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Contents:

(Illustrated articles are marked with an asterisk.)

THE PROGRESS OF CHEMISTRY IN 1870.

Although there have been no startling discoveries since the 1st of January, 1870, still chemistry has held even pace with all other sciences; and we have been called upon from time to time to record numerous improvements in the methods of manufacture of various articles, and in the new application of well-known compounds.

The uses of oxygen gas have been greatly extended since its cheap manufacture, and we hear of it as an important remedy in disease, as a powerful agent in the production of great heat, as a source of light, and it can now be purchased the same as any common agent employed by chemists.

The recent improvment in the preparation of hydrogen bids fair to become an important step in the manufacture of illuminating gas, as it can be converted into carbureted hydrogen very cheaply, when it will burn with a highly illuminating flame, thus affording a cheaper and purer light than has hitherto been known. The simultaneous discovery of the cheap and ready preparation of oxygen and hydrogen opens the way to many uses of those gases hitherto considered impossible on account of the expense attending their manufacture; and the study and development of this new industry must be assigned to the first half of this year. Hitherto, in speaking of hydrogen, we have been in the habit of assigning very few uses to it. That it would lift balloons on account of its levity has long been known, but its application in medicine is a novelty of which, now that we are likely to have the gas in any quantity, we shall probably hear much more. When breathed in large quantities it proves fatal, but in proper proportions it acts as an hypnotic, and we may hear of it hereafter as a rival to the hydrate of chloral in cases of sleeplessness.

Further uses of hydrogen in conjunction with oxygen for the fusion of the most refractory metals is no novelty, and has long been anticipated as a probable and desirable consummation. The practical application of the condensation of gases for the production of cold is a result that has been attained this year more than in any other former period. The fact of the possible compression of gases into liquids was long ago ascertained by Faraday, and feeble attempts were made a few years since to apply it for the production of cold, but it was not until recently that these experiments proved successful. There now appears to be no doubt that the liquefaction of gases is the true method upon which to found the artificial production of ice on a commercial scale; and we shall be glad to record the success of any mechanical contrivance that shall accomplish all that science pronounces as entirely practicable in this direction. The chemistry of the question has been fully worked out, and what remains to be done is a similar solution of the mechanical part of the problem.

During the present year we have recorded unusual progress in the art of photography, especially in the rapidity of printing, and the permanency of the pictures. The Albertype offers a method by which a thousand prints can be taken in a day, with durable ink, and in colors according to the natural appearance of the objects, where these colors are such that they can be introduced with the ink. The Albertype and the Woodburytype are among the most important improvements of the present day, and offer encouragement that a rapid method for the production of photographic prints has now been attained. Photographing natural colors has made very little progress during the last six months, and it appears doubtful if we shall ever be able to accomplish this desirable result.

In the manufacture of glass we have to mention the use of salts of baryta, of fluor spar, of salts of thallium, for optical purposes, and in general a very satisfactory progress.

Platinized mirrors have been introduced, and appear to give satisfaction for various purposes; but the manufacture has hardly reached such proportions as to enable us to pronounce with absolute certainty upon the success of the method. Silver mirrors, which at one time were urgently pushed as a cheap and most desirable invention, have by no means displaced the quicksilver mirror so long in vogue; and there would appear to be some practical difficulties in the way of the universal substitution of silver for mercury. From a sanitary point of view it is a misfortune that silver cannot take the place of mercury, as the latter is exceedingly poisonous to the workmen; and it was chiefly from this humanitarian consideration that Liebig took up the investigation and devised cheap and ready methods for silvering glass.

The uses of manganese have largely increased during the present year, and new and important industries appear likely to be founded upon recent discoveries of the cheap preparation of the permanganates and the metal. It is now well known that Tessié du Motay's method for the manufacture of oxygen gas is founded upon the use of the oxide of manganese and soda.

The ready way of making the manganate of soda has suggested the use of that salt for many purposes, and by degrees the permanganate has been introduced and applied as a disinfectant and for bleaching; it is for the latter purpose that the permanganates of lime and potash appear destined to become conspicuous. Disinfecting and bleaching are essentially founded on the same chemical process; for the former only small quantities of material are required, while for the latter the demand was much beyond the possibility of the supply. It has now been proved that the permanganates are among the best bleaching agents we have, and the past few months have shown the possibility of supplying them cheaply and in any quantity. No chemical progress of recent date is of more importance than this application of permanganic acid as a disinfecting and bleaching agent.

We have also to note the use of metallic manganese in combination with copper. Cupro-manganese is a white alloy closely resembling German silver, and possessing many of the valuable properties of the older alloy. It can be substituted for German silver in plated ware, and is now manufactured and successfully applied in Connecticut. There was formerly an insurmountable obstacle in the way of the use of manganese, and that was the production of the necessary heat to fuse it. This difficulty has now been overcome by the use of Siemen's furnace, and the alloy of copper and manganese is readily accomplished. We shall probably hear of its introduction as a substitute for the much more expensive alloy of nickel, and can now anticipate the manufacture of manganese steel more largely than ever before.

The progress in the economical use of products that were formerly wasted, has been satisfactory during the past six months. Earth closets have become better known, and by degrees we shall not only avoid the waste attending upon the old system, but also the frequent diseases and discomfort that custom has fastened upon us. The waste of coal-tar products is fast disappearing, and as we have recently had occasion to remark, so great has been the progress of discovery in the new application of the liquid and solid products of the distillation of coal that we may expect to see retorts erected for the purpose of producing them, rather than for the manufacture of gas. Gas will become an incidental product, while the object sought will be the tar from which to make aniline colors, and anthracene from which to manufacture alizarine and artificial madder dyes.

The manufacture and use of the hydrate of chloral, although not started this year, may be properly said to belong to it, as it has received its chief development within the last six months. This medicine may be pronounced the most valuable contribution of chemistry to *materia medica* that has been made for a long time.

The progress made in the uses of glycerin is worthy of note, and in nothing was it more unexpected than in the preparation of elastic sponge. By this recent improvement we have refuse sponge rendered available for mattresses, cushions, and other purposes. The use of glycerin in wine and beer, and for the preservation of animal substances from decay, and in medicine, is also worthy of note.

We cannot enumerate in detail each particular discovery, but have said enough to show that the recent progress of chemistry has been entirely satisfactory, and quite up to the precedents of the past few years.

STEAM ROAD ROLLING.

This method of consolidating roads, which, as our reader, are well aware, has been for the last two years under trial, both abroad and in America, seems to be entirely successful. So far as its results can be ascertained here they seem to warrant the belief that this system is destined not only to be adopted in cities but also upon rural highways, turnpikes, etc.

From abroad, we gather most encouraging accounts of the progress and results of the system in various cities of France and England. From the *Building News* we learn that Mr. Heaton, of Birmingham, calculates that an annual saving of $28,500 to that town would be effected by the use of the steam roller; the present annual expenditure for road material alone amounting to as much as $65,000. Though hesitating to assign a precise figure to the amount of saving effected by road rolling, Mr. Newlands, the Liverpool borough engineer, wrote in October, 1867, with regard to Messrs. Aveling and Porter's 30-tun roller: Our roads are in much better order, and easier kept clean, than before its use, and our bills for macadam are not so heavy."

Mr. Newlands expects, however, that "the saving in macadam by every coating being at once consolidated will be very great, though he cannot at present put a value upon it." During the last two years, Mr. Samuel F. Holmes, the borough surveyor of Sheffield, has "used a steam road roller made by Messrs. Aveling and Porter." He finds "the saving in the cost of macadamized roads to be even greater than when rolled with a horse-roller," but he is "not yet in a position to give exact figures." He has no doubt it will increase the saving "at least 40 per cent over unrolled roads." Mr. Edward Buckham, the borough surveyor of Maidstone, writes as to the steam rolling carried out there in March, 1868, with a 15-tun Aveling and Porter roller, that "the results obtained from using the roller are economy, durability, comfort, and uniformity of section of road." Mr. Buckham considers that the constant use of a steam road roller would effect an economy in road maintenance of "at least" 20 per cent.

These are only specimens of like testimony received from London and many other places in England, and from Paris in France. The New York Central Park Commissioners have used a heavy steam roller of Aveling and Porter's make, imported for the purpose, with great success.

On Fourth avenue, Brooklyn, a most beautiful drive has been made by this process.

While the results named are highly satisfactory, we are constrained to say that in our opinion *the* steam road roller which shall be beyond question adapted to universal use on all sorts of road beds is not built. Perhaps the different nature of the materials used in road making will render it impossible to construct a roller which shall be equally adapted to all. We think this highly probable; but if so there is certainly room for the profitable employment of inventive talent in the construction of this class of machines. It has been only within a week that the proprietor of a valuable patent paving material has made inquiry at our office for something lighter, more rapid and portable than anything of the kind now in market.

We believe that the system might be extended to American country roads with great profit, provided some inventor would hit upon the right thing to do the work.

GAS AS FUEL.

It is scarcely necessary to preface what we are about to say with any remarks about the numerous family of gas-stoves for the consumption of and generation of heat from the combustion of ordinary illuminating gas. Those already introduced into market are answering a good purpose, and are both economical and convenient for many domestic purposes. We should, however, certainly fail in judgment and sagacity did we not fully comprehend the fact that the use of gas as fuel is in its infancy, and that it is destined to a far more extended application than at present obtains.

When, however, we use the term gas, we mean much more than illuminating gas; we mean all gases which by their chemical combination are capable of developing intense heat.

The old idea of separating water into its elements to reunite them and employ them as heat producing agents is perhaps no chimera. It is true that the heat thus developed will only be the equivalent of the force employed to effect the separation; and unless some natural force be by future discovery rendered available by conversion to produce the separation, no gain will result.

But recent advances in chemical discovery indicate that hydrogen as well as oxygen will eventually be obtained at so cheap a cost that they may find extensive application for heating as well as for illuminating purposes.

Be this as it may, its further discussion is foreign to the purpose of the present article, which is to institute some comparison between the relative economy of common illuminating gas and coal as combustibles for ordinary domestic purposes.

The comparison of the relative values of these materials as heat-producing agents would become extremely complicated were we to consider, in making it, all the compounds which enter into their composition. We shall find it, however, sufficiently accurate for our purpose, to consider the chief constituents of illuminating gas. These are carbon and hydrogen. To determine approximately the proportions of these elements contained in the best quality of illuminating gas, we shall take the results of the experiments of Peclet, who gives as the mean result of investigations upon the composition of coal the following:

In one thousand parts, carbon, 812 parts; hydrogen, 48 parts; oxygen, 54 parts; nitrogen and sulphur, 31 parts; ashes, 55 parts. From an analysis of eight kinds of coals, by Dr. Fyfe, we find an average of coke after distillation to be 1,254 lbs. per tun.

From Peclet's analysis we find there are on an average 1,624 lbs. of carbon in a tun of 2,000 lbs. and 96 lbs. of hydrogen. The coke (carbon), on the average being 1,254 lbs. after distillation, leaves an average of 370 lbs. of carbon converted into gas, which, added to the weight of hydrogen, makes 466 lbs. of gas as an average yield from 2,000 lbs. of coal; 27 lbs. more than an average of the weight of gas obtained from seven kinds of cannel coals by Wright. The heating power of 466 lbs. of gas, composed as above, is according to Dulong.

Carbon.....370 × 12,906 =	4,775,220	Heat Units.
Hydrogen.... 96 × 62,535 =	6,003,360	Heat Units.
Totals.... 466 lbs.	10,778,580.	Heat Units.

This is all the heat that can be obtained from the gas pro

duced from a tun of coal. An average specific gravity of gas obtained from eight varieties of coal (Fyfe) is 0·629, air being 1. A cubic foot of air may be estimated as weighing 527 grains, nearly enough for our purpose, from which we compute the volume of gas corresponding to 466 lbs. as being 9,839 cubic feet. This amount is considerably lower than the best coals will produce. The cost of this gas in New York would be $3·50 per thousand cubic feet, or $34·44 for 9,839 cubic feet.

The heat developed by the combustion of an average tun (2,000 lbs.) of coal, as determined by experiments upon seventeen varieties, made by Playfair and De la Béche, is 26,088,000 H. U., or about two and one half times the amount produced from the combustion of the gas that can be distilled from it.

It is quite evident, therefore, that if the heat be as completely utilized in the one case as in the other, that gas cannot compare in economy with coal. The heat from the combustion of gas is without doubt utilized more fully than that of coal; but, admitting that its percentage of utilization is twice, or even three times as great as that of coal, the latter would appear the cheaper fuel, at present prices, if we fail to take into account another consideration which greatly tends to reduce this disparity in cost. In coal fires, considerable expenditure of fuel is required before a degree of heat is obtained sufficient for cooking or other domestic operations; and after these operations are completed, still more is expended before the fire is extinguished, both of which expenditures are a total loss in warm weather.

With gas, however, the maximum heat is at once obtained and all expenditure may cease at once when the fire ceases to be required. This obviates the necessity of keeping fires up in the intervals between their employment. In this way large savings are made, so that even in point of economy gas may compete with coal during warm weather, while in convenience it is infinitely superior.

Thus the use of gas for minor culinary operations, heating sad-irons, etc., in the kitchen and laundry, and its application to light metallurgic and other operations in the laboratory, are constantly becoming more popular and extended; but it must be obvious that its application to the generation of steam for motive power, as has been proposed, cannot be economical, even were its price reduced to one dollar per thousand feet.

In a paper recently read before the British Association of Gas Managers by Mr. G. Goddard, he strongly urges this application, and describes an invention designed to effect the generation of steam by the combustion of gas.

The invention consists of a vertical tubular boiler, so constructed as to possess great power of generating steam, but of very small dimensions; the tubes are not more than one inch bore, and are placed very close to each other, so that an enormous heating surface is obtained; beneath the tubes on a revolving plate are a number of atmospheric burners, each supplied with a cock so that the heating power is completely under control and can be increased or diminished at pleasure, as more or less power may be required.

We have but to take the statements of Mr. Goddard to verify our opinions as to the cost of this application. He gives as the average consumption of gas per horse-power per hour, in the boiler described, 100 cubic feet. This in New York would cost for one horse-power per day of ten hours exactly $3·50. Allowing ten pounds per horse-power per hour of coal, with coal at eight dollars per tun, the same power would cost, if coal were used to produce it, only forty cents. The convenience of gas must be very great to compensate for such an increase of cost.

In a subsequent article we shall endeavor to point out some defects, and suggest some improvements in gas furnaces and stoves for domestic use.

HYDROPHOBIA AND DOG MUZZLING.

The hot weather is again upon us, and the newspapers considering it to be in season, begin to dilate upon the immense dangers of hydrophobia, and the importance of muzzling dogs. City authorities are also announcing their determination to extinguish the vital spark of heavenly flame in the bosoms of all such of the canine race as shall appear on the streets without muzzles. Nervous people are working themselves up into a state of trepidation for fear they shall be bitten.

We recently heard it proposed by an elderly, respectable-looking gentleman on board a ferry boat, to lynch even a good-natured dog who sat lolling through the meshes of a wire basket which decorated his broad nose. We are glad to say the proposition was rejected with scorn and disgust, and the respectable gentleman in the fear that the said dog—that looked as though he could not be coaxed to bite anything more animated than a well buttered beefsteak—would immediately spring at his throat, left the cabin amid the derisive laughter of his fellow passengers.

This foolish fear is very far removed from wise caution, and is certainly as baseless as it is foolish. Cases of genuine hydrophobia are extremely rare. One runs much more risk of being struck by lightning, and the latter risk is not great.

There is no doubt, however, of the wisdom of properly providing against even this small risk. This can be done without cruelty and with little trouble. Dogs do not run mad instantaneously. They show that they are ill some time before their paroxysms are dangerous. A dog that is sick should at once be attended to, and should receive humane care, or be put out of his sufferings by a kindly shot.

We are not of those who believe the season has much to do with the generation of this disease; but as there are many nervous people who do, it is perhaps well to allay their fears by some precautions. Let the dogs be muzzled but don't use a strap. A learned Irish veterinary surgeon states that the origin of this system was its supposed efficacy in preventing one dog biting another, as well as security to people. It is believed that dogs are liable to become rabid during the summer months, and hence the muzzle. The putting on of a peculiarly constructed strap upon the nose and mouth of a dog (be he ever so viciously inclined) is an effectual remedy for biting, but he declares the act to be one of great cruelty.

"If to prevent one evil another of perhaps greater extent is to be substituted, it is well to consider whether there is not still another and better remedy at hand—one devoid of cruelty. The structure and function of the nasal organ of the dog show that the ordinary mode of muzzling dogs is an act of great cruelty, and if placed in such a manner that it ceases to be cruel, then the wearing of a muzzle is a delusion and a snare. When a dog is in a passive state during hot weather, he will of necessity open his mouth and protrude the tongue. This becomes more manifest during exertion. The only way to make an ordinary muzzle bearable is to secure the actual repose of the animal. The moment the dog is called into active exertion, that moment cruelty commences. Placing a log of wood to its neck amounts to an absurdity, because it cannot possibly check his vicious propensity, should he possess any. A log of wood to be of service should be of great magnitude, or of considerable weight. There are three remedies at hand for the treatment of our canine friends, either of which may be tried, and two out of the three will be found easy of application, within the reach of all, and without objection. A wire muzzle open at the bottom will protect the public from injury, and it will at the same time enable the dog to use his respiratory organs without let or hindrance; and, further, it will not annoy him after he is accustomed to it. The second remedy is that of leading dogs when out of doors, which is perhaps the most effective remedy of the twain. The third is that of keeping them at home."

Now these remarks contain some common sense, which it would do well for people to heed. We are not ashamed to say we like a nice dog, and always feel indignant to see him ill-treated. There is nothing very new in the directions here given for the treatment of dogs, but their reiteration is justifiable in view of the fact that the public are slow to right the wrongs of dumb slaves.

PROGRESS OF INVENTION ABROAD.

Among the most interesting of the new inventions announced in our European exchanges is a new method of raising the screws of propellers—an English invention. The stern length of the propeller shaft has its inner end supported in a pivoted bearing, and a passage or way is constructed in the stern of the vessel, through which the pivoted shaft may swing upward, when lifted by a chain attached to its outer end. The inner end of the portion of the shaft which swings up in this way, extends beyond its pivoted bearing, so that raising the outer end in the manner described uncouples it from the other part of the shaft. The blades of the screw are made so that they can be folded together, and, when the screw is raised as described, they are stowed away in a recess. The shaft passes on one side of the stern part, and a sort of shutter closes the opening in the run when the shaft is down.

Another English invention, which, if we are not mistaken, was tried some years ago in this country, is an arrangement of stone-cutting and dressing machine, in which the dressing operation is performed by rotating disk cutters having conical edges, these cutters being mounted so that they revolve freely on inclined axes carried by a revolving cutter-head. The arrangement is such that the cutters make a kind of rolling cut, and their action is thus very similar to that of the "magic diamond," with which our readers are all familiar.

A London inventor has devised a method of securing sheets and panes of glass in metallic frames, so that they shall not be broken by expansion and contraction of the frames, through changes in temperature. In applying this invention to a lantern, a metal frame is constructed, which is composed of an upper and lower band, united by bars at the corners of the lantern. The panes or sheets of glass are placed upon the outside of these corner bars, and are then secured by metal bars or clips of a V-shaped or concavo-convex sectional form. These clips extend from the top to the bottom of each pane, and are secured to the upper and lower bands of the frame by means of sockets, screws, pins, or other devices which will hold them firmly, but will also allow them to be readily removed when desired. The bottom of the frame is provided with a fillet to receive the lower edge of the panes of glass, and this fillet is perforated at the bottom to permit the escape of any water that may be caught therein. By thus securing the panes or sheets of glass within, or between strips or bars of metal, without putty or other adhesive substance, they are held with sufficient firmness to prevent any vibration or displacement in their frames, while at the same time the said frames permit them to freely expand and contract under the sudden changes of temperature to which they are exposed.

A Birmingham inventor has made an improvement in water tweers for forges, which consists in forming the water tweer for hot blast with the entrance and exit air and water passages in one casting, and in affixing it directly to the water cistern and to the air-heating box or chamber without the use of separate connecting pipes. One part of the tweer passes through the water cistern, and another part passes through the center of the said heating box or chamber, and the tweer is secured to both cistern and chamber by means of flanges and screw bolts and nuts. The joints of the parts are made air and water tight by suitable packing. The air passage of the tweer is so formed that the entering air is conveyed by it through the water cistern, and then by a curvature of the passage is conducted into the air chamber where it becomes heated; the heated air from thence passes by means of another curved passage to the nose part of the tweer into the forge fire. Surrounding the air passages is the water space which opens by two openings into the water cistern, one above and the other below the entrance air passage, and the openings are so situated as to cause a circulation when the water becomes heated against the nose of the tweer.

A Manchester mechanic has invented a very ingenious method of joining the ends of old warp to the ends of a new warp in weaving. The ends of the old warp to which the ends of the new warp have to be joined are held in a clip, and the ends of the new warp are similarly held in a clip. The two sheets of warp are then placed in the machine. The sheet of old warp being placed over the sheet of new warp, they are then acted upon by the machine as follows: 1. The warp threads are laid evenly by means of brushes. 2. A pair of clips or nippers take hold of both warps after they have been laid evenly by the brushes. 3. These nippers take the threads into a pair of rollers set at an angle to tighten the warp threads. 4. The end thread of the old warp and the end thread of the new warp are detached from the other threads of the warps by a reciprocating pair of nippers. 5. The threads so taken by the reciprocating nippers are laid by other nippers over the side of a tube, by which the two threads are formed into a loop. 6. A hook passed through the tube takes hold of the ends of the two warp threads, and draws them into the tube, so forming a knot, the ends of the threads having been severed by a cutting blade or scissors to allow of this. 7. The knot is tightened by the threads being drawn through a narrow nick, which will not allow the knot to pass, and the threads are cut close to the knot.

THE STEVENS INSTITUTE OF TECHNOLOGY.

The late Mr. Stevens, of Hoboken, N. J., left $500,000 in addition to the lot and building, for the purpose of founding an institution in which technical education could be conducted on a plan analogous to that pursued at the Technological Institute, of Boston. The Trustees of the fund very wisely selected Professor Henry Morton, of Philadelphia as President and to him has been confided the important trust of putting into practical shape the will of the testator. The building is in process of construction, and is after an imposing and attractive design. It is to be built of trap rock with brown stone facing, and will eventually occupy the entire block, bounded by Fifth, Sixth, Hudson, and River streets, and will cost, when finished, $150,000.

Martha Institute, which was completed a few years ago, and has been a flourishing and useful school, will be supplementary to the Stevens Institute, and in a measure enable Professor Morton to dispense with the elementary classes.

It is not intended to make the Stevens Institute a free school, but by a judicious use of the income it is hoped that the tuition can be placed as low as $75 or $80 a year, covering all the studies of the course. A few scholarships will be established in connection with the public schools and the Martha Institute. A school of design for women is also included among the terms of the bequest.

The establishment of schools of technology is a favorable sign of the times, and will meet with the hearty support of the citizens of our country. They have become a necessity, and it is therefore with pleasure that we witness the prosperous beginning of a new enterprise in New Jersey. We shall be glad to record the opening of the Institute in the fall with a goodly number of pupils under the direction of professors of approved learning and experience.

SCIENTIFIC INTELLIGENCE.

GLYCERIN CEMENT.

Professor Hirzel of Leipzig has discovered an important use of glycerin that ought to be more generally known. He finds that when glycerin is mixed with fine and well-dried litharage, it yields a cement that is capable of a large number of applications.

All metals and nearly all solid bodies can be bound together by this cement; it is said to harden under water as readily as in the air, and to resist a temperature of 500°. It is especially recommended for such pieces of apparatus as are exposed to the action of chlorine; hydrochloric acid, sulphuric acid, sulphurous acid, and nitric acid; also the vapor of alcohol, ether, and bisulphide of carbon, as none of these agents act upon it. The cement can be used in steam engines, pumps, foundations for machinery, and, finally, as a substitute for plaster in galvano-plasty and electro-plating. The preparation of glycerin and litharge to be taken must depend somewhat upon the consistency of the cement, and its proposed uses. An excess of glycerin would retard the setting, as it does not readily evaporate. This new use of glycerin adds another application to a substance that only a few years ago was thrown away.

INFLAMMABILITY OF ROTTEN WOOD DUST.

Dry wood dust blown into a candle gives a clearer and more intense flame than resin, and the wick becomes covered with a resinous crust, so that the burning of the candle is greatly retarded. As this kind of dust when coming in contact with a candle takes fire, it is unsafe to conduct manufactures in which it plays a part at night when a light is required, and it is equally dangerous to strike a match. It appears that an accident occurred in a factory in Silesia, where wood dust was employed, by which five workmen were fatally injured.

CORK AS A NON-CONDUCTOR OF HEAT.

Cork is such a poor conductor of heat that it is largely employed about steam engines to prevent the cooling of cylinders and the consequent larger consumption of fuel. According to careful experiments, the economy in fuel amounts to