Scientific American.

ESTABLISHED 1845

MUNN & CO., - - - EDITORS AND PROPRIETORS.

PUBLISHED WEEKLY AT

No. 361 BROADWAY, - - NEW YORK.

TERMS TO SUBSCRIBERS

One copy, one year, for the United States, Canada, or Mexico $3.00
One copy, one year, to any foreign country, postage prepaid. £0 16s. 5d. 4.00

THE SCIENTIFIC AMERICAN PUBLICATIONS.

Scientific American (Established 1845) ..... $3.00 a year.
Scientific American Supplement (Established 1876) ..... 5.00 "
Scientific American Building Edition (Established 1885). ..... 2.50 "
Scientific American Export Edition (Established 1878) ..... 3.00 "

The combined subscription rates and rates to foreign countries will be furnished upon application.
Remit by postal or express money order, or by bank draft or check.
MUNN & CO., 361 Broadway, corner Franklin Street, New York.

NEW YORK, SATURDAY, SEPTEMBER 2, 1899.

NICKEL STEEL IN BOILER CONSTRUCTION.

The practical experiments which have been made in the use of nickel steel for boilers have so far given excellent results. Not only is there a lightening of weights due to the superior tensile strength of the alloy, but, what is more important, it has shown both under the test of actual service and in laboratory experiments that it is far more durable than the mild steel ordinarily employed. The saving of weight by the use of the stronger material is not, of course, of so much moment ashore as afloat; but the increased durability which may be given to boilers by using nickel steel for those parts, such as the tubes, which are subject to the most destructive influences, is a question of the very first importance to steam users. Whether the longer life of a boiler built partially or altogether of nickel steel more than offsets its greater first cost may be open to question, but present indications are that it does.

Among the most valuable data on the subject are those afforded by tests which have recently been carried out by Mr. A. F. Yarrow, whose experiments on the question of circulation in water-tube boilers, made a few years ago, attracted much favorable comment and threw upon the subject some greatly needed light. Mr. Yarrow states that the deterioration of boiler tubes is due chiefly to three causes: First, the action of acids in water due to grease; second, the oxidation of the overheated tubes on the outer surface through contact with the hot gases; third, the action of the steam, which if it become superheated decomposes and causes deterioration on the inside of the tubes. Mr. Yarrow made use of lengths of nickel steel and mild steel to ascertain the comparative resisting power of the two materials to the wasting influences above mentioned. This was done in three ways: First, samples were exposed to the action of a dilute solution of hydrochloric acid for certain periods and their weights before and after immersion were compared; then two tubes, one of mild steel and the other of nickel steel, were heated side by side in the same furnace, and the loss due to oxidation through overheating both on the inner and outer surfaces was carefully observed; and lastly, the tubes were heated externally and a jet of highly superheated steam was allowed to act on the inside.

The results in each of the three methods of testing showed the nickel steel to be far superior to the mild steel. In the first test, made on two specimens of the same weight, the loss after 533 hours immersion was in the case of the mild steel 53·19 per cent, while the nickel steel tube had lost only 3·72 per cent.

In the second lot of tests, the amount of oxidation due to the action of fire only was 2·9 times as great in the mild steel as in the nickel steel tubes.

In the third series, with fire outside and superheated steam inside, the nickel steel again demonstrated its wonderful powers of resistance. Each tube weighed originally 612 grammes, and after the test had been running for ten hours, the mild steel tube had burnt entirely through. At this point the nickel steel tube had lost 12·7 grammes as against 85·2 grammes lost by the mild steel. A second mild steel tube was put in, the nickel steel one being retained. After eight hours the second mild steel tube gave out. A third tube was tried and it had been running three hours before the original nickel steel tube gave out, after enduring the test continuously for twenty-one hours. The average life of the first two mild steel tubes was only nine hours. From the last series of tests Mr. Yarrow concludes that deterioration from this cause alone would make it necessary to retube a boiler carrying mild steel tubes 2⅓ times as often as it would one provided with nickel steel tubes.

Another important feature brought out in these investigations related to the permanent increase or decrease in length of boiler plates and tubes due to their heating and cooling. The frequent and sudden variations in temperature due to varying rates of combustion, to opening and closing fire doors, etc., it is well known, produce permanent changes of length in boiler material. In the present tests exact measurements were taken in order to secure accurate data on a question which so materially affects boiler design. It was found that in a mild steel tube 3½ feet in length, which was heated twenty-one times to a dull red for successive periods of two hours length each, superheated steam at a pressure of 60 pounds being passed through the tube, the permanent reduction of length at the close of the tests was seven-eighths of an inch. Now in the case of a nickel-steel tube of similar dimensions exposed to like conditions there was an increase of length of seven thirty-seconds of an inch instead of a contraction. The important bearing of this fact on boiler construction where nickel steel and mild steel are to be placed in juxtaposition is very evident.

Taken altogether, the results of these experiments form a valuable addition to the ascertained data on this subject, and they certainly point to nickel steel as the very material for boiler construction, judged on the score of durability; for Mr. Yarrow estimates that under working conditions boiler tubes containing 20 to 25 per cent of nickel will withstand corrosion for a far longer period than tubes of mild steel, while their resistance to destruction by the action of heated gases or steam is estimated as about twice as great. Of course it must be borne in mind that the greater cost of the alloy more than offsets its longer life, and for this reason mild steel will probably continue to be used for the ordinary stationary boiler; but for special work, where it is desirable to save weight and avoid frequent repairs, it is certainly the ideal material.

TROLLEY CARS ON GRADES.

The trolley car disaster at Stratford, Conn., as we pointed out in our issue of August 19, directs attention not merely to the necessity for providing ample guard-rail protection on bridges but to the perils which arise from careless or ignorant manipulation of the cars on down grades. As a rule, electric cars are provided with unusually powerful hand-brakes and also with means to brake the car by reversing the current. The knowledge that he can stop the car in a very short distance is a temptation to the motorman to run at excessive speed on down grades and to swing around curves at a higher rate of speed than the super-elevation of the outer rail allows. This is a danger to which all trolley roads that combine steep grades and heavy curvature are exposed, and a proper regard for the safety of the public demands that an extra rail should be used on the inside of the inner rail where the degree of curvature exceeds a certain amount. This is particularly important on the long, steep grades which are to be found on many of the existing suburban or interurban trolley roads. A curve which a car will safely negotiate at a speed of fifteen miles an hour would derail a runaway car traveling at thirty or forty miles an hour.

Moreover, on all electric roads that traverse a hilly country the outer rail on curves should be elevated beyond the theoretical amount called for by the normal running speed of the car. This excess of elevation combined with the use of a steel guardrail against the inner rail on the curve would keep a car on the track at a high runaway speed.

The possible risks of a car "getting away" on a down grade received a curious illustration on August 21 upon the steep trestle which leads from the Jersey City Heights to the Hoboken ferry. It seems that the trolley pole had left the wire and that the motorman, in leaning out and looking back, lost his balance and fell from the car, leaving it free to descend by its own gravity. The track is thoroughly well guardrailed throughout, and no disaster followed. Fortunately among the frightened passengers was one having presence of mind enough to spring to the platform and apply the brake, thereby bringing the car to a standstill.

In view of the enormous growth of electric roads and the haste with which they are frequently constructed, it would certainly be advisable for the Legislatures to call in expert advice and pass some laws regulating the question of trolley car control and safety appliances, not merely on bridges, but on grades and heavy curvature.

THE STATISTICS OF OUR VAST RAILROAD SYSTEM.

The latest report of the Interstate Commerce Commission shows that the vast railroad system of the United States has settled down to a steady rate of growth which is in marked contrast to the enormous and, as later developments proved, disastrous additions to its mileage which were made in the last decade. That a boom in construction which resulted in the addition during a single year of 12,000 miles of new road was altogether disproportionate to the demands of the situation was proved by the large number of roads which went into the hands of receivers during and after the panic of 1893. Of late years there has been a decided improvement in the railroad situation, for not only have many roads been removed from the control of receivers, but a certain amount of new construction has been undertaken. The report for the year ending June 30, 1898, shows at that date 94 roads operating 12,744 miles of track were in the hands of receivers, a decrease of 6,116 miles. During the year 45 roads were removed from the receivers' hands as against 11 roads for which receivers were appointed. The total number of railways in the United States was 2,047, and the total number of miles of track in operation, including side tracks and sidings, was 247,523.

To operate this system required 36,234 locomotives and 1,326,174 cars, an increase of 248 locomotives and 28,694 cars as compared with the previous year. The total number of passengers carried was 501,066,681, which is 11,621,483 more than in the previous year, while the number of tons of freight carried showed an increase of 137,300,361 tons, the total for the year being 879,006,307 tons. The gross earnings reached a total of $1,247,305,621, an increase during the year of $125,235,848, while the net earnings for the year were $429,352,345, an increase of $ 59,787,336. The amount available for dividends or surplus was $140,319,421, and the total amount of dividends declared was $96,240,864. The total amount of railway capital outstanding was $10,818,554,031, and of this only thirty-four per cent paid any dividend.

We learn that out of a total of 47,741 casualties there were 6,859 persons killed during the year and 40,882 injured. Two hundred and twenty-one passengers were killed, or one for every 2,267,270 carried, while the number of injured was 2,945, or one for every 170,141 carried. The perils of "railroading," however, are painfully manifest in the facts that one out of every 447 employés is killed and one out of every 28 is injured, the total number of killed during the year being 1,958, and of injured 31,761. We feel constrained again to point out that these statistics of injuries and fatalities indicate that much remains to be done in introducing safety appliances for the protection of employés. The Interstate Commerce Commission has done good work in enforcing the equipment of cars with automatic couplers: and it is to be hoped that in its leniency toward roads which are financially embarrassed it will not lose sight of the fact that the life and limb of the vast army of employés that work our railroads are of paramount importance.

WEIGHT OF MAIL MATTER IN THE UNITED STATES.

Strange as it seems, the United States government has not taken a complete accounting of the actual total weights of the mail matter carried by it for over twenty years. During the time since the last general weighing of mails handled by the railroads and other common carriers the volume of our postal business has increased enormously, and in recent years the transportation weights charged for by these carriers have been largely taken on faith, as the Post Office Department could only estimate, but not accurately know, whether it was being overcharged in the enormous sums that it annually pays for mail transportation.

Some idea of the wonderful increase of this branch of governmental business is had from the fact that an expenditure of $30,393,209.53 for carrying the mails in 1888 had swelled to $52,294,382.23 in 1898, an increase to nearly double in ten years. In 1879 the total length of our postal routes was 79,991 miles; the last report shows it to be now 174,777. The annual transportation over these routes in 1879 was 96,497,463 miles, the last report showing a mileage of 281,595,612. In other words, less than twenty years has seen an increase of 116 per cent in the total miles of route, and of 191 per cent in the gross of annual mileage.

A partial idea of what this whole system of the transportation in bulk of our mail matter has grown to under enlightened management, and owing to the great increase in general literacy, is derived from the following statements taken from figures in the last annual report of the Postmaster-General: Of traveling post offices, on railway, steamboat, electric and cable tramways, we have 1,268 lines, covering 167,755 miles, with a grand total mileage of 285,565,343. Over these and throughout the service were handled 6,349,662,320 pieces of first-class matter, 5,876,043,900 pieces of inferior classification, and 591,492,490 pieces of purely city handling, a grand total of 12,817,198,710 pieces. These, if only averaging the length of a medium-sized envelope, would stretch 1,213,750 miles, or a little over forty-eight and one-half times around the earth.

It is scarcely to be wondered at, when we consider that an accurate weight tally of this enormous bulk of mail has not been taken within a time during which it has more than doubled in size, that there has been considerable Congressional and newspaper criticism of former Postmaster-Generals for paying the immense and rapidly growing bills for this transportation without question; nor is it to be wondered at that almost every session of Congress for the past decade has seen the introduction of some bill looking to the curtailment of these expenses.

The country is now to be congratulated on the fact that Postmaster-General Smith has set in motion an inquiry into this whole matter, from which will grow a clearer and more comprehensive report to Congress on this subject than has been possible since the days of the Grant administration. Three experts from New York city, aided by others already in Washington, have been for some days perfecting plans and preparing circulars, blanks, tables, etc., whereby on October 3 next every post office in the country will begin

weighing all matter passing through it. There are nearly 80,000 offices, and in each one of these this weighing will be kept up for thirty-five consecutive days. At the end of this time each office will forward to Washington its complete report and from this enormous mass of statistics will be compiled, by a special staff, yet to be selected, a wealth of information that cannot fail to benefit the service greatly.

It is likely that this general stock taking, if so it may be called, will reveal many opportunities for economy and kindred improvements in the railway postal service. It will assuredly set at rest the moot question as to whether bulk mail is being hauled back and forth, charged for both ways, by certain railways. It will also, we believe, show that both letter and newspaper postage, under proper restrictions, can be still further cheapened, and that manuscript designed for publication, proofs, and authors' revises and notes can all be treated more leniently in the interest of the wider dissemination of information and education by the press. The country is, also, to be congratulated that it now has at the head of this department a man of affairs, a newspaper man of long training, whose comprehension of the needs of the service under his charge is unusually broad and thorough.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

BY HORACE C. HOVEY.

The forty-eighth annual meeting of the American Association for the Advancement of Science was held in Columbus, O., from August 19 to August 26, 1899, and was marked by many features of scientific and social interest. Preliminary arrangements were made with unusual care by a large and representative Local Committee, whose executive officers were Hon. Henry C. Taylor, Chairman, Prof. B. F. Thomas, Secretary, and Mr. F. L. Kiesewetter, Treasurer. Special committees on reception, finance, excursions, railroads, hotels, printing, etc., did everything well and contributed largely to the success of the meeting. The hotel headquarters were at the Chittenden, whose spacious and elegant rooms were admirably adapted for the occasion. Evening meetings were held in the auditorium of the Board of Trade building. The daily meetings were in the various and commodious buildings of the Ohio State University, accessible by street cars or carriages. A noon-day lunch provided at the Armory, and free to the guests, enabled them to spend the day on the grounds. The general session met regularly at 10 A. M., followed by sectional meetings, with a noon intermission, and closed at about 5 P. M. Placards placed conveniently on rocks or trees guided the scientists to the different buildings where the opening addresses were made by the sectional vice-presidents. After the first day, however, most of the meetings were held in Townsend Hall. Eight rooms were connected by telephone, and in each was a bulletin board whereon was indicated whatever was going on in the other seven rooms. All the telephone girls were students in the University and did their best to keep us apprised of the progress of affairs. Simple and practical as this plan appears, it has only been adopted once before, at a former meeting in Boston. The American Association for the Advancement of Science is created expressly for the diffusion of knowledge among the people, and is in no sense an exclusive society for the enjoyment or glory of a few favored ones. The ancient fiat "Let there be light" might well be its motto. Besides the regularly elected fellows and members, the privileges of the meetings were extended to their families and their hosts, and indeed to all who took enough interest in scientific research to induce attendance.

The retiring President, Prof. F. W. Putnam, called the association to order at its opening meeting, and introduced the newly chosen President, Dr. Edward Orton, who replied to the greetings of the State and municipal officials. Ably he set forth the aims and claims of the American Association for the Advancement of Science on public regard, showing that it represents the broad continent, already including the Canadian Dominion, and willing to include Cuba, Mexico and Central America on the same terms. An inventory of epoch-making discoveries and inventions previous to this century shows only fifteen items of the highest rank, for instance, the alphabet, Arabic numerals, the mariner's compass, the printing-press, the telescope and microscope, the barometer and thermometer, the calculus, gravitation, planetary motion, the circulation of the blood, the steam-engine, the foundation of modern chemistry and electrical science, and the measurement of the velocity of light. We might add certain medical discoveries, as those by Jenner. Something like this is the record prior to the year A. D. 1800. Counting on the same basis, Wallace finds no less than twenty-four first-class discoveries and inventions in the nineteenth century, as over against the fifteen or sixteen of all past time. These the speaker proceeded to enumerate and described as warranting our styling this as above all others the Age of Science. And it is for the further "advancement of science" that this association exists. Its very title indicates that its work is yet incomplete, and we still labor to discover new forms of truth and new arts for human welfare. His address was all the more impressive by reason of the discoveries that have made the name of Dr. Orton famous throughout America.

After the opening exercises the sections organized for business. The vice-presidential addresses were given Monday afternoon. The subject of Prof. Benjamin's address before the Section of Social and Economic Science was "The Past Presidents of the Association." Prof. Whiteaves, of Canada, spoke to the Section of Geology and Geography on "The Devonian in Canada." "The Fundamental Principles of Algebra" was Prof. Macfarlane's topic for the Section of Mathematics and Astronomy. The Section of Physics was addressed by Prof. Thomson on the "Field of Experimental Research." Prof. Storm Bull spoke before the Section of Mechanical Science and Engineering on "Engineering Education as a Preliminary Training for Scientific Research Work." The Zoologists heard Prof. Gage speak as to "The Importance and the Promise in the Study of the Domestic Animals." (An abstract of this address will be found in SCIENTIFIC AMERICAN SUPPLEMENT, No. 1235.) To Chemists Prof. Venable spoke on "The Definition of the Element." Botanists were told by Prof. Barnes as to "The Progress and Problems of Plant Physiology." The Section of Anthropology was addressed by Prof. Wilson on "The Beginnings of the Science of Prehistoric Anthropology." Most of these addresses may appear in the successive numbers of the SUPPLEMENT, and hence are only mentioned by title now.

Prof. F. W. Putnam, whose labors in every way, but especially as permanent Secretary of the American Association for the Advancement of Science, have so largely contributed to its success in former years, addressed a large and highly appreciative audience in the evening on "A Problem in American Anthropology." He introduced his remarks by an announcement of the recent death of the eminent anthropologist and Past-President of the Association, Dr. D. G. Brinton, and paid a glowing tribute to his merit and success. Yet Prof. Putnam differed from him on certain radical points, particularly as to his theory of an all-prevailing psychological influence guiding men's development, and his claim that American art and culture were autochthonous, foreign resemblances being but correspondential analogies. Prof. Putnam briefly reviewed the various theories held by other authorities as to American anthropology. In advancing his own views he said, in part, as follows:

"Some mounds cover large collections of human bones; others are monuments over graves of noted chiefs; others are in the form of effigies of animals and of man; and in the South mounds were in use in early historic times as the sites of ceremonial or important buildings. Thus, it will be seen that earth mounds, like shell mounds, were made by many people at various times."

He also said there was another class of earthworks that had to be considered by themselves, such as the Newark, Liberty, Highland, and Marietta groups. So far as these have been investigated they proved to be of very considerable antiquity, shown by the formation of over a foot of humus or vegetable matter upon their sides.

In studying the art of these builders, Prof. Putnam said we found the meaning only by turning to ancient Mexico. The famous Cincinnati tablet which has been under discussion for half a century can be interpreted by its dual serpent characters, understood by comparing it with the great double image known in Mexico as the Goddess of Death and the God of War. In speaking of the builders themselves, he said the fortified hills have their counterpart in Mexico.

Our Northern and Eastern tribes came in contact with this people when they pushed their way southward and westward, and many arts and customs were doubtless adopted by invaders, as shown by customs still among the Indian tribes. Prof. Putnam is of the opinion that man was on the American continent in quaternary times and possibly still earlier. Recent investigation has shown the occupation of the Delaware Valley during the closing centuries of the glacial period.

In speaking of the epoch of exploration, he said it was no longer considered sacrilegious to exhibit skulls and skeletons and mummies in connection with the works of ancient or modern people. He said the public need no longer be deceived by accounts of giants and wonderful discoveries, as there is too much authentic material now for comparison.

After the address, the members of the association returned to the Chittenden Hotel, where they were received by President and Mrs. Thompson, of the University.

COPPER COINS MELTED UP.

Nearly ten thousand bags or about two hundred and fifty tons of copper coins have been brought from India. These coins are shipped as scrap copper and are worth more at the present price of copper than their coin value. The Brass Foundry Company, of New Haven, Conn., received five tons of this supply, and they have favored us with some interesting samples of the coins they are melting. The copper is worth 19 cents a pound in this country, but for 19 cents in American silver several pounds of copper coins can be obtained in Bombay or Calcutta. Of course, the coins are in common use there, but are so bulky that the natives are glad to dispose of them for silver and gold. The coins are bigger than a quarter of a dollar and are much thicker than any of our copper coins. They very much resemble the old American copper cent. There is no English inscription on the coins, and they are believed to be coined by the Indian native government in the early part of the present century, when the price of copper was very low.

THE ALLEGHENY OBSERVATORY OBJECTIVE.

We have been favored by Mr. J. A. Brashear with some particulars regarding the new Allegheny Observatory, and the glass which he is to make for them. He says: "The old observatory, in which Profs. Langley and Kuhn did such good work, became unfitted for modern research. First, on account of its rather meager equipment, but what was far more important, the city has so encroached upon it that the atmosphere is usually vitiated by the smoke from houses, mills, etc. As chairman of the observatory committee, I first had the good fortune to secure a splendid site in the very center of the new park given to Allegheny City by its generous citizens, which is situated beyond the smoke environments. The place set apart for the observatory is a hill in the center of the park 552 feet above low water mark of the Ohio River and about 1,200 feet above sea level, and it is so situated with reference to the two cities of Pittsburg and Allegheny that the prevailing winds give us a practically clear atmosphere. It is a fact, however, that a small amount of smoke diffused through the atmosphere contributes to steady definition in solar work, to which, I think, we shall devote most of the time of the new observatory.

Plans for the new observatory are now nearly complete, Prof. F. L. O. Wadworth, the new director, having devoted many months to a careful and critical study of the detail of the building and instrumental equipment; and if the plans are carried out to the fullest extent we shall have an observatory for astro-physical research second to none in the world. Not the largest telescope, we are not after that, but a complete equipment for work in the domain of the new astronomy.

Our plans now are to have a 30-inch clear aperture telescope; the disks for the objective of which have already been ordered from Mantois, of Paris, and will be ready for us about the first of the year. A large reflecting telescope, perhaps of not less than a 36-inch aperture, will be constructed for spectroscopic work. A 13-inch refractor will be erected and equipped solely for the use of the citizens, or, in other words, a free observatory for the use of the higher classes in the public schools, and any and every one desiring to see the "beauties of the skies." This has always been a hobby with me, for well I know, when a boy, how I would have given all the little I had to have a look in a telescope. But I am getting off the track. In addition to the telescopic equipment we expect to have an immense siderostat, by which we can use the great objective for projecting the sun's image on the slit of the large spectroheliograph, which will, by this arrangement, not have to be carried by the eye end of the large telescope, but will remain stationary in a specially constructed underground apartment. The entire basement of the observatory will be fitted up for correlated research, i. e. especially in the domain of solar physics, and the beam of light from the great siderostat will be brought down to the basement and by suitable mirrors made available in every department of the observatory. The building will be provided with a 60-foot dome, a 30-foot and a 26-foot dome. The architectural design of Mr. T. E. Billquit has been accepted. It is classic in style, and will look very beautiful on the hill in the park. It will be visible over an area of perhaps 50 square miles.

Mrs. William Thaw, Jr., a lady of Allegheny, has given the money for the great objective as a memorial to her husband, who always had a great interest in the work of the observatory, having contributed to its success during his life time. The family of that staunch friend of the observatory, Mr. William Thaw, Sr., have provided for the great telescope. Mr. Andrew Carnegie has given $20,000 toward the project, and a number of Pittsburg's and Allegheny's best citizens have contributed handsomely to the fund for the new observatory. Mr. George Westinghouse has given the complete electric plant, and there is no doubt of the successful issue of this "Temple of the Skies."

I have devoted nearly all my time for nearly two years to raising the fund for the building and equipment, and as an old-time reader of the SCIENTIFIC AMERICAN, I am glad to give you these notes.