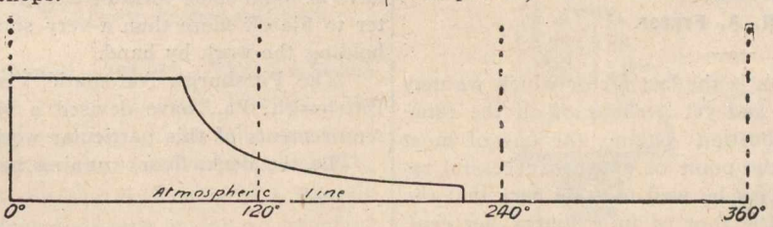
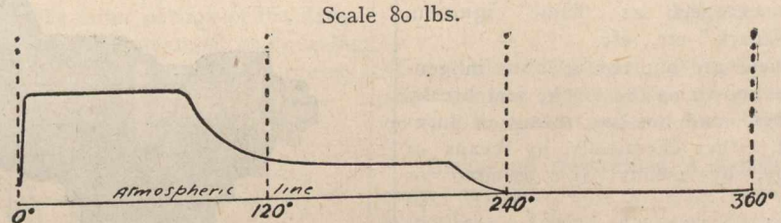
annular rings of copper, the outer circumference of the rings being anchored to the inside of the movable shells and the inner circumference clamped to the piston by clamping rings and screws. This gives a steam tight joint of great flexibility and allows the sides of the shells to be held against the cylinder heads by the steam pressure in the chamber. As the steam and friction may be readily proportioned to each other on the principle of a balanced valve, it will be seen that the packings on all points of wear are steam-controlled and that they will remain tight to the limits of wear; also that these limits are much greater than in the ordinary engine. The motion of the rolling piston is epicycloidal in all its parts, so that there is no wear on the cylinder wall, very little on the crank pin, which is fitted either plain or with roller bearings, and the motion of the shells rubbing on the cylinder heads will keep both shells and heads flat to the limits of wear. The shoes on the ends of the slides rub against circumference of the piston shells, but owing to the shape of the shoe, it is steam controlled, and the great latitude of motion in the pocket will keep it tight until worn to the point where renewal is necessary. These shoes are easily inserted. All curves are circular and all planes flat and right-angled, making them easy of renewal with limited facilities, as would be the case on shipboard, or in small ports with poor machine shops.



IDEAL CARD.
Scale 80 lbs.



ACTUAL CARD.

R.P.M. 400	M.E.P. 40.9
Steam 80 lbs.	I.H.P. 12.1
Spring 80 lbs.	Water 33.5 lbs. per I.H.P. per hour.

The friction surface is very small—much smaller than in any reciprocating cylinder engine,—and less than most experts would believe until they have calculated the epicyloid curves with due reference to the diameters of cylinder and piston in relation to the crank-throw. Having an actual crank in the cylinder, the side pressure of the steam is taken off the shaft and utilized in holding the piston against the cylinder walls, while any wear on the crank pin will not affect the working parts of the engine, as the piston is entirely controlled by the steam and the cylinder wall. The wear on the crank-shaft boxes is, therefore, less than in the reciprocating type of engine, as the shaft is not subject to the side thrust of the ordinary engine at the ends of the stroke. With one chamber exhausting, one with steam expanding and one taking steam at boiler pressure, or with two expanding, or in any other position, the resultant of the forces maintains the thrust always at right angles to the throw of the crank. The steam valve contains large flat surfaces and the valve seat and all moving parts of the steam cylinder are oiled by the oil carried in by the steam.

In starting, the engine takes steam at boiler pressure in two of the compartments at once, but as it gathers speed the cut-off reduces the angular opening of the steam admission valve until the cut-off attained is sufficient to carry the load at a given speed, after which the steam is used expansively, the reduced valve opening admitting steam to the various chambers in rotation. The shape of the chambers is such as to obtain the full pressure upon the surface of the piston with a very thin layer of steam, and there being no clearance, the economy in this direction is marked. The condensation is also very small, as the steam is filling the live, and exhaust sides of the cylinder heads, and the periphery is of such shape as to be easily jacketed. Compounding is simple and is accomplished by placing the additional cylinders side by side with the high pressure, with steam chests between them.

The simple engine, as shown, can be used condensing, and when so used the entire surface of the rolling piston exerts power to operate the crank shaft. The surface upon which steam pressure is exerted is equal to a plane whose length is the sum of the chords of the arcs of steam area, multiplied by the width of the cylinder, which gives a very large pressure surface to be acted on by a very thin layer of steam. The steam exerts a very gradual increase of pressure upon the piston, as the steam entry ports are close to the division walls, and as the point of contact rolls past the port the surface exposed to boiler pressure increases steadily until the point of cut-off is reached, when the pressure gradually decreases until the exhaust ports open, obviating the heavy blows caused by the steam striking the full surface of the piston of the ordinary reciprocating engine. The epicyloidal motion of the piston allows the chamber to enlarge considerably after the angle of one-third revolution has been passed, hence steam may be admitted at boiler pressure for one-third of a revolution, and then be used expansively for another third of a revolution. This is true of each of the three compartments in each revolution, so that there is a similarity to the triple cylinder engine, one compartment constantly taking steam at boiler pressure, one using it expansively, and the third exhausting. Hence as the area exposed to boiler pressure increases in one chamber, the preceding one decreases its pressure by expansion, thus maintaining a nearly constant pressure on the crank shaft.

The engine will start with full boiler pressure on two chambers and cut off as speed is attained: this gives by actual test, when starting, a pull of about four times the power used when running regularly. This is a particularly valuable feature of reversing engines.

The exhaust valve gives ample time to allow of the escape of steam and thus all liability of back pressure is avoided, as the steam has twice as long a time in which to escape as in the ordinary engine.

It shows an economical efficiency at speeds ranging from 20 to 2,000 revolutions per minute, and the same conditions exist under low and high pressure, ranging from 20 to 350 pounds per square inch. Having no dead centres, it will start under full load in any position, and is instantly reversible.

The cost of this engine, it is claimed, is only one-tenth that of a reciprocating engine of the same horse-power; and the weight per horse-power is about 5 pounds, a figure considerably lower than that for the reciprocating engine.

The inventor describes the principle of his engine in a very simple manner, as follows:—