an arrangement of levers and rods, the lowest type in the corresponding groove of the composing-cylinder is pushed radially outwards on to a very rapidly revolving disk, which carries it to an opening in the stationary guard surrounding the disk, and delivers it upon a moving belt, on which the types are carried in their proper order to a revolving lifter, which raises them in succession into a long setting-stick in front of the operator, terminating in a justifying-stick at the upper end of an inclined channel or galley.

In justifying, a section of the composed line of type is drawn to the mouth of the justifying-stick, and is justified with spaces taken from a case containing channels for the different spaces and the hyphen, the lowest of which are pushed partially out by ejectors worked with a treadle.

The lines of type, when ready for distribution, are inserted in the grooves of the distributing-cylinder from a special galley by means of a slide, with which a whole line at a time is pushed bodily into a groove.

It is claimed that this machine will distribute and set at the rate of six thousand ems per hour, doing, with three persons, the work of six men working in the ordinary way. Considering the purpose for which the machine is intended, the construction is simple, and there appears to be no difficulty or hitch in the working.

It should be remarked, that, by manipulating the keys in one direction only, several keys may be touched simultaneously without risk of the characters becoming transposed. In working the opposite way, each key must be touched separately. The machine is driven from a shaft by two small belts. One belt transmits motion to the revolving disk below the type-setting cylinder and to the type-lifter; while the other belt, by means of a tightening-pulley and ratchet-gear, produces the step-by-step motion of the distributing-cylinder.

THE STEAM-ENGINE, ITS PRINCIPLES, ITS DEVELOPMENT, ITS PRESENT CONDITION, AND ITS FUTURE PERFECTION.[1]

IN this lecture will be found, stated in a very compact form, the fundamental principles of the steam-engine, and a history of its development. Some of the statements at first glance seem very startling, but they are so supported by the records that surprise is overcome by conviction. One of these statements is, that "for a generation after James Watt's death the art of producing power from fuel by the intervention of a steam-engine retrograded; so that less power was usually obtained from a pound of coal consumed than had been obtained by the use of methods invented and fully explained by James Watt."

This is illustrated by the following: "Founded upon these principles, the steam-engines which were made by Mr. Watt and his associates and pupils before 1830, produced a horse-power with less than two pounds of coal an hour. These engines are known as the Cornish pumping-engines; and, if you will look into the history of these machines, you will find them reported as doing more than a 'hundred millions of duty,' which is a technical phrase, intended to express the fact that a hundred million pounds of water were lifted a foot high for a hundredweight of coal consumed. Turning that into horse-power, it means about two pounds of coal an hour a horse-power. This result was produced by cutting off steam in the cylinders at one-sixth or one-eighth of the stroke, and allowing it to expand six or eight times. The engines of that day, of course, were very imperfectly constructed, and great losses occurred from leaking pistons and from defective boilers; but, notwithstanding that loss, the result was equal to two pounds of coal an hour a horse-power."

In a note on the subject, reference is made to the authorities showing the "duty" of Cornish engines before 1830 to be more than a "hundred millions," or, what is the same thing, a horse-power with less than two pounds of coal an hour. Perhaps the contrast between the engines did not attract much attention, because the Cornish engine's economy was always stated in terms of weight lifted, whereas economy in other engines was stated in terms of coal an hour a horse-power.

[1] Abstract of a lecture delivered by Edward N. Dickerson, LL.D., before the Electric Club of New York, Jan. 17, 1889.

The lecturer, on this subject, makes this statement: "When steamships came to be built in England in 1840, and afterwards, notwithstanding the fact that high expansion with great economy was in constant operation on James Watt's Cornish engines and on Wolff's compound engines, no attempt was made to work the marine engines under high expansion; and as a consequence all the earlier steamships, for more than thirty years, were running at a cost of at least four pounds of coal an hour a horse-power; while, at the same time, compound engines had been well known for a generation, and were in actual use, making a horse-power for about two pounds of coal an hour. The Cunard Company, however, were making money in their business; and they considered that a sufficient answer to any suggestion that their fuel account was enormously expensive."

It is certainly a very remarkable fact that for a generation steamship-owners did not use high expansion on their ship-engines, when it had been in use on shore for thirty years, both in single and in compound engines.

The fact, perhaps, is not generally known, as stated by the lecturer, that "in 1825 several steamboats on the North River worked by double expansion engines, were built by Mr. Allaire in this city, — the 'Henry Eckford' for one; and the 'Sun,' which made the trip to Albany in about twelve hours, for another. At that time the subject was not well enough understood, and economy in fuel was not considered of so much consequence as the first cost of construction, and these engines were not largely reproduced. One of these double expansion engines made in England was brought to this country in 1830, and for many years was used in the oil-factory of Judd's Sons, giving very economical results. When they needed more power, a half-stroke cut-off engine was made for that factory and added to the other, but its results were vastly inferior to that of the compound engine."

The explanation is probably the true one, that the greater original cost of compound engines was of more consequence in those days than subsequent economy; and so the compound engines were neglected and lost sight of, till attention was again called to them by Mr. Jameson in 1860, when it was necessary to save a steamship company on the Pacific Ocean from ruin, because of the high cost of fuel there; and he adopted the very obvious remedy of reducing coal-consumption one-half by the use of the old compound engines, which had been disregarded for years.

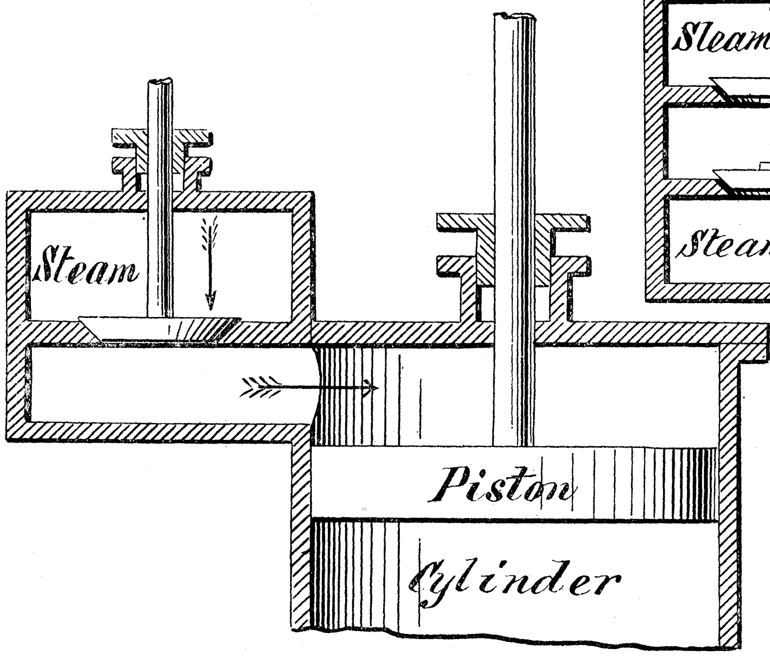
One very interesting fact brought prominently forward is thus stated: "The astonishing fact exists to-day, that, on an average, every steamboat running on the waters of New York is wasting certainly not less than fifteen per cent of all the fuel consumed, by leaking through the valves; and almost any one of them will run at the rate of four or five miles an hour without ever opening the steam-valves at all, and simply by the leakage through those valves; and yet that leakage is only the difference between what leaks in through the steam-valves and what leaks out through the exhaust-valves. Some of these steamboat-engines are so constructed that the engineer can 'unhook' the steam-valves without unhooking the exhaust-valves; so that, as the engine moves, the exhaust-valves are working, and the steam-valves are shut. That is particularly true of some of the steamboat-engines on the New Haven line; and when the pilot rings the slow-bell, as he frequently must do in going through the crowded thoroughfares, the engineer simply unhooks the steam-valves and lets them drop shut, and the steamboat moves on at a fair rate of speed from the leakage alone; whereas, if those steam-valves were tight, the engine would be stopped in half a revolution. This tremendous loss is not appreciated, because it is a case of internal hemorrhage, and no visible sign appears. The steam leaks into the condenser, and is pumped overboard with the condensing water; but, as far as I have observed, it has not raised the temperature of Long Island Sound at all, and therefore has not produced any effect on climate; and there is no advantage gained by that tremendous expenditure. The remedy, of course, is very simple, and that is to go back to James Watt, which would mean at least fifteen per cent of saving in the coal-bins."

A note very fully explains how this loss occurs, and why it escapes observation. All the earlier steamboats used the single puppet-valves of James Watt, which are necessarily perfectly tight when once ground into their seats; and, as they are forced into their seats by the pressure of steam, it is impossible for them to leak. But, being heavy to lift by hand, some one invented the double-balanced valve, in which the steam is pressing upward and trying to open the lower of two valves, while it is pressing downward on the upper one; so that there is no trouble in opening them by hand. Of course, such an arrangement must leak; and, when steam once begins to leak, it cuts its way through the crack, and very soon has an open passage.

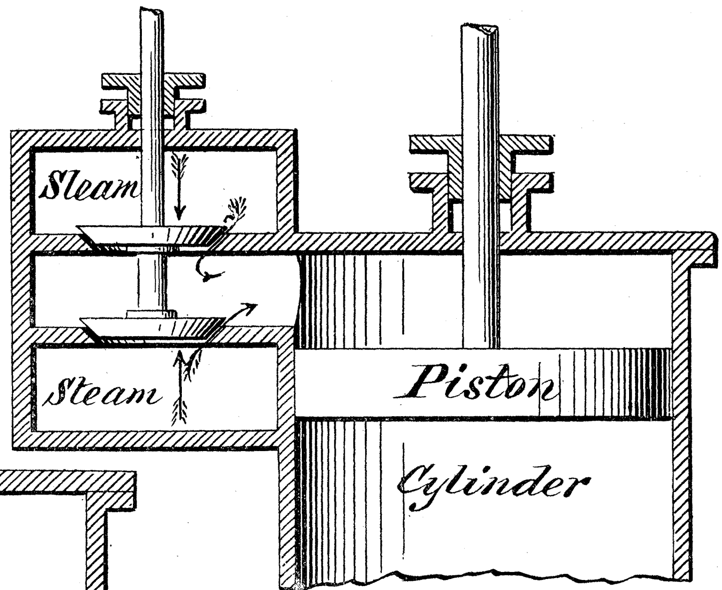
It has not, however, been supposed that the leak was so enormous as stated; but the lecturer appeals to what he says are facts within his knowledge, and which are easily verified any day. If it is true that steamboat-engines will run the boat without opening the steam-valves, as he says, and that it is done as a practice on some East River steamers when the engine is required to go slow, it is certainly most astonishing that owners should permit such a state of things to continue for a day. As the lecturer says, it is a case of internal hemorrhage, where the patient may bleed to death without knowing the cause.

The lecture contains two cuts, exhibiting the single puppet-valve of Watt, and the double or balanced American valve, as below.

It is very apparent from the sketch that the double valve must be leaky. The pressure upwards on the lower valve



JAMES WATT'S SINGLE PUPPET-VALVE.



AMERICAN BALANCED PUPPET-VALVE, WHICH MUST LEAK 15 PER CENT OF STEAM USED BY ENGINE.

balances the pressure downward on the upper one, and of course the valve opens easily; but unless the upper and lower valves, which are rigidly separated by a column, can be fitted at exactly the same distance apart that the seats are, of course they must leak, since no pressure can take effect on either to force it into its seat. If they could be so perfectly constructed as to be steam-tight when cold, the moment they are heated by steam, the expansion of the column must differ from that of the enclosing chest, and at once a leak begins; and when it does begin, it soon cuts away the metal.

The lecturer takes up the present theory that great losses are incurred in working steam expansively, according to the laws of Watt, by what is called "cylinder condensation," which is said to destroy as much as one-quarter of the steam introduced into the cylinder, and to that extent neutralizing the theoretical gain by expansion. This hypothesis was put forward by the engineers of the navy in 1860, as the true explanation of a very common fact, that a steam-engine does not give out power in proportion to the expansion used. This explanation was supported by an experiment tried by the United States on an engine on Lake Erie, to which the lecturer refers as follows: —

"In the history of the development of the steam-engine, one curious phenomenon deserves to be mentioned, and that is the attack upon James Watt and his laws of steam by the Government of the United States during the Rebellion, when vast sums of money were expended in building steam-engines. At that time the Government officially pronounced its judgment of condemnation upon the laws of Watt, and published that judgment in a book, which was distributed to the engine-builders and engineers of the country as the authoritative decision by the United States. This absurd conclusion was reached in consequence of some experiments ignorantly tried by some Government engineers, on a leaky engine on Lake Erie, which, as the report showed, was using more than twice the fuel to the horse-power that James Watt's engines were using. What was proved by the experiment was, that such a machine as that was not a good one to make forty-seven horse-power by expansion; but it was assumed that it proved there was no use in expansion. I quote from that book the following: —

"'The results obtained from this engine (that is, the Lake Erie engine) are rigorously applicable to all others in which saturated steam is employed in a cylinder not jacketed, and show conclusively the utter futility of attempting to realize an economical gain in fuel, under such conditions, by expanding the steam beyond the very moderate limit of one and a half times; and that, if the expansion be carried to three times, a positive loss is incurred; also that if measure of expansion, as high as those due to cutting off the steam at $\frac{1}{6}$ or $\frac{4}{45}$ of the stroke of the piston, are employed, the economy is considerably less than with steam used absolutely without expansion.'

"Upon that principle, the whole steam navy of the United States that was built during the war was constructed. This was a tremendous blow to progress, from which we have not yet entirely recovered; and but for the fact that the engineers of Europe have since built their magnificent steamers, and carried expansion to a high degree, we should have been building a navy to this day in accordance with this ignorance. But James Watt, for a dead man, made a magnificent fight in defence of his principles; and the money and resources of the United States have utterly failed to defeat him."

In an elaborate note, an explanation is made of the way in which this remarkable conclusion was reached, supported by the tabulated report on which it was supposed to rest. As the table shows, the "Michigan's" engine was run at various rates of expansion, beginning at nearly full stroke, and running down to a cut-off at one-eleventh of the stroke, — the pressure of the steam being kept constant, and the revolutions of the engine kept the same, by taking off resistance, — so that at full stroke the engine developed 280 net horse-power, and at one-eleventh of the stroke only 47 horse-power, and in that proportion. Each experiment lasted seventy-two hours. The water was carefully measured as it was taken into the boiler; and the steam which resulted from that water was estimated from the indicator diagrams as it went into the condenser. The result of these trials is thus stated in a note, quoting the figures from the report: —

"In round numbers twelve hundred pounds of water an hour disappeared from the engine, whether the steam followed the piston full stroke, or was cut off at one-eleventh of the stroke; and, of course, the expansion rate had nothing to do with its loss. Indeed, at the high expansion there appeared less loss of water than at lower rates. The fact, of course, was that the double-balanced puppet-valves of that engine leaked about the same amount of steam into the condenser an hour when the engine was running, and it made no particular difference whether the cut-off was long or short.

"If the estimated water in steam, as shown by the indicator, could have been ascertained as accurately as the water pumped in was, it would have appeared that at the high rates a still smaller loss occurred than the tables show, as compared with full stroke; because, after the cut-off valve shuts, the steam-pressure falls off in the cylinder, and less steam ought to leak into the condenser than if the boiler-pressure were kept up in the cylinder during its entire stroke; but these indicator measurements cannot be exactly accurate. They, however, established the fact that in this case high expansion destroyed less steam than full stroke, and so completely demolished the theory which the experiment was tried to establish. That, however, did not prevent the forcing of balances, and other similar manipulation of the honest figures, in order to prove the hypothesis under which the experiment was tried; and the result was announced that the Lake Erie experiment had proved what it was intended to prove, and the official United States Government report was issued to the world, announcing the new discovery.

"If book-keeping could have beaten James Watt, he and his laws would have perished from the earth; but, as it was, they were only driven for a season out of the American Navy."

It is not important for science to know whether the conclusion drawn from the facts was fraudulent, as the lecturer asserts, or simply a stupid blunder. The fact is, that an almost constant quantity of steam disappeared from the engine in an hour, under all circumstances, and of course its loss had nothing to do with expansion. The quantity — twelve hundred pounds an hour — was a very large percentage of 47 horse-power, and a small percentage of 280 horse-power; and this fact was put forward as proving that expansion destroyed a much larger amount of steam used than full stroke did, whereas in fact a trifle less steam was destroyed when high expansion was used than at any other time.

The explanation, open to any one's verification by the tables themselves, disposes of this extraordinary trial, and destroys the theory based upon it. It is great service to truth to make this exposure.

The lecture ends with this expression of opinion: —

"It is my opinion, that, with our present knowledge of machinery, a steam-engine can be built to day that will produce a horse-power with three-quarters of a pound of coal an hour, if of sufficient size to reduce the percentages of loss by radiation, friction, and leakage, to a minimum. Under those circumstances, your fuel expense would be less than one-third of what it now is."

It would seem that there should be some means of bringing this to a test. No one claims at present less than a pound and a half an hour in the most elaborate and extensive steamers; and, if this opinion is correct, half the coal now used, or a power double that now got from the same fuel in the most perfect machine, would be the result of such an engine.

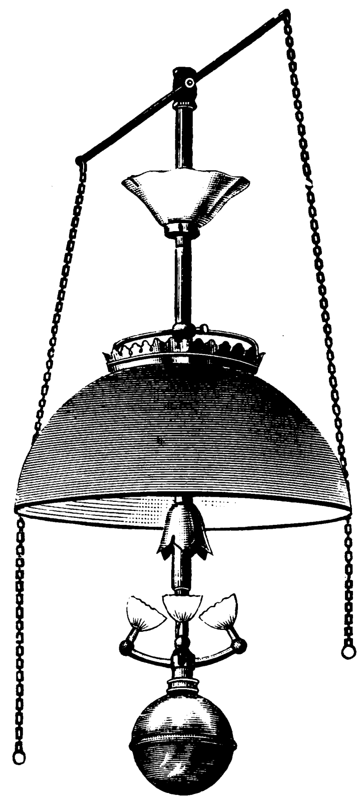
In a review we cannot go over the whole ground on which the lecturer places the case; but to those specially interested in the subject there is matter enough for very serious consideration, and we commend the paper to their notice.

SETH K. WARREN of Geneva Lake, Wis., publishes a little volume devoted to the "Evolution Theory of the Origin of Worlds."

IMPROVED GASLIGHT.

NOTWITHSTANDING the rapid development of the electric-light industry, gas still remains the most widely used and convenient illuminant; and any means of improving the quality or decreasing the cost of gaslight is of interest to the public. One improvement in both these features, now attracting much attention, is known as the "albo-carbon light."

In this light the ordinary illuminating-gas is passed through a simple apparatus, in which it is enriched by taking up a hydrocarbon vaporized by a current of heated gas. It is claimed by the company who have introduced it to the public that one thousand feet of common coal-gas, after being passed through their appliance, will give fully as much illumination as three thousand feet where ordinary burners are used: in other words, the cost of illumination is reduced to at least one-half, while the light is far more satisfactory. The apparatus can be attached to any ordinary gas-pipe or gas-fixture in a few minutes, and no change in the meter or



THE ALBO-CARBON GAS-FIXTURE.

gas service is required. The carburetting vessel is detachable, and may be readily removed from the fixture for refilling with "carbon." This operation is quickly performed, and the whole appliance is so simple that it requires practically no attention. There is no complicated mechanism, and consequently nothing to get out of order.

The adaptability of this light for illuminating purposes under all circumstances is proved by the fact that it is now in use in many of the largest business-houses in this city and Brooklyn. Professor Stevens of Girard College, Philadelphia, says of it, "I have tested the albo-carbon light. . . . The burner consumed 2 cubic feet of gas per hour. One foot of common gas per hour equalled 2.5 candles, while one foot of the gas when carbonized equalled 8.125 candles. Regarding candle-power, the carbonized gas is equal to 3.25 times the common gas. Comparing the common gas with the standard 5-foot Argand burner, 5 feet per hour with the Argand burner equalled 17.20 candles; 5 feet of carbonized gas equalled 40.625 candles, which is 2.36 times the candle-power of the standard Argand. . . . The perfectly steady, soft light furnished by the albo-carbon burner adapts the light admirably for reading, for manufacturing establishments especially, and for general household uses."

The tests referred to above refer only to single lights: when the