Mr. E. A. Cowper exhibited two diagrams of new arrangements of the ring-valve, in which the rings were arranged in the form of an amphitheatre, the outside, or larger rings being placed higher than the inside, or smaller rings, so as to give great convenience for obtaining a long steady guide in the centre. This form was being adopted in several 40 H.P. engines.

Mr. Hawksley thought the description of the action of the valves given in the Paper was very true and clear. Concussions were frequently caused by the return of the piston, through a space, upon a body of quiescent water, without any action of the valves. It did not follow, that because the blow might occur at the moment of the opening of the delivery valve, it was caused by the motion of the valve.

Mr. Scott Russell thought that, the conical form of the apertures, for the passage of the water, might have some influence in producing the shock, by directing the flow upwards, and imparting great velocity to the column.

Mr. Armstrong had used the annular valves, because the beat was large, and there was ample escape for the water; and the shock was proportionate to the difference of the upper and lower areas. The opening was continuous all round, and was much larger than the area of the inlet pipe. He could not, therefore, admit that the shocks were at all due to this form. In proof of the violent effects caused by the overshooting of a column of water, he might mention, that if water was rapidly discharged, and the column was allowed to rush violently forward, a vacuum appeared to be formed behind, and frequently pipes had been burst by the reflux, without any considerable pressure of head.

Mr. Henry Maudslay said, that in applying vulcanized India-rubber for valves, if the substance was fixed, it cut itself rapidly away, by falling into the same grooves; but if the discs of India-rubber were allowed to move about, it wore excellently. In corroboration of this opinion, he produced an old air-pump bucket-valve, made of India-rubber, which had been at work for some time, in one of the engines at Messrs. Maudslay and Field's manufactory, Lambeth.

Mr. D. Thomson had tried vulcanized India-rubber valves to avoid concussion, under heavy pressure, bu' he had not found them to diminish the shock of the beat; they appeared, however, to wear well.

Mr. SCOTT RUSSELL had tried an India-rubber tube for conveying oil to a revolving crank journal. It was stretched about one-sixth of its length each revolution. The result was that the cohesion was destroyed, apparently by the action of the oil, and it was abandoned.

Mr. BRUNEL, V.P., observed, that he had known vulcanized India-rubber to bear frequent compression, for a period of five or six years, without any injurious effect being produced. He had no experience as to the effects of tension for a lengthened period; but the rubber was liable to great changes, if exposed to the action of air, sunshine, and light. Its elasticity was then impaired, and he had known it become extremely brittle. It appeared as if the sulphur had been only held in mechanical combination, and was ultimately thrown off.

Mr. E. HUMPHRYS had examined a pair of air-pump valves of a marine engine, made of vulcanized India-rubber, after a twelve months' voyage, and found that they were in perfect order. The valves were 38 inches in diameter, working 36 strokes per minute, upon a metal grating, the bars of which were one-eighth of an inch wide, and the apertures five-eighths of an inch square.

Mr. HAWKSLEY thought, that if the elastic limit of the material was not exceeded, no injury would accrue. He had examined a piston-rod after it had performed one hundred million strokes, and it had suffered no deterioration. Gutta percha, when exposed to the atmosphere, deteriorated faster than India rubber, and after a few years, if unpainted, the substance laminated, and could be rubbed to pieces. Under water, however, it was more durable. Vulcanized India-rubber seemed to absorb heat in contraction, and give it out on distension; this produced an effect called " erema-causis," which eventually caused its disintegration.

Mr. T. R. CRAMPTON could corroborate the opinion just given, as he had found that the gutta percha covering of the wires of the Submarine Telegraph, was very durable under the sea, but on the face of the Dover cliff, where it was exposed to air and light, it had soon been destroyed. It was then buried under ground, and had proved perfectly successful.

Mr. W. Brockedon, through the Secretary, called attention to a vulcanized India-rubber valve, in which the disc of rubber was allowed to rotate, and thus change the points of pressure, instead of being fixed as formerly, when it was compelled always to beat in the same place. He thought that in the vulcanized India-rubber valves mentioned, as not having been found "to diminish the shock of the beat," there must have been a disproportion between the area of the openings, the width of the grating-bars, and the thickness of the India-rubber disc, or slab. Engineers were not agreed on these points. The openings in the valve beds varied from 1 square inch to 6 square inches in area, and the width of the bars from $\frac{1}{8}$th to $\frac{5}{8}$ths inch. The thickness of the rubber also varied from $\frac{3}{8}$ths to 1 inch. He thought that for a valve of 20 inches diameter, the opening in the bed-plate should be about $1\frac{1}{4}$ inch long, and 1 inch wide, and the width of the grating-bars about $\frac{5}{16}$ths inch. The disc for such a valve should be about $\frac{3}{4}$ inch thick. He believed that valves with something like these dimensions, and with proper precautions for the escape of air, which was always accumulating in pumps, and which, if retained, caused much concussion, would work easily and quietly. At Manchester, a new foot-valve had recently been put to an engine, in which the only materials used were cast iron and vulcanized India-rubber. There was no brass, and yet it was working perfectly. The brittleness of vulcanized India-rubber was not always produced by air and light. It depended in some degree upon the relative quantities of rubber and sulphur—the degree of heat and the time employed in effecting the change—and the further change which time and circumstances might produce upon it. In cases where it was known to what use, and to what degree of exposure, the rubber would be subjected, carbon had been combined with the rubber, as it was known to be a powerful preservative of animal and vegetable substances from decomposition. This effectually protected the caoutchouc from injurious changes, even in tropical climates.

Gutta percha was, in his opinion, far more liable to decomposition than vulcanized India-rubber. It was inelastic, until its temperature rose to 120°, above which its cohesiveness was rapidly lessened up to 140°, when it was as easily separated as wet paper. It could, however, be reunited, was plastic, and could be moulded into any form, in which it would set and become rigid again as it cooled. Gutta percha could not be vulcanized alone, nor could it acquire any of the properties of vulcanized India-rubber; but it might be combined with India-rubber, like any other material, to adulterate, or change the quality, and like such compounds it could be vulcanized. In this case the vulcanization was due solely to the India-rubber, and the compound was deteriorated for every purpose in which elasticity was required; and in which strength, at even moderately high temperatures, was necessary.

Mr. RENDEL,—President,—suggested, that an interesting series of experiments might be made, on the duration of the elasticity of vulcanized India-rubber; as that substance, as well as gutta percha, appeared to be eminently adapted for use in engineering operations.