they were marvelous. In 1830 there were only 23 miles of railway in the United States. In 1874, 69,273 miles had been completed, and including the two continents of Europe and America there had been built, in the same short interval, 125,000 miles of road.

Forty years ago the ocean steamship, with its side lever engines, its jet condenser, and its inefficient boiler, could scarcely carry coal enough for a voyage across the Atlantic. Now the iron hull, the screw propeller, the compound engine, the surface condensers, the high pressure boiler, the steam hoisting engines for loading and unloading freight, had converted the Atlantic navigation from the Eastern to the Western Continent into an extended ferry so far as the certainty and regularity of trips were concerned. Old merchants who began business forty years ago found it almost impossible to keep up with the age and adapt themselves to the wonderful changes which succeeded each other so rapidly. Twenty-five years ago, when Prof. Trowbridge was in California, the people there calculated that by the year 1880 they would have a railroad across the continent. Ten years later one road had been completed and two more were under way, both of which would soon be completed.

A gigantic contest had been and still was going on between man and the elements. With the aid of Ericsson's screw propeller, the iron hull, and the magnificent steam machinery of the present day—the work of men still living—the storms and waves of the ocean had been conquered and no steamship ever altered her course even to avoid a hurricane. There had also been a great contest on land. The railroad engineer had fought manfully and achieved great triumphs, although his battles were not yet ended. In piercing tunnels and ascending mountains he had attempted and accomplished feats unknown before to his art. He had brought to his use new explosives, electricity, the diamond and steam drill, and the strength of iron and steel in place of that of wood and stone.

Prof. Trowbridge then described the advances which have been made in military engineering. The result of the improvements in the art of attack and defense was that the wars of to-day were short and sharp, and fewer men were killed. Krupp's monster steel gun, weighing 50 tons and throwing a shot of 1,200 pounds with a charge of 170 pounds of powder, was the last and most formidable advance on the side of attack, but in the torpedo it found a deadly enemy which had come to the rescue of the side of defense.

Young engineers just starting out in the profession might think that there was nothing left for them to do except to copy the works of their predecessors, but if they allowed themselves to be discouraged by such an idea they made a great mistake. The field was as large as ever, perhaps larger. Sanitary engineering was only in its infancy, and there was no doubt that great changes were to be made in the manner of building railroads. It was a well known fact that under the present conditions a dead weight of about two and a half tons had to be drawn over the road for every passenger carried. This was certainly wrong and must be remedied. Four years ago the matter was very fully discussed in England, and the best engineer there concluded that there was no remedy. But the question was, nevertheless, an open one. Perhaps the elevated railroads which had risen like magic in the streets of New York would be the beginning of a solution of the problem. The demands of the future would be for faster travel at cheaper rates.

If any one said that there was no longer much work for educated engineers they had but to go to the top of the building (the School of Mines) and look about them. From that lookout they would see no less than half a dozen great feats in engineering going on before their eyes. He referred to the Brooklyn Bridge, the works at Hell Gate, the elevated railroads, the Harlem River improvement, the tunnel under the Hudson River, and the projected bridge over the East River at Blackwell's Island, with a span the longest in the world.

New York Steam Fire Engines.

The Fire Department of New York has, in daily use, forty-two steam fire engines, besides the steam fire boat, W. F. Havemeyer. Six of the engines are self propellers. Under favorable circumstances the best steamers can throw a horizontal stream 250 feet. The extreme height to which water has been thrown is 150 feet. The average height to which the stream is thrown on ordinary duty is 60 feet.

Each fire company costs about $14,000 a year, which sum includes the pay of officers and men, repairs to building, apparatus, etc. During 1878, the engines were employed 832 hours, each throwing on an average 16,000 gallons an hour, or over 16,000,000 gallons in all. The number of fires during the year was 1655.

MOLECULAR CHEMISTRY.—NO. III.

From the definition of a molecular volume given in our last paper, it follows directly that the volumes of all gaseous molecules taken at the same temperature and pressure are equal. They must be equally distant from one another, or else they would not expand equally when subjected to the same degree of heat. We may conclude, then, that water vapor is made up of molecules of hydrogen and oxygen, all having the same size.

Now, what happens when this water vapor is condensed to form liquid water, or, still further, to form ice? Are all the molecules condensed equally or unequally? Or does the condensation fall only upon one constituent?

According to Herrmann Kopp, there are temperatures at which liquids and solids are also equally affected by heat, and have therefore the same number of molecules in equal volumes. Calculations are made as follows: Calling the density of a water molecule at 0° C. unity, and its equivalent weight 18, the volume it occupies at that temperature is found by dividing the latter by the former: $\frac{18}{1} = 18$. The weight of a body being the product of its density by its size or volume, or $W = D \times V$, we have also $V = \frac{W}{D}$. Of course its volume will be greater at a higher temperature; hence the first point to be settled was: at what temperature must we make our comparisons? Kopp believed himself warranted in fixing upon the boiling points of liquids as the proper temperatures at which their densities should be compared, because, in the first place, there appears to be a close connection between the chemical composition of many liquids and the temperatures at which they boil. In numerous organic liquids, for example, whose composition differs by CH_2, the boiling points differ by 19°. Thus: alcohol C_2H_6O boils at 78°, propylic alcohol $C_2H_6O + CH_2$ boils at 78° + 19°, etc.

Again, he argued, regarding alcohol as made up of the elements of ether and of water, the volumes of the latter added together at the proper temperatures should be equal to the volume of alcohol computed from its density and equivalent. Selecting density determinations at random without regard to temperature, the results will be found discordant:

Ether $C_4H_{10}O$,	equivalent 74,	density at 12·5° =	·724,	volume 102
Water H_2O	" 18,	" 0° =	1·000	" 1
		Sum		103
Alcohol 2 (C_2H_6O)	" 92,	" 17·8° =	·792,	" 116

When, however, the densities are all taken at temperatures at which the tension of their vapors is the same—one of which is the boiling point—the results agree exactly:

Ether vapor has a tension of	·313 m. at 16°, volume	108 –
Water " " "	·313 m. at 77°, "	19 +
	Sum	127
Alcohol " " "	·313 m. at 57°, "	127

As we cannot accurately determine the density of a boiling liquid, Kopp was obliged to study the rate of expansion of liquids some distance below their boiling points, and calculate what their density would be, if they continued to expand at the same rate. The boiling point of a liquid may be regarded as that temperature at which its vapor has acquired sufficient tension to overcome the pressure of the atmosphere; and of course this tension is the same for all liquids boiling under the same barometric pressure. According to this view, temperatures other than the boiling points might also be chosen for a comparison of densities, provided the tension of the vapors is the same.

In the third place, Kopp found that isomeric liquids, *i. e.*, such as have very different properties, but are of the same chemical composition, and belong to the same group of bodies, have, as a rule, equal volumes at their boiling points.

Having thus, as he believed, sufficient reasons for selecting the boiling points of liquids as the proper temperatures at which to compare their densities, the question presented itself: If the specific volume of the water molecule at 0° is 18, as we have seen above, and this figure represents the sum of the volumes that $H_2 + O$ occupy in water, how much of it belongs to H_2, and how much to O? The answer to this question involved the study of an immense number of bodies, and was finally announced as the result of the following reasoning:

1. Two molecules of hydrogen may be replaced in organic liquids by one of oxygen without sensibly changing the volume. For example:

Ether	$C_4H_{10}O$ has a volume of	105·6 — 106·4
Butyric acid	$C_4H_8O_2$ " "	106·4 — 107·8
Ethyl acetate	$C_4H_8O_2$ " "	107·4 — 107·8
Acetic acid anhydrous	$C_4H_6O_3$ " "	109·9 — 110·1

It should be noticed, however, that there is here a slight increase of volume with each substitution.

2. Two molecules of hydrogen may be similarly replaced by one of carbon:

Benzoic acid	$C_7H_6O_2$ has a volume of	126·9
Valerianic acid	$C_5H_{10}O_2$ " "	130·2 — 131·2
Methyl butyrate	$C_5H_{10}O_2$ " "	125·7 — 127·3
Ethyl propionate	$C_5H_{10}O_2$ " "	125·8

3. In series whose composition progresses by increments of CH_2, the volumes increase by about 22:

CH_4O	has a volume of	41·9 — 42·9
C_2H_6O	" "	61·8 — 62·5
$C_5H_{12}O$	" "	123·6 — 124·4

The above are only a few selected out of a large number of examples given by Kopp to illustrate these three fundamental points.

Now, as CH_2 represents an increase in volume of 22, and as $C = H_2$, from the fact that it can replace H_2 without change of volume, it follows that the volume of C is 11, and that of H is 5·5, in the above compounds. $CH_2 = 11 + 2 \times 5·5 = 22$.

With this starting point, we can obtain the volume that oxygen occupies in water. The volume of water H_2O at its boiling point is 18·8. Subtracting the volume of the hydrogen, $H_2 = 2 \times 5·5 = 11$ from 18·8 we have left for oxygen 7·8.

When, however, oxygen is a constituent of a group of elements that enters into combination as a whole, and resembles an element in its characteristics, the volume just found will not fit. For such groups, or radicals as they are called, other values have to be sought, or else the sum of the volumes of the components will be either greater or less than the volume of the compound. Thus, in the case of aldehyde, the oxygen volume is as high as 12·2.

In 45 organic liquids containing only carbon, hydrogen, and oxygen in various proportions, the volumes computed by Kopp, according to the above figures, did not differ from those found experimentally and reduced to their boiling points by more than 4 per cent, which, he remarks, is within the limits of accuracy for such experiments. Considering these figures established, Kopp extended his investigations to substances, in which elements having ascertained volumes are combined with other elements whose volumes he wished to discover. He found the following figures: chlorine, 22·8: bromine, 27·8; iodine, 37·5; sulphur in a radical, 28·6; without, 22·6. Nitrogen assumes three widely differing values: 2·3 in aniline, etc.; 8·6 in nitrous acid; and 17·0 in ammonia. From this he concludes that the same element does not preserve a fixed volume in all its compounds.

Nearly 100 liquid compounds, containing the above elements in different proportions, have been tabulated by Kopp, in which the molecular volumes, computed by adding up the volumes of the constituents, agree closely with the volumes of the compounds found by dividing the molecular weights of the latter by the densities corresponding to their boiling points.

From this list of substances various groups may be selected, the members of which have molecules whose volumes add up to the same figure, notwithstanding great differences of composition. Hence we have in each group liquids which, when compared at their boiling points, follow the same law as gases, for they have the same number of molecules in equal volumes.

In the case of solids the alums are a noteworthy class of compounds, in which similarity of composition and identity of crystalline form are accompanied by a close agreement in molecular volume; but there are, on the other hand, numerous compounds in which, under like conditions, there is a wide dissimilarity of molecular volume, as, for example, in the case of the chlorides of sodium and potassium.

In our next paper we shall examine what other investigators have accomplished in the field opened by the laborious researches of Kopp. C. F. K.

The Advantage of Cheap Patents.

The Philadelphia *Public Ledger* remarks that although the patent right system has been in operation for many years, there is still a strong disposition not to recognize the property rights of individuals in ideas embodied in new inventions, and quite recently an attempt has been made to modify the patent laws in the direction of making patents very costly and difficult to obtain. Without entering into the general question as to what changes in the law, if any, are desirable, it is worth while to remark that *The Machinery Market* and other English trade papers ascribe our successful competition in manufacture to the influence of our patent laws in stimulating inventions. Mr. Thomas Brassey, several years ago, warned the British workman that he had "more to fear from the highly paid labor of America, which brought labor saving machinery and mechanical skill to such a degree of perfection, than from the lower wages of the continent of Europe." It costs fully ten times as much for a patent in England as in this country, and therein we have a great advantage. It is true that many patents are issued for useless or valueless inventions, but even the failures stimulate the invention of better devices, and the general result of encouraging inventors and inventions is that machinery is carried to a higher degree of superiority here than in any nation of Europe, and better machinery enables us to compete even where we are under commercial disadvantages as to the cost of raw materials, wages, etc.

Black Polish on Iron and Steel.

To obtain that beautiful deep black polish on iron or steel which is so much sought after, it is required to boil one part of sulphur in ten parts of oil of turpentine, the product of which is a brown sulphuric oil of disagreeable smell. This should be put on the outside as slightly as possible, and heated over a spirit lamp till the required black polish is obtained.

"Many Mickles Make a Muckle."

According to the calculation of Mr. G. T. C. Bartley, an ounce of bread wasted daily in each household in England and Wales is equal to 25,000,000 quartern loaves, the produce of 30,000 acres of wheat, and enough to feast annually 100,000 people. An ounce of meat wasted is equal to 300,000 sheep.