

Scientific American.

ESTABLISHED 1845.

MUNN & CO., Editors and Proprietors.

PUBLISHED WEEKLY AT

No. 361 BROADWAY, NEW YORK.

O. D. MUNN.

A. E. BEACH.

TERMS FOR THE SCIENTIFIC AMERICAN.

One copy, one year, for the U. S., Canada or Mexico.....\$3 00
 One copy, six months, for the U. S., Canada or Mexico.....1 50
 One copy, one year, to any foreign country belonging to Postal Union. 4 00
 Remit by postal or express money order, or by bank draft or check.

MUNN & CO., 361 Broadway, corner of Franklin Street, New York.

The Scientific American Supplement

is a distinct paper from the SCIENTIFIC AMERICAN. THE SUPPLEMENT is issued weekly. Every number contains 16 octavo pages, uniform in size with SCIENTIFIC AMERICAN. Terms of subscription for SUPPLEMENT, \$5.00 a year, for the U. S., Canada or Mexico. \$6.00 a year to foreign countries belonging to the Postal Union. Single copies 10 cents. Sold by all newsdealers throughout the country. See prospectus, last page. Combined rates for SCIENTIFIC AMERICAN and SUPPLEMENT will be sent for one year, to one address in U. S., Canada or Mexico, on receipt of seven dollars. To foreign countries within Postal Union eight dollars and fifty cents a year.

Building Edition of Scientific American.

THE BUILDING EDITION OF THE SCIENTIFIC AMERICAN is a large and splendid illustrated periodical, issued monthly, containing floor plans and perspective views pertaining to modern architecture. Each number is illustrated with beautiful plates, showing desirable dwellings, public buildings and architectural work in great variety. To builders and all who contemplate building this work is invaluable. Has the largest circulation of any architectural publication in the world. Single copies 25 cents. By mail, to any part of the United States, Canada or Mexico, \$2.50 a year. To foreign Postal Union countries, \$3.00 a year. Combined rate for BUILDING EDITION with SCIENTIFIC AMERICAN, to one address, \$5.00 a year. To foreign Postal Union countries, \$6.50 a year. Combined rate for BUILDING EDITION, SCIENTIFIC AMERICAN and SUPPLEMENT, \$9.00 a year. To foreign Postal Union countries, \$11.00 a year.

Export Edition of the Scientific American.

with which is incorporated "LA AMERICA CIENTIFICA E INDUSTRIAL," or Spanish edition of the SCIENTIFIC AMERICAN published monthly, uniform in size and typography with the SCIENTIFIC AMERICAN. Every number contains about 50 pages, profusely illustrated. It is the finest scientific, industrial, export paper published. It circulates throughout Cuba, the West Indies, Mexico, Central and South America, Spain and Spanish possessions—wherever the Spanish language is spoken. THE SCIENTIFIC AMERICAN EXPORT EDITION has a large guaranteed circulation in all commercial places throughout the world. \$3.00 a year, post paid to any part of the world. Single copies 25 cents.

Manufacturers and others who desire to secure foreign trade, may have large and handsomely displayed announcements published in this edition at a very moderate cost. MUNN & CO., Publishers, 361 Broadway, New York.

The safest way to remit is by postal order, express money order, draft or bank check. Make all remittances payable to order of MUNN & CO.

Readers are specially requested to notify the publishers in case of any failure, delay, or irregularity in receipt of papers.

NEW YORK, SATURDAY, DECEMBER 21, 1895.

CONTENTS.

(Illustrated articles are marked with an asterisk.)

Agricultural building, Atlanta*.....	393	Moon, eclipse of, September 3*.....	395
Archaeological discoveries.....	397	Navigation, ocean steam.....	396
Arkon, the discovery of.....	391	Notes and queries.....	396
Asafetida.....	390	Panama Canal, progress of.....	394
Atlanta Exposition, the*.....	393	Pasteur Institute farm.....	397
Bicycle brake, Stewart's*.....	393	Patents granted, weekly record.....	397
Bicycle, notes.....	398	Philosophy, the rewards of.....	390
Boat, Najor's foot-motor*.....	398	Pneumatic tire, metallic tread for, Growney's*.....	398
Books and publications, new.....	396	Police telephone, Chicago.....	398
Debts, private and public.....	399	Potatoes, experiments with.....	395
Dentistry in Japan.....	390	Propeller shafts, breaking of.....	394
Diseases, incubation of.....	391	Railway pole*.....	399
Electric power in New York.....	391	Rubber stamps, air cushion*.....	390
Electric railway street sprinkler.....	394	Savannah, the first ocean steamer*.....	392
Emerald, analysis of.....	398	Sawyer, Sylvanus.....	391
Fender, car, new.....	399	Sewing machine motor.....	394
Fine Arts building, Atlanta*.....	393	Silver from silver bromide.....	398
Forest, a submerged.....	391	Skin, artificial.....	394
Furnace, the "Alice," Birmingham, Ala.*.....	395	Spectrum, invisible.....	399
Gold, a substitute for.....	398	Steam navigation, early history of.....	392
Hair worms.....	397	Stellar systems, dimensions of.....	394
Insect stings remedy.....	390	Sulphur mining in Louisiana.....	398
Incubator.....	391	Traction engine, Ingletons*.....	394
Inventions, recently patented.....	395	Vehicle brake, Davis*.....	390
Iron founding, Alabama*.....	397	War steamer, the first*.....	392
Ketonic acid.....	397	Wamps, suicidal.....	390
Lead pencils, manufacture of.....	390	Wool for underclothing.....	391
Mars, no water vapor in.....	390		
Milk, electrolysis of.....	395		

TABLE OF CONTENTS OF

SCIENTIFIC AMERICAN SUPPLEMENT

No. 1042.

For the Week Ending December 21, 1895.

Price 10 cents. For sale by all newsdealers.

I. AGRICULTURE.—Lecture on Potatoes.—This article treats of the species and varieties of potatoes, hybridization, the prevention of disease, and grafting.—2 illustrations.....	16659
II. BOTANY AND HORTICULTURE.—Commercial Fibers.—By D. MORRIS.—Lecture I (continued).—This lecture treats of ramie, other nettle fibers, sunn hemp and sida fiber, jute and bilisus fibers.—3 illustrations.....	16659
III. CIVIL ENGINEERING.—Brighton and Rottingdean Tramway.—A description of this seashore car that runs on a roadbed which is entirely submerged at high tide.—3 illustrations.....	16653
A Novel Brick Chimney.—1 illustration.....	16654
The Making of a Tunnel.—The Waterloo and City Railway.—This railway will probably be completed by the end of 1896.—The entire length of the line will be one mile and a half.—There will be no intermediate station.—The engraving shows the Beach tunneling shield in operation.—1 illustration.....	16654
Portland Cement.—By SPENCER B. NEWBERRY.—A report of the annual meeting of the Association of German Portland Cement Manufacturers, giving particulars of a uniform testing apparatus, report of the committee on the influence of magnesia in cement, and report of the committee on the action of sea water on cement and on the process of hardening in Portland cement.—A full paper.....	16649
Railway Signaling.—By WM. MCGRAFTON.—This installment of a valuable paper treats of the construction of interlocking machines, facing point lock and detector bar electric lock, double point switch and lock movement, slotted signals and compensators.—4 illustrations.....	16652
The Savoyarde.—The Bell of the Church of the Sacred Heart, Paris.—A description of this enormous bell, with details of its transportation to Paris by rail and its passage through the streets of that city.—Fully illustrated by diagrams of the bell and mounting and engravings of its transportation.—7 illustrations.....	16647
IV. ELECTRICITY.—Electric Registering Water Level Indicator.—A detailed description of an elaborate system for registering water levels at a distance.—4 illustrations.....	16655
V. METALLURGY.—Notes on Gold Milling in California.—By ED. B. PRESTON.—Mill details.—This article treats of mill details and is fully illustrated.—25 illustrations.....	16656
VI. MISCELLANEOUS.—Collisions Between Steamers and Whales.—This article gives an account of various collisions between whales and ocean steamers.—1 illustration.....	16658
VII. TECHNOLOGY.—The Commercial Manufacture of Liquid Air and Oxygen.—3 illustrations.....	16650
Manufacture of Photographic Plates.—An illustrated article, giving details of the cutting of the glass for the plates, the cleaning of the glass, the preparation of the emulsion, the coating, drying, and packing of the plates.—2 illustrations.....	16651
VIII. VETERINARY SCIENCE.—Investigation of Bovine Tuberculosis, with Special Reference to its Existence in Iowa.—An interesting and important paper, giving a method of applying the test and giving the results of experiments, how the affection is extended, what are the symptoms of the disease, the relation of meat and milk supply to public health, etc.....	16651

PRIVATE AND PUBLIC DEBT IN THE UNITED STATES.

The production and trade of a country necessitate an elaborate system of debts and credits which increase proportionately to the magnitude of its commercial operations.

According to the Official Bulletin, the minimum private and public debt of the United States for the year 1890 was \$20,227,170,546. Of this sum, \$6,200,000,000 represents the debt of quasi public corporations, under which head are included railroad companies, street railways, telegraph, public water, electric and gas companies, etc., 91.44 per cent of this, or \$5,669,431,114, being the debt of the railroad companies alone.

The debts of individuals and private corporations reach a total of \$12,000,000,000, divided as follows:

Real estate mortgages.....	\$6,019,679,985
Crop liens in the South.....	300,000,000
Crop liens outside of the South.....	350,000,000
National banks, loans, etc.....	1,904,167,351
Other banks, loans and overdrafts.....	1,172,918,415
National, State and local taxes.....	1,040,473,013
Other net private debt (estimated).....	1,212,761,236
Total private debt.....	\$12,000,000,000
Total for public corporations (as above).....	6,200,000,000
Total.....	\$18,200,000,000

The public debt, less sinking fund, in which debt is included that of the United States, States, counties, municipalities and school districts, is \$2,027,170,546, which, added to the private debt, makes a total of all kinds for the country of over twenty billions.

It is significant that over 58 per cent of the combined debt on farms and homes occupied by owners was incurred for the purpose of the purchase of real estate. The large profits which were realized by the earlier purchasers or original owners of inside and outside property in and around the rapidly growing cities of the States encouraged an abnormal amount of speculation in this direction during the few years preceding the late crisis. In the middle, and particularly in the Western States, this form of speculation, if it was not directly contributory to the crisis, certainly served to render it very acute when it came.

The crop liens of the South are a legacy of the civil war. At its close the farmers possessed their land and a few mules and tools, but no money. The merchants furnished supplies in consideration of crop liens and mortgages on farm stock. The system thus begun has continued to the present day.

The loans from banks are obtained on the understanding that they are for capital.

The tax debt and the public debt are incurred "for the maintenance of justice, the promotion of public works and for education."

From the above categorical view of the various kinds of debt that go to make up the total for the country, it is seen that fully nine-tenths were incurred in the acquisition of capital and property. Less than one-tenth represents "debt necessitated by misfortune."

Next in importance to the question of the amount of debt of the country is the question of the rate of interest upon which the various loans were granted. The average rate of interest on railroad debts is 4.50 per cent; on street railways, telegraphs, etc., 5.89 per cent; on real estate mortgages, 6.60 per cent; bank loans and over-drafts, 6.60 per cent; crop liens outside the South, 10 per cent; crop liens in the South, 40 per cent; making an average rate on private debts of 6.67 per cent.

The rate on the United States public debt is 4.08 per cent; and on States, counties, and municipalities, 5.29 per cent. The average rate of interest on the total indebtedness of the country is 6.44 per cent.

Referring to the ruinous rate of interest paid on crop liens in the South, the report states that "extensive inquiries, answered by merchants and cotton buyers, who hold crop liens, point to the conclusion that the average rate on these liens must be as high as 40 per cent, rarely going as low as 25 per cent, and often going as high as 75 per cent and more!"

The relatively low rate of 4.08 on the debt of the United States is partly explained by the fact of its exemption from taxation.

Referring to the average rate of interest of 6.60 per cent on real estate mortgages, it should be noted that, in the case of farms occupied by owners, this rises as high as 7.07 per cent and 7.36 per cent on acre tracts.

The percentage of debt to wealth is for:

Railway companies.....	67.48 per cent.
Street railways and telephone companies.....	66.60 "
Incumbered farms occupied by owners.....	35.55 "
Incumbered homes occupied by owners.....	39.77 "
Taxed real estate and untaxed mines.....	16.71 "
The whole United States.....	31.10 "

The total wealth of the United States corresponding to the total debt of over \$20,000,000,000 is about \$65,000,000,000.

The total per capita debt, including both public and private debt, is \$323, or \$1,594 per family of 4.93 persons, as per the census of 1890.

In connection with the above classification of the various forms of indebtedness, public and private, it is satisfactory to learn that there was a total increase

of wealth, during the ten years from 1880 to 1890, of \$21,395,091,197; the increase for the year 1889 to 1890 being nearly three billions of dollars.

NEW YORK THE BIRTHPLACE OF OCEAN STEAM NAVIGATION.

Doubtless the majority of the readers of the SCIENTIFIC AMERICAN have a more or less distinct impression that New York was in some degree associated with the development of the first steamboat; but it will, no doubt, be a pleasant surprise to learn that this city has a threefold claim to be called the cradle of the steamship. The first practical river steamer, the first vessel propelled by steam to make a deep sea voyage, the first transatlantic steamship, and the first steam warship, all owed their existence to the inventive genius of New York designers and the practical skill of New York craftsmen.

In drawing attention to this interesting coincidence, we would not detract from the fame and credit due to the earlier inventors of the sixteenth and eighteenth centuries. Blasco de Garay and Denis Papin were undoubtedly the pioneer investigators of the possibilities of steamship propulsion, and, to a certain extent, they proved its possibility; but the mechanical forms in which they embodied their ideas were crude and possessed no practical commercial value. While the theory of steam navigation was old, centuries old, it required some master mechanic to embody this idea in practical, mechanical shape, and this was what Robert Fulton, associated with R. Livingston, accomplished, when, on August 7, 1807, he saw his first steamer, the Clermont, cast off her moorings at the New York docks and start on her maiden trip to Albany.

To Colonel John Stevens, and, indirectly, to a monopoly of navigation on the Hudson, granted to the owners of the Clermont, New York owes the distinction of having built the first deep sea steamer; and the credit of building the first steamer to make a transatlantic passage is shared by New York conjointly with Savannah, Ga. The Savannah having been built at New York and engined at the Southern seaport.

Of scarcely less historic interest than the Clermont is the battle ship Fulton the First, which was named after the designer, and testifies yet further to his inventive genius.

Like the other pioneer ships in their respective classes, the Fulton was built in New York ship yards, and thus clearly establishes this city's claim to be called the cradle of the modern steam battle ship.

A cut of the original plans for this vessel will be found in the SCIENTIFIC AMERICAN SUPPLEMENT for April 21, 1894. The dimensions of this vessel prove that Fulton had the courage of his convictions, for her displacement was greater than that of the average three-decker of that period, and considerably over that of the Victory, which carried Admiral Nelson at the battle of Trafalgar.

The Fulton the First showed a trial speed of over 6 miles an hour, which was far above the average, day in and day out, speed of the fleetest sailing frigates of those times.

In many details she anticipated the modern war ship; as, for instance, in the provision that she should be "furnished with four submarine guns, to discharge a hundred pound ball into an enemy, ten or twelve feet below her water line." The cross section shows that her engines and boilers were placed low down in the hold, and that the portion above the water line was protected by side armor of 5 feet of oak, an amount which was certainly impenetrable by the ordnance of that date.

It is unquestionable that, with her greater maneuvering power, her 100 pounder guns, and the superior protection afforded to the gunners, she would have proved more than a match for the best ship of the line of that date. The close of the war of 1812 prevented her from testing her strength against the English ships; but tradition has it that the appearance of this 2475 ton monster, gliding swiftly down the bay, with no visible means of propulsion, struck terror into the "indomitable heart" of the British tar!

Analysis of Emerald.

The author has operated on the emerald of Limoges (Chanteloube, Haute Vienna). He gives the following results:

	I.	II.
Loss at a red heat.....	1.46	1.41
Silica.....	66.06	65.80
Alumina.....	16.1	16.40
Glucose (? should be glucina) ..	14.23	14.21
Ferric oxide.....	1.2	0.9
Mn ₂ O ₃	—	—
Magnesia.....	0.75	0.61
Lime.....	0.17	0.14
Phosphoric acid ..	0.11	0.09
Alkalies.....	—	—
Titanic acid.....	traces	traces
	100.11	99.67

—P. Lebeau.