steam pressure. When running, it was found that no internal lubrication was necessary, with no wear on the rings and shaft, the rings not revolving with the shaft, but remaining stationary and floating on a thin layer of steam between the shaft and ring. With superheat this turbine was very economical in steam consumption, running well at a speed of 5,000 revolutions per minute.

The reversible turbine mentioned has two oppositely inclined sets of nozzles pierced in each chamber wall, the "go-ahead" sets playing on the most efficient side of the wheel vanes. This turbine was reversed from 4,000 revolutions per minute ahead to 4,000 revolutions in the opposite direction in five seconds, giving 75 per cent power backward with the same steam pressure.

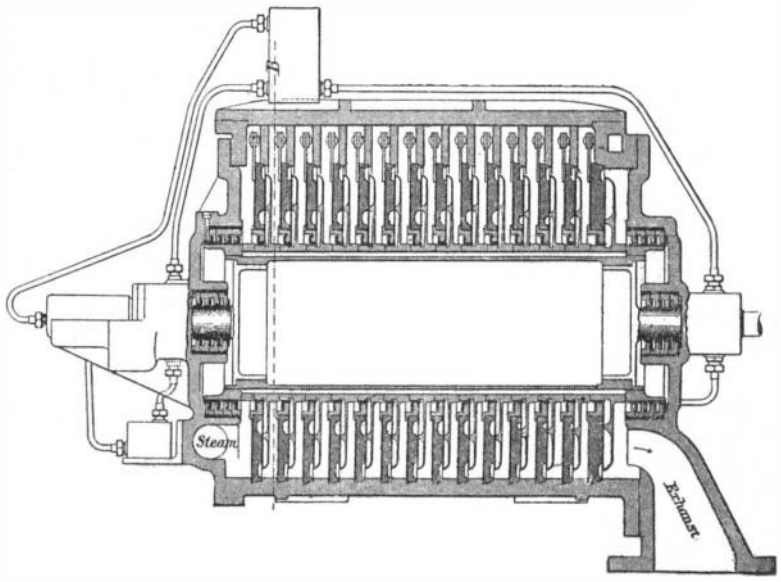
If equal reversing power is desired, the astern nozzles may have 25 per cent more area. A very thin circular valve is placed in front of each partition, the ports corresponding to the entrances of the nozzles, and a lever and shaft rotate these valves through a small angle, one way or the other, to produce forward or backward motion.

The simplest form of impulse steam turbine is the De Laval; but the disk turbines in this type must revolve at enormously high speeds, which in the case of a one-foot turbine reach about 15,000 revolutions per minute, with a pressure of about 75 pounds. In this form, which greatly resembles a Pelton waterwheel, the fixed nozzles guide the jets of steam onto the vanes or buckets on the outer rim of the rotating wheel.

A 100 horse power Laval steam turbine was installed some time ago in some German paper mills, and worked with such satisfaction that a 300 horse power turbine was installed later, a test of which was mentioned by W. Jacobson in the Zeitschrift Vereines Deutsch. Ingr. The dynamo was constructed by Ganz & Co. and the turbine by the Actiebolaget de Lavals Angturbin, of Stockholm. The speed of the turbine was 10,500 revolutions per minute, and the generator speed was 750 revolutions per minute, gearwheels being used for the reduction of speed; and an electric motor for operating an independent air pump. A Kausch superheater was employed and a Durr boiler; and with a steam pressure of 132 pounds and a vacuum of 26 inches, the steam consumption was about 18 pounds per horse power hour, the power developed being 300 horse power. The consumption was reduced to about 17 pounds per horse power hour with the steam at 572 deg. F. The length of the test was a trifle over five hours, and the mean steam temperature at the superheater was 415.6 deg., while the mean steam pressure in the boiler was 154.5 pounds. The temperature of the steam due to 154.5 pounds pressure was 364.8 deg. F., while the mean vacuum was 27 inches of mercury. The brake horse power was 342.1 with a mean reduced speed of 754.66 revolutions per minute. The water per brake horse power per hour was 15.67 pounds with an output of 337.6 brake horse power. In this test the steam for driving the feed pump, as well as the power to generate the current which was used to run the air pump electric motor, was taken from another independent boiler.

In a paper on Steam Turbines before the Engineers' Society of Western Pennsylvania, some time ago, Mr. F. Hodgkinson mentions a test made in France, where a Laval turbine working at 307.8 horse power with a speed of 772 revolutions per minute and a steam pressure of 192 pounds gave 13.92 pounds of steam per horse power hour. The superheat at this consumption was 69 deg. F. He also cites a Parsons turbo-alternator of 1,200 kilowatts capacity, which, when running under a pressure of 130 pounds and a superheat of 18 deg. F., produced an electrical horse power with a steam consumption of 14.025 pounds, which is equivalent to 11.9 pounds per indicated horse power hour, and in this case the turbine was driving its own air pump.

It is well known that geared motors are very undesirable, and are avoided wherever possible, and the multiple-step steam turbine of the Parsons type was devised to give a reduced speed of rotation suitable for the driving of machinery direct without the gears necessary with the Laval high-speed types. The first parallel-flow turbines constructed by Parsons consisted of a collection of zig-zag nozzles, the walls being formed of projecting rings of blades and intermeshing. One set was fixed on the periphery of a revolving cylinder, and the other set on the inner surface of the stationary hollow cylinder. The shape of the steam passages has been changed in the latest types of these turbines to smooth sinuous curves, and



7. EXPERIMENTAL, REVERSIBLE, MULTIPLE-STEP, STEAM TURBINE OF RATEAU.

the steam does not have to pass any sharp corners or turns. The highest economy of steaming of the modern Parsons steam turbines compares most favorably with the best reciprocating engines of high power and economy of the compound and triple-expansion types. The clearance and the workmanship in the construction of these turbines must be of the very finest, and the passage of steam from one end to the other acts as in a continuous nozzle, the expansion taking place between the moving and the fixed blades.

There are four of the Westinghouse-Parsons steam turbines in operation in the electrical power house of the Westinghouse Air Brake Company, each driving a 300-kilowatt alternator. The direct-current exciters are continuous-current, four-pole dynamos, driven by Westinghouse vertical engines. The speed of the turbo-alternators is 3,600 revolutions per minute, the alternators being constructed as bipolar machines. With a boiler pressure of 125 pounds per square inch and a vacuum of 26 inches, the full load consumption of these machines is about 16.4 pounds per electrical horse power hour, rising to about 22 pounds at a quarter load.

Prof. R. H. Thurston is quoted as stating that there is a considerable gain in both efficiency and capacity of a steam turbine by the use of superheated steam, but that the gain is greatly in excess of what would be expected from the increase of thermodynamic efficiency due to the higher range of temperature. The experiments made at the Sibley College at Cornell University on a 10 horse power Laval turbine show a gain of one per cent in efficiency for each three degs. superheat, while the increase would not be over one-tenth of this. The gain in efficiency is proportional to the amount of superheat; in the above case the capacity was doubled by the use of a superheat of 37 deg. F. The additional gain, Prof. Thurston says, seems to be due to the elimination of the loss by friction caused by moisture in the steam as it passes through the turbine.

In the Curtis steam turbine a few wheels of large diameter are used. The Curtis turbine is constructed with provision for changing the nozzle areas by opening or closing the tapered walls according to the load. In this way it is said to correct the expansion ratios for various loads and steam pressures. The fixed steam nozzles play only on part of the periphery of disks, in some cases only two nozzles being employed on the first disk.

The Westinghouse-Parsons steam turbo-alternator, which is now in operation at the Hartford Electric Light Company's plant, consists of a 2,500 horse power steam turbine direct-connected on the same base to a Westinghouse 1,500-kilowatt, sixty-cycle, two-phase alternator. The speed of this unit is 1,200 revolutions per minute, and the polyphase current delivered by the generator has a potential of 2,400 volts. The size of the generator is comparatively small for an output of 1,500 kilowatts, on account of the high speed of the turbine, and at a frequency of 60 periods per second the number of poles required is only six. The revolving part of the turbine is nearly 20 feet long and about 12 feet between bearings, while it weighs about 14 tons. The total unit, including generator and turbine, is nearly 34 feet long and about one-fourth as wide; while the total weight is about 90 tons. A worm gear is used to drive the governor and oil pump. The turbine is automatic and requires little attention, while the repairs and renewals of this class of machinery are very low, on account of the few working parts; and because of the absence of rubbing surfaces, high superheated steam and condensers can be employed to the best advantage, as no internal lubrication is necessary.

Unquestionably the day of steam turbines has come, particularly of large sizes, not alone on account of the wonderful economy of steam consumption; but also because of the advantages of economy of space, absence of oil from the condensed steam, and the excellent conditions for the use of superheated steam, as well as almost an entire absence of vibration. The sizes mentioned above have in each case been for increased output, those at Hartford, Conn., having a capacity of 2,500 horse power.

Fig. 1.—A ROCK PILLAR AT ACOMA, NEW MEXICO.

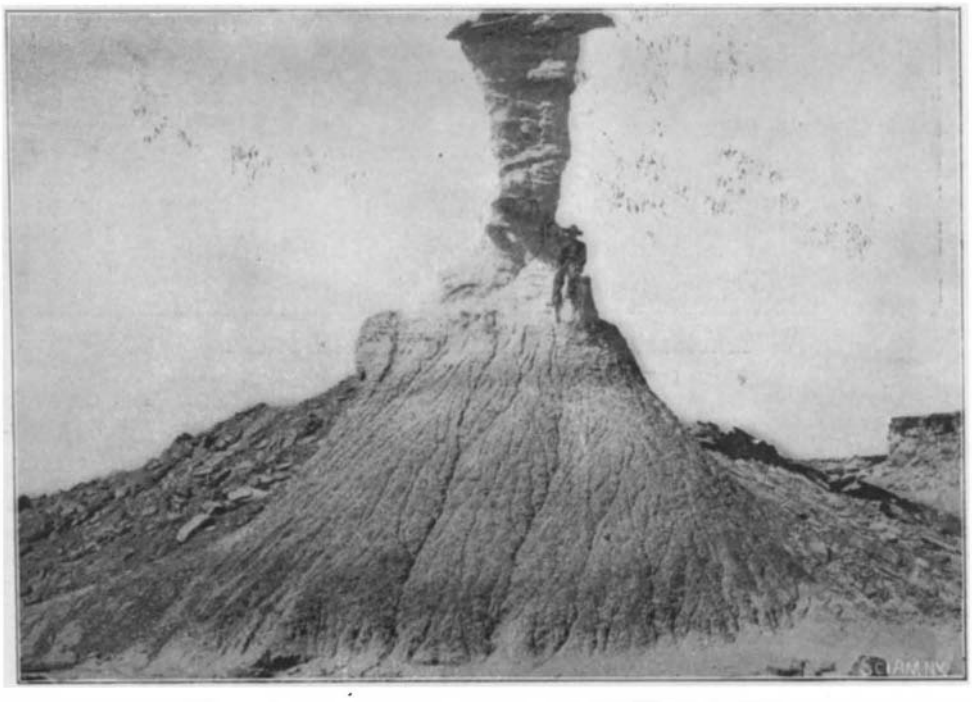


Fig. 2.—A COLUMN OF SHALE, SHOWING ERODED BASE.

BUTTES AND THEIR FORMATION.

BY CHARLES FREDERICK HOLDER.

It is demonstrated that if the dry land of the globe, the continents and islands, could be leveled or shoveled into the ocean the latter would cover the entire globe, so vast and deep is the watery envelope. The continents, then, and their inhabitants, might be considered simple accidents, as had the globe remained quiescent and upheavals of the crust not occurred, the globe would have been a vast sea. Happily for the human race the reverse held, and man has made his home upon what are virtually the tops of mountains or long elevated

mountain ranges ten miles in height measuring from the top of the highest mountain to the deepest abyss of the ocean. Many changes have occurred in the past millions of years since the dry land appeared, and doubtless many of the mountains were much higher; but nature is ever carrying on a fierce warfare, and slowly and imperceptibly the heights are leveled, the mountain peaks denuded, and the dry land washed down the great river courses into the sea; and theoretically, given sufficient time, assuming that no elevation occurs, the entire earth may disappear.

This wear and tear of nature is accomplished in many ways, and is productive of interesting results. Frost, snow, wind and rain are the principal erosive agents which are chiseling, cutting, grinding and wearing away the surface of the earth. The elements are all levelers, and the tendency is to reduce the mighty monuments of nature and level them in the dust. In the accomplishment of this, many remarkable natural monuments are made, splendid in their dignity and grandeur. Instances are found in the Garden of the Gods, in Colorado, where pillars, towers, monoliths, arches, gateways, titanic newel posts and forms and shapes of every possible kind and design are seen—the work of frost and rain.

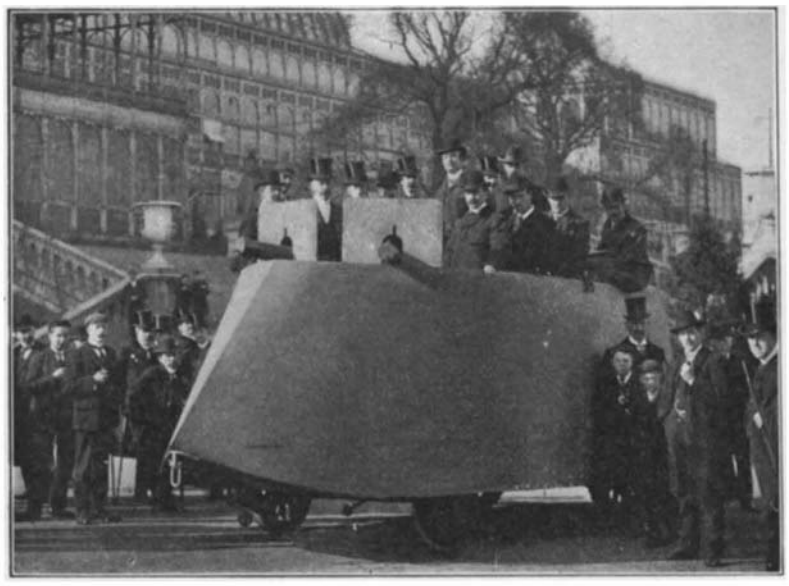
But it is further west that the most striking effects of erosion are found. In the region to the west of Salt Lake, and from there on, in what was formerly known as the Great American Desert, every overland passenger has been entertained by the weird and picturesque works of nature. Let but the fancy lead, and the eye rests upon cities, cathedrals, towers, minarets in the splendid buttes which rise everywhere along the line of public travel. They now appear silent and alone, gigantic monuments, or again in groups and clusters, rising on the horizon like ships upon the ocean; and it is not difficult to people these fantastic dwellings and imagine them the centers of human life. When the sun descends it paints them in marvelous hues—red, vermilion, yellow, and finally merging into purple and black in the quickening gloom. These strange forms, appealing so strongly to the imagination, are but the remains of past mountains, hills and plateaus. Rain floods have cut into and disintegrated them until all that remains is the core, or a harder portion that defies the elements and stands lofty and alone, a monument telling the story of the wear and tear of nature.

In New Mexico and Arizona there is still more striking evidence of this destruction. One should see it immediately after a contemplation of New England or the Middle States, where the country apparently has not changed materially in many centuries. The contrast is remarkable; the scenery bleak, rocky, barren, but with a charm peculiarly its own, a fascination few can resist. It is the land of the butte, and the lofty isolated mesa, the home of the washout, the cloudburst and violent outbreaks on the part of the elements, which in many regions appear to have wrecked the very face of the earth. Lofty buttes rise here and there, showing that in the past they have been the surface of a more or less level mesa which has been cut and worn by interminable floods until the very surface of the earth seems to have been washed away for hundreds of feet leaving the gigantic buttes, often acres in extent, to tell the story. Many of these are occupied by the native Indians who formerly used them as vantage points, and, when warfare and pillage are things of the past, still live there from mere force of habit.

One of the most interesting of the largest buttes is the famous Enchanted Mesa, which has been written up as a novelty by many modern writers and over which much discussion has occurred. This mesa is a type of extreme isolation and abruptness, the talus being so steep that ascent is extremely difficult to the average climber. This butte was inhabited ages ago, as all similar commanding positions, in all probability, have been, but, according to tradition, the means of descent were washed away by one of the cloudbursts, which made the mesa originally, and so it became uninhabitable.

A typical butte is well shown in the accompanying illustration—a rock pillar at Acoma, New Mexico, photographed by G. Wharton James. Harder than the rest of its surroundings, it has resisted the floods and rains of centuries, and stands, a gigantic monument to the resisting quality of certain portions of the surface. This pillar is merely a diminutive Enchanted Mesa. It may have been acres in extent at some early age, dwindling away with each successive year, the pillar being the heart or core of a sometime lofty and isolated mesa.

In the famous fossil forest of the Southwest the fossil trees often form interesting columns which have defied the elements. In Fig. 2 a pillar in this region is seen; not the trunk of a tree, but a column of shale piled layer upon layer which for some reason has resisted the elements and stands alone. Its base is fast disappearing, the talus even in the photograph being seen to be crossed and lined by the torrents which have poured down its sides and which ultimately will carry it entirely away, distributing it over the surface; and finally the column itself, weakened and undermined, will topple over and be reduced to its original composition of dust or gravel. Around the base of this pillar are seen the sections of fossil trees which have rolled down the slopes, telling a remarkable story of some change which has wiped out a great forest and devastated the land. In Mexico, not far from the island of Tiburon, there is a region undergoing a similar change and turning into a desert. The water is giving out; sand covers the land, but in it are found countless mesquite trees protruding here and there, showing that within the century the region has been well forested, as forests go in Mexico. But the land has been blasted, and the traveler over its burning and desolate areas may observe the actual change of a once fertile country into the typical desert.



THE SIMMS WAR-CAR.

An Interesting Discovery.

The German explorers in Babylon have made an unusually interesting discovery. Inscribed tablets of clay are common enough, and examples of them are to be found in the principal museums of Europe. But in the excavations at Nischan-el-aswad 400 tablets have been discovered, many of which are of a novel character. Several may be considered as of the belles-lettres class, says the Architect. They were evidently used for teaching, and therefore may be regarded as presenting examples of the Classic literature of Babylon. Some served as a dictionary, and on that account will be interesting to philologists. There is also a hymn which was chanted during the processions in honor of the god Mardik, whose temple has been brought to light by the German explorers. In another part of the same district the Temple of Adar or Ninev, the protector of physicians, has been discovered.

SERPOLLET'S RECORD-BREAKING STEAM RACER.

Automobile Department

THE NICE RACES.

Among the principal automobile events at Nice were the mile and the kilometer (0.62 mile) dash, the latter for the Henri de Rothschild Cup. These two events were run at the same time, and the automobiles after starting were chronometered at the kilometer and when required, at the mile points. The kilometer dash has been of especial interest this year owing to the record made by M. Serpollet of the kilometer in 29 4-5 seconds, and also of the general high speeds which were reached. M. Serpollet used a racing machine of special form, which will be observed in the engraving. It is a 12 horse power steam machine of the flash-tube boiler type, somewhat modified as to details. The front is formed of a sheet-iron cone which lessens the air resistance. The inventor considers that at such high speeds it is more essential to diminish the air resistance than to increase the power of the machine. Most of the racers used the machines which had been prepared for the Nice-Abbazia long-distance run, and it was interesting to see how these behaved on a short speed test. The best time for the mile was made by Osmont on a single-cylinder De Dion motocycle, which covered the distance in 57 4-5 seconds. The Mercedes 40 horse power machine built by the Daimler Company carried off the honors of the automobile class and the Darracq 20 horse power for the light automobiles.

The kilometer dash for the Henri de Rothschild Cup included automobiles from 1,430 to 2,200 pounds' weight, with two places occupied. The cup, a handsome work of art now on exhibition at the Nice Club, was won in 1901 by M. Serpollet, the time being 35 4-5 seconds.

THE SIMMS ARMORED WAR-CAR.

Vickers' Sons & Maxim, the well-known English armament manufacturers, have built a war-car, the invention of Mr. Frederick R. Simms, an expert who has devoted many years' experiments to this particular subject.

In general appearance the car can be described as a "mobile conning tower." It measures 17 feet in length, by 6 feet 2 inches in width over all, and has been designed to carry a maximum weight of 12 tons, though the actual weight to be carried will rarely exceed 6 tons. It consists of a rectangular frame constructed of heavy steel channels of U section. It is built with the intention of combining the maximum strength with the minimum of weight.

The special frame on which the motor, and speed differentiating gears are supported, is mounted on the car frame, and is built of Mannesmann steel tubes, the motor frame being supported to the main frame of the vehicle by suitable brackets and stays. The car is propelled by means of a 16 horse power four-cylinder light hydrocarbon motor of the Daimler type, fitted with the Simms-Bosch magneto-electric ignition and timing gear, with constant-level float-feed carbureter and governor acting on the exhaust valves. The bore of the cylinder is 90 millimeters, the stroke is 130 millimeters, and the compression 60 pounds per square inch. The motor is placed in the center of the car deck.

Petroleum of a specific gravity of 0.680 to 0.700 is the fuel used, but ordinary common kerosene of a specific gravity of 0.860 can also be burned if desired.

The cooling is effected by means of the Cannstatt marine type cooler—a copper tank containing about 5,000 copper tubes, through which air is induced by means of a fan rotated by the engine. The circulation of the air-cooled water between the cooler and the engine is kept up by means of a rotary gear driven pump. The water capacity of the cooler is four gallons, which is considered to be sufficient for at least 1,000 working hours. The engine runs normally at 750 revolutions per minute, but when the accelerator, with which it is equipped, is brought into action by means of a foot lever the velocity can be increased to 1,000 revolutions or more per minute.

The transmission of power is effected by means of a friction cone direct through a short end of shafting to the speed-changing gear, the female cone being developed as the flywheel of the engine, the male part being movable, and operated by means of a foot lever