the gas manufacture; but in works where shale and rich cannel coals are distilled, common coal must be used in the furnaces. At the Ivry Gas Works of the *Compagnie*

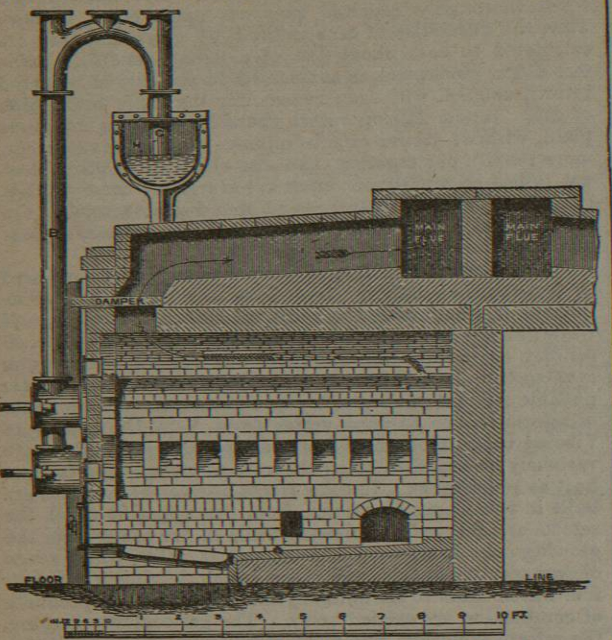

FIG. 6.—Section of Retort Bed on line A A of fig. 5.

Parisienne d'Éclairage et de Chauffage par le Gaz, the retorts are heated by gas on a method modified from the Siemens regenerative gas furnace. Sectional illustra-

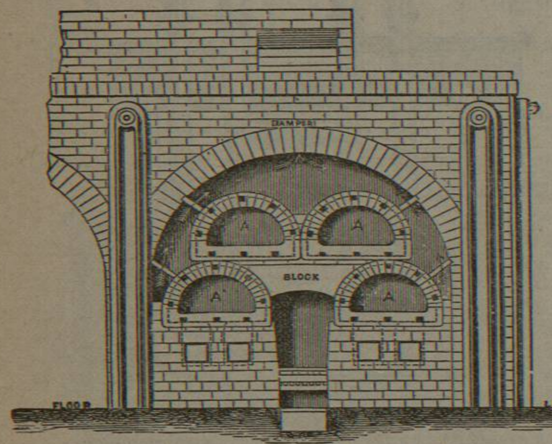

FIG. 7.—Retort Setting in Hislop's Furnace.

tions of a retort setting on this plan, and a description of the various arrangements connected with the regenerators and the controlling of the air and gas currents, will be found in the article FURNACE, vol. ix. pp. 846, 847.

Ordinarily the work of charging and drawing the retorts is accomplished by manual labour, by means simply of shovels for charging, and long iron rakes for drawing the spent charge. In the larger works it is usual to charge the retorts with a scoop semi-cylindrical in form, made a little shorter than the retort, and of such a diameter that it can with ease be pushed in and overturned within the retort. The scoop deposits the coal neatly over the sole of the retort, and of course the lid is much more quickly replaced than can be done with shovel charging. Numerous attempts have been made to introduce purely mechanical means of feeding retorts, hitherto with indifferent success,—such devices as a travelling endless sole and a rotating sole having been tried without good effect. A charging machine and a drawing machine, worked by hydraulic power, have been introduced by Mr Foulis, the engineer of the Glasgow Corporation Gas Works, but after prolonged trial both in Glasgow and in Manchester, these have not yet proved satisfactory in action. In West's patent the charging is effected by the introduction of a small waggon within the retort, which distributes the charge evenly and uniformly Neither has it, however, met general acceptance.

The retorts are kept at a bright red heat, and for coal with a high percentage of volatile matter a higher temperature is requisite than is needed for coal less rich in gas. As the retorts in one setting are necessarily subject to somewhat different amounts of heat, the charges in those nearest the furnace fire, and consequently most highly heated, must be drawn more frequently than the others, as otherwise the quality of the gas would be deteriorated, and a large proportion of sulphur compounds would be given off from the overburnt coke.

In drawing a charge the lid is first slightly opened and the escaping gas lighted, to prevent an explosion or "rap" that would otherwise ensue. The gas is prevented from escaping outward by the ascension pipe dipping into the hydraulic main as afterwards explained; but in some cases special valves are fitted on the ascension pipe to prevent a back rushing of the gas. A carbonaceous deposit forms on the sides of the retorts, which requires to be periodically removed by "scurfing" with chisels, or burning it off with free admission of air or steam.

The Hydraulic Main.—From the retorts the gas, after its production, ascends by means of pipes called ascension-pipes B (figs. 5 and 6) into what is termed the condensing or hydraulic main HH, which is a large pipe or long reservoir placed in a horizontal position, and supported by columns in front of the brick-work which contains the retorts A. This part of a gas apparatus is intended to serve a twofold purpose:—first, to condense the tar and some ammoniacal liquor, and secondly, to allow each of the retorts to be charged singly without permitting the gas produced from the others, at the time that operation is going on, to make its escape. To accomplish these objects one end of the hydraulic main is closed by a flange; and the other, where it is connected with the pipes for conducting the gas towards the tar vessel and purifying apparatus, has, crossing it in the inside, a partition occupying the lower half of the area of the section, by which the condensing vessel is always kept half full of liquid matter. The stand-pipes are connected by a flange with a dip-pipe C, arising from the upper side of the condensing main HH, and as the lower end of it dips about 2 inches below the level of the liquid matter, it is evident that no gas can return and escape when the mouthpiece on the retort is removed, until it has forced the liquid matter over the bend, a result which is easily prevented by making it of a suitable length. The tar which is deposited in the hydraulic main overflows at the partition, and is carried by a pipe to the tar well.

Condensation.—The gas as it passes on from the hydraulic main is still of a temperature from 130° to 140° Fahr., and consequently carries with it heavy hydrocarbons, which, as its temperature falls, would be deposited. It is therefore a first consideration in ordinary working to have these condensable vapours at once separated, and the object of the condenser is to cool the gas down to a temperature

nearly that of the surrounding atmosphere. The first contrivances employed for the purpose of condensation were all constructed on the supposition that the object would be best attained by causing the gas to travel through a great extent of pipes surrounded by cold water, and winding through it like the worm of a still, or ascending upwards and downwards in a circuitous manner. An improvement on this form of condenser, and one now in general use, is represented in fig. 8. It consists of a series of upright

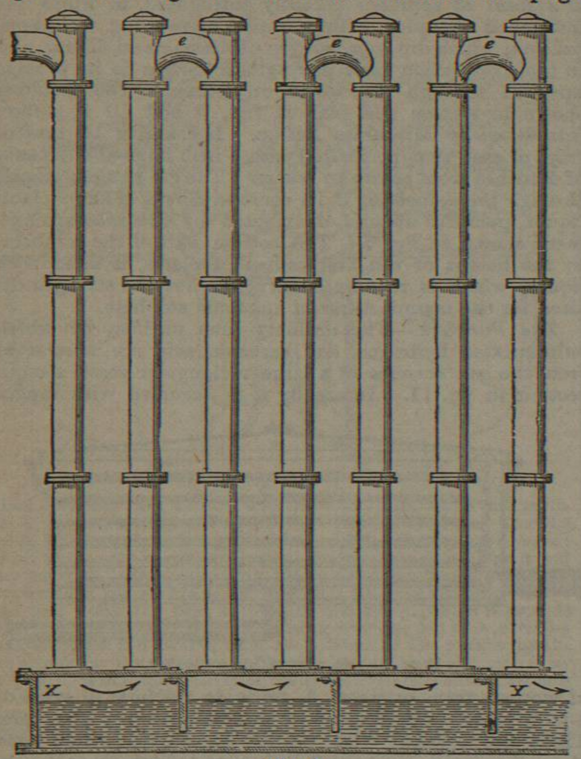

Fig. 8.

pipes connected in pairs at the top by semicircular pipes *e*, *e*, and terminating at the bottom in a trough X Y containing water, and divided by means of partitions in such a way that, as the gas enters the trough from one pipe, it passes up the next pipe and down into the next partition, and so on to the end of the condenser. The cooling power of this air condenser, as it is called, is sometimes assisted by allowing cold water to trickle over the outer surface of the pipes. Annulur tubes for condensing are also used, in which the gas is exposed to a much greater cooling surface, and in some large works the condensers are cooled by a current of water. In passing through the pipes the gas is considerably reduced in temperature, and the tar and ammoniacal liquor condense, the tar subsiding to the bottom of the troughs, and the ammoniacal liquor floating on the surface. In course of time the water in the trough is entirely displaced by these two gaseous products, and as they accumulate they pass off into the tar-tank, from which either liquor can be removed by means of a pump adapted to the purpose. The New York Gas Lighting Company employ a multitubular condenser, consisting of two sets of eight boxes, each containing 100 tubes 3 inches diameter by 15 feet long. Through each set of tubes, up one and down another, the gas travels, cooled by an external stream of water, while it traverses the 240 feet of piping in the condenser.

The practice of condensation and separation of tarry matter by rapid cooling is condemned by Mr Bowditch and many eminent authorities, on the ground that thereby a proportion of light hydrocarbons are thrown down with the heavier deposit, which on another method of treatment would form part of the permanent gas and materially enrich its quality. A system of treating gas has accordingly been introduced by Messrs Aitken & Young, in which the gas, kept at a high temperature, is carried from the retorts into an apparatus termed an analyser, which consists of an enclosed series of trays and chambers arranged in vertical series, in principle like a Coffey still, the lower portion of which is artificially heated. In action the analyser separates the heavier carbonaceous part of the tarry matter in the lower part or chambers, and as the gas gradually ascends from one tray or tier to another, it is at once cooling and depositing increasingly lighter fluids, while it is meeting and being subjected to the purifying action of the light hydrocarbons already deposited. Thus on entering the analyser it meets, at a high temperature, heavy tar deposits, and it passes out of the apparatus cooled down to nearly atmospheric temperature after being in contact with the lightest fluid hydrocarbons.

Exhaustion.—To the subsequent progress of the gas considerable obstructions are interposed in connexion with its further purification and storing in the gas-holders, and the result of which would be that, were it not artificially propelled, there would be a pressure in the retort equal to the amount of the resistance the gas meets with in its onward progress. The relief of this back pressure not only improves the quality of the gas, but also increases its amount by about 10 per cent. Among the numerous methods of exhaustion which have been proposed since the operation was first introduced in 1839, there are several rotary exhausters, having more or less of a fan action, and recently an apparatus on the principle of a Giffard's injector has been introduced, chiefly in Continental works. A most efficient form is found in the piston exhauster, a kind of pumping engine with slide valves, which exhausts the gas in both the upward and the downward strokes of its piston. The action of the exhauster is controlled by a governor, which passes back a proportion of the gas when the apparatus is working too fast for the rate of production in the retorts; and "pass by" valves are arranged to carry the gas onward without passing through the exhauster should it cease to work from accident or any other cause.

Purification.—The operations embraced under this head have for their object the removal from the gas of ammonia, sulphuretted hydrogen, and carbonic acid as the main impurities, with smaller proportions of other sulphuric and of cyanogen compounds.

The agencies adopted are partly mechanical and partly chemical, the separation of the ammonia being first effected in the "scrubber," from which the gas passes on to complete its purification in the "purifiers." In early times the purifying was performed in a single operation by the use of milk of lime in the wet purifier, a form of apparatus still in use where wet purifying is permissible.

The Wet Purifier.—This apparatus was supplied with a cream of lime and water, but, although it was a most efficient purifying agent, the ammonia now of so much value was lost by its use, and the "blue billy," as the saturated liquid holding the impurities was termed, created an intolerable nuisance, and could be in no harmless way got rid of. Except in small works, wet purifying is not now practised.

The Scrubber.—The object sought in an ordinary scrubber is to cause a large amount of gas to come in contact with the smallest possible quantity of water, so as at once to dissolve out ammoniacal gases, which are exceedingly soluble in water, to obtain a strong ammoniacal liquor from the scrubber, and at the same time, as far as possible, to

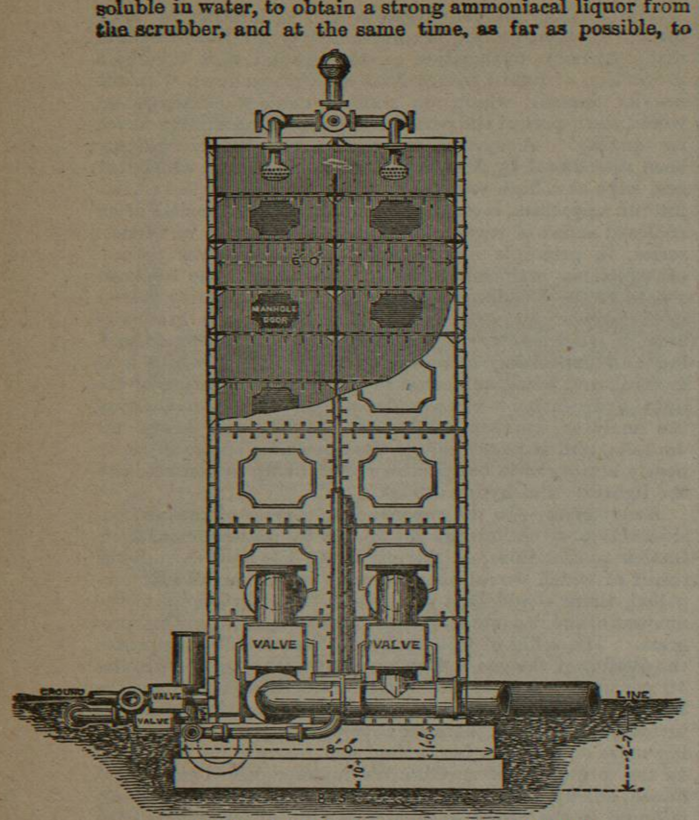

Fig. 9.—Hislop's Scrubber—Sectional Elevation.

prevent the heavy hydrocarbons from being acted on,—they being also soluble in water. The ordinary form of scrubber

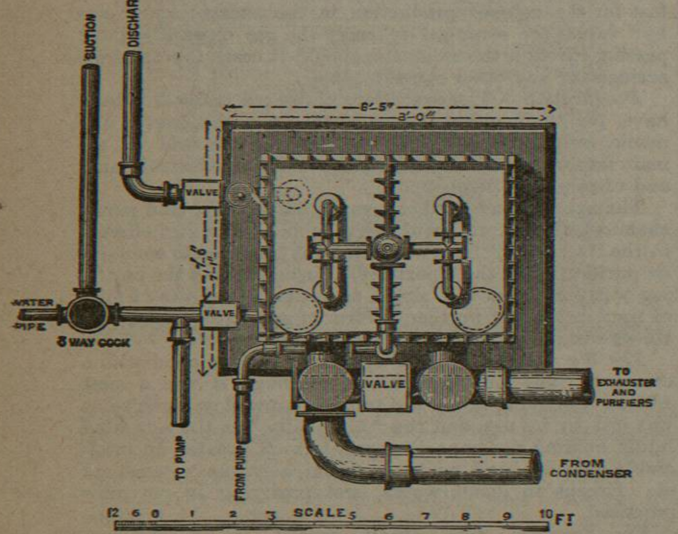

Fig. 10.—Hislop's Scrubber—Plan.

consists of a tower or hollow column, vertically divided into two, and filled with coke, &c. The gas passes up one side and down the other, and from the top a constant small stream of weak ammoniacal liquor trickles down. Such a scrubber, it is stated, is subject to clogging by deposits of tar, and equally efficient work is done without that draw-back by an apparatus in which perforated iron plates occupy the place of the coke, and in the Livesey scrubber layers of thin deal boards are employed. These boards are set in tiers perpendicularly, slightly crossing each other, with about ⅛ of an inch between each tier. Anderson's washer is a form of scrubber recently introduced, in which the interior is occupied with a series of rotating whalebone brushes, which dip into troughs of ammoniacal liquor, and in their revolution meet and agitate the gas in its passage upwards through the tower or column. The scrubber shown in section and plan in figs. 9 and 10 is a form introduced by Mr James Hislop. It contains 10 tiers of trays of cast iron, perforated with ⅜-inch holes at a distance of 2 inches from centre to centre. The gas passes upwards through these, meeting in its course a shower of ammoniacal liquor pumped up and distributed by the rose arrangement shown in fig. 9. The bottom part of the scrubber, to the height of the first course of plates, is filled with liquor, which is repumped till it reaches the strength desired for the manufacturer of ammonia sulphate.

The Purifiers.—The ordinary lime purifier, by which sulphuretted hydrogen and carbonic acid are abstracted from the gas, consists of a large rectangular vessel seen in section in fig. 11. Internally it is occupied with ranges

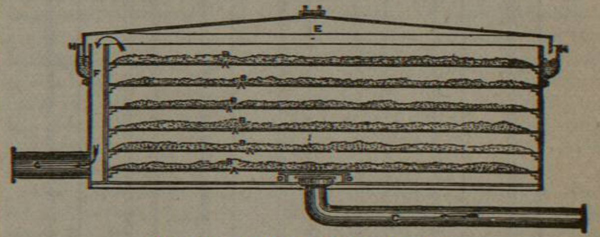

Fig. 11.—Section of Lime Purifier.

of wooden trays or sieves A, made in the form of grids of ½-inch wood, with about half an inch between the bars. These are covered with slightly moistened slaked lime B to the depth of about 6 inches, and from three to six tiers of such sieves are ranged in each purifier. The gas enters at the bottom by a tube C, the mouth or inlet being protected from lime falling into it by a cover D, and it forces its way upward through all the trays till, reaching the lid or cover E, it descends by an internal pocket F to the exit tube G, which leads to the next purifier. The edges of the lid dip into an external water seal or lute H whereby the gas is prevented from escaping. The purifiers are generally arranged in sets of four, three being in use, through which the gas passes in succession while the fourth is being renewed; and to control the course of the gas current among the purifiers, the following ingenious arrangement of centre valves and pipes was devised by Mr Malam (fig. 12).

It has a cover fitting within it in such a way as to communicate with the pipe *a* and either of the four inlet pipes, and also to communicate between one of the outlet pipes and the pipe *h*, which carries off the purified gas. The inlet pipes, *b*, *d*, *f*, admit the gas from the central case to the bottom of the purifiers; and the outlet pipes, *c*, *e*, *g*, return the gas from the purifiers back to the case, after it has passed up through the layers of lime, and descended at the back of a partition plate in each purifier to the outlet pipes at the bottom. *a* is the main inlet pipe for conveying the gas from the scrubber or the condenser, and *h* is the main outlet pipe for conveying the gas to the gasholder. The central cylinder contains water to the depth of 10 inches, and the ten pipes rise up through the bottom to the height of 12 inches, so that the mouth of each is 2 inches above the surface of the water. The cover which fits into the cylinder is 4 feet 3 inches in diameter, and is divided into five parts, the first of which, 1, fits over the inlet pipe *a*, and over either of the inlet pipes leading to the purifiers. The partitions 2,

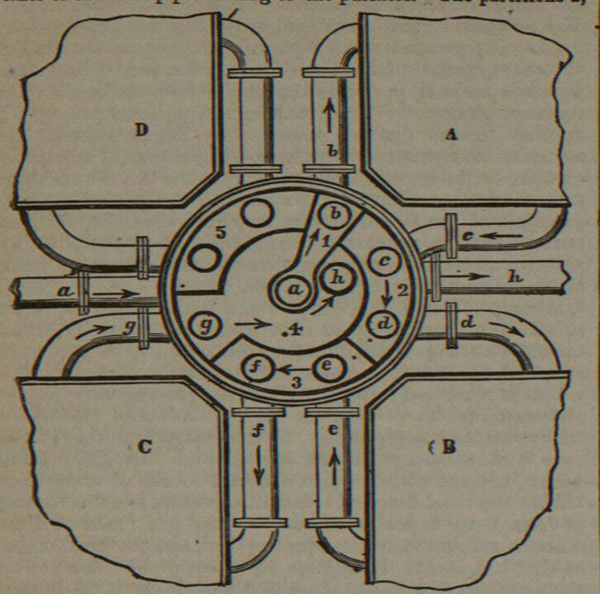

Fig. 12.

3, and 5 fit each over an inlet and an outlet pipe, while one partition, 4, fits over one outlet pipe from one purifier, and over the pipe *h*, which leads to the gas-holder. In fig. 12 the arrangement is such as to open a communication between the inlet pipe *a* and the purifier A. Now supposing the gas to have passed from the scrubber into the centre of the cylinder, its only means of escape is to pass down the pipe *b* into the purifier A, where it ascends through the layers of lime, and passing over the top of a dividing plate, descends and escapes from the bottom of the purifier by the pipe *c* back to the cylinder. Here its only means of escape is by the pipe *d*, which conducts it to the purifier B, in which it ascends and descends as before, returning by the pipe *e* to the cylinder, whence it proceeds by the pipe *f* into the purifier C, then along the pipe *g*, which is shut off from communication with any pipe except *h*, by which it is conveyed away to the gas-holder. By this arrangement the three purifiers A B C are being worked, while a fourth purifier D is being emptied and recharged with lime. When it is found, on testing the gas, that the lime is unfit for its office, the purifier A is thrown out of work, and D is brought in. The frame is then shifted so as to bring the triangular division 1 over *d*, by which means B C D will be the working purifiers, and A will be thrown out of use. In this way, by shifting the frame round its centre over each of the four outlet pipes, any three of the purifiers can be brought into action.

The "oxide" method of purifying the gas, originally introduced by M. Laming, and shortly afterwards patented by Mr Hills, is now largely used in ordinary gas-works. It is based upon the property of the hydrated oxide of iron to decompose sulphuretted hydrogen, a portion of the sulphur forming a sulphide with the iron. Quicklime is also used to separate carbonic acid, and the oxide of iron is mixed with sawdust or cinders (breeze) for the purpose of increasing the surfaces of contact, and this mixture is placed in the purifiers. When a sufficient quantity of gas has passed through it, the purifiers are opened, and the mixture is exposed to the air, under which new condition it combines with oxygen, and again becomes fitted for use in the purifiers. The chemical changes which occur in these operations are thus stated. The mixture of hydrated oxide of iron, &c., absorbs sulphuretted hydrogen, forming ferrous sulphide and water, and liberating sulphur, thus:— $Fe_2O_3 + 3H_2S = 2FeS + S + 3H_2O$. The ferrous sulphide, by exposure to the air, absorbs oxygen, and its sulphur is separated in an uncombined form, $2FeS + 3O = Fe_2O_3 + 2S$. The mixed material can be again employed in the purification of the gas, and the process may be repeated until the accumulation of sulphur mechanically impairs the absorbent powers of the mixture. The sulphocyanogen which accompanies the gas is retained by the oxide of iron, and gradually accumulates in the mixture. For the separation of the carbonic acid, which is unaffected by this treatment, the gas next passes on to a dry lime purifier.

The gas is now ready for use, and it is passed on through the station meter to register the amount made and stored in the gas-holders. At this stage it may be interesting to compare the composition of the gas as it exists at different stages of the manufacture, as these show the result of the successive purifying processes. Taking 1000 cubic feet, the figures are—

	From Condenser.	From Scrubber.	From Purifiers.	
			Iron.	Lime.
Hydrogen	380	380	380	380
Marsh gas	·390	388	403	394
Carbonic oxide	72	71	39	30
Heavy hydrocarbons	42	46	46	4[illegible]
Nitrogen	48	50	79	100
Oxygen	3	5	5	6
Carbonic acid	40	39	33	4
Sulphuretted hydrogen	15	15	3	...
Ammonia	10	5	..	...
	1000	999	988	957

Storing and Distribution.

The Gas-holder.—This, which is frequently designated the gasometer, though incorrectly, since it does not in any way measure gas, but simply stores it for consumption, consists of two portions—the "tank" T (fig. 13) and the "holder" G. The tank is a cylindrical pit, surrounding a central core, which is usually covered with concrete *c* at top, and has its sides built of masonry or brick-work, *p*, *b*. The tank is water-tight, and is filled to a high level with water, above which project two tubes *m m*, one being the inlet and the other the supply pipe which leads to the main governor.

Formerly gas-holders were made of heavy plate iron, strengthened by angle-iron and stays, and of so great a

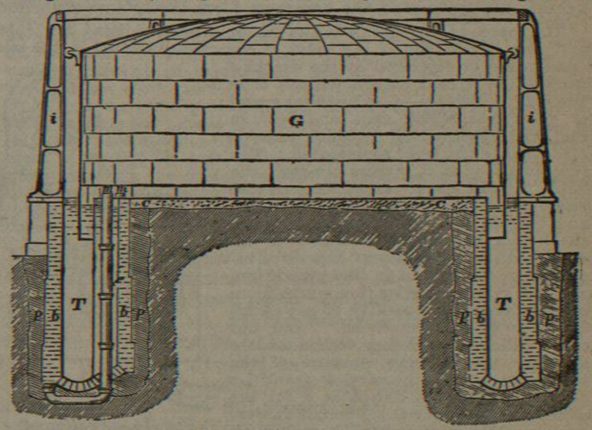

Fig. 13.—Section of Gas-holder.

weight as to require a complex system of equilibrium chains and counterbalancing weights to relieve the gas from the great pressure to which it would otherwise be subjected. They are now made so light that they require to be loaded in order to supply the required pressure, and their rise and fall are regulated by means of guide-rods *i i* round the tank. For economy of space holders in which different segments "telescope" over each other are now much employed. This form of holder consists of two or even three separate parts,—the upper having the form of the common gas-holder, and the other being open at the top as well as the bottom. They are connected by the recurved upper edge of the lower fitting into a channel which runs round the bottom of the upper, whereby the entire structure is rendered air-tight at the line of junction. Holders of great capacity are now erected in connexion with large works. The Imperial Company in London possesses two, at Bromley and Hackney, telescopic in form,—the outer segment measuring 200 feet in diameter by 35 feet deep, and the inner 197 feet by 35. These holders are each capable of storing 2 million cubic feet of gas, which at sp. gr. 480 would weigh 73 tons. A still larger holder is at the Fulham station of the Gas Light Company, it being 223 feet in diameter and rising 66 feet, with a capacity equal to 3 million cubic feet.

The Governor.—An efficient control of the pressure of the gas, along its whole course from the gas-holder to the point of consumption, is an object of great importance for the avoiding of leakage, for equal distribution, and for supplying the burners at that pressure which yields the largest illuminating effect. Uncontrolled pressure may supply certain levels in a proper manner, but will leave low-lying districts insufficiently supplied, while the pressure in high districts will be excessive. The variations from simple difference of level may be very great. Thus, with a pressure of 1·7 inch at the Leith works, the gas would be delivered in some parts of Edinburgh at a pressure of 4·5 inches. The varying consumption from dusk onwards also greatly affects unregulated pressure. To control and correct these and other irregularities and disturbances governors are now used,—at the works or station for delivering the gas to the mains, in districts to correct variations owing to level, and beyond the consumers' meters for controlling house supply; while in certain forms of burners a regulating apparatus is also inserted. The principle on which all governors are based consists in causing the gas by its own pressure to act on some form of sensitive surface which opens or closes a valve or aperture in proportion to the variations of pressure exerted on it. Fig. 14 is a diagrammatic section of the common form of station governor.

The course of the gas is indicated by arrows, *d* being the inlet and *e* the outlet pipe; *c* is a valve of conical form fitted to the seat *i* and raised or depressed by the weight *f* working by a cord over a pulley; *bb* is the bell or holder,—a cylindrical vessel of sheet iron which rises and falls in the exterior vessel *aa*, in which water is contained to the level represented. The gas, entering at *d*, passes through the valve, fills the upper part of the inverted vessel *bb*, which it thus partially raises, and escapes by *e*. If the pressure from the holder be unduly increased or diminished, the buoyancy of *bb* will be increased or diminished in like proportion, and the valve being by this means more or less closed, the quantity of gas escaping at *e* will be unaltered. And not only will the governor accommodate itself to the varying pressure of the holder, but also to the varying quantities of gas required to escape at *e* for the supply of the burners. Thus, if it were necessary that less gas should pass through *e*, in consequence of the extinction of a portion of the lights, the increased pressure thus produced at the holder would raise the governor, and partially shut the valve, leaving just sufficient aperture for the requisite supply of gas.

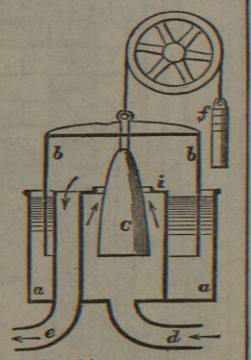

FIG. 14.—Section of Governor.

Numerous improvements have been made on the ordinary station governor. In the form invented and manufactured by D. Bruce Peebles, the bell or holder is enclosed in a gas-tight case or chamber, and a small portion of the inlet gas flows in and out of this chamber above the holder. The pressure of this small quantity of gas is regulated by passing it through a small separate governor; and, acting on the outer surface of the holder, this, in a very delicate and sensitive manner, performs the duty of weights in the older forms of governor. An arrangement similar in principle is applied to the district governor by Bruce Peebles, the minimum day pressure being secured by means of a stopcock or screw-valve on the apparatus, and the maximum night pressure is controlled by a small subsidiary governor. The principle of the small governor, which thus plays an important part in regulating large flows of gas, will be explained under consumers' governors, the apparatus being shown in section in fig. 18 below.

Supply Pipes.—The street main and service pipes are tubes of malleable or of cast iron, the gauge of which must be arranged according to the quantity of gas to be supplied, the length it has to travel, and the pressure under which it is carried forward. Practical gas-engineers possess elaborated tables of data for the regulation of the size of their various supply pipes. Notwithstanding the utmost care and accuracy in the laying and fitting of street mains, leakage at joints is a constant source of annoyance. Under the most favourable conditions there is a discrepancy of from 7 to 8 per cent. between the gas made and the amount accounted for by consumption, and the greater part of that loss is due to leakage in street pipes. To convey the gas from the main pipes and distribute it in houses, pipes of lead or of block tin are generally used.

Consumers' Meters.—Of these there are two forms in actual use, the "wet" and the "dry." The former, the invention of Mr Clegg, is represented in the two sections (figs. 15 and 16), where *cc* represents the outside case, having the form

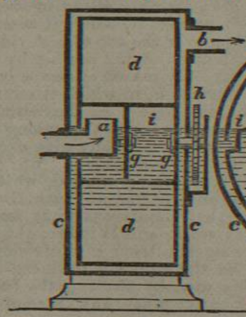

Fig. 15.

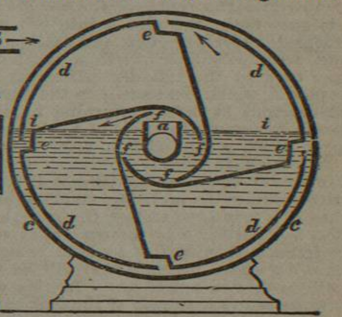

Fig. 16.

of a flat cyclinder; *a* is the inlet tube and *b* the outlet pipe; *g*, *g* are two pivots, and *h* a toothed wheel fixed upon the pivots and connected with a train of wheel-work to register its revolutions. The pivots are fixed to and support a cylindrical drum-shaped vessel *ddd*, having openings *e*, *e*, *e*, *e*, internal partitions *ef*, *ef*, *ef*, *ef*, and a centre piece *ffff*. The machine is filled with water, which is poured in at *h* up to the level of *i*; and, on gas being admitted under a small pressure at *a*, it enters into the upper part of the centre piece, and forces its way through such of the openings *f* as are from time to time above the surface of the water. By its action upon the partition which curves over the opening *a*, a rotatory motion is communicated to the cylinder,—the gas from the opposite chamber being at the same time expelled by one of the openings *e*, and afterwards escaping at *b*, as already mentioned. Wet meters work easily, and, when well set and properly supplied with water, measure the gas with much accuracy. But excess or deficiency

of water impairs their measuring power, which may also be affected by the meter being lifted off the level. The freezing of the water also frequently occasions trouble, and the action of the water on the gas passing through it by dissolving out part of the valuable illuminating hydrocarbons on the one hand, and diffusing watery vapour through it on the other, doubly affects its illuminating power.

The dry meter is free from the defects just mentioned, but does not pass the gas with such steadiness as the wet meter. The ordinary dry meter consists of an oblong box enclosing two measuring cylinders, with leather sides which contract and expand as they are being emptied and filled, on the principle of ordinary bellows. The pressure of the gas entering this meter is sufficient to keep it in operation, and by a system of valves the one cylinder is in process of filling as the other is being emptied through the service pipe. The chambers communicate by means of lever arms with a crank which turns a train of wheels in connexion with the indicator dials on the face of the machine.

Consumers' Governor.—In order to consume gas in a perfectly uniform and economical manner, it is essential that the pressure at the burners should be always invariably the same. That pressure is liable, however, to variation from a number of causes, such as fluctuation in the number of lights in use, either in the house or in the neighbourhood, or the application or withdrawal of pressure at the works' governor. And as all good burners are fitted with regard to a fixed standard quality and pressure of gas to be consumed, if this is not maintained the conditions of maximum illuminating power are lost. A consumers' governor secures uniformity of pressure at all the burners supplied by the pipe on which it is placed. The principle of the governor is identical with that of the station governor already described, increased pressure in both cases causing the orifice through which the gas escapes to be contracted. The mechanical arrangements by which this contraction of orifice is effected are various. In some instances they are in direct contact with the separate burners, while other governors are applied to the supply pipes of a whole establishment. They are separable into pressure governors, which, like the station governors, give a constant or uniform pressure under all variations of consumption; and volumetric governors which pass a constant volume or amount of gas under all variations of pressure.

Of pressure governors the forms devised by Sugg and Bruce Peebles are in extensive use, the latter especially being much applied to street lamps. In Sugg's consumers' governor (fig. 17)

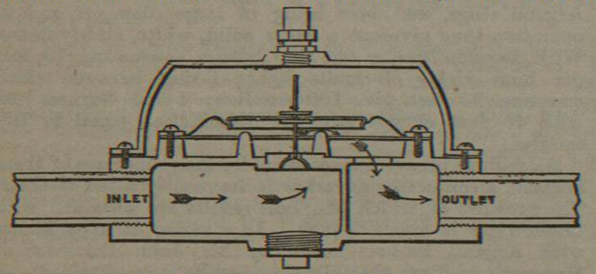

FIG. 17.—Sugg's Consumers' Governor.

the gas enters at the inlet, and, following the course indicated by the arrows, passes through the regulating plate of the governor into the gas-holder, and thence, by the opening provided for it, it reaches the outlet. The gas-holder has suspended from a disc in the crown a half-ball valve, which closes or opens the opening in the regulating plate as the gas-holder rises or falls. A weight placed on the top of the holder fixes the pressure required to raise it. As a consequence, if the pressure of the gas on the inlet is greater than that required to lift the holder, then the latter rises, carrying the half-ball valve with it, till such time as the opening left between the sides of the valve of the regulating plate is sufficient to allow the passage of the necessary quantity of gas to balance the holder. On the other hand, if the pressure at the inlet falls below that required to lift the holder, the full opening of the regulating plate allows all the gas there is to pass through the governor to the burners. Where a very perfect control is desirable, the parts of the governor are made in duplicate, and a double control is thus established. With certain structural differences the action of the Bruce Peebles governor (fig. 18) is the same. The gas enters at 1,

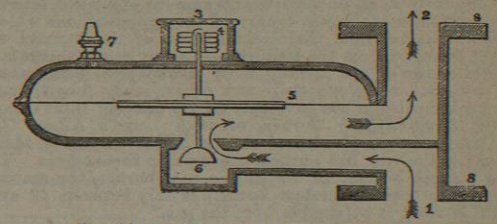

Fig. 18.—Consumers' Governor (Peebles).

and passes out at 2 into the pipe leading to the burners. To adjust the governor the brass cap 3 is unscrewed, and the weights 4 taken off or put on until the desired pressure, of say 5-tenths, at the burners is obtained, when the brass cap is again screwed to its place. The weights now keep the valve 6 open so long as 5-tenths pressure is not exceeded in the main; but any variations in the main above that pressure act at once on the diaphragm 5, and partly close or open the valve, thus maintaining under all circumstances a steady outlet pressure.

Of volumetric governors the best known is Giroud's glycerin rheometer, which consists of a closed cylindrical casing containing a very light metal dome or ball dipping into a circular channel filled with glycerin. In the upper part of the dome is a small orifice through which the gas passes, and on its top is fixed a conical valve which works in a seat at the top of the casing. As the pressure from the supply side rises or falls, the bell responsively moves up or down, opening or closing by the conical valve the orifice by which the gas passes outward; and so delicately is this compensation adjusted that the gas passed is the same in amount however different the pressure. Bruce Peebles has invented a simple and inexpensive form of volumetric governor (fig. 19), in which the use of glycerin is dispensed with. It consists of a conical dome resting on a needle-pointed stud, the cone having an orifice at C, and there is besides a variable consumption channel at the side A B A, which can be controlled by the external screw. As soon as the stopcock is opened the gas fills the interior of the cone, and momentarily closes the valve; but, finding its way by the vertical passage, or through the hole C, in the cone, it reaches the chamber above the cone. The cone is therefore now surrounded by gas at the same pressure, and, having nothing to support it, falls, and lets gas pass to the burner. But this only takes place to an extent that allows a differential pressure to be established sufficient to support the cone, which is then equilibriated between two pressures; and the difference between these two pressures remains constant, however much the initial pressure of the gas may vary, unless, of course, it gets so low as not to be able to raise the cone.

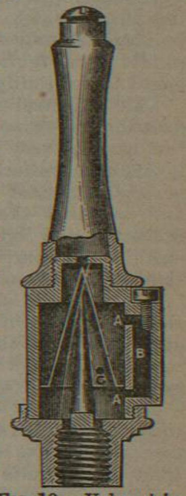

FIG. 19.—Volumetric Governor (Peebles).

Burners.—The question of the arrangements by which the maximum illuminating power may be developed in the consumption of gas, being one which principally affects individual consumers, has not received the attention which their importance merits. As a rule, gas-fitters are ignorant of the principles involved in the economical use of gas, and are often prejudiced by the assertions of certain inventors; and thus it happens that, owing to defective fittings, unregulated pressure, and imperfect burners, an enormous loss of illuminating power is suffered. In their report to the Board of Trade in 1869, the referees under the City of London Gas Act state, of a large number of burners examined by them, that