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 "
American Homes and Gardens.................................. 3.00 "
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, New York.

NEW YORK, SATURDAY, JANUARY 12, 1907.

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.

CAPE COD CANAL.

Attention has been again directed to the project for cutting a ship canal across Cape Cod, by the recent announcement that a prominent financier, who controls the transportation interests in this city, has become interested in the scheme, and is prepared to furnish the necessary capital to put it through. It takes only a glance at the map of the New England coast to understand why the opening of this canal is desired both by maritime and naval interests, and particularly by the former. The passage from Long Island Sound to Boston and northern New England ports must now be made around Cape Cod, where navigation is rendered perilous by the stormy waters, the fogs, and the swift tides off the Cape. Moreover, the cutting of the canal would shorten the distance between New York and Boston by one hundred and forty miles on the sea route, and by seventy-six miles over the route through the Sound. It is estimated that at present the annual tonnage of coastwise trade which passes around Cape Cod is about 22,000,000 tons. As the greater part of this consists of coal, it is certain that the opening of the canal would mean the supplying of fuel to the mills of northern New England at a considerably lower rate than is now possible. The advantage to passenger traffic would lie in the fact that travelers who left New York in the evening would be landed in Boston next morning without having to make the uncomfortable early morning change from boat to train.

Commencing at Buzzard's Bay, the route of the canal extends across the narrowest part of Cape Cod to a terminus at Barnstable on Massachusetts Bay. The entrance on Buzzard's Bay will call for about 4½ miles of dredging through the shoals, and the length of the canal proper from shore to shore will be about 7½ miles; the total length of the canal, from deep water to deep water, being thus about 12 miles. The survey follows the valleys of two rivers, with a maximum deviation of not more than half a mile on each side of a tangent drawn from terminus to terminus.

The canal is to have a depth, throughout, at low tide of 25 feet. The minimum width at the bottom is to be 125 feet, and there will be four passing stations to accommodate vessels going in opposite directions, where there will be a maximum width of 350 feet on the surface. The borings, which have been of a very extensive character, indicate that the sub-surface is composed entirely of gravel, sand, and loam, free from quicksands, rock ledges, and bowlders. The average height of the ground above tidewater level is 9 feet, and it is the easy character of the excavation which accounts for the comparatively low estimated cost of the canal, which can be built in three years at an outlay of $12,000,000.

An important point to be considered in connection with any canal in the Northern States is that of the formation of ice during the coldest weather of the winter. Fortunately, there is a variation of four feet in the respective rise and fall of the tides in Buzzard's Bay and in Massachusetts Bay, the range being about 9 feet in the former and 5 feet in the latter waters. Moreover, the times of high tide are different. There will, therefore, be a constant current through the canal which, with the passage of shipping, will serve to prevent the canal from being closed by the ice.

THE PENNSYLVANIA AND NEW HAVEN CONNECTING RAILROAD.

Seldom has a franchise been granted by the city of New York of greater importance than that recently conceded for what is known as the New York Connecting Railroad. The line has been designed to form a link between the Pennsylvania and New Haven and Hartford Railroads, and it is to be operated ultimately in conjunction with the tunnels which the Pennsylvania Company is now building between Jersey City and Long Island. This system of tunnels, including the terminal station, is, however, designed exclusively for passenger traffic; whereas the avowed purpose, for the present at least, of the Connecting Railroad is to form a connecting link for the transfer of freight traffic between the two railroads.

At present, the method of transfer of freight from the New England territory to the Pennsylvania system is by means of large car floats, which are towed down the East River and across the Bay to the Pennsylvania freight yards in New Jersey. Under the new arrangement, the New England freight will be taken from Jersey City across the Bay to Bay Ridge, where the cars will be transferred to the Long Island Railroad tracks and hauled to Sunnyside, a suburb of Long Island City. The connecting railroad will start from this point, and will be carried by means of a viaduct to a point opposite Ward's Island, where it will cross the East River by means of a massive four-track arched bridge, with 150 feet clearance above the river, and a single span of 1,000 feet. From Ward's Island the tracks will be carried at high level to the Mott Haven yards of the New Haven system. This arched bridge, which has been designed by Gustav Lindenthal, the late Commissioner of Bridges, will be the largest arched bridge of any kind ever built, being 200 feet greater in span than the 800-foot arched highway bridge at Niagara Falls.

Although the connecting railroad is designed primarily, and will have its first use, as a freight line, there is little doubt that ultimately it will serve to give the New Haven passenger trains an independent entrance to their own terminal station in New York city. Recent heavy purchases of real estate in the neighborhood of Thirty-fourth Street and Park Avenue are believed to mark the beginning of a scheme for building a new passenger terminal for the New Haven system at this spot. It has for many years been evident that the Forty-second Street Grand Central Station, even when the proposed enlargements are completed, must ultimately become insufficient to accommodate the rapidly-growing passenger service of two great systems, and that the New Haven Company must, sooner or later, seek an independent terminus. The locality will be admirably placed for the convenience both of the railroad and the traveling public; for the passenger trains will be run over the Ward's Island bridge, to Long Island, and through the Thirty-fourth Street East River tunnel of the Pennsylvania Company to the new Park Avenue station, where passengers will be in direct communication with the underground rapid transit system of the city.

THE SEVENTH NATIONAL AUTOMOBILE SHOW AT MADISON SQUARE GARDEN.

To the student of the art of automobile manufacture, the annual exhibition at the Madison Square Garden affords an unrivaled opportunity, not merely for observing the progress of the year, but of forecasting the probable trend of development in the future. In the present issue of the SCIENTIFIC AMERICAN we have endeavored to illustrate the machines and the parts and accessories, which, because of their novelty and importance, illustrate both the progress of the year and the present state of the art. In summing up the impressions of the Show, we find that the general trend of improvement is in the following directions.

In the contour or outline of the cars, one notes a disposition to avoid the curved lines of the earlier cars, and accentuate the rectilinear lines, particularly in the horizontal direction. In this we see an instinctive appreciation of the fact that an automobile belongs more to the class of the locomotive than that of the carriage. When steam railroad trains were first introduced, the car bodies were modeled after the stage coach, the early cars being simply stage coach bodies mounted upon flanged wheels; but ultimately it was realized that the simple, vertical and horizontal lines, which now distinguish the railroad car, were more suitable to its structural requirements and produced a better looking vehicle. So, in the development of the automobile, it is coming to be realized that the longer bodies and straight lines produce a car, which is not only, if we may use the term, more shipshape, but which possesses more of that inherent beauty that belongs to a properly proportioned self-propelled vehicle, whether it be intended for use upon steel rails, or upon a macadam road.

The improved appearance of this year's cars is largely aided by the considerable increase in the wheel base which, in the case of some of the heavier machines is now as great as 123 inches. Furthermore, the use of six-cylinder motors has brought with it a considerable increase in the length of the bonnet, and this also adds to the generally rakish and smart appearance of the up-to-date machine. By a judicious attention to these principles, the builders of even the low-powered and low-priced machines have succeeded in giving to their output a style, which was altogether lacking in the earlier models. Other elements which have helped to improve the appearance are the better designed mud guards, which are now frequently brought up to a junction with the frame of the cars, and are designed in long, easy, sweeping lines of decided grace and beauty, and the provision of continuous running boards in place of the earlier and rather crude-looking step, which, like the curved car bodies, was a relic of the carriage builder's influence.

The detachable or folding tops for summer use, and the closed and semi-inclosed bodies for winter, have become standard; and, thanks to the care with which the carriage builders have accommodated the bodies to the necessities of the chassis, the majority of the automobiles shown are marked by no little beauty and distinction.

We notice a tendency to increase the diameter both of the wheels and the tires, particularly of the rear wheels. It is not unlikely that in the future the prevailing custom will be to make the front wheels and tires smaller than those at the rear. In some machines the diameter of the rear tires has reached the rather high limit of 5 inches; although at its first introduction, this size rather detracts from the graceful and otherwise well-proportioned appearance of the cars. The disastrous failure of American non-skid tires in the Vanderbilt cup race proves nothing material against such tires when used on touring cars, as the experience of the past year has proved that the best makes are capable of showing excellent endurance under the severe test of the roads of this country. Considerable attention is being given to the subject of shock absorbers, most of these being designed to operate by friction, and others by air on the method of the well-known door check; while a meritorious attempt is being made to apply the principle of the hydraulic brake as used in checking the recoil of heavy guns. A novelty in shock absorbers is a device which consists of a central cylinder, containing brake shoes, associated with two smaller cylinders provided with compound springs, the slight vibrations being absorbed by the springs, while in the heavier shocks the springs and brake shoes act together to retard the rebound.

Although the four-cylinder, vertical, water-cooled engine must still be reckoned as the standard type, the six-cylinder engine has unquestionably come to stay, the advantages of more even torque and better control offsetting, in the opinion of its votaries, the disadvantages of greater weight and multiplication of parts. A refinement of design based on good mechanical considerations, is the tendency to unify the engine and transmission by inclosing both in a single housing, mounted on a three-point suspension. In one instance, the flywheel is mounted at the forward end of the engine, this change being made to avoid the enlargement of the casing which is necessary when the wheel is carried between the engine and the transmission.

There is an increasing use of the shaft drive, although many of the old-time, standard cars show a preference for the side chains. One maker, in the endeavor to secure the dust-proof qualities of the shaft drive, has inclosed the chains in a dust-proof shield, a device which was found to have valuable qualities on the bicycle, and should prove of even greater value in prolonging the life and reducing the resistance of automobile chain drives. There is noticeable a more general adoption of ball-bearing crankshafts, the favored type being the spring-separated, one-ring bearing. Ball bearings are also being extensively used on the transmission, the rear axles, and the wheels. Several novel and important designs of transmission are shown, some of these providing four speeds with the direct drive on the third speed; the fourth speed giving multiplication from the engine to the wheels and being used for fast traveling.

In carbureters there are also several improvements, among which we noticed the use of multiple jets, or the adoption of two distinct carbureters of different sizes, the smaller one being used for ordinary running at low power, and the larger one for high speed or hill climbing.

One of the novelties this year is a new gasoline-electric touring car brought out by one of the oldest New England firms and one which has had considerable experience with electric vehicles. This car is provided with the usual 4-cylinder engine which is direct-connected to a dynamo forming a magnetic clutch. In ascending hills the magnetic clutch is allowed to slip to a greater or less extent, and the current generated is passed to an electric motor which helps to propel the car at a slow speed but with increased pull, while the full torque of the engine is still transmitted directly through the propeller shaft to the rear axle. The car is fitted with five forward and two reverse speeds and an electric brake. The advantage of this construction is that a large percentage of power of the engine is always used direct without its efficiency being reduced, by conversion into electricity, and then back into mechanical power. The magnetic clutch acts in the same way as a friction clutch, but there is no contact between the driving and driven part of the clutch, and consequently, no frictional loss through slipping.

Cars of this type have frequently been experimented with abroad, but this is one of the few instances in which they have been developed in this country.

The advocates of the two-cycle engine are represented by a new touring car with three cylinders, for which they claim to secure the same horse-power as can be developed with six cylinders of the same diameter and stroke. It goes without saying that structurally the two-cycle is a far simpler engine than the four-cycle, and theoretically it should, on the same cylinder capacity, give double the power. Hitherto, however, the difficulty of getting rid of the exhaust before the introduction of the fresh charge, has rendered it impossible to bring the brake horse-power up to the theoretical horse-power. It is claimed that in the engine above referred to, and in some other new designs of the two-cycle type, this problem has been satisfactorily solved. As against this and other losses, there is a distinct gain in respect of the heat losses through radiation, which must necessarily be less because of the reduction of cylinder surface. There is also an obvious gain in reduction of parts and wearing surfaces, to say nothing of the weight. A commendable two-cycle engine was exhibited at the recent Grand Central Palace Show as applied to motor trucks. In this engine the charge is directed up through the center of the piston, being admitted to the latter through a port in the cylinder walls.

A simplification and decided improvement in valve mechanism is obtained by the use of walking-beams operating pairs of valves set in the cylinder heads, the valves of each pair being on opposite sides of the center line of the engine. This permits of the operation of the valves, say of a four-cylinder engine, with four instead of eight cams and rods, the whole being operated from a single camshaft.

Low tension ignition is not widely used. Indeed, it has not had the vogue which was predicted for it at the time of the exposition one year ago. The prevailing practice is to use the high tension jump-spark with the magneto; although some makers prefer to use two separate systems, with separate plugs for the battery and coils and for the magneto.

SOME EARLY AMERICAN AUTOMOBILES.

STEAM MACHINES.

One afternoon in the late autumn of 1855 three men whose names add luster to the history of the mechanic arts were discussing the feasibility of building an automobile wagon. Each agreed that such a vehicle was practicable, and each asserted that if put to it he would produce a self-propelling carriage that would meet every needed requirement. The discussion resulted in an odd wager, which was that all three should build a self-moving wagon, and to the one whose effort was most successful the award should be made.

The trio which entered into this strange compact was composed of the late Richard Dudgeon, famous as the inventor of the hydraulic jack; William Fletcher, the best-known builder of steamboat engines in his day; and another great inventor to whom the world owes much, "Boss" Hudson, of the Rogers Locomotive Works. Each set to work at the task with enthusiasm, not for the possible profits that success might have yielded, but much after the manner of three boys doing "stunts," each zealous to outdo his companions in friendly rivalry.

Before long the three wagons were completed, and queer enough they must have looked in those days, when even the locomotive was in many parts of the country a curiosity. It would be to no purpose to describe the machines of Fletcher and Hudson, since they were both failures, holding however within themselves, no doubt, great latent possibilities, had the spirit of the times encouraged further efforts. But the Dudgeon machine was perfect in every point. Of course, it was not the finished, graceful, triumphant vehicle that to-day glides by with scarcely a whirr to tell of its passing; but then the automobile of the present is the fruition of years of endeavor, whereas the Dudgeon machine was but the hasty effort of an inventor—with limited tools and devices to fashion the necessary parts—to give concrete expression to his theory of how such a vehicle should be constructed.

This machine, it is claimed, traveled forty miles an hour, and it is said to have been under perfect control when "rushing" over the roads at the rate of thirty-five. When we recall that only a few years back the sight of an automobile caused the average citizen to stand in his tracks and note it with open-eyed wonderment, it is not difficult to imagine the impression made upon the populace of Manhattan Island by this strange device, that swept through Broadway and startled both man and beast.

Unfortunately, this original wagon was destroyed in the memorable fire that caused the destruction of the Crystal Palace, for it was there on exhibition; and to old New Yorkers, at least, it need scarce be said that it was not the least inspected of the many wondrous things gathered under the roof of that historic edifice. But the inventor was not dismayed by its loss; for the embers of the machine had scarce stopped smoldering when he was at work upon a second wagon—the one here illustrated. This machine was completed in 1860, and soon became a familiar sight as it puffed and snorted through the upper section of Manhattan Island, through which the owner and inventor was wont to "exercise" it.

It is an exact duplicate of its prototype, which was given birth under such strange conditions, and is to-day just as it was when turned out of the shop, save that fifteen years ago its rust-caked boiler was replaced by a new one. This wagon, it should be added, was a product of the days when mechanical appliances in the machine shop, the carriage builder's, or the wheelwright's were few in number, so that it was practically made by hand.

The solid cedar wheels, it will be observed, are in a remarkable state of preservation, the tires not having expanded perceptibly since they were shrunk on forty-five years ago.

It will be interesting to engineers and mechanics to learn that it was while at work on this wagon that its inventor conceived the idea of the roller-tube expander, which, together with his hydraulic jack, have made the name of Richard Dudgeon secure in an honored place in the history of this country's inventors. A brief description of his automobile is appended.

The engine, which develops 8 to 10 horse-power, was built in accordance with the locomotive design common during the period of its construction. The boiler is of the ordinary locomotive type. The cylinders, two in number and located one on each side of the forward end of the boiler, are of 4½-inch bore, with ordinary slide valves. The cut-off of the latter is adjusted by a shifting link. The stroke is 18 inches, and the crossheads slide on two rods extending from each cylinder, which is set at an angle with the horizontal. The cranks are directly on the rear axle, which likewise carries the valve eccentrics, and the connecting rods thus extend from the crossheads to the rear axle.

The machine is guided from the driver's seat, located at the rear end of the machine, by means of a steering wheel like that of the automobile of to-day. The steering is done by turning the front axle through the usual intermediate gearing. The throttle for governing the speed is of the common locomotive type.

Ten passengers can be carried on two longitudinal seats or benches, above and on each side of the boiler, as appears from the accompanying illustration. Under each bench is a long metal water tank to supply the boiler. The fuel (coal) is carried in a sort of cab at the rear of the machine, in which also the driver's seat is placed. The smokestack, like that of the ordinary locomotive, is located at the forward end of the boiler. The firebox is of the ordinary design, and is located at the rear. The whole machine is carried by leaf springs.

Another steam machine that was planned a decade later than the first Dudgeon car, and that was eventually constructed and run over the roads in and around Bridgeport, Conn., in 1866, was that of the House brothers (James A. and Henry A.)—inventors who were at that time actively engaged with the firm of Wheeler & Wilson in perfecting the sewing machine. The House steamer, as can be seen from the drawing, was in several respects like the modern automobile. It had, for example, a double side chain drive from a countershaft to the rear wheels, the engine was placed under the seat, and the steering was accomplished by a wheel at first, though a lever was afterward resorted to on account of its quicker action and greater sensitiveness. The entire front axle was swung on a fifth wheel by means of a chain that ran from one end of the axle back around horizontal sprockets on the reaches and then forward to the other end of the front axle. One of these sprockets was on the lower end of the vertical steering column, which was provided near the bottom with a double sliding universal joint and turned by a vertical wheel on top connected with it through a worm gear. After running through fences several times owing to their wheel steering device not being quick enough, the inventors placed a lever directly on the vertical shaft, and afterward experienced no more trouble. The machine steered very easily, as most of the weight was on the rear wheels and when it was running the front wheels rested lightly on the ground.

The boiler used on the House machine was of the regular fire-engine fire-tube type, but it was noteworthy as being the first steel shell boiler to be constructed in the vicinity of New York. The boiler was built in Bridgeport, Ct. It was tested hydraulically to 300 pounds pressure, and ordinarily carried this pressure when used on the machine. The gage on the footboard indicated only half this amount, however, as people at that time were afraid to ride alongside of a boiler carrying 300 pounds of steam. A pop safety valve was fitted, but this used to scare so many horses that it was taken off and the regular spring-and-lever, locomotive type (which could be held down when a horse came in sight) was substituted. The boiler was fired with a mixture of cannel coal and charcoal from a seat placed transversely behind it for the fireman. On each side of the boiler was an upholstered seat capable of accommodating two persons. Besides the driver and fireman, five passengers could therefore be carried. The fuel was placed in an inclined box built around the boiler, and the water in a tank forward and under the fuel.

The motive power consisted of a twin-cylinder, double-acting, slide-valve steam engine having a 4¼-inch bore by 6-inch stroke. The connecting rods worked on disk cranks and the engine was provided with the usual link valve gear. The throttle and reverse levers were brought up through the middle of the front seat. There were two chains from the engine shaft to the countershaft, either of which could be put in use by means of jaw clutches on the latter. With one of these a speed reduction of 3 to 1 was had from the crankshaft to the countershaft, while with the other, or high speed, a similar increase was obtained. In order to allow for the differential movement of the wheels in turning corners, the brothers drove the sprockets on the countershaft through a double-acting ratchet and pawl, which answered for both forward and backward motion. When in the backing position the engine could be used as a brake. The machine had no brakes, the reverse being used for this purpose and enabling a very quick stop to be made. To reverse the car, all that was necessary to do was to kick the ratchet reverse lever on the footboard to one side, set the links of the engine with the reverse lever beside the seat, and open the throttle.

There were two water gages placed beside the boiler, one back of the front seat for the driver and one behind the boiler for the fireman. A variable-speed pump was driven from the engine by a slotted lever connected to the crosshead. The pump connecting rod was attached to a block in this slotted lever, which could be set at different distances from the fulcrum of the lever and thus made to vary the stroke of the pump. This device was worked by the fireman. The engine complete with water pump, etc., weighed but 110 pounds, and so perfectly was it balanced that Mr. Henry House states he could lift it off the ground while it was running at the rate of 1,500 R. P. M. It developed about 12 horse-power in the machine, but if supplied from a boiler of sufficient capacity it would have developed fully 50 horse-power. The 12-horse-power actually attained was sufficient to send the machine along an ordinary country road at over 30 miles an hour. The best performance the brothers made with it was 5 miles in 10 minutes. The weight of the machine complete, with water and fuel sufficient for a 10-mile run, was 1,800 pounds.

THE FIRST ELECTRIC AUTOMOBILE.

To Mr. Andrew L. Riker belongs the credit of having devised and run the first electric automobile in America. When abroad in 1886, he brought home from England a Coventry tricycle, to which, the following year, he applied a 1/6-horse-power battery motor of his own make in the manner shown on our front-page illustration, and thus produced a motor-driven tricycle capable of a speed of 8 miles an hour on good roads. The 8-volt motor drove the large wheel of the tricycle by means of a grooved pulley that fitted the solid rubber tire. The motor was mounted on a long arm, which, as the motor tended to climb the wheel, drew it tighter against the latter and thus increased the friction. The four cells of storage battery were carried in a box mounted on the frame of the tricycle. Their capacity was sufficient to run the machine for four hours, so that a 25-mile ride could easily be taken on level roads. From this first simple machine, within a decade, Mr. Riker advanced to the manufacture of the first successful electric automobile built in this country. Afterward he turned his attention to gasoline cars, with which he has also been very successful, one of the racing cars of his design having won third place in the Vanderbilt cup race of 1905.

EARLY GASOLINE CARS.

One of the photographs reproduced on our front page shows Mr. Charles E. Duryea's second gasoline automobile, which was constructed in 1893. This was one of the first crude attempts at converting an ordinary horse-drawn phaeton into a motor vehicle. The engine was placed horizontally beneath the center of the vehicle at the rear. It was a single-cylinder engine, with the crankshaft placed vertically and with the flywheel located, as shown, on the under side. The original arrangement used was a friction drive, the face of the flywheel being used as the driving surface. Parallel to the lower face of the flywheel was a drum on a countershaft. Between this drum and the flywheel was fed a loose belt, the speed of which, and consequently of the drum, was determined by the distance out from the center of the flywheel. The flywheel was hollowed out a little at the center, to re-

(*Continued on page 50.*)