June 18, 1844.

The PRESIDENT in the Chair.

No. 688. "On the means of rendering large supplies of Water available in cases of Fire, and on the application of manual power to the working of Fire Engines." By James Braidwood, Assoc. Inst. C.E.

The plans at present in use, are so few and simple, that it is conceived merely necessary to state the quantity of water required, and to describe the most approved modes of supplying it, in cases of ordinary fires. Supplies of Water for Fires, Fire Engines, &c.

If water can be obtained at an elevation, pipes with plugs or firecocks on them, are preferable to any other mode at present in use. The size of the pipes will depend on the distance and elevation of the

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suspicion, to the water-cistern, where, least of all, any highly inflammable matter is expected, and an explosion ensues, with a violence, which the large admixture of atmospheric air greatly augments. In this way serious personal injury, as well as damage to property, has been occasioned.

"In seeking a remedy for the evil, the gas companies have been urged to search for their leakages, while the affected service (naturally supposed to be itself defective) has been at the same time stripped,—in some instances driven anew,—and proved, under considerable pressure, to be thoroughly water-tight, but all in vain.

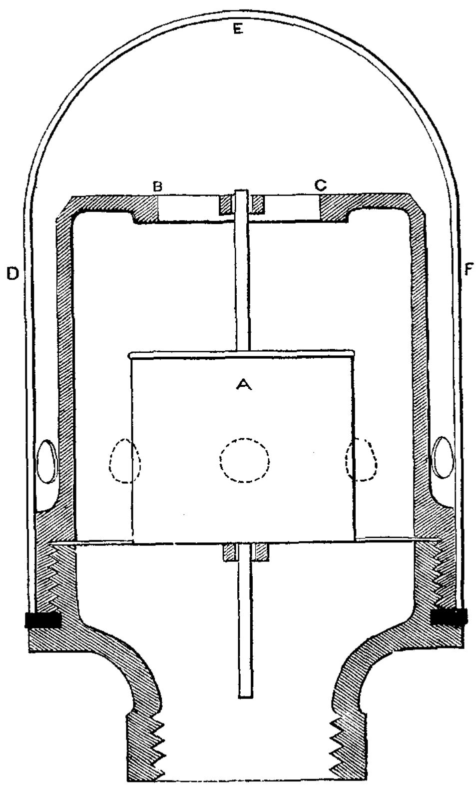
"The circumstances which lead to the result under notice may thus be traced :—The service has one or more branches, which deliver themselves at a lower level than that which it occupies : as a consequence, whenever the supply has been intercepted, the water tends to fall out, and leave an unbalanced atmospheric pressure, by which the surrounding fluid, whether gas or air, is urged to enter, and which, being sometimes equal to a column of water, many inches in height, is capable of effecting the passage of gas into cast-iron pipes, apparently perfectly tight. The foul air, remaining in contact with whatever small quantity of water may be retained by the service, impregnates it; and both are ready to be driven into the most accessible cistern whenever the water is again turned on.

"This view of the matter induced the proposal of the following simple expedient, as a means of counteracting the evil; it has in several cases been applied, and in all with full success.

"From the highest part of the service affected by the gas, a wrought-iron tube, ¾ inch in diameter, strong enough to resist any tendency to form such a curve as would retain water, is laid evenly, and with an upward inclination, towards the nearest protected situation, such as the side of a house, where it is made to terminate in a vertical piece, extending to any required height above the ground. On the top of this vertical piece is screwed the small float valve (Fig. 3). The float (A) forms the valve. It consists of a cylindrical piece of cork, in the axis of which a brass wire is fixed, to serve as a spindle for guiding it. The top is covered with leather, by which an air-tight joint is made with the aperture (B C) above, when the float valve is raised : (D E F) is simply a cover of copper, for the purpose of preventing the entrance of obstructions, and is not an head, and also on the size of the buildings to be protected. It may be assumed as a general rule, that the intensity of a fire depends, in a great measure, on the cubic content of the buildings; distinction being made as to the nature and contents of such buildings. If no natural elevation of water can be made available, and the premises are of much value, it may be found advisable to erect elevated tanks; where this is done, the quantity of water to be kept ready and the rate at which it is delivered, must depend on the means possessed of making use of the water.

essential part of the instrument. The valve opens a free communication with the external air as soon as the water begins to fall out of the service, and by thus establishing an equilibrium between the fluids around and within, destroys any tendency which the former might have to force an entrance. As soon, however, as the service is again charged with water, the valve closes, and prevents all improper escape."

Fig. 3.

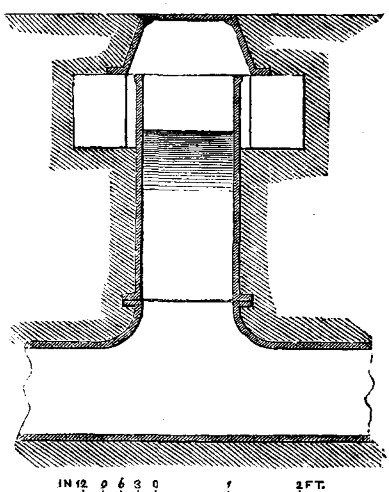


Vertical section—full size.

The average size of fire engines may be taken at two cylinders of 7 inches diameter, with a length of stroke of 8 inches, making 40 strokes each, per minute. This sized engine will throw 141 tons of water in six hours, and allowing one-fourth for waste, 176 tons would be a fair provision in the tanks for six hours' work; this quantity multiplied by the number of engines within reach, will give an idea of what is likely to be required at a large fire. If however there are steam engines, to keep up the supply through the mains, the quantity of water kept in readiness, may be reduced to two hours' consumption, as it is likely that the steam engines would be at work before that quantity was exhausted. This is what may be supposed to be required, in case of serious fires in dockyards, in large stacks of warehouses, or in large manufactories.

Where water can be had at nearly the level of the premises, such as from rivers, canals, &c., if it is not thought prudent to erect elevated tanks, the water may be conducted under the surface by large cast iron pipes, with openings at such distances as may seem advisable for introducing the suction pipes (Fig. 1.) This plan should not be adopted, where the level of the water is more than 12 feet

Fig. 1.



Opening for Suction pipe.

below the surface of the ground, as although a fire engine will, if perfectly tight, draw from a much greater depth than 14 feet (2 feet being allowed for the height of the engine), still a very trifling leakage will render it useless for the time, at such a depth.

The worst mode of supplying engines with water, is by covered sunk tanks; they are generally too small, and unless very numerous, confine the engines to one or two particular spots, obliging the firemen to increase the length of the hose, which materially diminishes the effect of the fire engine. If the tank is supplied by mains, from a reservoir, it would be much better to save the expense of the tank, and to place plugs, or fire-cocks, on the water-pipe. Another evil in sunk tanks, is, that the firemen can seldom guess what quantity of water they may depend upon, and they may thus be induced to attempt to stop a fire, at a point they would not have thought of, if they had known correctly the quantity of water in store.

Where sunk tanks are already constructed, they may be rendered more available by a partial use of the method shown in Fig. 1.

A great deal has lately been said as to extinguishing fires by jets from water mains, without the use of fire engines. This, no doubt, may be done under particular circumstances, where the pressure is considerable, the pipes large, and if only one or two jets are required; but at large fires, where ten or twelve jets are necessary, the expense would be too considerable, especially, as where the largest fires may be expected, water is generally least wanted for other purposes; besides, it appears wrong in principle, to employ a power, which decreases exactly in proportion to the extent to which it is used, independent of the great loss by friction in the leather hose, which reduces the delivery, and of course the height or force of the jet, 2½ per cent. for every 40 lineal feet of leather hose, through which the water passes, as was fully shown by the following experiments.

Memoranda of experiments, tried on the mains and service pipes of the Southwark Water Company, between 4 *and* 9 A.M. *of the* 31*st January* 1844. *The wind blowing fresh from N.N. W.*

The pressure at the water-works at Battersea, was kept at 120 feet, during the experiments, and every service pipe or other outlet was kept shut.

1*st. Experiment.*—Six standcocks, with one length of 2½ inches riveted leather hose 40 feet long, and one copper branch 4 feet to 5 feet long, with a jet ⅞ inch in diameter on each, were placed in six plugs on a main 7 inches diameter in Union Street, between High Street, Borough, and Gravel Lane, Southwark, at distances of about 120 yards a part. The water was brought from the head at Battersea, by 4250 yards of iron pipes 20 inches diameter, 550 yards of 15 inches diameter, and 500 yards of 9 inches diameter.

1st. One standcock was opened, which gave a jet of 50 feet in height, and delivered 100 gallons per minute.

With four lengths of hose the jet was 40 feet high, and the delivery 92 gallons per minute. When the branch and jet were taken off, with one length of hose, the delivery was 260 gallons per minute.

2nd. The second standcock was then opened, and the jet from the first was 45 feet high.

3rd. The third standcock was opened, and the jet from the first was 40 feet high.

4th. The fourth standcock being opened, the first gave a jet of 35 feet high.

5th. The fifth being opened, the first gave a jet of 30 feet high.

6th. All the six being opened, the first gave a jet of 27 feet in height.

2nd Experiment.—Six standcocks were then put into plugs, on a main 9 inches diameter in Tooley Street, the extreme distance being 450 yards, with hose and jets as in the first experiment. The water was brought from the head at Battersea by 4250 yards of iron pipes of 20 inches diameter, 1000 yards of 15 inches diameter, 1400 yards of 9 inches diameter. The weather was nearly the same, but the place of experiment was more protected from the wind, than in Union Street.

1st. With one standcock open, a jet 60 feet in height was produced, and 107 gallons per minute were delivered.

2nd. The second standcock was then opened, and the difference in the first jet was barely perceptible.

3rd. Other two standcocks being opened, the first jet was reduced to 45 feet in height, and the delivery to 92 gallons per minute.

4th. All the six standcocks being opened, the first jet was further reduced to 40 feet high, and the delivery to 76 gallons per minute.

3rd Experiment.—Two standcocks, with hose, &c., as in the first experiment, were then put into a service pipe, 4 inches diameter and 200 yards long, in Tooley Street, the service pipe was connected with 200 yards of main 5 inches diameter, branching from the main of 9 inches diameter. The weather was still the same as at first, but the wind did not appear to affect the jets, owing to the buildings all round being so much higher than the jet.

1st. The standcock nearest the larger main was opened and a jet of 40 feet high was produced, delivering 82 gallons per minute.

2nd. Both standcocks being opened, the first gave a jet of 31 feet, and delivered 68 gallons per minute.

3rd. The standcock furthest from the large main, only being opened, gave a jet of 34 feet, and delivered 74 gallons per minute.

4th. Both standcocks being opened, the furthest one gave a jet of 23 feet, and delivered 58 gallons per minute.

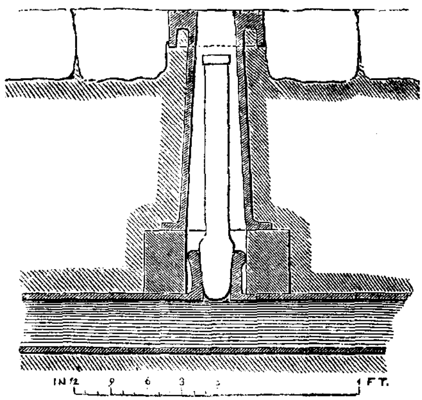
When both these plugs were allowed to flow freely without hose, the water from that nearest the large main, rose about 18 inches, and the farther one about 1 inch above the plug-box.

These and other experiments, prove the necessity of placing the plugs on the mains, and not on the service pipes, where there are mains in the street.

The different modes of obtaining water from the mains or pipes are shown in the accompanying drawings.

(Fig. 2) is a section of a common plug when not in use.

Fig. 2.

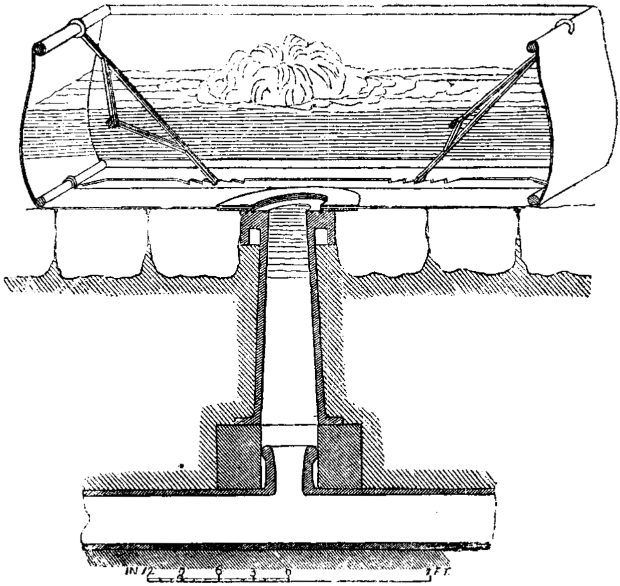


Common Fire-plug.

(Fig. 3) is a section of the common plug, with a canvas dam or cistern over it, as used in London. The cistern is made of No. 1. canvas, 15 inches deep, extended at top and bottom by $\frac{5}{8}$ inch round iron frames, a double stay is hinged on the top frame at each end. When the cistern is used, the top frame is lifted up, and the stays put into the notches, in two pieces of hoop iron, fixed to the bottom frame. There is a circular opening 9 inches diameter in the canvas bottom, two circular rings of wash-leather about 2 inches broad, are attached to the edges of the opening in the canvas, so as to contract it to 4 inches or 5 inches diameter; the plug being opened, the cistern is placed over it; the wash-leather is pressed down to the surface of the road by the water, and a tolerably water-tight cistern, with about 12 inches or 14 inches of water in it, is immediately obtained.

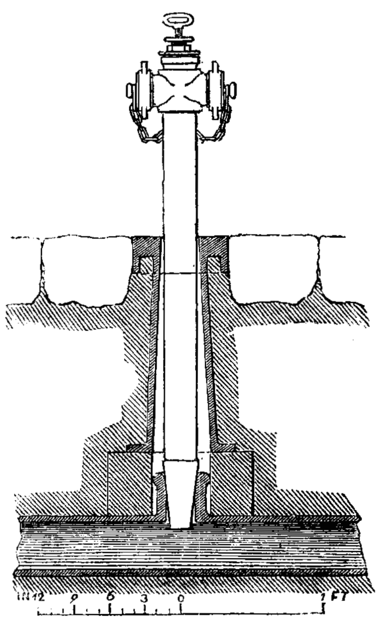
(Fig. 4) is a plug with a standcock in it, to which hose may be attached.

Fig. 3.



Fire-plug with canvas Cistern.

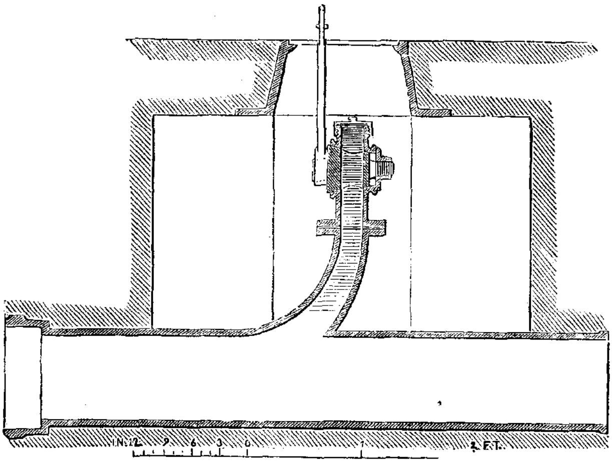
Fig. 4.



Plug, with Standcock.

(Fig. 5) is a common single firecock with a round water-way 2½ inches diameter.

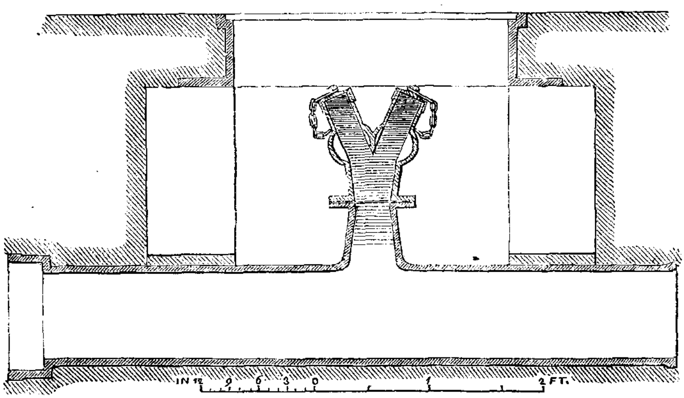
Fig. 5.



Single Fire-cock.

(Fig. 6) is a double firecock, as laid down in Her Majesty's Dockyards.

Fig. 6.

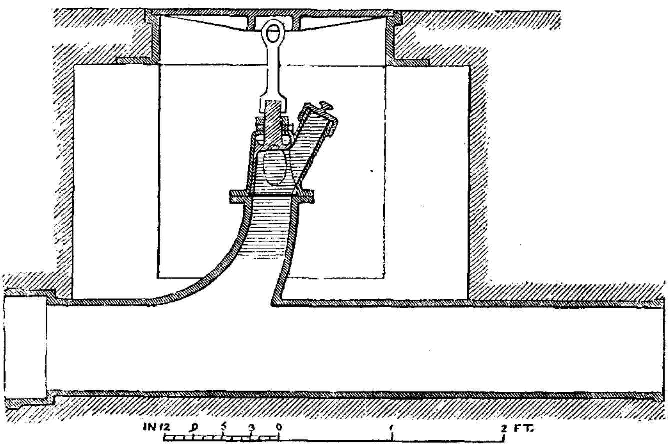


Double Fire-cock, used at the Royal Dockyards.

It will be observed, that the short piece of pipe between the main and this firecock is not curved to the current of the water, but merely opened a little; this is done with a view of increasing the supply by steam power, and as the steam engines are, in most cases, situated in a different direction from the tanks or reservoirs, therefore, the curve that would have assisted the current in one direction, would have retarded it in the other. It has been objected to these firecocks, that the opening does not run through the centre of the key, therefore only one side of the key covers the opening in the barrel, while in the common firecock both sides are covered.

(Fig. 7) is a double firecock, as laid down at the British Museum.

Fig. 7.



Double Fire-cock, used at the British Museum.

This has a very good delivery, and is certain to be always tight, if well made, as the pressure of the water forces the key into the barrel; this also renders the cock somewhat difficult to be opened and shut, if the pressure be great; but as a lever of any length may be used, and the key, from its perpendicular position, may be loosened by a blow, this objection is, in a great measure, obviated.

In Figs. 5 and 6, the openings in the street are large enough to admit of the levers for opening the cock to be fixed, that no mistake may occur from the lever being mislaid; but with those at the British Museum, it was not thought necessary to have fixed levers, as a crow-bar, or anything that could be introduced into the eye of the spanner, would open them.

The plug and firecock have both certain advantages and disadvantages, which the author describes.

The plug, with a canvas cistern, is the easiest mode of obtaining water; the plug-box being only the size of a paving-stone, is no annoyance in the street, and the water has only one angle to turn before it is delivered.

On the other hand, where the supply of water is limited, the plugs give but little command of it; there is, however, comparatively very small loss at a large fire in London, from this cause, as it is very seldom, that all the fire-engines can be supplied direct from the plugs, and those that arrive late, must pick up the waste water as they best can, by using another description of canvas dam, or opening the street; but in enclosed premises, especially where the water is kept for the purpose of extinguishing fires, firecocks are much to be preferred. It is very difficult to insert the standcock into a plug, if there is a considerable force of water, and if the paving has moved, it cannot be done without raising the plug-box; but this is, however, the easiest mode of using firecocks, and where there is a considerable pressure of water, if the watchmen or the police are supplied with a hose reel and branch pipe, they can, in enclosed premises, direct a jet on the fire while the engines are being prepared, and if they cannot reach the fire, they will have water ready for the engine when it arrives.

Inclosed premises are particularly mentioned, because the principal duty of the watchmen, in these cases, is to guard against fire and their other duties being comparatively few, the men are not often changed, and they can be instructed thoroughly in the matter. With the general police of the metropolis it is quite different, their duties are so numerous and varied, that to add that of firemen to them would only be to confuse them.

Firecocks, if kept at 9 inches to 12 inches below the surface, are easily protected from frost, by stuffing the opening with straw.

The advantage which the double firecocks have over the single ones, is merely the increased water-way, as a firecock $3\frac{1}{2}$ inches diameter could not be so easily opened or shut, as two cocks of $2\frac{1}{2}$ inches diameter.

One of the greatest objections to firecocks, is the very large openings required in the streets, the first cost and the repair of which are both considerable, besides their liability to accident. To take them to the foot-path, increases the expense and diminishes the supply of water, as it is generally done with a small pipe, and the number of angles is increased. In some instances, where firecocks have been put down on one side of the street, no less than four right angles have been made in the course of the water; and if the fire happens to be on the opposite side of the street from the firecock, the thoroughfare must be stopped. The expense also is no slight consideration, for if laid along with the water-pipes, each firecock, if properly laid, and the pit built round with cement, will cost eight or ten times as much as a plug.

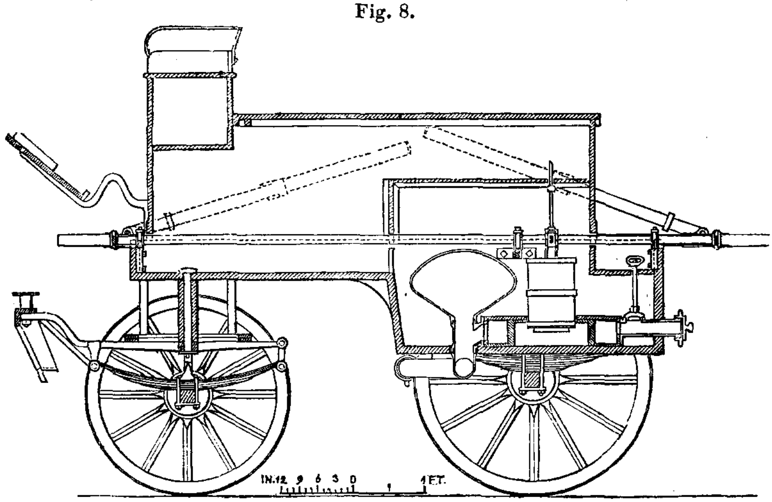
On the application of manual power to the working of Fire Engines.

In the application of manual power to the working of fire-engines, the principal object is, to apply the greatest aggregate power to the lightest and smallest machine; that is, suppose two engines of the same size and weight, the one with space for 20 men to work, throws 60 gallons per minute; and the other with space for 30 men, throws 80 gallons in the same time; the latter will be the most useful engine, although each man is not able to do so much work as at the former. Fire Engines.

The reciprocating motion is generally preferred to the rotary for fire engines. Independent of its being the most advantageous movement, a greater number of men can be employed at an engine of the same size and weight; there is less liability to accident with people unacquainted with the work, and such as are quite ignorant of either mode of working, work more freely at the reciprocating, than the rotary motion. To these reasons may be added, the greater simplicity of the machinery.

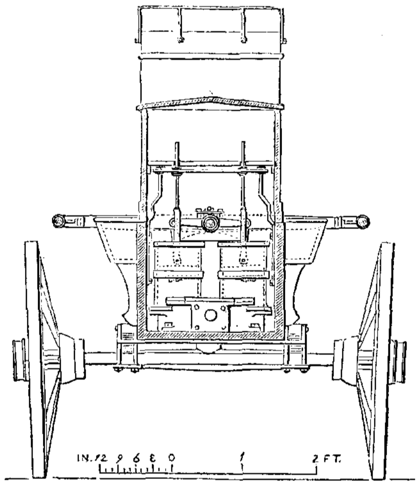
Various sizes of engines, of different degrees of strength and weight, have been tried, and it is found that a fire-engine, with two cylinders of 7 inches diameter, and a stroke of 8 inches, can be made sufficiently strong at 17½ cwt. If 4 cwt. be added for the hose and tools, it will be found quite as heavy as two fast horses can manage, for a distance under 6 miles, with five firemen and a driver (Figs. 8 and 9).

Fig. 8.



Fire Engine, used by the London Fire Brigade.
Longitudinal section,—with the Levers turned up for travelling.

Fig. 9.

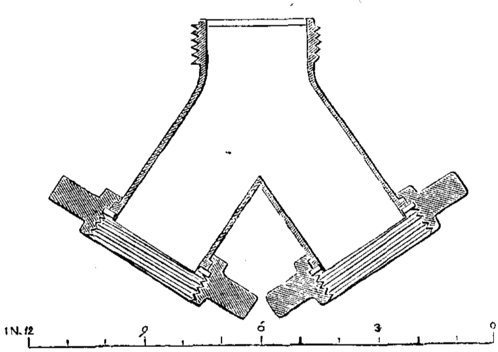


Transverse section.

This size of engine has been adopted by the Board of Admiralty and the Board of Ordnance, and its use is becoming very general.

When engines are made larger, it is seldom that the proper proportions are preserved, and they are generally worked with difficulty, and soon fatigue the men at the levers. When a large engine is required in London, two with 7 inch cylinders are worked together by means of a connecting screw (Fig. 10), thus making a jet very nearly

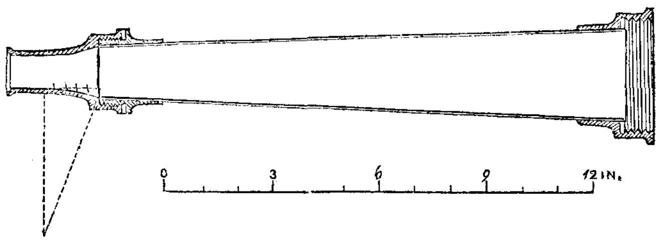
Fig. 10.



equal (as 98 to 100) to that of an engine with cylinders 10 inches diameter; any larger size than this cannot be used, as the friction in the hose of $2\frac{1}{2}$ inches diameter, is so much increased that the jet is comparatively weak; the hose may of course be enlarged in diameter, but the weight is augmented, and the whole of the machinery is rendered more unwieldy and less useful.

A great many different shapes of jet have been tried, and that shown in Fig. 11 was found to answer best when tried with other

Fig. 11.



forms. The old jet was a continuation in a straight line of the taper of the branch, from the size of the hose screw, to the end of the jet pipe; this had many inconveniences; the size of the jet could not be increased without making the jet pipe nearly parallel. As the branches were sometimes 7 feet or 8 feet long, in some instances the orifice at the end of the jet-pipe, was larger than that at the end of the branch. The present form of the jet completely obviates this difficulty, as the end of the branch is always $1\frac{1}{2}$ inches diameter.

The curve of the nozzle of the present jet is determined by its own size; one-tenth of the difference between the jet to be made and the end of the branch, is set up on each side of the diameter of the upper end of the branch, a straight line is then drawn across, and an arc of a circle described on this line, from the extremity of each end of the diameter of the jet, until it meets the top of the branch; the jet is then continued parallel, the length of its own diameter; the metal is continued one-eighth of an inch above this, to allow of a hollow being turned out to protect the edge. The rule for determining the size of the jet for inside work is, to " make the diameter of the jet one-eighth of an inch for every inch in the diameter of the cylinder, for each 8 inches of stroke. The branch used in this case is the same size as shown in Fig. 11. When it is necessary to throw the water to a greater height, or distance, a jet one-seventh less in area is used, with a branch from 4 feet to 5 feet long.

The usual rate of working an engine, of the size described, is forty strokes of each cylinder per minute, this gives 88 gallons. The number of men required to keep steadily at work for 3 or 4 hours is 26; upwards of 30 men are sometimes put on when a great length of hose is necessary. The lever is in the proportion of $4\frac{1}{4}$ to 1. With 40 feet of leather hose and a $\frac{7}{8}$ inch jet, the pressure is 30 lbs. on the square inch; this gives 10·4 lbs. to each man to move a distance of 226 feet in one minute. The friction increases the labour $2\frac{1}{2}$ per cent. for every additional 40 feet of hose, which shows the necessity of having the engine, and of course the supply of water, as close to the fire as is consistent with the safety of the men at the levers.

The paper is illustrated by nine drawings (Nos. 3650 to 3658), showing the fire-engines, fire-plugs, cocks, hose-screws, jets, &c.

Mr. J. Simpson.

Mr. Simpson said, that the subject of Mr. Braidwood's communication was liable to so many contingencies, that it became one of extreme difficulty to lay down comprehensive rules on the question.

In rendering supplies of water available, in cases of fire, the question to be solved was, what were the appliances most likely, under all circumstances, to prove serviceable in sudden emergencies, taking into account the effect of alarms of fire, and the excitement caused by them, among all classes of persons.

In the course of his practice, he had designed and executed plans for affording supplies of water in case of fire, and it was a subject to which he had occasionally paid considerable attention. He was sorry to differ, in any degree, from so good an authority as Mr. Braidwood, but he thought that the services of sunk tanks, or underground receptacles, were improperly undervalued; in small water-works, where the power of the pumping machinery was limited, and in comparatively level countries, when elevated reservoirs of magnitude could not be constructed, he knew of no plan so likely to succeed as sunk tanks; because with trifling attention, they were not liable to be deranged, or to be affected by frost, and they were so immediately available in the hour of need; the large quantity of water required to be supplied in a short time at fires, being usually, far beyond the pumping power of small water-works. He had frequently applied tanks with success. In the fire supply at the Royal Hospital at Chelsea, of which he presented a plan (Drawing No. 3659, Fig. 12), which he designed a few years since for the Commissioners of Her Majesty's Woods, Works, &c., three tanks, containing 5000 gallons each, were introduced, in compliance with the desire of one of the officers, in order to obtain half-an-hour's supply of water for the fire-engines of the establishment, and thus to avoid delay and afford time to communicate with the turncocks. The tanks were supplied by