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Contents:

(Illustrated articles are marked with an asterisk.)

THE SCIENTIFIC AMERICAN AS A PREVENTIVE OF BOILER EXPLOSIONS.---VALUE OF ITS CORRESPONDENCE.

Our readers, in their kind letters of commendation of the SCIENTIFIC AMERICAN, very frequently tell us that the information they derive from its columns is of the greatest value to them in their several callings, and every day we are told that a single hint put in practice is often the means of making or saving considerable sums of money. Of course these flattering testimonials are very gratifying to ourselves, and we are glad to know *how* the money was saved or earned: whether, in fact, the writers measure the amount of practical information they gain in dollars and cents, and then are unable to think of any sum which will adequately express its value, or whether from its columns they obtain ideas which enable them to improve the quality of their work, and so derive increased incomes; or whether, in some special instance, a direct gain can be traced or an accident avoided. Sometimes, however, a correspondent enlightens us, and sends an item which is not only interesting to the editor, but serves a useful purpose to others. A letter now before us is an excellent example in point.

Mr. S. E. Worrell, of Worrell, Hannibal county, Mo., writes that he has read the SCIENTIFIC AMERICAN for fourteen years, and that he has learned more from its pages than during the period he attended school. In perusing a recent number, he goes on to state, his attention was attracted by the report of boiler inspections by the Hartford Boiler Insurance Company. "On glancing over the article, I remembered," he writes, "that I had not heard the escape of steam from our safety valve for some time. Upon going to the mill the next morning and on making an examination I found that the valve would not rise even with the steam gage standing at 120 pounds and the weight off the lever. I even had to knock the lever up with a hammer, and then could not get it back until the steam was entirely out of the boiler. I afterwards found the valve stem had become rusted in the cover of the valve. Our boiler is only a small one, but its explosion might have caused the loss of a number of lives and of much property."

We congratulate our correspondent on his narrow escape from a probable casualty. We commend him for his careful attention to what he reads. If every mechanic, on receiving a number of the SCIENTIFIC AMERICAN, would thoroughly consider its suggestions, and seek to apply them to his individual case, there is no doubt but many of the disasters occurring in the use of machinery would be avoided. The information imparted by practical men in their various callings in the correspondence columns of this paper is of great value to all classes of readers, coming, as it does, from the experience and observations of those willing to impart hints beneficial to others, expecting, in return, that others will communicate information of benefit to themselves.

We would suggest that this feature of the paper may be made still more useful and interesting, if every subscriber will take the trouble to communicate some new fact or discovery he has made, whether by accident or experiment.

A few lines of such information from the workshop are frequently of more practical value than a volume of essays on some abstract science by the most learned author. Certainly every subscriber can furnish during the year at least one item of interest. This will give nearly fifty thousand facts from as many different sources, which would furnish, in the aggregate, an amount of information not otherwise attainable.

THE BROTHERHOOD OF LOCOMOTIVE ENGINEERS.

Those of our readers who are familiar with the course of events during the strike of railroad engineers, which occurred, principally on western lines, some two months since, will remember that the demonstration elicited a strong letter of disapproval from Mr. Charles Wilson, Grand Chief Engineer of the Brotherhood of Locomotive Engineers. This document, which went the rounds of the public press, while unreservedly condemning the movement, also stated that such action on the part of members of the above named association was in direct opposition to the principles and practices of their organization. To the opinions thus plainly expressed, and to the influence exerted by Mr. Wilson, the failure of the uprieing may be in no small measure attributed; and hence to his good sense, moderation, and just views is mainly due the prevention of imminent losses to both contending parties. It would naturally be thought that the men engaged in the controversy, even if rendered somewhat irrational at the time by the incident excitement, would on sober second reflection perceive the sound reason in Mr. Wilson's action; and consequently, if they did not feel a certain amount of gratitude for his clear-headed advice, would at least tacitly recognize the justice in the position he had assumed. But not so the locomotive engineers. Having called a convention at Cleveland, Ohio, recently, they proceeded to arraign the course of their president. So far as we can learn from the reports of the meeting, the discussion was carried on principally by noisy individuals who had been foremost among those fomenting the past disturbances. However this may be, the result of the deliberations was far from evidencing either the common sense or the justice of the delegates; for, by an almost unanimous vote of 120 to 18, the acts of the strikers were approved and Mr. Wilson requested to resign his presidency of the order.

The locomotive engineers of this country are as a rule an able and thoroughly reliable body of men. To their hands are entrusted immense responsibilities, and from them are required the exercise of an amount of skill, cool judgment, and, at times, absolute heroism which raise them far above the average mechanic. Of how uniformly they have met and do meet all these requirements, their past record, coupled with the small percentage of railway casualties yearly occurring in this country (considered in relation to those happening elsewhere) offers abundant testimony. It is in view of these very facts, however, that we find ourselves at a loss for an explanation of the action above noted. Are we to understand that the men to whom are hourly entrusted hundreds of lives and property of untold value mean deliberately to endorse the malicious acts of the wretches who misplaced switches, who shot workmen down at their posts, who disabled machinery, and committed other wilful and malicious crimes against not merely their employers, but against the entire community? If such be the inference, (and we can form no other from the strong evidence of the vote, on the one hand and the letter which gave rise to the convention, on the other), then the Brotherhood of Locomotive Engineers as it now stands has as an organization manifestly survived its time of usefulness, and the sooner it disappears from the public gaze the better. It has sunk down to the level of those who perpetually seek to promote disorder by the threadbare arguments of eternal antagonism between employer and employed, and to have submitted itself to the leadership of the violent extremists who somehow contrive to creep into the counsels of nearly every trade organization.

Mr. Wilson, we understand, proposes to appeal to the Brotherhood as a whole, against the action of their delegates, and invites such members as do not acquiesce in the course of the latter, to join him in forming a new society on the old basis, as expressed in the letter referred to in the beginning. We trust that this invitation will meet with a cordial response from every right-minded man in the Brotherhood; and that for their own sakes, if only to relieve their reputations from the slur which the convention has cast upon them, the large majority of the members will hasten to repudiate the disgraceful vote of their representatives.

THE MARVELS OF MECHANICS.

During the last siege of Paris, the inhabitants from time to time effected communication with their friends beyond the German investing lines by means of carrier pigeons. In fact, a regular pigeon post was organized, having one of its receiving stations in London. Here the written messages for Paris were received, and, by photography, reduced to microscopic size, each letter being reduced so small as to be invisible to the eye except as a speck. Some two thousand of these specks were then printed on bits of tissue paper about an inch and a half square, which was rolled and carefully attached to one of the tail feathers of the pigeon. On the arrival of the bird in Paris, the postal officials placed the paper under the microscope, which enlarged the several specks into readable communications, which were duly copied in writing and delivered to the persons to whom they were addressed. The total postage received for the transmission of one of those tiny bits of paper frequently amounted to two thousand dollars.

Small as this photo writing seems, it has been surpassed by mechanism. In a recent number of the *Lens*, Dr. J. J. Woodward, U. S. A., gives an enlarged photograph of microscopic writing done by machinery on glass, by means of a diamond, executed by Mr. William Webb, of London. The writing consists of the Lord's Prayer, which is written upon glass, within a space equal to one two hundred and ninety fourth part of an inch in length by one four hundred and fortieth part of an inch in width, or a space perhaps equal to the dot in this letter i. The photograph given by Dr. Woodward shows this dot of writing enlarged so as to occupy a space of about two inches long by one and a half inches broad. All the words are brought legibly out on the photograph, the total number of letters being 227; and such is the exceeding fineness of the original writing that 29,431,458 letters written in the same way would only cover one square inch of glass surface. The combined Bible and New Testament contain in all 3,566,480 letters; hence it would be possible for Mr. Webb to write the entire contents of more than eight bibles within the space of one square inch. Two specimen plates containing the microscopic writing above alluded to have been supplied by Mr. Webb for the United States Museum at Washington. Their cost was fifty dollars each.

The Webb machine, however, does not equal, in the fineness of its writing or perfection, the prior instrument of Mr. N. Peters, a wealthy banker of London, who, as long ago as 1855, was able to write nearly three times finer than Webb. So perfect was the Peters machine that it was competent to engrave the entire contents of the Bible and New Testament twenty-two times over within the space of a single square inch.

METROLOGICAL SCIENCE.

The American Metrological Society, the first session of which was held during December last in this city, forwards us a copy of its constitution and by-laws, in which the objects of the association are fully set forth. These, briefly, are to improve the system of weights, measures, and moneys at present existing among men, and to bring the same as far as practicable into relations of simple commensurability to each other. The universal adoption of common units of measure for the expression of quantities which require to be stated in presenting the results of physical observations or investigation, and for which the ordinary systems of metrology do not provide, is also to be advocated, and it will be the effort of the society to secure, in regard to the denominations of weight, measure, and money, the acceptance of the decimal system.

President Barnard, of Columbia College, has been elected President, and the names of several well-known scientific gentlemen, including Professors Hilgard, Newton, Cooke, Elliot, and Thurston are among the officers and council. The association has already begun its labors and has prepared two memorials to Congress which are now open for signatures of all persons interested in their objects. In 1866, Congress legalized the use of metric denominations, and in the recent coinage act the weights of all silver coins of the United States, except the trade dollar, are thus set forth. The first memorial prays that means be taken by suitable legislation to introduce the metric system more directly into, while not interfering with, the general business of the people. The passage of laws is urged, rendering the system obligatory to the Post Office Department; in reports of public works conducted under authority of the Federal Government; in all statistical or other documents involving statements of quantities, issued under similar sanction; and in the estimation and computation of custom duties of the United States.

The second memorial refers to the legal weights of our gold coinage, and asks that the pure gold contained in the dollars shall be exactly one gramme and a half. The *Engineering and Mining Journal*, in commenting on the subject, adds that it is only necessary that the fineness of standard gold should be everywhere nine tenths (as it is everywhere already, except in Great Britain), that the weight of pure gold in coins should be given on the coins in metrical units, and that the mints of civilized countries should do honest work: when the immediate results would be that the gold coins of nations adhering to the plan could safely be made legal tender in exact proportion to their weight.

The gramme of pure gold would thus become the world's unit of money, and the problem of an international coinage thus quickly and easily settled.

THE DETROIT RIVER TUNNEL.

An interesting history of the attempted construction of the tunnel under the Detroit river, between Detroit and Windsor, on the Canada shore, is given in a paper read by Mr. E. S. Chesborough, C. E., at the last annual convention, and published in the Transactions, of the American Society of Civil Engineers. Up to July, 1872, it seems that the prospects of the work were quite favorable; but in the latter part of that month, when excavation at the Windsor end had progressed about 250 feet through hard ground, a sudden irruption of sand and water occurred, which threatened to fill the tunnel out to the sump and choke the pumps. Three bulkheads were built, each nearer the shaft, and the last one quite close to the same, before a successful stand was made. After a delay of several days, operations were resumed; but hardly had thirty feet of new tunnel been made when another irruption ensued, and again bulkheads were resorted to. After beginning once more, a third break followed, and finally a fourth, when the contractors, finding that the work was costing four times the price they received for it, determined to make a lift shaft at the end of the drift on the Windsor side and start a new drift 10 feet higher than that of the drainage tunnel. This was done; but the irruptions again appeared, coming from the bottom instead of the top of the excavation, there being a vein of sand at the level of the top of the lower drift. Finally, after advancing 370 feet from the shore shaft, it was decided to abandon progress in that direction.

On the Detroit side, other difficulties were being encountered. At 1,180 feet from the shaft, the ventilating apparatus proved inadequate and two of the workmen were killed. At 1,220 feet (new machinery having been established) the

influx of water became so great as to require more powerful pumping engines, and then the contractors, discouraged, sought and received permission to relinquish the work.

Then the directors attempted to continue on the Windsor end by means of two parallel trial drifts, and to begin a second one at the shore shaft, at a level 10 feet above the grade of the drainage tunnel, leaving the latter to be used as a sand holder in case of further irruption, the idea being that, in either one or the other drift, some progress might be made. Experience, it seems, had shown that a stream of sand and water flowing into the tunnel at one point would never be accompanied by a troublesome one flowing in at another. It is unnecessary to enter into the details of the last effort. The actual advance in new ground during the last two months was only 64 feet, and the cost about $7,500, or more than 6½ times the contract price, and the directors, in turn discouraged, abandoned the enterprize.

Mr. Chesborough answers various criticisms on the mode of carrying on the work, and states reasons why the orifices through which the irruptions occurred could not be stopped. A shield, he remarks, could not be used to advantage, nor could success have been assured by the pneumatic process. The causes of the irruption were springs and water courses, having their source 100 feet higher than the tunnel, and much above the level of tide water. Mr. McAlpine notes a similar case in the building of the dry docks at Brooklyn, N. Y., where fresh water came in with a head of 50 feet higher than that of the salt water. The water entering at Detroit was sulphur water, and without doubt owed its origin to Sulphur Springs at Sandwich, below Detroit, where the level rises from 30 to 40 feet above that of the river.

A HILL OF SULPHUR.

One of the most remarkable deposits of native sulphur, as yet discovered, is a great hill composed of the almost pure article, found some two years ago at a distance of thirty miles south of the Union Pacific Railway and nine hundred miles west of Omaha. This marvelous deposit is found to consist almost wholly of sulphur, containing only 15 per cent of impurities. The best deposits heretofore available are those found in Sicily. The principal supplies for the manufacture of sulphuric acid come from there; the deposits contain 35 per cent of impurities and 65 per cent of sulphur. Our western sulphur hill, therefore, is much the most valuable, and promises to become ere long of great importance to the country.

THE LAUNCH OF THE CITY OF PEKING.

The country has good cause for self-congratulation in the efforts which our prominent shipbuilders and capitalists are putting forth to regain the commerce which, during the war, passed from under our flag. Another great vessel has been launched, one of the largest ships ever constructed, save the Great Eastern, which is to form part of the Pacific Mail steamship line; a second vessel of similar proportions is on the stocks, and the same builders, we learn, are maturing plans for a line of European steamers. The City of Peking, which was recently successfully launched at Chester, Pa., was constructed by the Delaware River Iron Shipbuilding and Engine Works, of which Mr. John Roach is President, and is without doubt one of the most magnificent vessels, in construction, form, and fittings, ever built. Her length is 420 feet, beam 47 feet 4 inches, and tunnage 6,000 tuns. She has compound engines of 4,500 horse power, and a Hirsch four bladed screw 20 feet 3 inches in diameter. There are four decks, with accommodations for 2,000 passengers, fitted up in almost palatial style. No improvement in interior conveniences has been omitted; the machinery, soon to be inserted, is said to be a masterpiece of workmanship.

The ship is entirely of iron, five million pounds of the metal being used in her hull. She has four masts, three of which are of iron and are used as ventilators, and she spreads 33,000 square feet of canvas. Her estimated consumption of coal under her ten boilers is estimated at between fifty and sixty tuns per twenty four hours, and her speed will be about fifteen and a half knots.

The ceremony of launching was made the occasion of a holiday in Chester, and the town was thronged with visitors from New York, Philadelphia, and Washington. Large numbers of prominent men were present, including senators, representatives, chiefs of bureaus and other government officials. The ship, as the last shore was removed, glided into the water in splendid style, and was duly christened by the daughter of the builder, breaking the traditional bottle of wine over the bows. Speeches were afterwards made by Senators Cameron and Bogy, and by Mr. Roach, the latter gentleman detailing the operations of the company since its formation two years ago. The City of Peking will be commanded by Captain Jefferson Maury, and will shortly be brought to this city to receive her machinery at the Morgan Iron Works.

THE CHARACTER OF METALS AS EXHIBITED BY THEIR FRACTURE.

BY PROFESSOR R. H. THURSTON.

In an article published in the SCIENTIFIC AMERICAN of January 17*, a series of finely executed engravings illustrated the value of an inspection of the fractured surfaces of test pieces of metals broken by torsion as a means of judging of their character.

During the research there referred to, of which the results are given at length in a paper now in course of publication by the American Society of Civil Engineers, in the "Transactions" of that society†, the effect of various changes of condition, in production of alteration in the characteristics of fracture, has been found to present an interesting and useful study.

Referring to that article, the reader will observe the marked difference between numbers 16 and 22 as exhibiting the effect of a difference in thoroughness of working, the former being a good iron badly worked, and the latter being the most perfectly worked piece of iron which has ever come under the observation of the writer. Nos. 23 and 30 show the difference between a cast iron highly charged with carbon and a specimen containing a minimum percentage, while still other illustrations exhibit the low steels 58, 68, 71, containing only iron and a low portion of carbon, and the malleableized cast irons, 33, 35, which are steels which retain the impurities of cast iron, and are somewhat irregular in structure.

The effect of cold upon the properties of iron has been but little understood. One party of experimenters claim to have proven an increase, others a decrease, of strength with decrease of temperature. In a paper, originally prepared for the *Iron Age** and since republished by several other periodicals,† the writer collated such information, as then existed, from both scientific and engineering authorities, which showed that the general effect of low temperature seemed to be a decrease in power of resisting blows and an increase in power of resisting a steady strain, these seemingly contradictory effects being the consequence of increased tenacity accompanied by a simultaneous and yet greater decrease of ductility. Subsequent experiments by the writer, with the autographic testing machine designed by him for the Stevens Institute of Technology, in which errors of observation are avoided by so arranging the apparatus that the specimen tested shall write legibly its own story, have to some extent confirmed those deductions, but have revealed some reversals of the rule and have indicated that good materials are better in both respects at temperatures not far removed from zero.

The paper referred to was called forth by the request of the editor of the paper in which it first appeared, to whom Mr. Oliver Williams had forwarded a specimen of metal which had been broken at one point at a temperature of 75° Fah., and at another place when at a temperature of 20°. This specimen was afterwards placed in the cabinet of metals and minerals, in the lecture room of the writer, at the Stevens Institute of Technology. The method of fracture is stated to have been precisely the same in each case. The difference in appearance is very remarkable. The fracture at 70° is a strikingly perfect illustration of the fibrous, as that at 20° is of the granular, fracture.

Judging from general experience, I should be inclined to consider this iron far less reliable in cold than in warm weather. Careful experiment, however, is daily convincing engineers that the distinction, here so well shown, is a far less reliable indication of the strength and ductility of iron than was formerly supposed.

A kind of fracture which is probably always indicative of brittleness is generally, and possibly correctly, termed crystaline. It is supposed to be produced by a long continued succession of shocks, which, straining the metal to the elastic limit, permit the crystaline grouping of molecules to take place. Dr. Percy, the leading metallurgical anthority of the world, seems to have been fully convinced of the possibility of the formation, in this way, of true crystals; but direct experiment is still desirable to fully determine it. A singular instance of this peculiar molecular action recently occurred at the Morgan Iron Works, New York. While a powerful steam hammer was at work upon the red hot end of a very large shaft, originally designed for the engines of a large naval steamer, a piece of the opposite end, which was cold, and which was supposed to be strong enough to transmit several thousand horse power, dropped off. This was an extraordinary event, but not unprecedented. In all such instances, the fracture seems to follow a plane passing through a comparatively sharp angle at the side of a collar or at the end of a journal.

The effect of cold is not always observable, particularly with ductile iron, of which two specimens were tested, one, at 10° Fah., and the other at 70° Fah. The metal was a cheap grade of wrought iron, quite cold-short, and very irregular. Two specimens from the same bar of good tool steel were also tested, one having been broken at 18° Fah., and the other at 70°.

The purest irons and low steels, and even the shear steels, do not usually show a change in form of fracture with change of temperature. At all temperatures likely to be experienced in this latitude, at least, they are equally reliable.

Two specimens of copper were also tested. The first was cast in dry sand and broken at 10° Fah., the second was cast in green sand and broken at 70°. The beautiful crystaline structure of the former is apparently due, principally, to low temperature. The unsound structure of the latter is the consequence of using a damp mold, and exhibits the advisability of using dry sand whenever possible. The two are very characteristic specimens. Copper is strongest at low temperatures and seems to lose none of its ductility. Forged specimens of copper, in all but color, resemble, when fractured, the toughest and most ductile kinds of iron.

The wonderful difference in properties of steel, under different methods of treatment, is shown by two specimens from the same bar of fine cast steel. The first has been carefully annealed, the second as thoroughly hardened. The close resemblance of the former to the low steels, shown in the former communication, was at once noticed. It does not appear like a true steel, not having even the faintest resemblance to the hardened specimen, which presents the uneven fracture and fine grain characteristic of the best tool steels.

Still another illustration of a peculiar modification of iron produced by special methods of treatment is seen in a piece of iron which had been subjected to the process of cold rolling. The effect of this action is to produce a marked increase of strength and of elasticity. In precisely what way this effect was produced was long a disputed point. No change of density had been detected, and some of the most talented and distinguished scientific men and engineers who had occasion to examine this singular material, as members of the International Jury at the Vienna Exhibition, found it exceedingly difficult to credit the claims made for it, although sustained by reports of experiments made upon it by well known authorities at home and abroad.

It has lately been shown by the writer that the effect of cold rolling is to render the iron more perfectly homogeneous and to produce such a disposition of internal strains as to greatly increase its elastic resistance.*

The thready appearance of the side of the broken specimens, and the toughness and compactness, of which good evidence is seen by an inspection of the end of the test piece, are the peculiar characteristics of this material. Those of the readers of the SCIENTIFIC AMERICAN who have occasion to adopt the method of testing metals, described in the issue of January 17, will be interested in learning the effect of varying the proportions of copper, tin, and zinc, in bronze, brass, and other compositions.

An alloy of ten parts copper to one part tin has two thirds the strength of iron and about one half its ductility. Such a metal is very valuable wherever strength and toughness are required in a cast metal. An increased proportion of tin produces increased hardness and a loss of ductility. Sixty-nine parts copper to thirty-one parts tin is an alloy which is very hard and as brittle as glass. Increasing the proportion of copper gives greater ductility at the expense of strength, and castings become liable to unsoundness.

Zinc is a brittle metal of crystaline structure, and vastly different from tin. Yet an alloy of zinc and copper may be made of considerable strength and of great ductility, as is the case with wire brass where the proportions are about two of copper to one of zinc, and with an unusually beautiful special grade of brass made at the Stevens Institute. This specimen exhibits characteristics common to all the more ductile alloys as well as of the metal tin. The curious, irregularly wavy appearance of the exterior, and the half fibrous, half granular fracture, are seen in gun metal, soft brass, oroide, phosphor bronze, and many other alloys which have been tested. Metal workers often make a free working and fine looking alloy by uniting copper, tin, and zinc. For some purposes such a mixture is well adapted, but it often happens that, without suspecting it, the workman seriously injures his material by adding, for appearance sake, zinc to a bronze in proportions seemingly too small to effect its mechanical properties.

The writer has found the addition of but a fraction over one per cent of lead, to a good brass, to reduce its strength nearly a half, and to cause a corresponding loss of ductility, thus making it but about one fourth as valuable in resisting blows as the clean alloy.

A good bronze, containing about ten of copper to one of tin, to which less than three per cent of zinc was added, was also tested in comparison with a brass in which lead was thus a component. The former is a metal of fine looking exterior, works well and takes a good polish. Its strength is slightly increased by the addition of the zinc, but its ductility is hardly a sixth that of the pure copper and tin alloy. The fracture shows this change to the eye with unmistakeable clearness. Instead of the toughness and extensibility shown so plainly in the specimen with lead in it, is exhibited a ragged, dull, irregular break like cast iron.

Such experiments as these are exceedingly instructive; and every worker in metals, every iron and brass founder, would find himself well repaid for time expended in such researches by the discovery of the mixtures best fitted for his work; and if each were to make public the results of his work, whenever evidently important, he would benefit the world without loss to himself.

Dr. Arnott.

The decease is announced of the celebrated Dr. Neil Arnott, at the advanced age of eighty-five years. He was not only a physician of eminence, but an author, a scientist, and an inventor. His "Elements of Physics," published in 1827, was largely circulated, and greatly promoted the study of the sciences. His researches upon warming and ventilation, and his inventions of stoves and ventilators, have greatly added to human comfort, and have led the way to various other important discoveries. Dr. Arnott was the recipient of many honors, and no one more justly deserved them. His life was a most useful one.

TO NEW SUBSCRIBERS.

It has been our custom to commence at the beginning of the year, all subscriptions received previous to the first of April, and to send the back numbers from the first of January. Hereafter the paper will be sent from the date of receipt of subscription; but to those who wish them, the back numbers from the commencement of the volume will be furnished, and the subscription dated from the first of the year.

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*Testing the quality of iron, steel, and other metals without special apparatus.

†March 1874, *et seq.*

Iron Age, June, 1873.

†*Van Nostrand's Engineering Magazine* July 1873; *Journal of the Franklin Institute*, September, October, 1873; London *Iron*, January 1874, etc.

*Trans. Am. Soc. C. E., March, 1874.