

## ON BARTON AND WEST'S WATER PRESSURE REDUCER.

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The object of this Pressure Reducer is to relieve low-lying and branch mains, and domestic service pipes, from excessive and unnecessary pressure; and thereby to reduce the danger of bursts in the former case, and of injury to house-fittings in the latter.

For mains the reducer may be made in two forms, either to reduce the pressure to a fixed percentage of the normal head, or to deliver the water at any required absolute pressure less than that in the principal main, no matter how the head in the latter may vary. Thus, with a pressure in the principal main varying from 200 to 500 feet head under different conditions of pumping, the branch mains may be made to deliver at a uniform pressure of 60, 80, or 100 feet as may be required; and should it be desired, this latter pressure may be altered instantaneously by the officers of the water company.

For house service the small reducers adapted to  $\frac{1}{2}$  in.,  $\frac{3}{4}$  in., and 1 in. service pipes are only made to give a fixed percentage of reduction—40, 50, or 60 per cent. as may be required; and they are not susceptible of modification when once fixed. There is no reason however why, if desired, they should not be made precisely similar in construction to the larger reducers: the question being purely one of expense in production.

*Reducer for Mains* (Fig. 1, Plate 56).—The main body or outer casing A of cast iron has sockets or flanges to receive the inlet and outlet pipes B and C; of these the inlet B leads into the circular chamber D containing the valve E; which valve opens or closes the communication to the lower chamber F, from which the outlet pipe C is led. The valve is of the balanced class, and whatever be the pressure in the inlet pipe there is no tendency to open it. The top of the chamber D is bored to an easy fit for the upper disc of

the valve, while the bottom is faced to form a seat for the lower disc to bear against. The upper part of the valve is sealed with an india-rubber packing G, which prevents the water pressure from getting upon the top of it and forcing it downwards. Below the lower or outlet face, the body of the valve is reduced at H in any convenient proportion; this reduced diameter is preserved through the lower chamber F, and the bottom end is sealed by an india-rubber packing similar to that used at the upper end. A bolt J, with nuts and wrought-iron washers, passing through the body of the valve from top to bottom, keeps the india-rubber joints tight; the ends of this bolt are prolonged, the lower one fitting in a step at the bottom of the machine so as to form a guide, and the upper end passing through the top cover so as to be acted upon by a lever L and dead weight or spring.

The action of the apparatus is as follows :—The valve is perfectly balanced, so far as the inlet pressure is concerned; hence, if there be no pressure in the outlet main, it falls from its seat by its own weight and allows the water to pass; but when the pressure on the outlet main, acting against the annular area at II, becomes sufficient to lift the valve, it forces it up to its seat, where it will remain until the pressure in the outlet is again reduced. All therefore that is necessary in order to obtain a fixed limit of pressure in the delivery pipe is to weight the valve, either by dead weight or spring and lever, to such an extent as to balance the intended outlet pressure when acting on the annular area II. When this has been done, the pressure in the inlet may vary to any extent, but that in the outlet can never rise above the fixed limit.

As an example may be taken the 3-inch regulator, shown in Fig. 1, the dimensions of which are as under :—

Diameter of upper and lower discs of valve . . . . .	5 in.
Diameter of lower portion H of valve body . . . . .	4 in.
Weight of valve . . . . .	35 lbs.

The fixed limit of pressure in the outlet pipe may be assumed to be 50 lbs. per sq. in. The difference in area between a 5-in. and a 4-in. circle being about 7 sq. in., and the weight of the valve

being 35 lbs., the pressure in the outlet to balance the weight of the valve will be 5 lbs. per sq. in. Consequently, 45 lbs. per sq. in. extra load will be required on the valve, if it is to close at 50 lbs. pressure. This requires  $45 \times 7 = 315$  lbs. downward pressure on the valve, which, with a leverage of 8 to 1, would require about 40 lbs. dead weight. If this be applied, the valve will keep open so long as the pressure in the outlet is below 50 lbs. per sq. in.; but the moment this is exceeded the valve will close automatically. This working or delivery pressure in the outlet may be instantly increased or reduced by altering the weight on the valve.

*Reducer for Service Pipes* (Fig. 2, Plate 56).—The smaller class of reducers are so made that the proportion of pressure in the inlet to that in the outlet is maintained constant. In this case the construction is simpler; the inlet chamber B is underneath the valve VV, the upper and lower faces of which are proportioned to the required reduction in pressure. With a view to avoid stuffing-boxes, two discs of india-rubber are inserted, cutting off the water from the back of each portion of the valve. There is a communication K between the outlet C and the upper face of the valve.

Again to give an example, suppose the areas of the upper and lower valve faces to be as 2 to 1. Then as long as the pressure in the outlet pipe does not exceed one half the pressure in the inlet, the valve will be raised and the water will pass; but the moment the outlet pressure rises beyond that proportion, the valve will close, and will so remain till the outlet pressure is again reduced. The proportional pressure on each side of the reducer remains the same, whether the water be at rest or running; and the delivery will in every case be equal to that due to the reduced head on the outlet side.

An extensive series of experiments was lately made with two of these reducers at the South Essex Water Works, under the direction of Messrs. Edward Easton and L. F. Vernon Harcourt, who have reported that in every sense they fulfilled the purposes for which they were designed.

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*Discussion.*

Mr. J. McFARLANE GRAY said the two systems of water valve presented by the authors would be at once recognised by most engineers as being merely modifications of the many valves with which they had long been acquainted for reducing the pressure of steam. There were two principles employed: one, that of proportionate reduction; and the other, that of reduction to a fixed absolute pressure. In the case of the proportionate valve, the pressure was regulated by the outlet pressure; where the pressure was fixed, it was regulated by the weight applied. Referring to Fig. 1 (Plate 56) in Mr. Thomas's paper, he thought that, although the india-rubber diaphragms might be very reliable, the chamber above the valve ought to be connected by a pipe with the chamber under the valve; otherwise, should one of the diaphragms give way, the valve would open or close, as the case might be, and pressure would soon accumulate under the diaphragm. Therefore provision should be made to ensure that the pressure should always be the same above the valve as it was below it. Of course in the case of reducing valves for water pressure it was not necessary to have the valve so absolutely tight as was required in the case of reduction of steam pressure: they were more of the nature of throttle-valves, because the connections in a district would never be all absolutely tight, and the reducing valves would therefore be always open to such an extent as would keep up the proper reduced pressure in those connections.

Mr. J. G. MAIR asked Mr. Alley if he had made any valves similar to Fig. 5 and Fig. 7 (Plates 53 and 55), and what variation of pressure was necessary to overcome the friction of the three L leathers. He had himself made a great many reducing valves at the works of Messrs. Simpson and Co. (who had made them since 1860), and had always tried to do away with the L leathers as far as possible; and although it had been said in the paper that it was impracticable to put sufficient weights on to control the outlet pressure, he had done so in most instances, and even for valves of 14-inch mains. He

considered that there was no doubt but that the valves would work better when directly weighted, and would be far more sensitive than they would be with three L leathers, which were necessitated by the complicated arrangement shown, as the variation in the outlet pressure from a maximum to a minimum depended directly on the friction of the valve and its pistons. With regard to the quantity of water that would pass through the valve, he had found in practice more would pass if the valve were turned the other way up, so that it was always trying to open itself, instead of trying to close as at present; and great advantage had been derived from that inverted form.

Mr. C. COCHRANE wished to ask a question with reference to the pipes in the case of the retentive valve shown in Fig. 7 (Plate 55). It was said that the valve was there maintained open partly by the outlet and partly by the inlet pressure; but the inlet, being in excess of the outlet, must be doing all the work: it could not be done partly by one and partly by the other.

Mr. WALTER MACFARLANE said there was no doubt that the question before them was a very important one. Remembering the enormous variety of pressures in their own city of Glasgow, it had often occurred to him that they had made a mistake at the fountain head in reference to most of the water supply systems throughout the country. His opinion had been for many years that they ought to have distributing reservoirs at various levels, the want of which was the fundamental mistake in almost all large water supplies. If they reflected on the minute mechanism that the water had to go through, the enormous wear and tear was something almost unbearable in a town like Glasgow. No doubt regulating valves could, to a certain extent, overcome the difficulty; but to his mind there was no power that could overcome it like that of nature. In Glasgow the houses were about 50 ft. high, so that the lowest part of a building was under a head of water 50 ft. greater than the upper floor: from that alone there must be a great deal of wear and tear in the minute mechanism used in the domestic supply. His own experience as a manufacturer was that there was as much water lost through waste as was used through proper consumption. In his

own works during the last six or eight years he had not had a single overflow pipe attached to any one of the taps. The water was turned off every night and locked, just as in the case of gas. If those who used water by meter would look into it, they would find there was more water running to waste than was actually consumed.

Mr. A. PAGET said Mr. Macfarlane appeared to think that they ought to have distributing reservoirs instead of reducing valves, because the one was worked by the powers of nature, and the other was not. He failed to see why a system of distributing reservoirs was worked by the powers of nature more than either of the valves that had been described. If Mr. Macfarlane's system were worked out to the full extent, he was perfectly staggered at the number of distributing reservoirs that would be required : as in that case, either the different flats of the tall houses in Glasgow must be connected by separate service-pipes to separate large distributing reservoirs ; or else a distributing reservoir must be provided to each house and to each series of flats or each individual flat. He would venture to suggest that a reducing valve would, if worked properly, be almost identical in its effect with a distributing reservoir, and might for practical purposes be called a cheap distributing reservoir. Therefore the two gentlemen who had brought the subject before the meeting had really helped to provide Mr. Macfarlane's ideal of regular pressure by a cheaper and a really practical method.

Mr. MACFARLANE did not mean that there should be reservoirs to regulate completely the supply of a city, but that there should be divisions of level, say every hundred feet ; there would be one district 100 feet high, another district 200 feet, and so on, each with its own reservoir. He valued most highly the inventions that had been described in the two papers now read ; they were in the right direction, for hitherto, so far as he was aware, there had never been the means of really regulating the pressure of the domestic water in large cities.

Mr. R. E. B. CROMPTON, being himself a manufacturer of water fittings, had always had a great deal of trouble wherever the mains

contained water which threw down a certain amount of deposit. Wherever the fittings moved generally within a certain limited range, there was a ridge formed by the deposit on the interior surface of the cylinders at each end of the range; and if there was ever any extraordinary pressure which caused the piston to move up to the ridge, it would invariably stick at that point. Such fittings were considered failures, and were always returned. He had a design of his own to overcome that difficulty; and he should be glad to know how the author avoided it: he would have to get over it either by making the pistons fit very loosely in the cylinders, or by the use of L leathers, which, as all who were connected with the subject knew, gave a great deal of trouble.

Mr. E. A. COWPER to a certain extent agreed with Mr. Crompton. The working of a piston in a cylinder, even if lined with gun-metal, did cause a ridge or shoulder of dirt, or at all events a surface which had not so little friction as the part on which the piston generally worked. This was a serious matter in working with balanced pressures; but he understood that the valves described by Mr. Alley were large valves, in which case a little deposit on the surface did not so much come into play to check or vary the working of the instrument, because the power was ample to overcome it. Those valves were chiefly for mains; whereas Mr. Barton's smaller valve was rather intended for domestic service-pipes, and he thought in those valves the leather or india-rubber diaphragms—he was not sure which Mr. Barton preferred—would certainly avoid the difficulty of piston friction. If they were made cheaply for services in houses they would give exactly what Mr. Macfarlane desired, namely an uniform pressure without reference to the height of the house. Very many of the streets in Glasgow were peculiarly situated. They ran up from a long main street at a very considerable incline, and thus two mains would be required in the street, attached to two distributing reservoirs, and in some cases perhaps more; whereas by maintaining a pressure of a certain amount, within a few pounds, at each spot, it appeared to him that the fittings which had been described, if they could be made cheaply, would accomplish the

object desired. It was well known what multitudes of arrangements there were for supplying water-closets from high-pressure mains, and generally they were very unsatisfactory. If the pressure could be reduced at once by these valves, it would be reduced for all the fittings, and very ordinary and simple fittings might then be used.

Mr. ALLEY said in reply that the arrangement of valve shown in Fig. 7 (Plate 55) was really a retentive valve, made to act against the flow on a descending main, so as to hold the water back in the reservoir in the event of a burst at the low level. Mr. Cochrane had asked why the two pressures should come into action. It would be noticed that the valve was partly balanced by the area of the top piston. If both pressures were in action, then, if the difference of area between the top and bottom pistons were properly proportioned to suit the two levels, the valve would keep open; but when the outlet pressure was lost, which would be the case on the bursting of the main, the balance of the valve was lost, and it closed at once.

With regard to the L leathers, there was no doubt a great deal of friction with them; but that could be balanced by keeping the one valve slightly larger than the other. The actual amount of the variation on the reduced side, when the valve moved, he had not investigated.

With reference to Mr. Crompton's question, there would no doubt be a certain ridge in the cylinder, where it was worn by the cup-leather or piston—perhaps most in the case of a piston, where the metal was much harder than the cylinder, and would wear it smooth more rapidly. The inventor however did not confine himself to any particular form of packing or stuffing; piston-rings might be used, or anything that was found suitable. The wear was not great, because the motion of the valves was so little, being merely that of slightly easing up and down as the pressure increased or diminished. He did not think the objection would prove a serious one, if the metal used in the lining of the cylinders was of a proper quality.

The valves had now been at work about six months without any difficulty arising. Small valves had been working on the same principle as Fig. 6 (Plate 55), down to  $\frac{1}{2}$  in. diameter; while the



largest at work was 8 in. diameter; but the larger they were, the better they would work, as there would be a larger area for the controlling pressure to act on.

Mr. W. FOULIS said the idea of making regulating valves was certainly not new, but in nearly all the attempts that had been made the weight was put directly on the valve; the area on which the pressure acted was reduced by putting a plunger on the top of the valve, and in other ways. The effect was that if the weight was reduced there was also a reduction of the effective pressure which tended to open the valve. By the simple arrangement which had been described, while the pressure on any valve was regulated by weights of only a few pounds, yet the full pressure of water acting on the whole area was actuating the valve. For example, in the case of a 12-in. valve, a variation of 1 lb. per sq. in. would give 113 lbs. of effective pressure to move the valve; and as the area of the regulating arrangement was only  $\frac{1}{2}$  sq. in., it was evident that a weight of  $\frac{1}{2}$  lb. placed on the regulator would give an effective pressure to move the valve of 113 lbs.—quite sufficient to overcome the friction of the piston. So that the valve was very sensitive with a very few pounds of pressure. The principle therefore was different from those of other designs.\*

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\* Mr. W. R. Copland has since communicated to the Secretary the results of experiments made to determine the saving effected by employing a Foulis governor valve. This valve was fitted up about March 1879 at Cambuslang, near Glasgow, at the junction of a branch with the main pipe. The distributing reservoir is about 160 ft. above the houses supplied through the valve, which are chiefly of the tenement class, with very inferior fittings. The main is 4 in., the branch 3 in. diam.; the undisturbed pressure in the main would be about 70 lbs., and the governor is set to 30 lbs. per sq. in. The consumption had been taken for about a week before the governor was fitted; and it was found that to lower the level in the distributing reservoir by  $6\frac{1}{2}$  ft. required on an average  $4\frac{2}{3}$  hours. After the governor was fitted, the experiment was repeated, and it was found that the time required averaged  $7\frac{1}{4}$  hours, showing a saving of 35 per cent. The experiment has been several times since repeated with the same results. The branch referred to supplies only one-third of the total population; so that, if all the piping were similarly controlled, the saving would be much larger than that given above.

Mr. C. C. BARTON said the only questions asked with reference to his valve had been as to cost of manufacture and efficiency. In regard to efficiency, he would refer to a report by Messrs. Edward Easton and L. F. Vernon Harcourt, after a trial of two months:—"In experimenting on Barton and West's water meter, at the South Essex Water Works, where there is generally a pressure on the mains of from 220 to 240 lbs., we have found their pressure reducer very serviceable when wishing to obtain low pressure. The pressure reducer is simple in construction and principle, and we are able to state from our trials of it that it answers its purpose admirably. The small cost at which it can be made ought to ensure its early adoption, wherever the pressure of water delivered from the mains is greater than actually required. Undue pressure in service pipes could thus be removed, and loss of water from leaks considerably reduced. We consider that this pressure reducer supplies a long felt want, and confidently recommend it to the notice of all persons interested in water supply."

The PRESIDENT thought the papers just read were very important at this time, when the extension of waterworks in a large number of towns and even in country villages had become so common, and the difficulty of leakage in fittings created such disagreeable intercourse between landlord and tenant, or tenant and agent. At Leek, in his own neighbourhood there was a constant complaint of the leakage of fittings when the pressure accumulated, as it did when the service was left on all night; therefore if some contrivances, such as those suggested and put into practice by the authors of the papers, could be fairly and cheaply adopted, a great advantage would be obtained in supplying at a reasonable expense the wants of the various populations. The members were therefore much obliged to those gentlemen for bringing the subject before them; and he would ask the meeting to accord to them their best thanks.

The vote of thanks was passed by acclamation.

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The following paper was then read:—

Fig. 1. *Regulating Valve or Water Governor.*

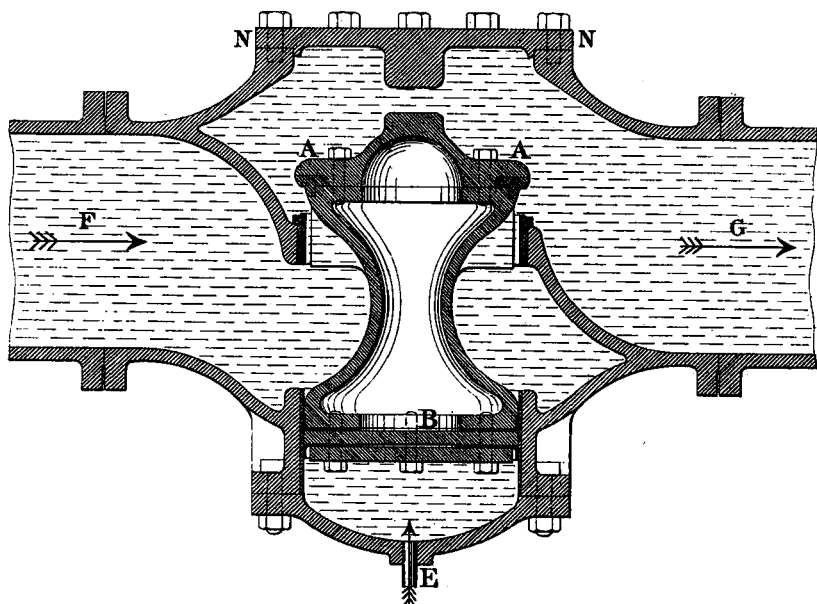
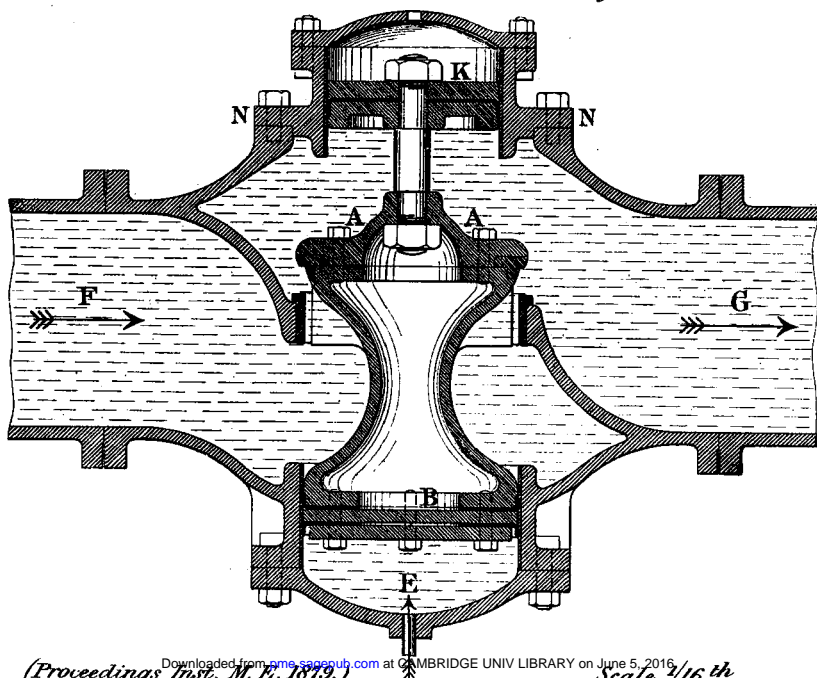


Fig. 5. *Differential Governor, controlled by Cistern.*



# WATER PRESSURE REGULATOR. *Plate 54.*

Fig 2. *Regulating Apparatus for adjusting Pressure.*

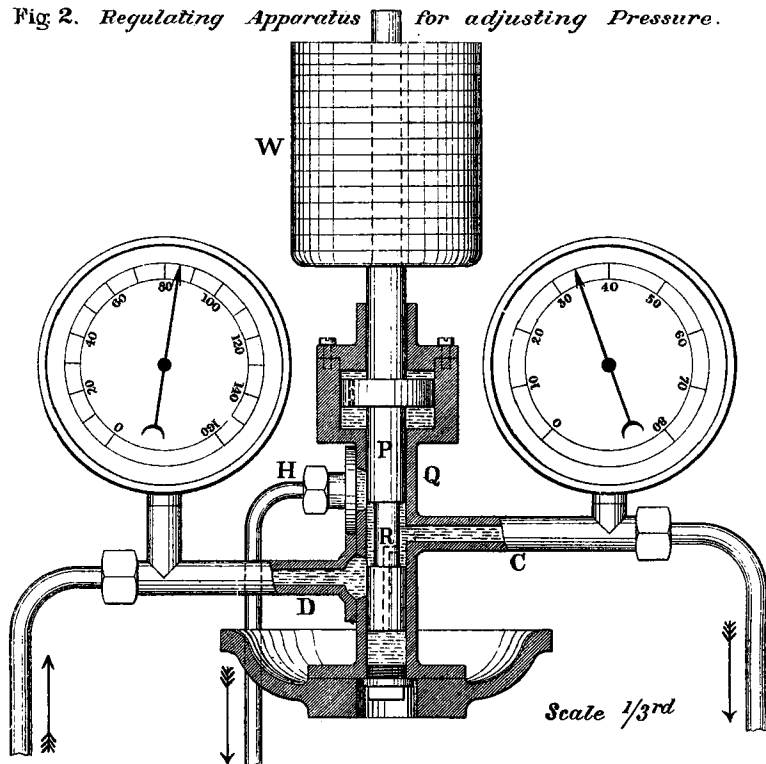


Fig. 3.  
*Regulating Apparatus placed in lamp-post.*

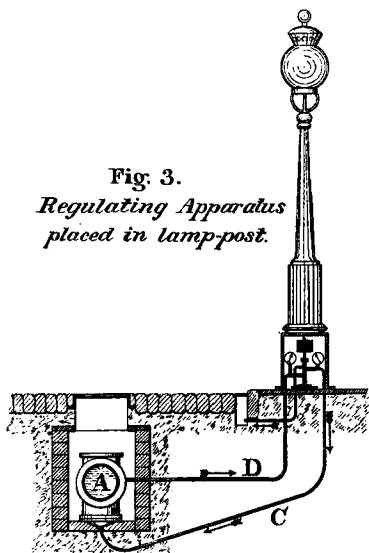


Fig. 4.  
*Regulation by cistern and Differential Governor.*

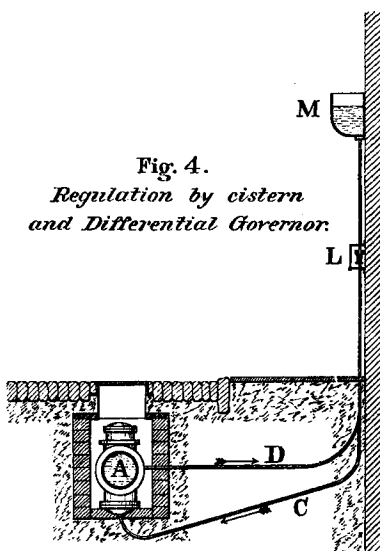


Fig. 6. *Differential Valve for proportionate pressures.*

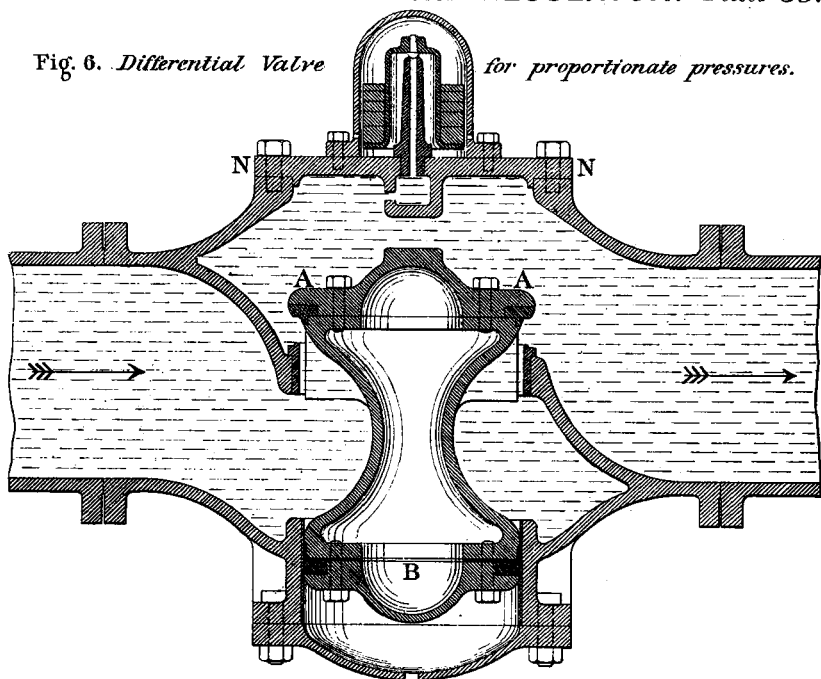


Fig. 7. *Retentive Valve for descending mains.*

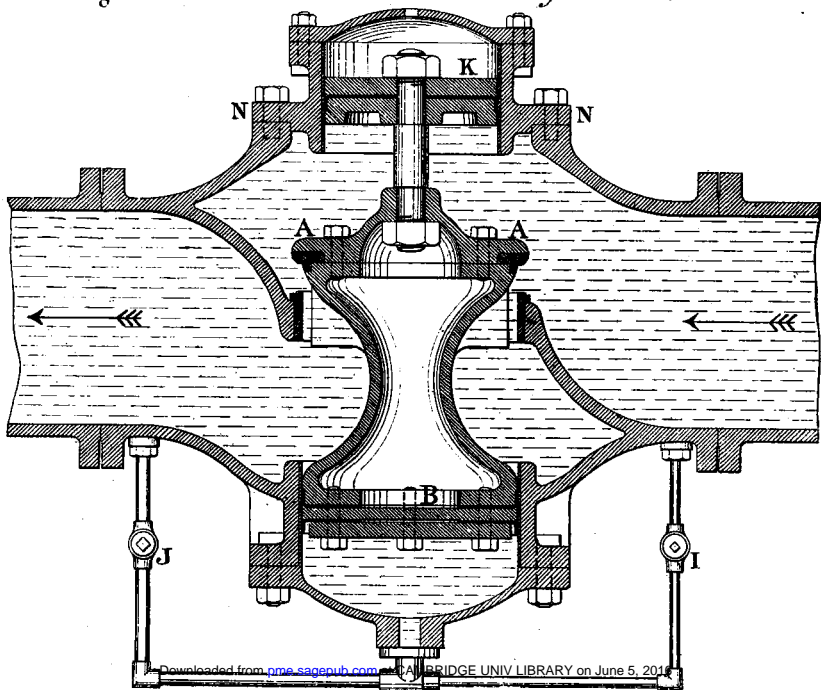


Fig. 1. *Reducer for Mains.*

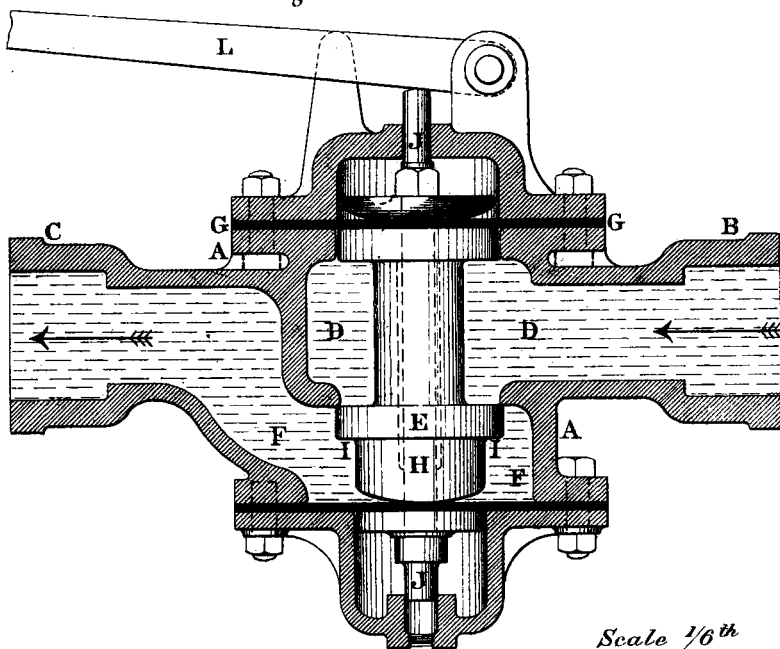


Fig. 2. *Reducer for Service Pipes.*

