being regulated to any given pressure; they are portable, strong and durable, and cannot easily be put out of order, and all their parts are so constructed as to be replaced with facility in case of need.

The paper is illustrated by diagrams from which Figs. 1 and 2, presented by the Author, are compiled.

Mr. BRUNEL, V.P., had been long anxious to find some water meter capable of indicating correctly the supplies to the several boilers of a steam-vessel, in order to ascertain the steam actually raised by each boiler; that analysis of duty had hitherto been very difficult, on account of the steam from the several boilers forming one general supply. He did not, however, perceive how this meter could be made to work under any considerable pressure, and from the construction and the elasticity of the bags, he fancied there would be some variation; if there was any differential pressure, or any friction, or resistance of the cones, there would be some inaccuracy.

The piston and cylinder system, as in Kennedy's meter, had been unduly depreciated. Some of these meters had been very satisfactorily employed on the Great Western Railway, at Paddington, and from their construction, he thought they must be more accurate than the meter under consideration. A very little packing rendered the piston tight enough to prevent leakage, and the rack and pinion indicated the aggregate lengths of strokes of the piston, or the length of the column of water passed. There was not any inconvenient concussion from the column of water, and though by packing the piston too much, the friction might be augmented, that evil was soon perceived and easily remedied, and led to no error of measurement. He found that meter would enregister either large, or small quantities of water.

He was not in a condition to make a comparison between the cost of the two meters, but he could not perceive, without further explanation of the meter under consideration, how the measurement could be accurate, when it depended on the variable elasticity of vulcanized caoutchouc. Supposing one bag to sustain injury, and be changed, would the capacity of the new bag be exactly similar to that of the others? It would

appear probable, that the friction of the cones over the bags would tend to destroy them, and that the different amount of distention, produced by variable pressure, would create irregularity of measurement.[1]

Mr. C. W. SIEMENS gave a succinct description of his water meters, an account of which had been read before the Institution of Mechanical Engineers, at Birmingham.[2] He contended, that although a single screw suspended in a current of water, might allow a considerable quantity of fluid to pass unmeasured, at low velocities, that defect had been counteracted, by the addition of a second screw, working in the opposite direction, and by a general equilibration of the working parts;—that meters of this description had been found to measure water with great accuracy, at all speeds above 1 per cent. of the maximum speed; but that they had failed, after working during a period of from six to fifteen months, in consequence of the inevitable abrasion of the spindles working under water. To obviate this serious difficulty, which applied equally to piston, or to diaphragm meters, the more simple contrivance, of a form analogous to that of a Barker's mill, was adopted. The water entered the rotating disc of this meter, through a contracted funnel, and spreading outward, issued through tangential apertures into the surrounding casing. Inasmuch as the outlets would act, to some extent, in the manner of jets, this drum would revolve proportionately faster at high velocities; to counteract this effect, upright blades were attached to the revolving portion, giving a resistance in the water, increasing as the square of the velocity. A uniform ratio, within the limits of 2 per cent., was thus practically obtained. The only step, or bearing of this meter, was effectually protected from the water, by forming a closed oil chamber at the bottom of the disc, into which there entered an upright stud with a steel point, abutting against a steel plate at the bottom of the

---

[1] By a recent communication from Messrs. Macintosh and Co. it appeared, that Mr. Kennedy had abandoned the packed piston for his meters, and had adopted Mr. Woodcock's vulcanized caoutchouc 'Rolling Piston,' as described in the Repertory of Patents, vol. xiii. page 293.—EDITOR.

[2] Read January 25th, 1854, and published in the Proceedings of that Institution.

chamber. In like manner, the reducing wheels of the counter were enclosed in a sealed oil chamber.

Out of three hundred meters on this plan, which had been in constant operation, under the most varied circumstances and pressures, for about twelve months, not one had failed in the working parts. He, therefore, contended, that as the machine had ample power to overcome extraneous resistances, and as the friction had been reduced to a minimum, variations in that friction would not affect the measurement to any sensible degree. The advantages of this meter were, its compactness, cheapness, and general applicability, either for water-works' purposes, or for measuring the water pumped into steam boilers. It would, he believed, enregister correctly, at as low a velocity as one-tenth of a gallon per minute, and the leakage, at that rate, could not be important, with an article of such low value as water.

Mr. J. F. BATEMAN conceived there must be some sensible loss of pressure in passing through the meter; he had found this to be the case, in some trials at Manchester, made by jets attached on each side of the meter. He had some doubt as to the durability of the vulcanized bags. He entertained this opinion, from observing the effect on the caoutchouc covering of the wooden balls originally used in the hydrants, made by Messrs. Guest and Chrimes. The material appeared to undergo a decided change, from the action of the water and the pressure; it was also cut into strips in a very peculiar manner. It had been found necessary to substitute balls of gutta-percha and collars of caoutchouc, and the success was now complete. It should be stated, that fearing the action of copper, or brass on the vulcanized caoutchouc, the faces with which the balls were in contact were made of pure tin.

Mr. BROCKEDON was much surprised to hear this statement, relative to the destruction of the vulcanized caoutchouc; it was so completely opposed to the experience of a great number of trials, extending over many years, and also to the general reports of those who had put the material to numerous uses. He had specimens of the article, which had been in water in a tranquil state, for fourteen years, without any visible change. Perhaps there was no manufacturing process, the rationale of which was so little understood, as that of 'vulcanizing' the

caoutchouc; all that was known had been learned from observation;—a given quantity of sulphur, was administered to a certain thickness of caoutchouc, at a certain temperature, and certain results were confidently reckoned upon; though he must admit, more by practice, than from theory. Failures no doubt did occur, during the first periods of manufacturing; but for some years past such occurrences had scarcely been heard of. The surplus sulphur appeared to be susceptible of being removed mechanically from the basis, by the friction arising from the extension and contraction of the piece of vulcanized material; and under certain circumstances of extreme tension, such, for instance, as when a ring, or band was placed round a bundle of papers, and they were packed, in that state, into a drawer, the rings would be found, after some years, to be very tender and to snap readily, on attempting to stretch them. Some remarkable change took place under such circumstances, but it was an exceptional case. He had specimens of the vulcanized caoutchouc which had been buried in damp earth, for ten years, without exhibiting the slightest appearance of change. As to injury from blows, he had exhibited at the Institution, pieces which had been subjected to the force of Nasmyth's steam-hammer without showing any signs of injury. It appeared to be almost impossible to impair the elasticity. The articles were moulded and then vulcanized under pressure, so that the form thus given, became the normal state of the mass, and it was not possible to roll it out, or to extend it permanently.

There did appear, however, to be a peculiarity with respect to the material of which the mould was made; if tin was used, the articles were delivered perfectly clean; but if brass, or copper was used, the material adhered to the mould; probably from the sulphur having a greater affinity for one metal than the other.[1]

[1] In a communication from Messrs. Macintosh and Co., recently received, it was stated, that the only effect of long-continued immersion of vulcanized caoutchouc in water, was a slight change of colour,—a hydrate produced by superficial absorption,—and that change of colour disappeared on the substance being dried. If they were called upon to select a situation, under which the substance would retain, for the longest period, all its properties, they would prefer immersion in water. After many years' experience in the use of pipe-joints, hose-pipes, valves for pumps and steam-engines, &c., they had never known an instance of injury arising from the contact of any kind of water. —EDITOR.

Mr. J. T. COOPER corroborated the statement as to the duration, and the unchanged character of the material from simple immersion in water; he had specimens which had been for fourteen, or fifteen years in water, without exhibiting any appearance of change. Messrs. Macintosh had, as an experiment, coated some logs of wood with vulcanized caoutchouc and caused them to be towed at the wake of a vessel all the way to Demerara and back, when it was found, that the coated logs were intact, whilst the uncoated timber was riddled by marine insects. Within the range of his experience, he had never found water of any kind to exercise any chemical effect on the material.[1]

Everything depended on the process of vulcanizing, and in that, it was admitted, there was some uncertainty; if the process was performed slowly and at a low temperature, the result was almost invariably good; if it was done in too short a time, or too great heat was employed, the material became hard and brittle and was apt to crack. About 2, or 3 per cent. of sulphur was generally absorbed, when the process was properly performed, and when any excess was left, the elasticity was impaired. Numerous modifications of the ordinary process had been introduced, for producing a variety of new conditions of the vulcanized material, and for giving certain appearances to it. These effects were produced by the mixture of extraneous substances, and by subjecting the articles to greater, or less degrees of temperature.

Mr. J. SCOTT RUSSELL proposed a series of experiments being tried on the elasticity of caoutchouc, because being a pure and homogeneous substance, nice and accurate results could be arrived at, without trouble, or expense. From results he had observed in using tubes of this material, he was induced to believe, that under certain circumstances, certain changes did take place, when tubes were worked too near the range of their ultimate elasticity; for instance, when a tube was frequently and regularly stretched to three times its ordinary, or contracted length, it soon snapped; tubes conveying oil to bearings, or journals of shafts, were rapidly destroyed. In one

[1] About twenty-six years ago, Mr. Hancock sealed up a given quantity of water in a bag of caoutchouc, and on weighing it every year, he found that it gradually decreased, and at last entirely evaporated by 'exosmose.'—EDITOR.

case a tube, under these circumstances, which was only extended 1 foot in 6 feet, at regular and frequent intervals, lasted but six hours. It was probable, however, that the oil acted chemically on the substance, and he invited the chemists to investigate the action of fatty matters on the vulcanized material.

Mr. T. WEBSTER said, that after undergoing the process of vulcanizing, the caoutchouc appeared to be totally changed in character, and to have become unlike any other known substance, as it was not apparently affected by any ordinary degrees of heat, or cold. A careful series of experiments upon its capabilities and its various properties would be very valuable, and he would suggest, at the same time, the clear definition of the terms elasticity, flexibility, and extensibility, which were all applicable to the substance, and were susceptible of being misapplied.

Mr. LILLEY exhibited a meter, invented by the late Mr. William Parkinson, which was described as not having any 'tumbling lever,' or 'tumbling weight,' as in a meter invented by a person of the same name, and with which this instrument had been confounded.

The measuring wheel was similar to that of the well-known gas meter, which had been so extensively manufactured by Messrs. Parkinson and Crosley. When the meter was in action, the water entering by the inlet pipe, fell through a regulating valve into a square box at the back; this valve being governed by a small float, which closed it, as the water arrived at a certain height, and opened it again, when a given quantity had escaped from the box, so that under whatever column of water the meter was working, the quantity passing into the measuring-wheel was always nearly the same. The wheel revolved in a trough, the top edge of which was always retained in a level position, by its being suspended on a swivel, or point, so that when the surface of the water in the trough was once fixed, at a proper distance below the axis of the wheel, the same quantity must always be measured at each revolution. The inlet and outlet openings, of the wheel, situated at the opposite sides of the meter, were so constructed, that the water in its flow, was always higher in the descending cavities, than in the ascending cavities, and thus a constant and uniform rotation was imparted to the wheel, by the regular flow of the water to be measured.

The action of the meter was perfectly noiseless, and its delicacy was such, that if the water only arrived by drops, during several hours, the quantity would be as accurately measured and enregistered, as if it had been supplied from a head of 300 feet, or 400 feet, under which pressure all these meters were tried and proved.

Mr. CHADWICK said he thought the principle of the meter had scarcely been sufficiently examined by the speakers, or they would not have questioned the results which had been mentioned; they were not theoretical impressions, but practical facts corroborated by extensive experience. The novelty, and the simplicity of the meter appeared to be admitted, and the only doubt was as to the uniformity of expansion, or extension, and the durability of the vulcanized caoutchouc bags. On this point he had made careful inquiry, and he was perfectly convinced, that no instance could be shown of any chemical, or mechanical change taking place in the material from immersion in water. The duration of the discs of vulcanized caoutchouc in Lambert's taps, in Jennings' and in Kirkwood's water-closets, and in many other cases, where the friction and the sudden extension and recoil were much greater than in his water meter, showed how little was to be feared from the friction, or abrasion of the cones, rolling over the bags. Messrs. Macintosh and Co. assured him the material was indestructible in water, but that grease and oil might act injuriously upon it. They stated, that the vulcanized caoutchouc chambers, as used in these meters, would retain their elasticity unimpaired, and their figure and capacity unchanged, for many years, even quite as long as the metallic parts of the meter would endure. The bags were all made to the same pattern and were all tested; so that he could not perceive how there could be any variation in their elasticity, or extensibility, and therefore, in the accuracy of their measurement; but even admitting, for the sake of argument, that after a meter had been in use for a long time, a bag did wear out, or was injured, a new one could be substituted in half an hour, and if the capacity was found to differ from that of the old bag, it would be easy to compensate for it by the alteration of a tooth in the counter-wheels.

When tried by a pressure gauge on each side of the meter, only 1 per cent. of difference was shown; and the power

required to propel the cones was scarcely appreciable. A meter with an inlet pipe 1 inch in diameter would deliver 100 gallons in three minutes, under a pressure of 175 feet; and at a very low velocity, almost without pressure the variation would be only about 5 per cent.

CARR'S RAILWAY CROSSING.

After the Meeting, Mr. Carr exhibited models of his Improved Railway Crossing. The chief deviation from the form of the common crossing, appeared to consist, in filling the hollow on the inside of the wing rails, so as to afford support to the part where the wheels bear partially on them, and thus to preclude the possibility of the overhanging flange being sheared off,—which was stated to occur frequently with ordinary crossings. The point rails were similarly filled, and also blocked out so as to render the point one solid piece, of much greater strength than usual. The joint of the point-rails, being on a chair, appeared to obviate the necessity of bolting the rails together, whilst it dispensed with the splice-joint of the ordinary construction.

A loose block was also introduced between one wing-rail and the point, in each of the point-chairs; this alteration allowed the wing-rail, the loose block, and the point, to be all wedged firmly in the chair by one key.

It was shown, that although the upper surfaces of the filled wing-rails and the solid point might be worn down, they could not be crushed, and the deficiency of metal which might be produced, by wear, could be easily restored, by heating the rail, and slightly hollowing the side; whereas in the common crossing, the overhanging flange being liable to be sheared off, or crushed, entirely destroyed the rail:—so that in the one case, a few shillings would restore the crossing; in the other, it was entirely destroyed, and must be replaced by a new one.

Fig. 1. (p. 438) is a general plan of the solid point with the joint on the chair.

Section (*a b*) shows the wing rails, the solid point, at its widest part, and the loose block, between the wing-rail and point, all secured in the chair by two wooden keys.