

## SCIENTIFIC AMERICAN

ESTABLISHED 1845

MUNN &amp; 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 15s. 5d. 4.00

## THE SCIENTIFIC AMERICAN PUBLICATIONS

Scientific American (Established 1845) ..... \$3.00 a year  
 Scientific American Supplement (Established 1876) ..... 5.00  
 American Homes and Gardens ..... 5.00  
 Scientific American Export Edition (Established 1875) ..... 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, New York.

NEW YORK, SATURDAY, OCTOBER 6, 1906.

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are sharp, the articles short, and the facts authentic, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

## HUGE PROPORTIONS OF THE NEW GOVERNMENT IRRIGATION DAMS.

In the presence of the vast irrigation dams and reservoirs which are being built by the government for the reclamation of the arid lands of the West, our eastern reservoirs, such as the Croton and the Wachusett dams for the water supply of New York and Boston, look positively small. The largest of these reservoirs are the Shoshone, the Pathfinder, and the Roosevelt. The Shoshone dam, which will be the highest in the world, is being built in northern Wyoming, the Pathfinder dam in southeastern Wyoming, and the Roosevelt dam in Arizona. All three structures are greatly favored by the natural configuration of the country, which is such that, by damming up a comparatively narrow cañon, the water is impounded in vast natural basins, which widen out above the sites selected, and afford unusual storage area. The new Croton dam is 297 feet high from the lowest foundation course to the crest, 1,168 feet long on the crest, carries a depth of water at the dam of 157 feet, and contains 833,000 cubic yards of masonry. Its total cost was \$7,600,000, and the cost of the dam per million cubic feet of water stored therein was \$1,900. Comparing these figures with those of the three irrigation dams, we find that the Shoshone dam is 175 feet along the crest; Pathfinder, 226 feet; and Roosevelt, 650 feet. The height above foundations is, respectively, for Shoshone, 308 feet; Pathfinder, 210 feet; and Roosevelt, 280 feet. The depth of water at the dam at Shoshone is 240 feet; Pathfinder, 190 feet; and Roosevelt, 230 feet. While the new Croton dam can store 4,000 million cubic feet of water, Shoshone can store 19,863, Pathfinder, 43,560, and Roosevelt the enormous total of 61,000 million cubic feet of water. The great economy resulting from the advantages of lofty height and narrow width of the cañons at the site of the dam is shown in the comparative cost per million cubic feet stored; for while the new Croton dam cost \$1,900, Shoshone cost only \$35.25, Pathfinder \$13.78, and Roosevelt \$32.80 per million cubic feet of water.

A feature which broadly distinguishes these western dams from our large eastern structures is that the outlets, instead of passing through the masonry of the dam, are being formed in large tunnels, which are driven from the interior of the reservoir into the solid side walls of the cañon, and carried through the rock entirely around the masonry, finally discharging into the cañon below. This has the advantage of allowing the dams to be built in one solid monolithic mass.

## SUCCESS OF THE INDEPENDENT RAILWAY MOTOR CAR.

Further proof of the ability of the independent motor car to meet the most severe requirements of railway service has recently been afforded by the performance of the gas-electric car, which was illustrated in the SCIENTIFIC AMERICAN SUPPLEMENT of March 10 of the present year. The new car is distinguished from others of its class by the novel character of its motive power. Practically all of the independent railroad motor cars are driven by steam or gasoline engines; but in this car the equipment includes a gasoline engine, a generator, a storage battery, and motors. The storage battery receives the surplus power from the generator when the load is light, and it is drawn upon for the extra power required in starting the car or in climbing steep grades. The interposition of the generator and storage battery between the engine and the car axle was made principally to overcome the difficulties of mechanical transmission, and to realize the well-known economy which is secured when the peak of the load is taken care of by a storage battery. Since the publication of our article, the car has traveled over 18,000 miles without any cost for repairs, except that due to the renewal of brake shoes. After being used in preliminary service on eastern railroads, it was sent from Philadelphia to Kansas City under its own power, and

since its arrival it has been in continuous service on the Missouri and Kansas Interurban Railway. During the run to Kansas City the average speed for a considerable part of the distance was 45 miles an hour. During a round trip of 550 miles on the Santa Fé system an average speed was maintained of 40 miles per hour; and on a round trip of 118 miles over the Burlington branch, where the grades run as high as 3½ per cent and curves of 16 degrees are encountered, the average speed was 27 miles per hour. The advantage of reserve power, which is a distinguishing feature of this system of propulsion, was seen during a snowstorm early in the year, when, although the regular trains were delayed, the motor car was able to force its way through the drifts and maintain schedule time.

The continued success of the independent-unit car will tend to modify the present system of running long trains at considerable intervals and substitute a system of shorter trains, or single-car units, running at more frequent intervals. The elaborate and costly electric installations which are being carried out by the New York Central and Pennsylvania Railroads are expected to result in a great development of traffic, and a wide extension of the suburban radius, mainly because of the frequent short-train service which will be rendered possible. Where the density of the traffic is not sufficient to warrant the heavy expense of third-rail or trolley equipment, the independent motor car is certain to find an ever-widening field of usefulness.

## THE CALIBER OF A GUN.

There is surely no word in the nomenclature of guns, big and little, which has caused, and is causing, so much confusion in the lay mind as the word *caliber*. Evidence of this is to be found in the large number of letters which we receive, asking for the exact meaning of the word as used in its different applications. The majority of these letters indicate that the confusion arises chiefly from the use of the term in an adjectival sense to indicate length, as when we say, a 50-caliber, 6-inch gun. The word *caliber* as applied to artillery signifies essentially and at all times the diameter of the bore of a gun measured diametrically from face to face of the bore, the diameter measured on the rifling being, of course, somewhat larger. A gun, then, of 6-inch caliber is a gun whose bore is just 6 inches. For convenience, and because the power of a gun, when once its bore has been decided upon, depends so greatly upon its length, artillerymen are in the habit of defining the length of the gun in terms of the caliber. Thus, the 12-inch United States naval gun, which is 40 feet in length, is spoken of as a 40-caliber, 12-inch, the length being just forty times the bore. The 6-inch rapid-fire gun, as mounted on the latest ships of the navy, is a trifle under 25 feet in length and is, therefore, known as a 50-caliber gun. From this it will be evident that the term may refer either to the diameter of the bore, or to the diameter of the bore used as a unit of length. In the case of small arms, the caliber is expressed in hundredths of an inch, as when we say a 22-caliber or 32-caliber pistol, meaning that the bore is 0.22 or 0.32 of an inch in diameter.

## A NEW PROBLEM AND ITS SOLUTION.

The unlooked-for rise of temperature in the New York Subway, due to the operation of the trains, proves, once more, how essential it is, in planning a new work of this kind, to consider carefully the effect of any novel conditions that enter into it. It is seldom that a great engineering project of this magnitude receives such exhaustive consideration as was given to the preliminary plans for the Subway. Moreover, no expense was spared either in the construction of the tunnel or in its equipment, to render it in every particular absolutely first-class. And yet, it was discovered, as soon as the first spell of hot weather was encountered, that instead of the air in the Subway being, as was confidently predicted, cooler than that of the streets above, it was considerably warmer. The trouble was found to be due to the radiation of heat from the powerful motors. That electric motors, doing such heavy duty as those which drive the Subway trains, become heated and radiate a large amount of heat into the surrounding atmosphere was, of course, well known; but until the opening of the Subway, electrical traction in New York had been confined to the street-car and elevated-railroad service; and since the cars were run in the open, where the heat was quickly dissipated, no inconvenience resulted, and there was nothing to suggest that heat from the motors might, under other conditions, become a serious problem.

As the result of a very thorough investigation of the problem, the Rapid Transit engineers have installed a system of ventilation and cooling which, up to the present, has been showing highly satisfactory results. A plant for cooling the air has been established at the Brooklyn Bridge station, and a series of ventilating chambers has been built between the Bridge station and Ninety-sixth Street. The ventilating open-

ings are placed midway between the stations. Each consists of a large chamber, opening out from the side of the tunnel, equipped with a series of shutters arranged somewhat after the plan of Venetian shutters, which are so balanced that normally they remain closed. At the approach of a train, the pressure of the air which is being driven forward in front of the train raises the shutters and the heated air is driven out into the chamber. The vacuum created at the rear of the train causes the shutters to close as the train passes by, and the same suction tends to draw the air in through the openings at the station which the train has just left, the double action of expulsion and suction thus serving to renew continually the whole body of air within the Subway. At each ventilating chamber there is an electrically-driven exhausting fan, which is used during the night when traffic is light, the combined capacity of the fans being sufficient to exhaust the heated air and bring in fresh and cold night air from the outside.

The Bridge station was selected for the experiments in air cooling for the reason that it is the warmest station on the whole system. The plant consists of four driven 6-inch wells, 45 feet deep, which take water from a level about 20 feet below the station platform. The water is pumped at a temperature of 61 deg. F., and distributed through two large cooling coils, which contain an aggregate length of nine miles of one-inch pipe. The coils are inclosed in sheet-iron casing, and air is forced through them by four motor-driven fans capable, together, of delivering 150,000 cubic feet of air per minute. After passing through the coils the air is forced through two large distributing ducts, which are suspended from the ceiling, immediately over the two platforms. The cooled air is finally discharged from the bottom face of the ducts and flows directly down upon the platforms. The plant has proved to be a great success, as is shown by the fact that, whereas before it was put in, the Bridge station was always several degrees warmer than Fourteenth Street station or that at Forty-second Street, the conditions are now reversed, and the Bridge is always cooler than the other stations, on some occasions by as much as 6 degrees. Tests taken during one of the warmest days of the summer showed that the temperature had been lowered as much as 8 deg. below what it would have been before the cooling plant was put in. With the erection of similar plants at Fourteenth Street and the Grand Central station, and the completion of the system of ventilating chambers, it is confidently expected that the temperature of the Subway will be restored to normal conditions.

## A NEW PROCESS FOR THE COMMERCIAL UTILIZATION OF ATMOSPHERIC NITROGEN.

Nearly ten years ago—to speak more accurately, in 1898—Sir William Crookes, then president of the British Association for the Advancement of Science, compiled a series of disheartening statistics, the purpose of which was to present a picture of the fate that awaited us if something were not done to augment the world's wheat supply. At the time when Sir William delivered himself of his remarkable foreboding, about 163,000,000 acres of the globe were cultivated for wheat, yielding annually 2,070,000,000 bushels, on the assumption that 12.7 bushels could be grown on each average acre. In thirty years, the president of the British Association pointed out that 3,260,000,000 bushels would be required, that only by increasing the yield to 20 bushels for each acre would future demands be satisfied, and that 150 pounds of sodium nitrate must be annually mingled with the soil of every acre in order to encourage it to this greater activity. Inasmuch as the 12,000,000 tons of nitrate thus required were not then available, Sir William was not inclined to take a very cheerful view of the world's future breadstuff supply.

Fortunately, Sir William's gloomy forecast has not been fulfilled, but it had at least the effect of prompting chemists to devise ways of utilizing the nitrogen of the atmosphere. Perhaps the method of attaining this end with which Americans are most familiar is that of Bradley and Lovejoy, who built a plant at Niagara Falls, but never attained a commercial success. Bradley and Lovejoy, it will be recalled, employed potentials of 10,000 volts, securing steadiness in the discharges by the use of a rotating framework and of projecting electrodes. Arcs were produced and interrupted at the rate of 414,000 a minute, although the apparatus was only of five-kilowatt size. The technical obstacles encountered in the utilization of this apparatus proved a sufficient cause for abandoning the plant, notwithstanding the fact that much nitric acid was produced.

In Norway Birkeland and Eyde have attacked the problem in a different way, and apparently with such success that their plant at Notodden (described on another page), started in May, 1905, may be destined to endure. The high-tension arc in this Norwegian process is produced between water-cooled electrodes of copper tubing, which electrodes are held in the