Scientific American.

NEW-YORK, APRIL 19, 1856.

The Architecture of Cast Iron.

We have before us, in an illustrated and a well written pamphlet by John W. Thomson, A. M., of this city, an account of the origin, application, and advantages of cast iron in the construction of buildings. No city in the world is undergoing such an architectural transformation, at present, as New York, and cast iron is a powerful agent in this revolutionary work. In one single street ten handsome houses—some of brick and some of stone —which a few years ago were used as the mansions of wealthy citizens, are now being taken down, and on their sites are to be erected ten structures for stores, with ornamental cast-iron fronts. Designed upon one plan, and placed close together they will resemble a single harmonious, stately, and imposing edifice. The "happy adaptation of cast-iron to ornamental architecture," no man can doubt for a moment, after viewing the majestic pile of Messrs. Harper, in Pearl street, and other cast-iron buildings which have been erected during the past few years in New York, and other American cities. The value of cast-iron as a plastic and stable material for building, is now being appreciated; and in a few years hence, so many beautiful buildings of it will be put up in our cities, as will make them far surpass, in architectural effect, the most famous cities of the old world.

The origin of cast-iron buildings is due to James Bogardus, of this city. The pamphlet informs us, that it was while contemplating the rich architectural designs of antiquity in Rome and Florence, in 1840, that he conceived the idea of emulating them in his native country by the aid of cast-iron. When he returned, some years afterwards, he devoted his attention to the subject, and in 1848 commenced to build his factory on the corner of Center and Duane streets, which we are informed was the *first* entire cast iron edifice ever erected. The inventor met with much to try his patience, and to discourage him during the time it was building. There was a general prejudice, amongst all classes, and peculiarly so among most men of science, against the use of metal as a building material. It was believed that by the changes of atmospheric temperature, it would expand and contract so frequently, that a building made of it would soon become loose in its joints, buckle in its several parts, and become unstable and unsafe. Experience has proven such notions to be unsound and erroneous. The atmospheric changes of temperature exercise no appreciable effect upon such structures.

The pamphlet states that not a single joint in Mr. Bogardus' factory has ever moved an hair's breadth, although a powerful steam engine, is kept at work on one of the floors, and heavy machinery kept in operation on all the others. To us it appears that such cast-iron buildings must be more stable than those of granite, stone or brick, the numerous joints of which are only united by a feeble bond of mortar, whereas, the whole of the joints of these cast-iron structures, are turned true in a lathe to fit accurately, and then they are all screwed together, thus making a cast-iron building as strong as if it were one entire casting.

It may justly be asserted that cast iron has already been the means of originating new styles of architecture, and we may be pardoned for indulging in a feeling of national pride, because of its American origin. In brick, stone, marble, and granite, the finest modern structures are but feeble imitations of the old masters; and as Ruskin has placed metal as a building material, beyond the pale of conservative architecture, we may justly claim cast-iron building as the only new architectural art which modern genius has devised. Hitherto its use has been chiefly confined to factories, stores, lighthouses, and towers, but we hope the day is not far distant when churches, spires, mansions, and cottages will be constructed of it.

A single ornament for a building may be as cheaply executed in marble or freestone, but when a multiplicity of such is required, they can be cast in iron at an expense not to be named in comparison with like ornaments in wood or stone, and with this advantage they will always retain their original fullness and sharpness of outline. The pamphlet referred to contains some very beautiful and chaste ideas on this point, which we cannot do better than close this article with:—

"Fluted columns and Corinthian capitals, the most elaborate carvings, and the richest designs, the architect may have dreamed of, may be re-produced in iron for little more than the cost of ordinary castings. Ornamental architecture, which, with limited means, is apt to be tawdry, because incomplete, thus becomes practicable, and its general introduction would tend to elevate the public taste for the beautiful, and at the same time gratify one of the finest qualities of the human mind."

Recent American Patents.

Sifting Apparatus—By Samuel Harris, of Springfield, Mass.—Consists in providing the cover of the sifting box with a series of pins, which, when shut down, project into the sieve and come in contact with the substance to be sifted. When the sieve is moved back and forth the pins serve to stir up the substance and separate particles that adhere, and thus ensure thorough sifting. For spices and many other articles this plan is admirable. The sieve is moved by a crank and rod.

New Method of Arranging Steam Propellers—By Aaron Arnold, of Troy, N. Y.—The inventor provides two extra keels, running along on the bottom of the vessel, one on each side of the central keel. A propeller is attached to the end of each extra keel. The keels are bored to accommodate the propeller shafts, and, if desired, a propeller may be placed at both ends of each shaft. Located on the bottom of the vessel where the water is more solid and unbroken by the passage of the ship the propellers are expected to act with greater effect than when placed at the stern in the common manner.

Driggs' Improvements in Pianofortes.—This invention, described and illustrated in the last number of our paper, was patented in the United States Dec. 18th, 1855. It has also been patented in Great Britain and France through the Scientific American Agency.

Machine for Mixing Mortar—By Henry W. Hunt, of Peekskill, N. Y., and John Sands, of Greenwich, Conn.—The lime and sand are spread out on a circular platform on which traverses a large wheel, while behind follows a couple of scrapers, placed at different angles. Riding on the scrapers is a vessel from which water is allowed to drip upon the lime and sand, so as to impart the necessary consistency. The action of the wheel is to spread out the mortar, but the scrapers immediately throw it up again into a continuous heap. The mortar is thus very quickly and intimately mixed. At a suitable part of the platform there is a trap door through which the mortar falls, in a heap, when duly prepared.

Improvement in Slate Frames.—By Edwin Young, of Philadelphia, Pa.—Slate frames are generally made of four pieces of wood, dovetailed and pinned together at their corners. In this improvement only one piece of wood is used, which, after being grooved to receive the slate, is bound around the same like a hoop and fastened. Slates thus formed may be made in oval form, the framing consisting of rattan or other light handsome wood. They are rendered much more convenient to handle, are more durable, as the frame cannot easily give out, will not brake on falling, are cheaper, &c. This is an excellent improvement.

Fastenings of Folding Doors and Windows—By G. H. Lindner, of Hoboken, N. J.—Where folding doors are used it is necessary, for security, that one of them shall be firmly fastened, independent of the other; this is generally done by means of bolts at the top and bottom; to fasten and unfasten these bolts is inconvenient. In the present improvement a new kind of self-acting latch is used which takes the place of the bolts, so that by the mere act of closing the two doors one or them will be secured at the top and bottom as before

Tidal Flood Gates—By George W. Flanders, of Lynn, Mass.—On many parts of the sea coast the rise and fall of tide water is employed to drive grist and other mills. For this purpose a dam is generally thrown across a creek, a sluice way being left in the middle. The sluice is furnished inside the dam with a hinged gate, so that when the tide rises it pushes up the gate and rushes into the enclosure formed by the dam. When the tide begins to fall and the current changes the water closes the gate; the fall thus obtained is employed to turn a wheel until the tide rises again. The gate is generally hinged at the top and passes across the top of the sluice, so that navigation is wholly cut off. The present improvement consists in hinging the gate at the bottom, so that it may be made to turn down level with the ground either by force or by the incoming of the tide, thus leaving the sluice open for vessels to pass through.

Universal Lathe Chuck—By Michael Neckerman, of Pittsburg, Pa.—The design of the inventor of this improvement is to permit the centering of an object in lathe, either on its true center or eccentrically, as may be desired, without inconvenience. Most chucks are so arranged that the article cannot be centered eccentrically without taking the chuck apart to alter the position of the jaws; after use the chuck must be again taken to pieces to restore the parts. In the present invention there is an ingenious arrangement, whereby the chuck may be instantly altered to hold the object eccentrically or otherwise, at pleasure. It is a good improvement.

Pressure Tea Bell—By Jason Barton, of Middle Haddam, Conn.—Ornamental tea bells of the gong shape, operated by pushing down a button, are extensively sold. In these the hammer is connected with a spring and escapement. In the present improvement, which is of the same form and class, the button is attached to one end of a lever within the bell and the hammer to the other; the fulcrum of the lever is placed quite near to the point where the button connects, so that the opposite or hammer end of the lever, when the button is pressed, will have a larger sweep than the other end, and strike the bell. The improvement cheapens this kind of bell considerably, and renders it more durable, as the spring and escapement are wholly dispensed with.

Fire Regulator for Steam Boilers—By Wm. S. Gale, of New York City—This improvement relates to a method of regulating the draft damper of steam boilers, so as to increase or diminish the fire according to the pressure of the steam. When the pressure exceeds a given weight the apparatus shuts the damper and slacks down the fire; and when there is not steam enough the damper is opened so as to quicken the fire. These contrivances are coming into very extensive use. They effect an important economy in fuel by assisting to maintain a steady fire in the furnace.

Most of the apparatuses of this kind consist of a lever attached at one end to the fire damper, and at the other to a piston, which rises and falls according to the pressure of steam.

The present improvement consists in giving the interior of the piston cylinder a slightly conical or taper form for the purpose of allowing the piston to fit easily within it while the damper is open, so as to be very sensitive to any increase of pressure, but to increase the friction of the piston as it is lifted by an increasing pressure of the steam, thereby causing the damper to check the draft quickly at first and then more gradually, instead of entirely closing it with a sudden movement as in other regulators. Another portion of the improvement relates to the construction of the piston.

Improved Washboard.—By Royal Hatch, assignor to H. C. Hatch, of Strafford, Vt.—The washboard is composed of beaded rounds placed together lengthwise in a frame, the beads of one round fitting into the spaces between the beads of the next round, so that a perfect corrugated surface is obtained for the clothes to be rubbed over. The water will pass through the rounds, but the suds will be retained, spattering will be prevented, &c.

Machine for Polishing Buckles—By Robert G. Pine, of Sing Sing, N. Y.—Consists in securing the buckles or other articles in clamps attached to rotating shafts, which work in yielding or elastic bearings, said shafts being placed at each side of a polishing wheel and guide wheels so that the articles to be polished will be properly presented to the polishing wheel. The shafts while rotating are moved longitudinally, so that the whole surface of the work will be presented to the polishing surface. The polishing is done quickly and in a very thorough manner.

Improvement in Shot Guns—By Buckel and Dorsch, of Munroe, Mich.—This invention consists in giving the barrel of the gun a slightly undulating form, for the purpose of causing all the shot to strike within a certain circle, and prevent its indiscriminate scattering. The barrel is divided into an odd number of parts, say five, seven, or nine, according to the length, the said parts being made alternately of larger and smaller diameter. The parts next the breech and at the muzzle are of the larger diameter, and the intervening parts smaller and larger alternately, thus producing an undulating bore. Many experiments, we are told, have been made with shot guns of this construction, and the result in all cases is, that the shot fall within and evenly cover a certain sized circle, never scattering beyond. Such guns must be far more effective for sporting purposes than the ordinary kind.

Improved Safe Lock—By William Maurer, of New York City—The invention consists in an ingenious construction and arrangement of a series of thimbles, bolt catch, and bit. This lock is believed to present perfect security against burglary, while the expense of manufacture is quite small.

Recent Foreign Inventions.

Cure for Cholera, Dysentery, &c.—T. Sleight, of Hull, England, has obtained a patent for the following compound to cure bowel complaints: Essential oil of cassia, peppermint cloves, and nutmeg, (about an ounce each) are added to spirits of wine (a pint) and when intimately mixed, about an ounce of ground apple of the *pinus picea*, or silver fir tree, is also added. A little of the tincture of opium is also added, and the compound is complete. It is given in very small doses, and the smaller the better we opine. No patents for medicines have been granted for a long period by our Patent Office; but in our notes on "Curious American Inventions" we shall present some which will throw the above one entirely in the shade.

Water Gas—W. H. Lancaster and J. Smith, of Liverpool, patentees.—This invention embraces the introduction of water into the common coal gas retort during the process of distillation, whereby the water is decomposed and its hydrogen given off with the carbon and hydrogen of the coal. The claim is for the simultaneous decomposition of water and coal n one retort.

New Lubricating Compound for Railway Axles, &c.—G. Durham and C. Wyatt, of London, patentees.—Take 24 parts of tallow, 12 parts of common soap, and 2 parts (all by weight) of resin, and mix them with warm water. The tallow, soap, and resin may be heated and rendered fluid before they are placed in the hot water. The compound is stirred until quite cool. Some of our engineers should make some experiments with this lubricator.

Compound for Feeding Horses and Cattle.—The patentee of the following great interior invigorator is A. C. Morrison, of London—a relative, perhaps, of the renowned Dr. Pill Morrison. It consists of kidney beans, oats, barley, rice, linseed, liquorice, niter, carraway, Peruvian bark, galingal, gentian, sulphur, salt, resin, cream of tartar, carbonate of soda, grains of paradise, ginger root, Iceland moss, arrow root, aniseed, cardamus, turmeric, cascarilla bark, canella, alba, and guacum. These are mixed together, in various proportions, to feed the animals, and is stated to be an improvement on the feed compound patented by G. W. Henri, Jan. 30, 1855.

This receipt surpasses the one of Sam Slick for feeding his horses on pine shavings by mounting them, at meal times, with green spectacles. Sam's, however, has the merit of being short, dry, and cute; while this one of Morrison is long, soft, and kinky.

Cannon—J. C. Haddan, of "Cannon Row," London, patentee.—This invention consists in lining the interior of old and new cannon with rifled or plain tubes to fit the bore. They are inserted into the cannon after it is cast, and are made in one, two, or more pieces, longitudinally or transversely. Such tubes for cannon are intended to be renewed from time to time as they wear out, so that the body of the cannon may serve for a long period, and not as they are constructed at present, the whole gun having to be laid aside as useless on account of the worn bore.

The above-named place, where the inventor of this improvement resides, harmonizes with the character of his invention.

Silver and its Uses.—Concluded.

A great quantity of silver is used for articles of domestic use among the more wealthy classes; but although such articles pass under the name of "silver plate," they are all alloyed more or less with copper. In our country there is a great difference in the quality of articles which pass for silver, owing to their degrees of alloy. In England, on the other hand, there is a standard for plate silver, and in order to prevent fraud, all silver vessels are required to be inspected and stamped. The alloy is composed of 111 parts silver to 9 of copper, by weight. In France, the standard for plate is 19 parts silver to 1 of copper. The addition of a small quantity of copper to silver, while it increases its hardness to a wonderful degree, scarcely diminishes its whiteness. The greatest degree of hardness is obtained by using of copper one-fifth the weight of the silver. With equal weights—copper and silver—the alloy is a good white. Articles formed of alloyed silver are subjected to a process to remove the baser metal from the surface. They are heated nearly to redness, then plunged while hot into warm wateracidulated with sulphuric acid, which removes the oxyd of copper (formed while heating the article) from the surface,leavingit of a blanched appearance, called *dead silver*. Alloyed silver articles are sometimes boiled in bi-sulphate of potash to produce a like effect. Those parts of plate requiring to be burnished are polished with proper tools.

The most important salt of silver is the "nitrate;" it is prepared by dissolving silver in nitric acid, and evaporating the solution to dryness, or until it is sufficiently concentrated to crystalize on cooling. The crystals are colorless and transparent, readily soluble in water and alcohol. If these crystals be heated in a crucible, they fuse like niter, and are formed into sticks, called *lunar caustic*. This salt blackens by exposure to the sun. Ivory, marble, &c., may be stained black by soaking them in a solution of this salt, and exposing them to the sun's rays. It is used for making indelible writing ink. The article to be marked, is first moistened with carbonate of soda, then dried, then written upon with a weak solution of the nitrate, and exposed to the sun; it soon assumes a black appearance. It is also much employed for dyeing the hair of those who wish to conceal the marks of age. A weak solution of it applied to the hair, is all that is required to color it black, or deep brown. Care must be exercised not to touch the skin with it. The cyanide of potassium will remove nitrate of silver stains.

When nitrate of silver is taken as a medicine, it gives to those parts of the body exposed to the light, a leaden gray color. In a weak solution, it is used by some oculists as a wash for inflamed eyes, but it should be avoided if possible, as it greatly discolors the white part of the eye. A weak solution of it is often applied by physicians for curing diseases of the throat.

The nitrate of silver is much used in preparing daguerreotype plates, and photographic paper; it plays an important part in sun painting. Its sensitiveness to light, and other substances, is the reason of this. A plate of clean copper introduced into a solution of it, produces a brilliant crystaline deposit of silver; a stick of phosphorus placed in it soon becomes encrusted with tree-like crystals of the metal. Mercury poured into a solution of it produces that beautiful crystaline deposit of the metal known by the name of *arbor Dianæ*.

The chloride of silver is formed by mixing together a solution of nitrate of silver with a solution of common salt; it is termed *horn silver* when found native. This salt is soluble in ammonia, and in a solution of the cyanide of potassium; it is much used in photography. By introducing a solution of potash or soda into one of nitrate of silver, a protoxyd is formed; it falls to the bottom of the vessel in the form of an olive colored powder. If this be digested in a strong solution of ammonia, a black substance is produced, which is terribly explosive—fulminating silver. It explodes under water when heated to 212°, and when it is dry, the touch of a feather, or the rolling of a carriage across the street explodes it. Fulminating silver is also obtained by the action of warm alcohol on nitrate of silver. The iodide of silver is formed by adding nitrate of silver to the iodide of potassium. It is easily decomposed by light, and it therefore forms the basis of the film of photographic pictures. Silver solder is composed of 667 parts of silver, 233 of copper, and 100 of zinc.

Silver was early applied to the purposes of ornamenting by plating, that is, covering an inferior metal, like copper, brass, and iron, with a skin or coating of silver. The articles to be plated were scoured bright, then heated to a point just below that at which the metal changes color, the silver in thin leaves then laid on and the adhesion produced by a burnisher.

The best method of fire silver plating is that pursued in Sheffield and Birmingham, England, which is to make plated ingots, and from them manufacture the articles. Ingots of copper or brass are carefully filed, then the silver in thin sheets is neatly laid on them, their edges joined together and brushed with a solution of borax. They are then tied with wire and introduced into a furnace heated with charcoal. The ingots are laid on the red-hot charcoal and submitted to heat until the silver is observed to draw into the copper. The attendant who watches the process now withdraws the ingots, for if suffered to remain longer the silver would become amalgamated with the copper. Although electro-silver plating has recently become so common we have been assured that the business of fire-silver plating has in no wise diminished.

Electro-silver plating is now carried on to a great extent. The silver is deposited from a solution of the argento-cyanide of potassium on the articles to be plated by a galvanic current generated in a battery. White metal, or a composition of tin and copper, is the best basis for silver plating, because when the plating wears off, the white metal underneath is not so readily noticed. Electro silver plating is an art only a few years old, yet owing to its flexible character—the facility with which so many articles can be covered with a coat of this beautiful metal—it is the most interesting of all others for which silver is used

Notes on Ancient and Curious Inventions.—No. 3.

Linen and Duck—Previous to the invention of the cotton gin, and while cotton was a dear material, linen was most generally employed for all the purposes of domestic and personal use, now fulfilled by cotton cloth. The manufacture of linen was therefore sought to be early encouraged in the Colonies, and a Bill was introduced into the Connecticut Legislature in 1735, to pay a bounty on every yard of fine linen made. The bill, however, was not passed, and to this day no *fine* linen has yet been made in America. In 1724, Richard Rogers, of New London, Conn., manufactured excellent duck for sails, and obtained a patent for its exclusive manufacture in the year following.

Silk, Flax, and Hemp.—The Legislature of Connecticut early offered encouragement to those who would cultivate hemp and flax, and raise silk. In 1784 a bounty was offered for every ounce of silk raised from cocoons.

Pins.—As early as 1775, a factory for manufacturing pins was proposed to be erected at Wethersfield, Conn., by Leonardus Chester, but until 1812—during the last war with England—our country received all its pins from across the Atlantic. In that year their price rose to one dollar per paper, when some pin makers came to New York from England, and commenced business, at which they continued until the war ceased, when they abandoned it. The first patent for manufacturing pins by machinery was obtained by L. Morse, of Boston, in 1813. The *solid* headed pin, the one now in common use, which has entirely superseded the old separate headed pin, was invented by Lemuel W. Wright, of Haverhill, N. H. He obtained patents for America and England, in 1825, and went to the latter country to sell and introduce his machinery for their manufacture. A working machine was in operation in 1826, in London, and the inventor made and sent out two machines to his own country, but these were never set in operation. His machines were defective in forming the pin points, owing to the difficulty of arranging and keeping the rotary files in order for this purpose, consequently his machines were, at last, only employed to take the wire from a reel, straighten, cut it into lengths, then head and deliver it to be pointed by hand. This inventor, like J. Perkins, took up his residence in England, where he was living three years ago, and was highly esteemed for his mechanical genius and integrity. The names of the inventors of the steam engine, cotton gin, steamboat, and telegraph, are often mentioned with enthusiasm and respect, because of the benefits they have conferred upon mankind by their inventions, but who ever heard of the name of Lemuel W. Wright, of the Old Granite State being toasted as an inventor, and yet his invention was a most useful, and ingenious one. Like many other good inventions, however, the authorship of the solid-headed pin is disputed. On page 381, Vol. 9, SCIENTIFIC AMERICAN, there is a notice of the solid-headed pin having been made fifty years ago by D. F. Taylor, of Birmingham, Eng., whose brother now manufacturers them at the rate of 200 per minute. In 1832 a patent was granted to John J. Howe, for a pin machine, and in 1835 a Company was formed in this city to carry on the manufacture under his patent. The machine formed the head of a coil of fine wire by dies, and the pin so made did not differ from the English diamond pin. In the same year Samuel Slocum, of Rhode Island, obtained a patent in England for machinery to make solid-headed pins, and in 1838 a factory for their manufactory was set in operation at Poughkeepsie, N. Y.; he did not obtain an American patent; the machinery was operated in secret. In 1838, J. Howe also obtained a patent on improved machinery for making solid-headed pins, and the "Howe Pin Manufacturing Co." at Birmingham, Conn., are now making pins by his machine. "The American Pin Manufacturing Co.," of Waterbury, Conn., bought out Slocum's machine, at Poughkeepsie, in 1848. The weekly manufacture of pins by these two companies amounts to about 9 tuns. At one time all the pins were inserted into their papers by hand, but machinery has been employed for a number of years to execute this work, so that from first to last, the manufacture of pins, as at present conducted—from the wire until they are ready for market—is performed by self-acting machinery. The American improvements in pin making, and sticking the pins, have been in use for several years, we understand, in England.

Railroads; Speed: Grades, and Curves.

We are indebted to the Superintendent—D. C. McCallum, Esq., for a copy of a very complete report of the New York and Erie Railroad for 1855. There are some matters of a scientific nature in this report, a brief review of which will be interesting to a number of our readers.

The whole length of track—including double and branch tracks—belonging to the Company, is 769 miles; and the tracks are 6 feet gauge. It is a stupendous railroad, involving the use of an immense amount of property, and employing a vast number of persons; therefore, as it does a great amount of business, its affairs require to be managed with great circumspection.

Speed—In the transaction of a passenger traffic great speed forms an important item of cost. The expense of running a train is stated to be increased nearly as the square of the speed. Delays and accidents are the attendants of high speeds The report says:—

"When the time-table is so arranged as to call for speed nearly equal to the full capacity of the engine, it is very obvious that the risks of failure in making time, must be much greater than at reduced rates, and when they do occur, the efforts made to gain time must be correspondingly greater and uncertain. A train whose prescribed rate of speed is thirty miles per hour, having lost five minutes of time, and being required to gain it, in order to meet and pass an opposing train at a station ten miles distant, must necessarily increase its speed to forty miles an hour; and a train whose rate of speed is 40 miles per hour, under similar circumstances, must increase its speed to 60 miles per hour."

The liability to collisions on a single track, with high speeds, are thus clearly set forth, and moderate speeds are recommended.

The Telegraph—It is stated, in the report, that a single track railroad may be rendered more safe and efficient by a proper use of the telegraph, than a double track railroad without its aid. The double track obviates collisions on trains moving in opposite directions, but not in the same direction; and it is asserted to be a well established fact, that collisions between trains moving in the *same direction*, "have proved by far the most fatal and disastrous." *We* have always entertained a different opinion to this. Mr. McCallum asserts that a single track, with proper turnouts, and the use of the telegraph, is a more safe and profitable investment than a double track without a telegraph. "In the moving of trains by telegraph, nothing is left to chance." Those railroads, therefore, which do not use the telegraph, exhibit a great want of sagacity and good management.

Resistance of Grades and Curves—The report also contains an account of a series of experiments for determining the effect of resistance of grades and curves. These took place in the month of September last, and were made with a view to determine the relative power required upon the several Divisions of the road for the transportation of heavy freight.

A single locomotive was run the entire distance from Dunkirk to Piermont with trains varying to suit the ruling grades of the different divisions. The engine selected for this purpose weighed 40,050 lbs. on the driving wheels, it had cylinders of 17-inch bore and 24 inches stroke; driving wheels 5 feet in diameter, and an effective steam pressure of 125 lbs. on the square inch.

The traction of the engine was 14,485 lbs., that is, the total resistance it could overcome with steam at the above pressure; its friction without load was 347 lbs. It has been customary to estimate the friction of cars on 30-inch. wheels with journals 3 inches in diameter at 7 lbs. per tun, but the experiments demonstrated this to be too high. The friction of such cars was demonstrated to be only 4 1-2 lbs. per 2000 lbs., the resistance of curves 1-2 lb. per tun per degree of curvature the 100 feet. The adhesion of the engine was 36 per cent. of the insistant weight; this has heretofore been estimated to be from 12 1-2 to 25 per cent. A train consisting of 100 loaded cars, weighing totally 1765 tuns was taken over a mile of road on an ascent of 6. 14 feet, and a curve of 1° 5730 feet radius in 11 1-2 minutes.

The following were the resistances overcome. Friction of engine and tender 347 lbs., cars at 4 1-2 lbs. per tun, 7702 lbs., gravity of engine and train 4104 lbs. Resistance of curve 882 lbs., and additional friction 1410, making a total of 14,445 lbs., or 40 lbs. less than the estimated traction of the engine. On a grade of 60 1-2 feet ascending and a curve of 5° 1146 feet radius, with a train of 429 tuns total weight the resistance was 14,363 lbs., or only 82 lbs. less, while the load drawn was less than a fourth of that on the low 6 feet grade and the one degree curve. This was done in six minutes and a half, but it shows the great amount of power consumed in ascending inclines, because the whole train, as it were, takes as much power as would lift its entire weight to that hight—60 1-2 feet in the second example. No experiments were made test the increase of resistance with an increase of speed, but it is very evident that the Superintendent is of opinion that, with the exception perhaps of friction, they increase according to the square of the speed.