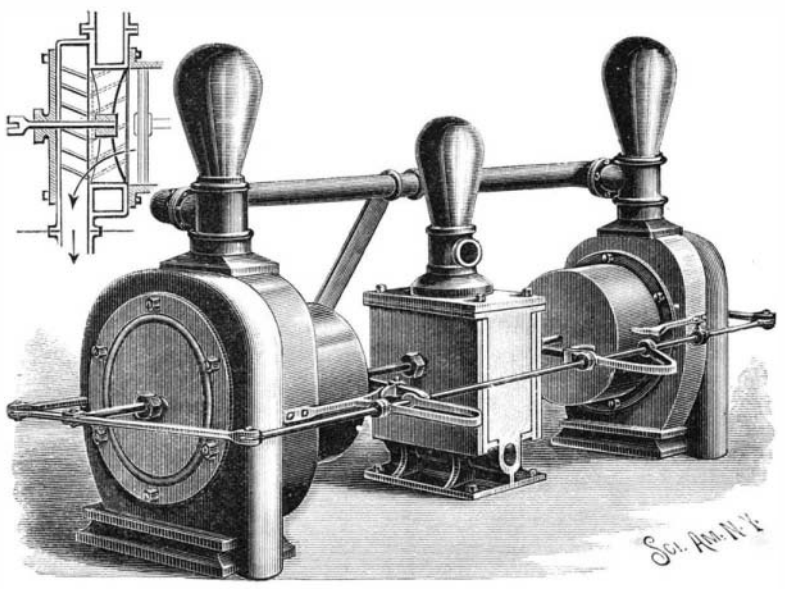
obtaining for Germany a practical patent law, after agitating this subject for a number of years, in connection with the Society for Patent Protection, which he founded, and of which he was appointed permanent president.

For the foregoing particulars we are indebted to the *Electrical Review*, London, and for our portrait to the *Street Railway Review*.

The funeral took place at Berlin, December 10. Chancellor Von Caprivi, Dr. Von Boetticher, Secretary of the Home Office; Herr Von Berlepsch, Prussian Minister of Commerce; Dr. Hermann von Schelling, Prussian Minister of Justice; the municipal authorities, and a large number of scientific men and artists were present. The funeral was conducted with much pomp. The route to the cemetery was lined with thousands of people. Four thousand workmen from the Siemens factory followed the hearse. Among the floral offerings was a wreath from Thomas A. Edison, inscribed "To my friend."

AN IMPROVED MOTOR.

The motor shown in the engraving is more especially designed for use on artesian wells, etc., to obtain, with a low pressure of water as a driving medium, a large amount of power for actuating other machinery. The improvement has been patented by Mr. B. S. Partridge, of Jacksonville, Fla. The machinery to be actuated may be of any desired construction, the improvement being represented as applied to a double-acting pump, the piston in the middle pump being on a piston or power rod carrying pistons in cylinders near its ends, these cylinders being open at their inner ends and connected at their outer ends with the valve chests of inlet chambers through which the motor agent enters. In these chests slide cylindrical valves, whose rims open and close the inlet and the outlet ports alternately, the valves having each a central hub and radial spokes, as shown in the sectional view, to form a discharge opening for the cylinders at the time the valves are seated over the inlet ports of the inlet chambers. The valves are at all times entirely surrounded or filled with the motive agent, and thus are constantly and perfectly balanced. Outwardly extending valve stems are pivotally connected with transverse pivoted arms, whose free ends are pivotally connected with each other by a rod extending at one side from one outer end to the other of the motor. This rod slides in bearings formed on arms secured to the power rod, the bearings engaging collars on the ends of V-shaped springs, which have at their other ends collars abutting against collars secured to the rod, while the latter collars abut against spring arms secured to the valve chests. In operation, as the power rod moves in either direction, one of the springs is first compressed and then released, to force in one direction or the other the rod connected with the valve stems at the ends, thus alternately opening and closing the outlet and inlet ports in each chamber. A practical test of this improvement has been made before the Board of Public Works and the fire department of Jacksonville, Fla., in which water was taken at 20 pounds pressure through a 6 inch pipe, and, using a 2½ inch hose and ¾ inch nozzle, a stream was thrown 107 measured feet, the pressure varying from 40 to 60 pounds, and when the valve was closed the pressure rose to over 100 pounds. As this was effected with an experimentally made motor, it is claimed that much better results can be obtained with a motor specially manufactured after approved patterns in accordance with this invention.



PARTRIDGE'S WATER MOTOR.

Ocean Mails Under the American Flag.

The new foreign mail service so far contracted for under the recent act of Congress is as follows:

Beginning of Contract.	Termini of Routes.	Number of Trips.	Period of Contract.
Apr. 26, 1893..	Galveston to La Guayra	3 times a month.....	5 years.
Mar. 1, 1892..	New York to La Guayra	3 times a month.....	10 years.
Feb. 1, 1892..	New York to Colon....	3 times a month first 2 years; once a week 8 years	10 years.
Feb. 1, 1892..	San Francisco to Panama	3 times a month first 3 years; once a week 7 years.....	10 years.
Feb. 1, 1892..	San Francisco to Hong-Kong.....	Once every 28 days; once in 2 weeks.....	10 years.
Oct. 12, 1895..	New York to Southampton	Once a week	10 years.
Oct. 12, 1895..	New York to Antwerp.	Once a week.....	10 years.
Dec. 10, 1892.	New York to Buenos Ayres.....	Once a week with calls; 28 days without.....	5 years.
Dec. 1, 1892..	New York to Rio.....	Once in 24 days.....	5 years.
Nov. 1, 1892 .	New York to Tuxpan..	Once a week.....	5 years.
Nov. 1, 1892..	New York to Havana...	Once a week.....	5 years.

The new service applies to eleven lines, comprising, when completed, forty-two ships of 165,802 tonnage, and the contractors will be required to spend $14,000,000 to provide ships necessary to make the service contracted for frequent enough and quick enough to comply with the terms agreed upon.—*Report of the Postmaster-General.*

The Manufacture of Small Arms.

At a recent meeting of the Institution of Civil Engineers a communication on "The Manufacture of Small Arms" was read by Mr. John Rigby, M.A., superintendent, Enfield factory.

The author traced the history of the interchangeable system of manufacturing small arms, from the date of the first factory in England, set up in 1852 at Pimlico by Colonel Colt, who imported the machinery from America. He then proceeded to describe the various processes of manufacture of the components of the Lee-Metford Mark I. magazine rifle, of 0·303 in. bore, the weapon adopted for the British army, prefacing the account with a general description of the Enfield factory.

The most important part of a rifle was the barrel, which had always engaged the special attention of gunmakers. Up to the time of the Crimean war it was, for the bulk of British troops, a comparatively rude tube of iron, lap-welded under rolls and tapering externally, with a cylindrical bore of about ¾ in. diameter. The barrel of the present day was a steel tube of accurate workmanship, only $\frac{5}{10}$ in. bore, almost perfectly true and straight, rifled to $\frac{1}{8000}$ in., and so closely inspected that the existence of the most minute gray or seam in the bore, requiring a highly practiced eye to detect it, was sufficient to condemn it. The material used was produced either by the Siemens-Martin or the crucible process of manufacture, and was supplied to Enfield as a solid round bar 1⅜ in. diameter and 15½ in. long. After severe testing, this bar was passed through a rolling mill to draw it to its full length; it was then taken to the forge, the swell at the breech end was stamped to the required shape by a steam hammer, and afterward straightened cold. The next step was to submit the bar, without annealing, to the turning and drilling machines. The latter were horizontal, the drills operating from each end. In the process of drilling the barrel revolved at nearly 1,000 revolutions a minute against half-round bits held flat down, a capillary tube of brass supplying soap and oil emulsion, at a pressure of 80 lb. to the square inch, to wash out the swarth and cool the cutting edge. The drills advancing from each end continued boring until a small disk about $\frac{1}{100}$ in. diameter broke out, and the two holes met. The tendency of the drills to follow the line of axis of a revolving bar was one of those curious occurrences in practical mechanics which might be accounted for after observation, but which no one would predict. Occasionally, through some defect in the steel, a drill wandered from the axial line; in this case the barrel was taken from the machine and reset sufficiently to bring the hole true again. To test its truth, a ray of light was made to illuminate the flat bottom of the hole while the barrel slowly revolved. It was very rarely that a barrel was rendered waste from bad drilling. Rough boring followed with a three-edged bit, the blade being about 4 in. long. The rough external turning was effected in self-acting lathes, which gave the required curved taper. Three or four cutters acted simultaneously, each producing a long cutting that attested the quality of the metal of the barrel. The operation of barrel setting followed. Previous to rough turning, the barrels were fairly straight internally, but the removal of the metal caused slight inequalities which were tested by the eye of the barrel setter, and corrected by transverse blows. This constituted skilled labor of a peculiar character, and was performed by young men of good sight, who were specially trained for that purpose. After middle life the eye generally lost some of the quality necessary for this work, and it was rare to find a man excel in it after that period. Many mechanical devices had been contrived to supersede the simple ray of light laid, as if it were a straight edge, along the surface of the bore; but the eye still remained the arbiter of straightness and could be relied on for very accurate results. The construction of the barrel was completed by the important operation of rifling. In British small arm factories the system was followed of planing out each groove separately with a hooked cutter, and had been brought almost to perfection. In Continental and American factories the grooves were plowed out by cutters with several cutting or knife edges set at an angle and following one another in the manner of a single-cut file or float. Similar machines have been tried at Enfield, but did not give as smooth a cut as the slower moving single-tooth machines. A few passes of a lead lap fed with fine emery removed any burr that might remain, and completed the polish; a cylindrical lap, spinning rapidly, was then passed through, and gave the final finish to the barrels. The limits of gauging were from 0·303 in. to 0·305 in. Next in importance to the barrel was the mechanism of the breech, for which the material preferred was crucible cast steel of a mild character, but capable of being hardened in those parts exposed to the pressure of the bolt. The body was forged in two operations under the steam hammer; it was then drilled and subjected to a long series of operations, in the course of which the end was recessed to receive the screwed end of the barrel, and the corresponding thread in the recess was milled out in a specially contrived machine, which insured that the thread should always start in the same place relative to the gauged part of the body, a point of great importance. The bolt, also of crucible cast steel, was forged under the steam hammer. A special machine, invented at Enfield, was used to finish the bolt after shaping. After machining, the bolts, packed in wood charcoal in iron cases, were heated and hardened by immersion in oil. The temper of the handle was then reduced in a lead bath. The rest of the bolt was tempered straw color. The bolt head was similarly hardened and tempered.

The other components of a complete rifle were mostly shaped by mills built up to the proposed profile, or by copy milling machines. The process of drifting was used with good results at Enfield. All such slots or perforations as had parallel sides, and were not cylindrical, were so finished. The common practice in drifting was to push the drift, but at Enfield much better work was accomplished by pulling. It was found that used in this way drifts were very valuable for interchangeable work. The sides were cut with successive teeth, each slightly larger than the preceding one, and the whole length of the drift was drawn through. Emery wheels were also largely used at Enfield, as a substitute for finish milling and filing. The wheels ran under hoods connected with a pneumatic exhaust that carried away the heated particles of steel and grit. It was popularly supposed that a machine once adjusted to turn out a component of a certain size and shape was capable of reproducing such in large numbers, all absolutely identical. This was so far from being the case that no die, no drill, and no milling cutter actually made two consecutive articles of the same size. The wear of the cutters or dies proceeded slowly but surely, and it was only possible to produce in large numbers components of dimensions varying between a superior and an inferior limit. In small arm manufacture a variation of about one two-thousandth of an inch was about the amount tolerated, but it varied according to the size of the piece. A difference of diameter of one two-thousandth of an inch in the sight axis hole, and in the size of the pin or axis, would cause a serious misfit, whereas a similar difference in the measurement of the magazine, or of the recess in which it lay, would be quite immaterial. The operations of gauging, proving the barrel, and sighting, were successively described, as also the manufacture of the stock, which was of the wood known as Italian walnut, though largely grown in other countries. Among the smaller components, the screws were mentioned as being rapidly produced by the automatic screw-making machines of Pratt & Whitney.

The component store received the various finished parts, which numbered 1,591, or, including accessories, 1,863, and issued them to the foreman of the assembling shop. Theoretically, the assemblers should have nothing to do but to fit and screw them together, but in practice small adjustments were found necessary. The amount of correction was generally exceedingly small, and was done wherever possible with the aid of emery wheels. The completed arms were submitted to inspection and then issued in cases of twenty each to the Weedon government store or elsewhere.

The paper concluded with an account of the manufacture of swords and sword bayonets, which had recently been resuscitated in England.

ILLUMINATED walking sticks are among the latest applications of electricity. A small incandescent lamp is concealed in the head of a cane and can be ignited by a spring.