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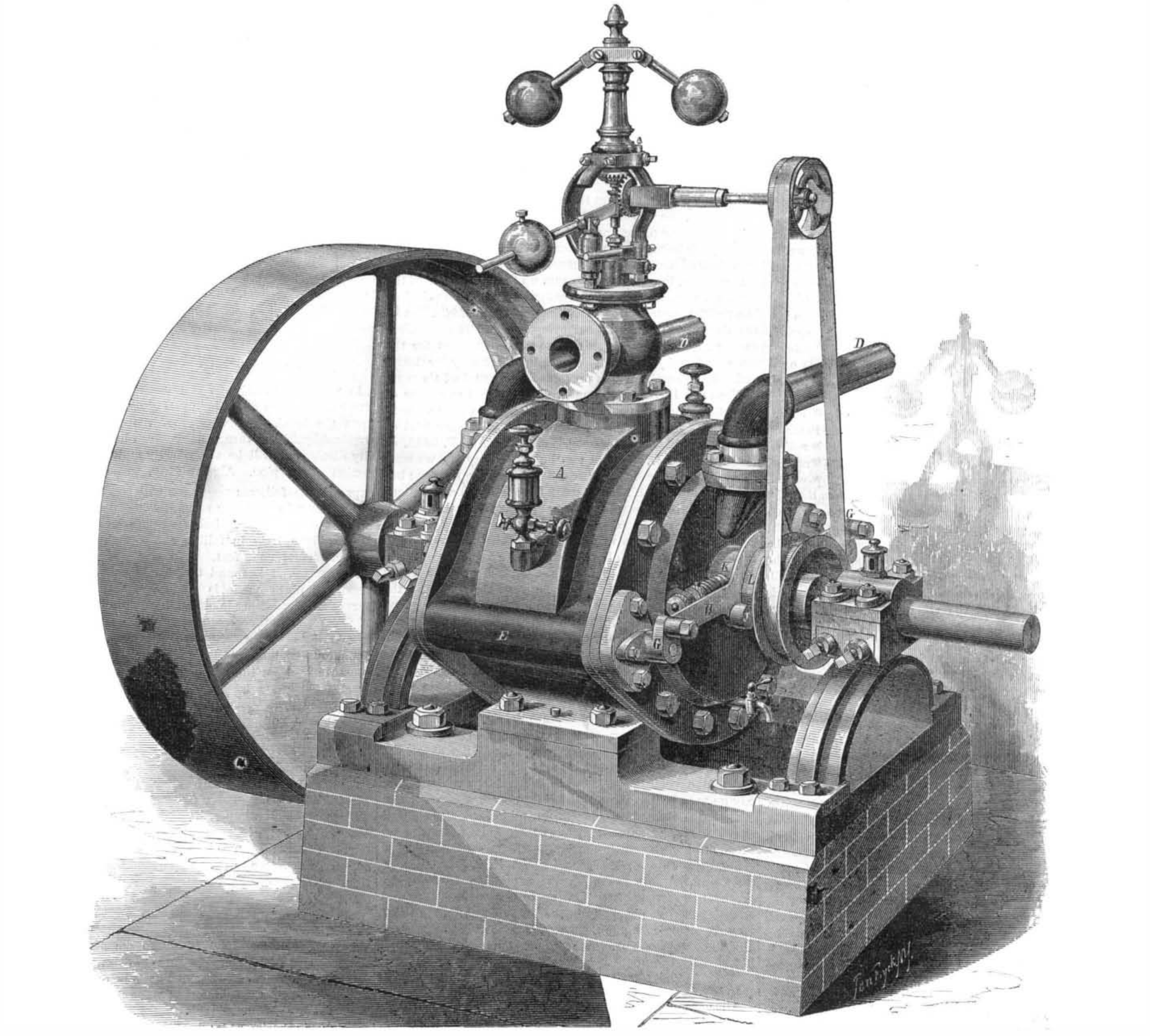

THE BALTIMORE CONCENTRIC ROTARY ENGINE.

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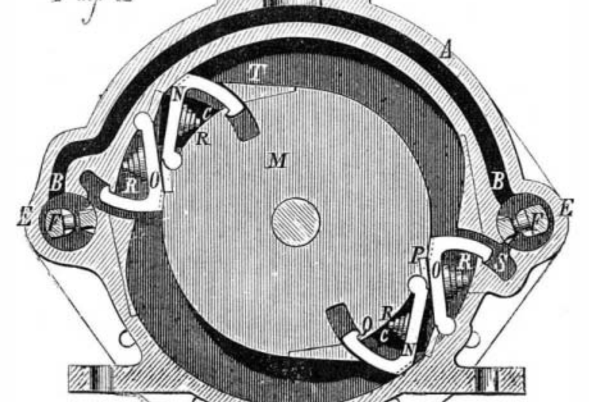
It is hardly necessary, at the present day, to direct especial attention to the relative proportion of advantages and defects inherent to the rotary engine as a type; nor is it here needful to draw any contrast between it and the reciprocating engine. Although having the merits of compactness and lightness, and generally that of cheapness, which render it admirably adapted to certain requirements, the rotary is in comparative infancy; and hence, while, in the future, inventors will unquestionably seek to augment its advantages, at present their efforts are more particularly directed toward overcoming the practical difficulties which militate against its employment to an equal extent with its older rival.

Fig. 2



The principal obstacles to be surmounted, as we have before remarked in referring to engines of this class, are those in the way of using steam expansively with a variable cut-off and without undue clearance, and also in the reduction of frictional loss to a minimum by prevention of wear and by perfect equilibration of working parts. These, by proper means, once overcome, it is clear that an advance of no small importance will be effected, and an engine produced manifestly capable of coping with the best reciprocating machines of equal power, as regards durability, efficiency, and in point of economy of fuel.

The inventor of the device, to which in the following description we propose particularly to refer, has, he states, conceived the same with a full knowledge of the matters wherein the older forms of rotary engines have been found wanting. How he has succeeded in avoiding such difficulties is a subject for the intelligent judgment of the reader; though it is a matter of regret that the short period which has elapsed since the completion of the invention, has precluded the making of necessary competitive trials, and the consequent formation of opinion upon a basis other than that afforded by a careful examination into the construction and general operation of the machine.

Fig. 3 Fig. 5

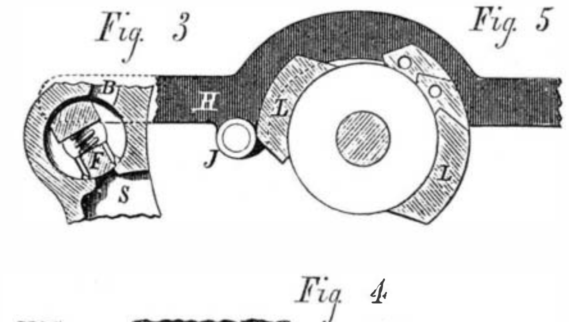
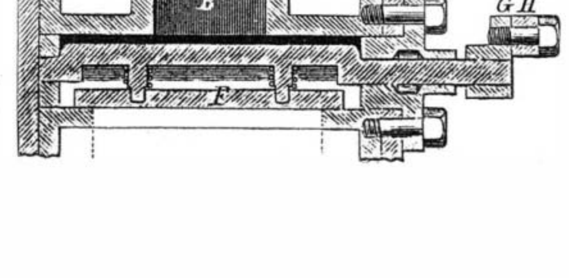


Fig. 4



Referring to the foregoing engravings in illustration of our subject, Fig. 1 affords an excellent idea of the exterior appearance of the engine, and the smaller drawings, Figs. 2, 3, 4, and 5, relate to especial parts which will be adverted to as we proceed.

The concentric cylinder or casing, A, is bored out smoothly to form a perfect circle within, and is pierced at either side with induction ports, B, Figs. 2, 3, and 4, which extend across the rim, forming narrow slits of about half an inch in width. At C, Fig. 2, are shown the exhaust openings, of which there are four, two on each face, and which together aggregate in area four times that of the induction ports. A steam jacket, represented in section in the upper portion of Fig. 2, incloses the top of the case so that the steam, entering by the pipe from above, is supplied to both induction ports at once. The exhaust passes through the openings above noted, into annular chambers, and thence exits by the pipes, D.

A E, Figs. 1 and 2, are the steam chests communicating with the jacket and containing the valves, F, the form of the latter being more clearly shown in Fig. 4. It will be here observed that the two parts of the valve are separated by springs, and that the outer part is made in the segment of a circle (see section in Fig. 3) to fit the chamber, against which the springs hold it. The valve journals are arranged as shown, one resting in the cover and the other passing through and terminating in a short crank, G. The construction is of course the same in both valves.

Between the cranks, G, extends a horizontal bar, H, Fig. 1, the portion of which passing over the shaft is shown in Fig. 5. On this bar is a small projecting roller, J, and formed on its inner side are other projections. The lug on the left side of the bar, or that nearest the reader, is perforated and travels on a horizontal screw-threaded bar, secured to the head of the casing. Also inclosing this bar is a spiral spring, K, which presses against the lug. On the opposite side of the bar, H, another projection, not shown, also travels on a screw-threaded rod held in fixed standards, on which, however, are nuts which can be turned forward or back on the screw so as to limit the play of the projection and consequently the horizontal movement of the bar, H, to which the latter is secured. On the shaft of the engine is a disk, L, Figs. 1 and 5, shown in the former figure just in rear of the governor pulley, on which are formed two cams which, in the revolution of the disk, press upon and push aside the roller, J. The motion of the valves is therefore governed as follows: Rotating the disk throws the roller, J, to the left; the spring, K, is consequently compressed by the lug on the bar, H, being carried against it. As soon, however, as the cam pressure relaxes, the spring acts and, by its recoil, throws the bar over in the opposite direction, so that by this means the cranks, G, and the valves attached thereto, are moved. Referring now to Fig. 5, on the left side of the right hand cam will be noticed a number of additional pieces. These are movable blocks bolted on and easily adjustable, which serve to increase the length of the cam so as to control the points of time of opening the valves and admitting steam. When it is desirable to cut off earlier, with reference to the revolution of the drum within, more of these blocks are added; and when a more continuous supply of steam is needed, some are removed. The ready manner in which the cutting off can thus be regulated is, we think, an ingenious and novel improvement.

Through the action of the lug and nuts on the right of the bar, H, in governing the horizontal play of the latter, it is clear that the apertures of the induction ports are also thus regulated, for necessarily, if the cranks, G, are carried over a shorter distance, the valves are moved over diminished space. By this means the induction orifices can be arranged to admit steam to their full capacity, or to allow it to enter in the thinnest possible sheet, so to speak, in accordance with the power and work required of the engine. The same device can also be made to afford an extremely sensitive variable cut-off, by connecting the governor with a movable wedge which will thus, by entering more or less, shorten or lengthen the play of the bar, H, and thus automatically control the valves in their motion over the very narrow ports. These changes, the alteration of the cams and the nuts on the sliding bar, it should be noticed, are all easily accomplished in a moment, from the fact that the parts are outside the machine, and hence directly at the hand of the engineer.

In Fig. 2 the interior arrangements are clearly depicted; M, the revolving drum, is secured to the shaft, and its length is very nearly that of the case, so that its ends when rotating are in such close approximation to the latter that steam is prevented from passing between. The weight of this drum is such and it is so constructed as to act as a balance wheel with equal momentum throughout its entire revolution. The pistons, N, and abutments, O, against which the steam presses, are located in the space between the drum and cylinder. The pistons, N, are hinged by their cylindrical ends in projections, P, screwed to the drum, which form sockets. From these extremities the pistons are flattened for a certain distance, sufficient, when at a proper angle, to cause them to close the space. Their width is such as to permit their front or loose ends to extend across and completely fill the said space, while their extremities enter slots formed in the drum. These slots are provided with shoulders, at Q, which the flanged ends of the pistons take against, so that when the latter are lifted by the springs, R, under them (which are made only just strong enough for such purpose) or by steam entering beneath, they will be caught and prevented from being forced up so as to cause undue friction between their upper surface and the inner periphery of the cylinder. The wearing edge of each piston is faced with steel, as indicated by the dotted lines, the plate being screwed on and easily removable. In order to obtain access to this part of the engine for alteration or repairs, it is only necessary to remove the head of the cylinder and draw the pistons laterally from their positions by hand, an operation very quickly and easily performed.

The abutments, O, fixed on the case are arranged similarly to the pistons, their movable ends entering slots, S, and steam passing along their outer sides. It will be observed that the pistons come under these abutments, so that each moves through one half the space between the drum and cylinder, while they laterally entirely and closely occupy the chamber. All jar and consequent wear due to sudden contact is ingeniously obviated by a nice arrangement of working parts; thus, supposing the drum to turn from right to left, the abutment, O, is first met by the inclined projection, P, which slides under and is prolonged by the flat portion of the piston, N, which is followed by another inclined projection, T, secured to the drum. By this means the parts which travel under the abutment are inclined planes, which readily slide by without jar. Similar arrangements, it will be noticed, are provided in connection with the abutments to prevent sudden contact of the pistons with the cylinder.

The operation of the engine can now be easily comprehended. Steam entering at the top passes through the jacket, thence through the ports, and thence, entering the cylinder, actuates the drum. In Fig. 2 the pistons are shown near the end of the stroke. Before their faces have reached the exhaust ports, the valves will have closed, thus cutting off the steam while the pistons are passing the abutments. The exhaust ports being open, the moment the faces of the pistons pass their edges the steam exhausts.

It remains, in conclusion, to sum up the advantages of the machine, as claimed by the inventor. Of these the principal is a positive equalization of steam pressure, on all sides of the drum, at all times and at every point of its revolution, so that frictional wear is reduced to its lowest point for the main shaft and journals. The drum is balanced by the steam, and hence its oscillation is prevented. In proof of these assertions the inventor, in our presence, caused an engine of some thirty horse power to start and operate under a steam pressure of less than half a pound. From further trial of the machine at the Ridgewood Works of Mr. C. P. Ladd, of Bloomfield, N. J., where it was built, we may add we were favorably impressed with its construction and operation; but of course, in the absence of complete tests and calculations as to power, etc., we are unable to speak, with such certainty as we should desire, of its probably high efficiency.

Further points of advantage may be briefly stated as follows: Cheapness, as all the parts are simple lathe work, strictly circular, or else have flat and straight edges easily planed; compactness; economy of fuel, because the driving power is always at the same leverage from the center of the main shaft, and, through the cam, steam may be employed expansively to any extent compatible with length of stroke or size of engine, according to the horse power required for the work to be done; simplicity and ready accessibility of working parts; practically no appreciable clearance; capability, from its plane surfaces, of being packed as readily as a reciprocating engine; lastly, and especially claimed by the inventor, owing to the machine being concentric and the steam space being uniformly the same, the amount of steam used can be cubically calculated so as to institute a comparison between this and the reciprocating engine as to bulk of steam used and power developed. There are other matters, mostly of theoretical nature, also claimed to prove further advantage, but owing to lack of space we are obliged to omit their consideration.

Patented July 23, 1872, by Colonel E. P. Jones, one of the Commissioners to the Vienna exposition from Mississippi. For further particulars regarding proposals for construction, rights, etc., address the manufacturers, the Baltimore Concentric Engine Company, General Wade Hampton, President, care of Carolina Insurance Company, Baltimore, Md.

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FRICTION OF WATER IN PIPES.

In a perfectly straight and smooth pipe, the quantity of water that will be discharged in a given time depends only upon the head. The velocity of the water will be that acquired by falling through the given head, and the quantity discharged will be the velocity multiplied by the cross section of the pipe. Algebraically, these results will be expressed as follows: $v^2 = \sqrt{2gh}$, and $Q = v \times S$, where v is the velocity in feet per second, h the head in feet, Q the number of cubic feet discharged per second, g the velocity acquired by a body in falling one second, and S the cross section of the pipe in feet.

In practice, it is found that the actual velocity with the smoothest pipes made is much less than the theoretical, part of the head being taken up in overcoming the resistance of friction. In the case of curved pipes, there is another loss of head, and consequently of velocity, at each bend. Numerous experiments have been made to determine the amount of this frictional resistance, and formulas have been constructed from the results. These formulas should always be checked by actual experiment, when great accuracy is required, as the results are greatly altered by seemingly unimportant details. Our object, in this article, is to give the best and simplest formulas for general use. Very good tables, showing the amount of water discharged under different heads from pipes of various diameters and lengths, will be found in Trautwine's "Engineer's Pocket Book."

For smooth iron pipes, Prony's formula is as follows: $h = 0{\cdot}00040085 \times L \div d[(v + 0{\cdot}15412)^2 - 0{\cdot}02375)]$, which may be thus translated: To find the necessary head of water to produce a given velocity of discharge, add 0·15412 to the velocity, square the sum, subtract 0·02375, and multiply the difference by 0·00040085 times the length of the pipe divided by the diameter, noting that all dimensions are to be taken in feet.

In 1858, some very interesting experiments were made by the Brooklyn Water Commissioners to determine the friction in pipes, the pipes experimented upon being very much corroded by long use; and, from the data so obtained, Prony's formula was modified to meet this case. The formula constructed from their experiment is: $h = 0{\cdot}00046749 \times L \div d(v + 0{\cdot}397)^2$, or: To find the head corresponding to any required velocity, add 0·397 to this velocity (expressed in feet per second), and multiply the sum by 0·00046749 times the length of the pipes divided by the diameter, in feet. For ordinary use, a much simpler formula, by Mr. Lane, will answer: $h = 0{\cdot}00025 \times L \div d \times v^2$, or: The required head equals the square of the velocity multiplied by 0·00025 times the length, divided by the diameter of the pipe, all measurements being taken in feet.

Knowing the actual head required for any velocity of discharge, we can readily ascertain the head required to overcome friction, and consequently the increased pressure necessary, in pounds per square inch. Thus, the theoretical head (disregarding prejudicial resistances) necessary to produce a given velocity is found by dividing the square of the velocity by 64·4; or, expressed algebraically, the formula is $h = v^2 \div 2g$, and the difference between the actual and theoretical head is the amount required to overcome friction. The pressure per square inch required to overcome this friction is equal to the weight of a column of water of one inch cross section, and with a hight equal to the ascertained head.

In order to render the preceding remarks more intelligible, we will assume data and work out an example by each formula. Length of pipe = 100 feet, diameter of pipe = 3 inches. Required velocity = 2 feet per second. By Prony's formula:

Required head $= 0{\cdot}00040085 \times 100 \div {\cdot}25 \times [(2 + 0{\cdot}15412)^2 - 0{\cdot}02375)] = 0{\cdot}74$ feet.