relations, shows throughout a decrease of them, with decrease of the length of equally thick bars; with reference to moments of bars of equal length, but different thickness, there seem to be the most manifold varieties. If, however, the maximum remanent moments be ranged according to the dimension-relation α , a conformity to law at once appears. The maximum of remanent magnetism referred to unit weight of a bar is a constant function of the dimension-relation α . This function, with $\alpha =$ about 7, cuts the axis of abscissæ; below this value it is negative, above it positive. Above $\alpha = 7$ it rises very quickly, turning its convex side to the axis of abscissæ; this relation then reaches a maximum, and the curve rises in less degree than before. The remanent magnetisms are therefore greater, the longer the bars. The remanent moments in unit weight reached the remarkable value 727, a value which is over 80 per cent. of the corresponding induced moment, and far exceeds all hitherto observed moments. We must not here dwell on the relation of the remanent magnetism to the lengths of the bars, their thickness, and the magnetizing force, which are fully discussed by M. Ruths. It may merely be observed that the remanent magnetisms here referred to had quite a stationary character. In long bars, 24 hours after induction the loss of force was only about 3 to 4 per cent., which may very well have been caused by shaking in the process of removing from the spiral. A general survey of the peculiarities of induced magnetism and remanent magnetism, as above indicated, leads to the conclusion that "in direct opposition to the prevailing opinion, according to which the laws of induced magnetism are considered directly transferable to remanent magnetism, the remanent magnetism of soft iron shows a very different behavior from the induced magnetism." This conclusion places remanent magnetism in quite a new light. M. Ruths is going to make it the starting point of new investigations. In an appendix the author considers the magnetism of steel, and shows that similarly, not only the induced, but also the permanent, magnetism of steel depends on the dimensions of the bar.

AMERICAN IRON AND STEEL WORKS.

By A. L. HOLLEY and LENOX SMITH.

THE Black Diamond Steel Works at Pittsburgh, Pennsylvania, belonging to Park, Brother & Company, although not extensive in comparison with some of the similar establishments abroad, is one of the most important crucible steel works in the United States, and is well planned both as regards simplicity and convenience of general arrangement. The iron refinery, which includes the puddling forge, together with its auxiliary buildings, coal bunks, etc., is 336 feet by 124 feet in extent. The puddled blooms are hammered under a 3 ton double acting steam hammer, the steam for which is obtained from boilers over the puddling furnaces. The hammered blooms, after passing over the scales located between the offices, are reheated and rolled into bars in the rolling mills, and are then converted. The converting house is 60 feet by 186 feet in extent, and contains six cementing furnaces of 30 tons capacity each. Adjacent to the converting house, the cemented iron is arranged according to different degrees of temper in bins after being broken up and selected ready for melting. The melting house is 450 feet in length, containing 72 coke melting holes, two 24 pot Siemens gas melting furnaces, one 30 pot gas melting furnace, and 8 gas producers, giving a total melting capacity of 30 tons daily.

The rolling machinery is all under one roof; there are four engines supplied with steam from a battery of six double flued boilers. This building is 401 feet by 217 feet, with an addition of 65 feet by 116 feet in area, and in it is rolled all iron to be cemented, and also tool, spring, machinery steel, etc., from the smallest to the heaviest size, besides plate and sheet steel. This department contains six trains of rolls, the smallest being 8 inches and the largest 30 inches. The 8 inch and 10 inch trains are driven by a vertical engine with 23 inch cylinder and 30 inch stroke, giving 150 horse power. By a simple and rapid arrangement the speed of these trains can be varied from 80 to 290 revolutions per minute, according to the work on which they are running. The 12 inch and 16 inch trains are driven by a vertical engine; the cylinder is 30 inches, and the stroke 30 inches, giving 250 horse power. The largest engine is also vertical, having a cylinder 42 inches in diameter, and stroke 42 inches, the horse power being 600. It drives two sheet and plate trains, the large plate train consisting of one pair of rolls 30 inches in diameter, two pair 24 inches, and one pair 26 inches in diameter. The fourth engine is horizontal with 12 inch cylinder and 24 inch stroke, giving 50 horse power; it drives the eighteen shears used in trimming sheets, slabs, plates, etc.

The forge and hammer shop, is 96 feet by 125 feet, and contains ten steam hammers, the smallest being 4 cwt. and the largest 60 cwt.; also five heavy helve hammers driven by a vertical 50 horse power engine with 14 inch cylinder. This building also contains twenty furnaces for reheating ingots. The smaller forge and hammer shop is 60 feet by 132 feet, and contains four double acting 12 cwt. hammers, eight reheating furnaces, and also a battery of eight double flued boilers, which supply steam to the fourteen steam hammers, and to the engines which drive the five heavy helve hammers, the machine shop, roll turning shop, and fan blowers. In these two forges all shapes of tool steel bars are produced from $\frac{1}{4}$ inch up to 8 inches in diameter, and also railway and other forgings of every description.

To facilitate the transportation of ingots from the melting shop, and also of the finished product from the mills and forges to the inspecting house, a tramway is constructed traversing the yards throughout. The crucible house has a total storage capacity of 2,000 crucibles. The machine shop is 50 feet by 52 feet, and is well supplied with lathes, planers, drill presses, slotting machines, bolt cutters, etc.

The roll turning shop is 24 feet by 60 feet in extent, and has complete appliances. A system of steam pipes is arranged throughout the entire establishment in such a manner that steam can be used from both batteries of boilers, jointly or separately, thus allowing one set to be cleaned while the other is running, and also allowing the running of such portions of the works as may be most needed when steam can be had from one battery of boilers only. The works are traversed by an underground system of galleries or vaults, aggregating 1,301 feet in length, through which the ashes and cinder are discharged into the river.

The capacity of these works is fully 10,000 tons per annum, the product comprising every kind and form of crucible steel which the trade requires.

The exhibit of Messrs. Park, Brother & Co. at Philadelphia was twofold, one portion being in the Government Building, and a similar though less extensive display in the Main Building. The exhibit in the Government Building was surrounded by a homogeneous steel railing twisted cold,

the supports being bars of different sizes, with bases, caps, and nuts of homogeneous steel. The display consisted of Lake Superior, Lake Champlain, and Missouri ores, raw, crushed, washed, and calcined; also loops, billets, pig, puddle balls, blooms, rolled iron, blister bar, and ingots, some of which were fractured, besides steel bars, sheets, and plates. The central feature of the exhibit was a very graceful shaft composed of round machinery and "spindle" steel surmounted with an ornamental cap and a pennant or guidon of steel. The height of the shaft, including the base, was 16 feet, the base being 5 feet in height, and composed of square blocks and bars of die steel, the corner columns being octagonal die steel and railway axles. The panels of the base were formed of square, flat, round, "pivot," and "eye pin" shapes and sheet steel, both plain and highly polished. Some very handsome specimens of boiler and fire-box plate were also shown, bent cold in some cases, the most striking test being a plate 20 feet long, 32 inches wide, and $\frac{1}{2}$ inch thick, tightly coiled in a roll of the same material. A number of large fractured bars, reaper knives showing the required tests, oil well forgings, bits, reamers, railway frog points and plates, and agricultural steel were also shown, together with a variety of solid steel edge tools with the eyes punched, and also files, cutlery, taps, dies, etc. Several beautifully finished axes, picks, and other tools were also exhibited still attached to the ingots from which they were respectively forged.

The exhibit in the Main Building also consisted of a display of raw materials and various finished products, the specimens of difficult flanging of plates in various shapes being especially remarkable. The most complex flanging was in the form of a large star having a diamond shaped opening in the center, also flanged. An ingot was shown which was "cogged," welded, and finished in different sizes, decreasing towards the end, illustrating the successive stages of manufacture from the ingot to the bar. Many tested samples were included in the display, and a conspicuous feature was a large homogeneous plate 168 inches long and 72 inches wide, which was beautifully finished. As regards the quality of material and workmanship, this comprehensive and tastefully designed exhibit was certainly most conclusive, the high finish of the products, their great variety of grades, and numerous tests, all contributing to render it singularly interesting and instructive. The exhibit contained every variety of crucible steel demanded by the trade, and each grade showed especial adaptability to the purpose for which it was intended.—*Engineering*.

ANCIENT RIVER CHANNELS.

WE give the result of an interview with Mr. H. S. Jacobs, who has lately made an extended trip in the gravel mining regions of California. Regarding the manner in which the channels of the buried rivers were formed, as well as the character of the streams themselves, and the agencies most active in filling them up, Mr. Jacobs entertains opinions not altogether in accordance with the more commonly accepted theories. The channels of these old rivers, he believes, were eroded by fluvial, and not by glacial, action. These rivers,

itself a new channel. Through the repetition of this process the several old river beds, forming an irregular and somewhat complicated system, as we now find them, were produced.

THE OUTPOURINGS OF THE VOLCANOES.

In the meantime, the volcanoes along the crest of the Sierra for a distance of several hundred miles, belched forth at intervals showers of ashes, which, falling into the torrents along the mountain sides, were carried down and deposited in the channels of the rivers, already partially filled up with gravel, clay and boulders, forming with the alumina and magnesia, brought down the masses of pipe clay with which the auriferous material is interstratified or overlaid. Following these outpourings of ashes and this flow of other matter, came floods of lava and conglomerate, which, running down the mountain sides, covered up, above a certain line of elevation, both the pipe clay and the entire country, in many places to a great depth.

OTHER EXAMPLES.

The alumina and magnesia, being the lightest materials in the interior of the earth, would naturally be on top of the boiling mass that filled the volcanic craters, and, hence, the first to flow out. Of this fact, Mr. Jacobs, during a visit to the Sandwich Islands, learned from an eye-witness a striking confirmation, which occurred during an eruption of Mauna Loa, in the Island of Hawaii, where a stream of this material, forcing an orifice through the lip of the crater, shot out like the arch of a rainbow, and passing over a number of persons without injuring them, fell upon others further down the mountain side with fatal effect. Mr. Jacobs has examined the gold-bearing gravel deposits of Australia and believes them to be coincident in chronology, and to have been formed by the same agencies as were those of California.—*Min. and Sci. Press*.

THE WIGZELL & HALSEY MACHINE.

WE give above engravings of a form of single-acting engine by Wigzell & Halsey, of London. It consists of two single-acting cylinders placed opposite each other with the crank shaft between them, each cylinder being fitted with a deep piston from which a connecting rod is led direct to the crank. The connecting rods are, of course, always in compression. The pistons, we may mention, are fitted with Mr. Wigzell's packing, in which a spiral steel spring is employed to set out the cast iron packing rings, the construction of the spring being such that it not only tends to spread the rings radially, but also forces them against the faces of the piston.

The distribution of the steam is effected by a conical rotating valve, the spindle of which carries a crank arm which takes hold of the crank pin of the crank shaft, as shown in Fig. 4. As will be seen from Figs. 1 and 4, the conical valve revolves within a conical seating, which can itself be turned through a small arc by the hand lever shown. The effect of so turning the valve seat is to transpose the communications with the steam and exhaust openings, and so reverse the

THE WIGZELL & HALSEY ENGINE.

though of great magnitude and running swiftly, were not remarkable for their length. They had their sources, like the modern river system, in the valley of the Sacramento, and did not head in the far north, traversing some thousands of miles in their course, as some writers on this subject hold; their theory being that the enormous boulders formed in the channels of these buried rivers could have been brought down only by a vast, swift rushing volume of water, and that they must have come a great distance to have been rounded and polished as we now find them. In the great width of the water-worn bedrock, as disclosed by hydraulic and drift operations, we find, as these theorists alleged, further evidence of the immensity of these pliocene rivers. But as this might have been produced by these streams shifting their channels, it does not conclusively prove for them an extraordinary width.

HOW THE BOULDERS AND GRAVEL WERE PRODUCED.

This entire country was once submerged by the sea, as is shown by the marine fossils scattered over it. The volcanic action that produced the Sierra Nevada gradually raised the whole country above the surface of the ocean, after which the ancient rivers began to form, wearing out in course of time their present channels. After these were eroded, volcanic and other dynamic movements ensued, crushing the quartz veins that thickly ribbed the Sierra to its top and grinding them into fragments, accumulated along the mountain sides great masses of this gold-bearing detritus. Some of these convulsions, occurring periodically and with great violence, so tilted up the westerly slope of the mountains that immense quantities of these boulders and this auriferous gravel, rendered smooth and sound by previous commotions, were suddenly swept into the old river channels running not far below, filling them up and forcing the water further over towards the west, where it formed for

engine. The particular engine shown in our engravings is adapted for use in a steam launch, but Messrs. Wigzell & Halsey are constructing the engines for a variety of purposes, some of the engines being made with three cylinders.—*Engineering*.

AMERICAN AXES IN ENGLAND.

A WRITER in the *British Trade Journal* says: "I venture to bring to your notice a circumstance which would appear to be the commencement of a very sharp contest with our American cousins for the supply of a certain class of goods in the home market. Having occasion to buy an ax in one of our best retail shops in London, I was strongly recommended to invest in an implement bearing the brand 'Collins & Co., Hartford,' as being of better temper, more durable, and of better shape than an English ax. On my expressing surprise that our edge tool manufacturers could not compete with Americans in their own market, I was informed that the English makers declined to alter either their style or their shape. I was aware that the hickory handles were always imported from the States, and, as I understood, headed, and sent back again, but it appears that we are not only beaten in the States, but also on our own ground, which seems incomprehensible. Inventions for saving labor, of course, find their way to England, and being protected by patents, make their own reputation if appreciated by the public, but the British workman is scarcely alive to his own interest if, owing to the high price of labor and constant strikes, he renders it impossible for our manufacturers to turn out such a simple article as an ax at a price, and of such a quality, as would discourage the importation of foreign goods.

"Probably my ax is only one of many American tools used in England, and it would seem that our American friends are beginning to attack the colonial markets, and will