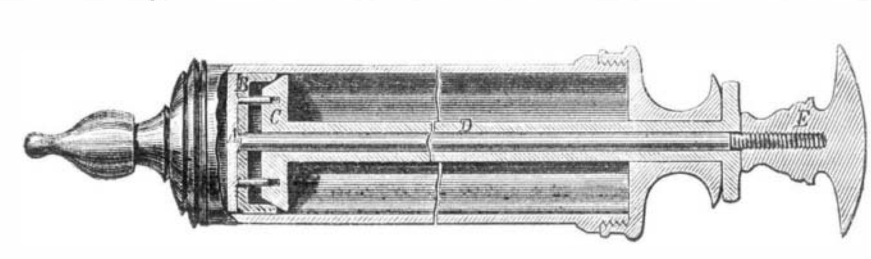
IMPROVED EXTERNALLY ADJUSTABLE PACKING FOR PISTONS.

The great difficulty which has always attended the use of pistons is that of keeping them tight. Exposed to constant friction the wear is great, and in addition to this, if soft packing be employed, the result of the friction is to condense its texture and impair its elasticity. Hence the piston which fits the cylinder accurately to-day, must, unless re-adjusted, fit it less accurately to-morrow.

In the use of pumps, syringes, etc., it has been necessary to rearrange frequently the packing, for which purpose it was necessary to take off the head of the cylinder, and often to remove the piston.

By means of the invention, shown in the accompanying engraving, this necessity is avoided, the expansion of the packing being effected without opening the cylinder, by simply turning a nut at the outer end of the piston rod.



The engraving represents the invention as applied to a common syringe, but, with slight modifications in the details, it is applicable to all classes of pistons.

The piston, A, is provided with a cup leather packing, B. This cup leather is expanded by a conical head, C, attached to a sleeve, D. The turning of the knob, E, presses the head, D, down into the cup leather, or relieves it from pressure, according as the knob is turned to the right or left. We need not dwell on the means necessary to adapt this principle to pumps, steam engines, etc., as they will readily suggest themselves to all mechanics.

Under the present system when the leakage of the piston becomes too great to be tolerated any longer, the cylinder is opened and the packing re-adjusted. This requires a considerable outlay of time and labor, and to avoid the necessity for its immediate repetition the piston is packed about as tightly as possible. This results in considerable loss of power by friction, which gradually diminishes until it is succeeded by gradually increasing loss by leakage. Thus friction and leakage alternately operate against economy of power.

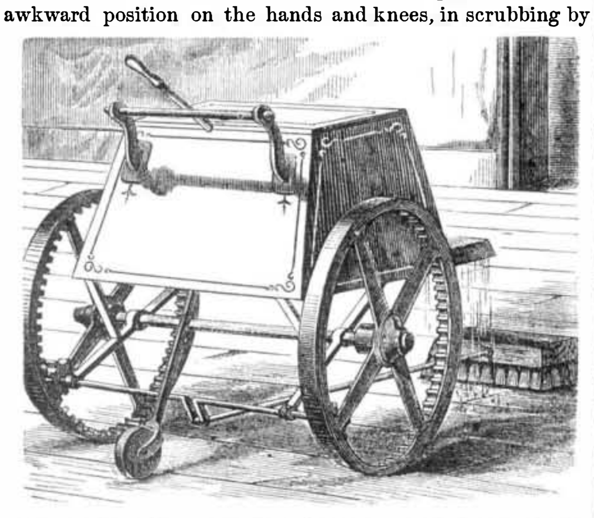
By means of this device it is easy to expand the packing from day to day precisely to the extent required without causing any unnecessary pressure upon the interior of the cylinder. There need therefore be no loss by leakage on the one hand or by unnecessary friction on the other, to say nothing of the time involved in removing the head of the cylinder.

In syringes and pumps in which soft packing is employed an interval of a few days without use is almost certain to be followed by such a shrinking of the packing as to require considerable trouble to get the piston to work. By means of the improved piston this annoyance is entirely overcome. A single turn of the nut renders the packing, however dry and shrunken, perfectly tight.

Patent allowed through the Scientific American Patent Agency, and will issue next week to A. H. Smith. For particulars apply to W. H. Wells, 948 Broadway, New York.

SCRUBBING MACHINE.

Mr. Andrew Irion, of Femme, Mo., has invented a scrubbing machine, of which our engraving is a representation. A tank containing the water made alkaline by soda or soap, is arranged on wheels, as shown. The wheels have teeth on the interior of their rims, which gear with a pinion on a crank shaft, from which motion is communicated through a connecting rod to a large scrubbing brush. The water is sprinkled upon the floor in advance of the brush, the flow being controled by a valve actuated by a hand lever. In use, the hands grasp a horizontal bar, attached to the tank by brackets, and the machine is rolled over the floor or sidewalk to be scrubbed, which imparts a rapid reciprocating movement to the brush. The substitution of the erect posture for the awkward position on the hands and knees, in scrubbing by



hand, renders the work far more easy and cleanly to the operator; and, as a consequence, the work may proceed with greater rapidity. In the cleansing of large open floors, this machine may be used to advantage.

THE disastrous war in Europe has given great impetus to some of our fancy manufactures, as we are now prevented from obtaining French goods. The change is especially noticeable in the artificial flower trade. The annual consumption of these apparently trifling articles is estimated to reach $16,000,000, and the employment to women and girls it affords is a most important consideration.

Spurious Metallic Filling for Teeth.

One of the refinements of the art of deception is described in the following passage, for which we are indebted to the *Dental Cosmos*, of Philadelphia:

"A man called upon the doctor to have a tooth extracted, as he had pain all over the right side of his face, which he located in one of the molar teeth, that had apparently a very nice gold filling. The patient was dismissed without extracting the tooth, as the doctor thought that the pain was due to neuralgia, caused by something else, and treated him accordingly. The patient called again the next day, saying the tooth must come out, as it pained intensely. It was extracted, but no relief was afforded. He called on the following day, and desired to have other teeth removed. The molar tooth that had been extracted was broken open, and found to have been half filled with tin foil and finished with gold. The other fillings were then taken out of the remaining teeth, and found to have been in the same condition, thus making a galvanic battery. The patient was sent to a good dentist to have these fillings renewed with gold. Immediate and permanent relief was obtained."

The name of the ingenious dentist is withheld; had it not been we would have given him and his deeds a most undesirable publicity.

PERPETUAL MOTION.

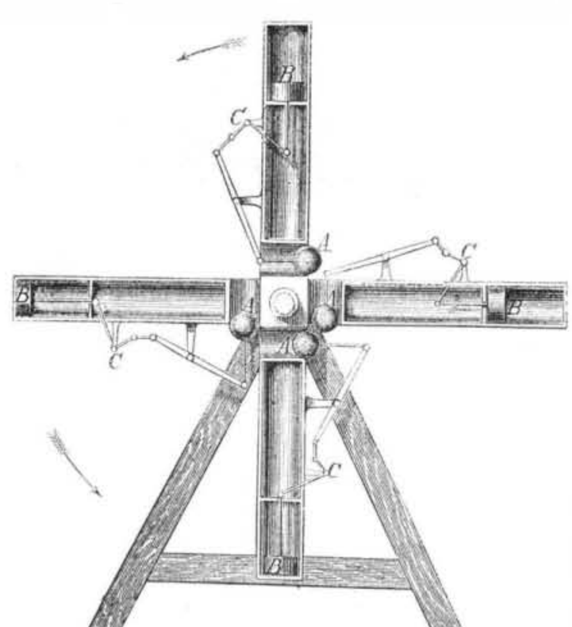
NUMBER X.

CARNOT'S OPINION OF PERPETUAL MOTION.

The celebrated physicist and mathematician, Carnot, has given his opinion on "perpetual motion," as follows:

From what we have observed regarding friction and other passive forces, it may be inferred that perpetual motion is a thing absolutely impossible, when only such bodies are employed as are not acted on by motive power, or any heavy body; for, as these passive forces, which cannot be avoided, are constantly resisting, it is evident that the movement must continually abate; and, from what has been said, it will be seen that, when bodies are not acted on by motive power, the sum of active force will be reduced to nothing; that is to say, that the machine will be brought to rest when the amount of activity absorbed by friction, since the commencement of the movement, will have become equal to one half of the initial active force; and when the bodies are weights, the movement will terminate when the amount of activity absorbed by the friction equals one half of the initial active force; moreover, one half of the active force existing, if all the parts of the system have a common speed, equals that which is due to the hight of the point where, in the first instance of the movement, was the center of gravity above the lowest point to which it can descend.

FIG. 22.



It is easy to apply the same reasoning to constructions where springs are used, and generally to all such constructions where, abstracting from friction, the moving force, in order to bring the machine from one position to another, must consume an amount of activity as great as that which is absorbed by the resisting forces when the machine returns from the last to the previous position.

The movement will terminate still sooner, if any percussion takes place, as the sum of active force is always diminished in such cases.

It is therefore evident, that one must altogether despair of producing what is called the perpetuum mobile, if it be true that all the motive powers existing in nature consist in nothing but attraction, and that it is a general property of this power to be always equal at equal distances between given bodies; that is to say, to be a function that only varies in cases where the distance of these bodies varies itself.

This opinion may be appropriately followed by that of Dr. Lardner, given in the following extract:

There is no mechanical problem on which a greater amount of intellectual ingenuity has been wasted, than that which has for its object the discovery of the perpetual motion. Since this term, however, is not always rightly understood, is will be useful here to explain what the perpetual motion it not, as well as what it is.

The perpetual motion, then, which has been the subject of such anxious and laborious research, is not a mere motion which is continued indefinitely. If it were, the diurnal and annual motion of the earth, and the corresponding motions of the other planets and satellites of the solar system, as well as the rotations of the sun upon its axis, would be all perpetual motions.

To understand the object of this celebrated problem, it is necessary to remember that, in considering the construction and performance of a machine, there are three things involved: 1st, the object to which the machine gives motion; 2d, the construction of the mechanism; and 3d, the moving power, the effect of which is transmitted by the machine to the object to be moved. In consequence of the inertia of matter, the machine cannot transmit to the object more force than it receives from the moving power; strictly speaking, indeed, it must transmit less force, since more or less of the moving force must be intercepted by friction and atmospheric resistance. If, therefore, it were proposed to invent a machine which would transmit to the object to be moved the whole amount of force imparted by the moving power, such a problem would be at once pronounced impossible of solution, inasmuch as it would involve two impracticable conditions: first, the absence of atmospheric resistance, which would oblige the machine to be worked in a vacuum; and second, the absence of all friction between those parts of the machine which would move in contact with one another.

But suppose that it were proposed to invent a machine which would transmit to the object to be moved a greater amount of force than that imparted by the moving power, the impossibility of the problem would in this case be still more glaring; for, even though the machine were to work in a vacuum, and all friction were removed, it could do no more than convey to the object the force it receives. To suppose that it could convey more force, it would be necessary to admit that the surplus must be produced by the machine itself, and that, consequently, the matter composing it would not be endowed with the quality of inertia. Such a supposition would be equivalent to ascribing to the machine the qualities of an animated being.

But the absurdity would be still greater, if possible, if the problem were to invent a machine which would impart a certain motion to an object without receiving any force whatever from a moving power; yet such is precisely the celebrated problem of the perpetual motion.

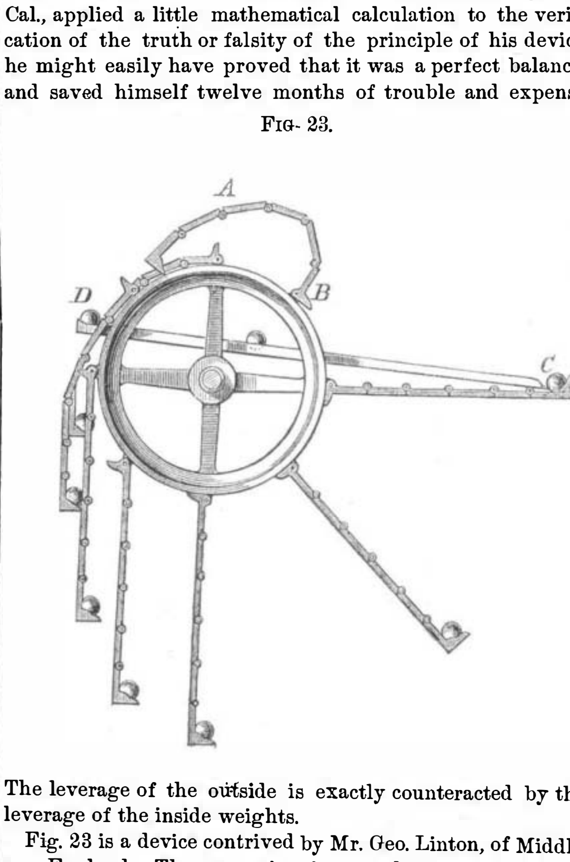
In short, a perpetual motion would be, for example, a watch or clock which would go as long as its mechanism would endure, without being wound up; it would be a mill which would grind corn, or work machinery, without the action upon it of water, wind, steam, animal power, or any other moving force external to it.

It is not only true that such a machine never has been invented, but it is demonstrable that so long as the laws of nature remain unaltered, and so long as matters continue to possess that quality of inertia which is proved to be inseparable from it, not only in all places and under all circumstances on the earth, but throughout the vast regions of space to which the observations of astronomers have extended, the invention of such a machine is an impossibility the most absolute.

Fig. 22 is a drawing of a supposed perpetual motion, which the inventor says will not go, though he has worked at it twelve months. He has now given it up in despair, and vows he will waste no more time upon it. The central weights, A, each weigh one fourth more than the weights, B, at the extremities of the arms. The two sets of weights are connected pairs, each pair being joined by a lever, link, and bell crank, C. The action of gravity in the central weights compels the sliding weights at the ends of the arms to assume the positions shown in the engraving.

Had our correspondent, Mr. Geo. C. Phillips, of Alleghany, Cal., applied a little mathematical calculation to the verification of the truth or falsity of the principle of his device, he might easily have proved that it was a perfect balance, and saved himself twelve months of trouble and expense.

FIG. 23.



The leverage of the outside is exactly counteracted by the leverage of the inside weights.

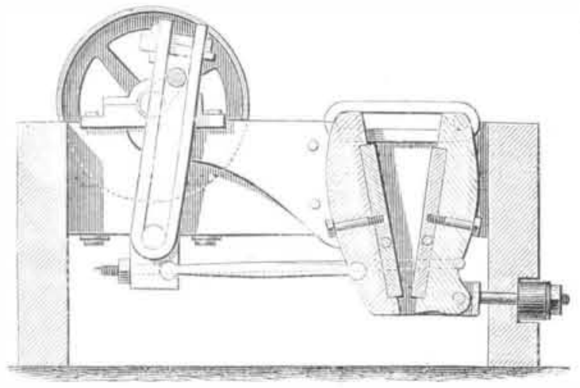
Fig. 23 is a device contrived by Mr. Geo. Linton, of Middlesex, England. The engraving is an end view of a series of vertical wheels, one only being seen. The lever, A, is represented in the act of falling from the periphery of the wheel into a right line. The lever is composed of a series of flat rods, connected by ruler joints, which said ruler joints are provided with a stop, or joggle, to prevent their collapsing at any time more than will bring any one of the rods which compose the levers at a right angle with the rod next to it. This lever is attached to the periphery of the wheel by the hinge joint, B, provided with the shoulder, to prevent its falling into any other than a right line from the center of the circumference of the wheel. The levers are furnished at their outer extremities with a bucket, or receiver, the bottom of which is sufficiently broad to retain the ball, C. The balls remain in the buckets till the buckets come into the position of the lever, D, when they are expected to roll out of the buckets on to the inclined plane, and by their own gravity roll to the other end of the inclined plane, ready to be again taken into the buckets.

QUARTZ CRUSHER.

In machines designed for breaking stones, crushing ores, etc., simplicity is absolutely essential. Pride and poverty are fully as congenial as rude work with complication in mechanism. The parts of such machines should therefore be few and massive, and be so put together thas even common laborers may be able to keep them in running order.

Messrs. Varney & Rix, of San Francisco, Cal., have patented a machine which seems, so far as simplicity is concerned, to answer the requirements of the case.

Our engraving is a representation of this machine. The power is transmitted from cranks on the shaft of a heavy fly wheel through a system of powerful links, or toggle bars,



to pivoted jaws, which thus approach each other with great force at each revolution of the fly wheel, compressing the quartz and thus crushing it. The general principle of the mastication of food by the jaws of animals is very nearly approached in this machine.

ACTION OF THE RECIPROCATING PARTS OF STEAM ENGINES, AND ITS INFLUENCE ON THE PROBLEM OF HIGH PISTON-SPEED.

Read before the Polytechnic Club of the American Institute, by Chas. T. Porter.

Your attention is invited to a proposition, which, on its bare statement, will probably strike many persons as absurd. It is, that a reciprocating engine is, with respect to the line of centers, identical with a rotary engine; reciprocation is, in the line of motion, identical with rotation; the reciprocating parts of an engine, at the instant when the direction of their motion is reversed, exert a force, which is precisely the same centrifugal force that would be exerted by them continually if they were revolving with the crank; so that reciprocation may properly be defined to be rotation in a straight line.

I am well aware that the doctrine that the reciprocating parts of an engine exert a force on the dead centers where they are at rest, when their motion in one direction has ceased and that in the opposite one has not yet begun, is rank heresy; as much so as was once the assertion that the earth revolves on its axis. It is, however, equally true. The demonstration of it is quite simple, and I do not doubt that at every step I shall have your entire and cordial concurrence. If we find ourselves on ground not before trodden, we shall nevertheless be sure that it is firm and solid ground.

It may be observed here, that the action which we are to investigate has no *necessary* connection with high piston-speed. Although it is what makes rapid speed practicable, and although a correct understanding of it wholly removes any theoretical objection to the employment of such speed, still it takes place at all speeds, varying only in the amount of centrifugal force developed, according to the law of central forces, namely: directly as the mass, directly as the diameter of the circle when the number of revolutions is constant, inversely as this diameter when the velocity is constant, and as the square of the speed in a given circle.

We know that the motion of a piston controlled by a crank is not uniform, but, commencing from a state of rest, it becomes at the mid stroke slightly in excess of that of the crank-pin, and at the termination of the stroke has been reduced back to nothing. In giving the piston-speed of an engine, we always name its mean speed, found by multiplying the length of the stroke, in feet, into the number of strokes made per minute; but the speed attained at the middle of each stroke is about 57 per cent greater than this, having the same relation to it that the semi-circumference bears to the diameter of a circle.

Let us take, for illustration, the case of a horizontal engine, of 16 in. diameter of cylinder, by 30 in. stroke, the reciprocating parts of which weigh 1200 lbs., and which makes 122·3 revolutions per minute. The mean piston-speed is 611·5 feet per minute, while that reached at the middle of each stroke is 960 feet per minute, or 16 feet per second.

The first question requiring to be answered is: What is the amount of accelerating force, constantly exerted through a distance of 15 inches, that is required to impart to a body of 1200 lbs. weight a velocity of 16 feet per second? We suppose the motion to be without friction, and are inquiring only for the force required to overcome the inertia of the mass. The laws of falling bodies will furnish the answer to our question.

The motion being horizontal, gravity has no effect, either to produce or to destroy it; but a force of 1200 lbs., equal to the weight of these parts, would, by being constantly exerted horizontally through a distance of 16·083 feet, give to them a velocity of 32·166 feet per second, this being the velocity imparted by gravity to a falling body.

But what velocity would this force impart, by acting through a distance of 1·25 feet? The velocity acquired by a body accelerated by a constant force, varies as the square roots of the distances through which the force acts. Thus, a falling body, to acquire a double velocity, must fall through four times the distance, and to acquire five-fold velocity, it must fall through twenty-five times the distance; and so the force equal to their weight, acting through 1·25 feet, would impart to the reciprocating parts a velocity of 8·968 feet per second.

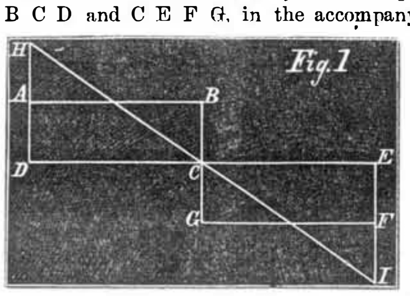
$$\frac{32{\cdot}166 \times \sqrt{1{\cdot}25}}{\sqrt{16{\cdot}083}} = 8{\cdot}968$$

But if 1200 lbs. will give a velocity of 8·968 feet per second, what force will be required to impart a velocity of 16 feet per second? The forces required to impart different velocities by acting through a given distance, must vary as the squares of the velocities imparted. Thus, to give to a body in moving through a distance of 16·083 feet, a velocity of 64·332 feet per second, or double that which gravity would impart, the accelerating force must be equal to four times its weight, and so the force required to impart to a body of 1200 lbs. weight a velocity of 16 feet per second by acting through a distance of 1·25 feet, is 3820 lbs.

$$\frac{1200 \times 16^2}{8{\cdot}968^2} = 3{\cdot}820$$

We have thus completed the first step in our demonstration. There can be no doubt that our piston, crosshead and connecting rod have attained a velocity of 16 feet per second, that this velocity has been imparted to them in moving through a distance of 15 inches, and that they must have been accelerated by a force, supposing it to have been exerted constantly, of 3820 lbs.

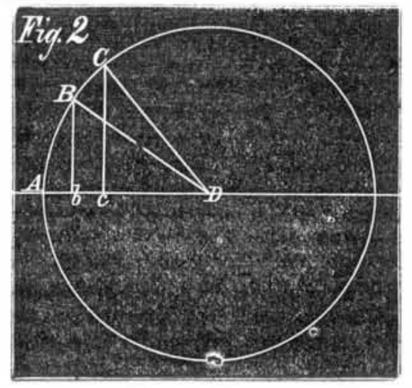
But it is obvious that the force accelerating the motion of a piston cannot be a constant force, because if it were so, then at the middle of the stroke, where acceleration ends, it must cease abruptly, and retardation must commence in the same manner, as would be illustrated by the two parallelograms, A B C D and C E F G, in the accompanying figure.



Now we know very well that, instead of this, acceleration passes at the mid-stroke into retardation, in a manner wholly insensible.

How shall this mystery be explained? There are various methods, more or less abstruse, of reaching the explanation, but there is one that is exceedingly simple, indeed so much so that it is surprising that engineers are not uniformly familiar with it. It is found by almost the mere inspection of the table of versed sines.

The motion of a piston, disregarding the effect of the angular vibration of the connecting rod, is equal to the versed sine of the angle which the crank forms with the line of centers. The versed sine of any angle shows, then, the motion of the piston from the commencement of the stroke. If we take the versed sine of any degree, and subtract from it that of the preceding degree, the remainder will represent the motion of the piston while the crank is moving through the last degree



Thus, in the above figure, while the crank is traversing the arc, A B, the piston is moving through a distance equal to A b, the versed sine of the angle, A D B, and so on.

The following table, which any one can complete, shows, in the first column, the versed sine, or total piston motion, for the first and last five degrees which the crank passes through while the piston is making a half stroke, and in the second column, obtained by subtraction as above, shows the motion for each one of these degrees.

The motion for each succeeding degree, of course, increases all the way, but in what ratio does it increase? This is the vital question. To answer it, we subtract from the motion for each degree that for the preceding one, and the difference shows the velocity imparted while the crank was moving through the last degree. In this manner we obtain the third column, showing at a glance the velocity imparted to the piston at each degree; and how wonderful is the revelation! The acceleration, at first nearly uniform, diminishes in an increasing ratio, which for the 90th degree is less than $\frac{1}{57}$ that for the first degree, and is just equal to the diminution in the acceleration for the 89th degree, showing how at the end of this degree it ceases altogether.

Degrees.	Versed sine, or total motion	Motion during each 1°.	Velocity imparted during each 1°.	Difference.
1	·0001523	·0001523	·0003046	
2	·0006092	·0004569	·0003046	0
3	·0013705	·0007613	·0003044	2
4	·0024359	·0010654	·0003041	3
5	.0038052	·0013693	·0003039	2
86	·9302435	·0173992	·0000265	
87	·9476640	·0174205	·0000213	52
88	·9651005	·0174365	·0000160	53
89	·9825476	·0174471	·0000106	54
90	1·0000000	·0174524	·0000053	53

The motion during the first two degrees seems to be uniformly accelerated; but if we should go to a sufficiently high place of decimals, we should find the acceleration absolutely greatest on the very dead center.

It will be interesting to compare this diminishing acceleration with the uniform acceleration of the motion of a falling body. The following table represents the latter; decimals are omitted for convenience, but this does not at all affect the table for the purpose of this comparison. The second and third columns are derived from the first by subtraction, in the same manner as above.

Seconds.	Total distance fallen through.	Distance fallen in each second.	Velocity in feet per second imparted during each second.
	ft.	ft.	
1	16	16	32
2	64	48	32
3	144	80	32
4	256	112	32
5	400	144	32
6	576	176	32

If now, at each degree, we draw an ordinate, perpendicular to the line of centers, and of a length proportionate to the acceleration at that degree, we shall find that a straight line connects all their extremities, showing the acceleration to be represented by the right-angled triangle, D C H, Fig. 1. This any one can verify.

It is thus revealed to us, that precisely on the dead center the acceleration of the piston's motion is double its mean acceleration, and the force required to produce it is twice that which would be constantly required; or, in the case we are considering, is 7640 lbs., equal to a pressure of 38 lbs. on each square inch of piston area.

The fact is so important, that it may be well to exhibit it also in another manner. We have seen that the motion of the piston is, for the first two degrees, accelerated in a manner which may be regarded as uniform. The distance moved through by a body uniformly accelerated, increases as the square of the time, as shown in the last table.

If, then, we take the coefficient of the motion for the first degree, ·0001523, and multiply it by the square of the number of degrees traversed by the crank in one second, we shall have the distance which the reciprocating parts would be moved in one second, at their original rate of acceleration, supposing it to be continued uniformly during that time, if the length of the crank equaled 1. This distance is 82·05254 feet, for the crank moves in one second through 734 degrees, and $734^2 \times {\cdot}0001523 = 82{\cdot}05254$. The length of the crank is, however, 1·25 feet, so that the distance moved through would be 102·5 feet. This distance, divided by 16·083, gives the quotient 6·37, which is the accelerating force in terms of the weight of the parts. But $1200 \times 6{\cdot}37 = 7644$, the same result as before.

The second point in our demonstration is now established that on the dead center, where motion begins to be imparted to the piston, it is imparted in double the average ratio, and the force required for this purpose is just twice as great as a uniform accelerating force would have to be, to give to it the velocity that it has at the mid-stroke.

The retardation of the motion of the piston by the crank, bringing it to rest at the end of the stroke, is the reverse of the acceleration, commencing insensibly at the middle, and culminating at the termination of the stroke, and is represented by the triangle, E, C, I, Fig. 1. This, to one who has clearly apprehended the acceleration, must be sufficiently obvious.

We are arrived now at our final proposition, that the resistance offered by the reciprocating parts to this alternate acceleration and retardation is, at its culminating point, the dead center, precisely the centrifugal force that the same weight would exert continually, if it were revolving with the crank pin.

Let us examine this action in the light that has now been thrown upon it. We will suppose the steam to be suddenly shut off, so that the acceleration, as well as the retardation, is effected through the crank. We note, first, this distinction, that while at the mid-stroke acceleration passes when diminished to nothing into retardation commencing at nothing; at the centers, on the contrary, retardation passes at its maximum into acceleration at *its* maximum. A closer examination shows, however, that while, in the first case, the direction of the force changes, in the latter it does not change. This direction must be reversed twice in each revolution, and this reversal takes place at the middle of each stroke, and not on the center. The crank begins, at each mid-stroke