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HISTORY OF THE OTTO - LANGEN ENGINE

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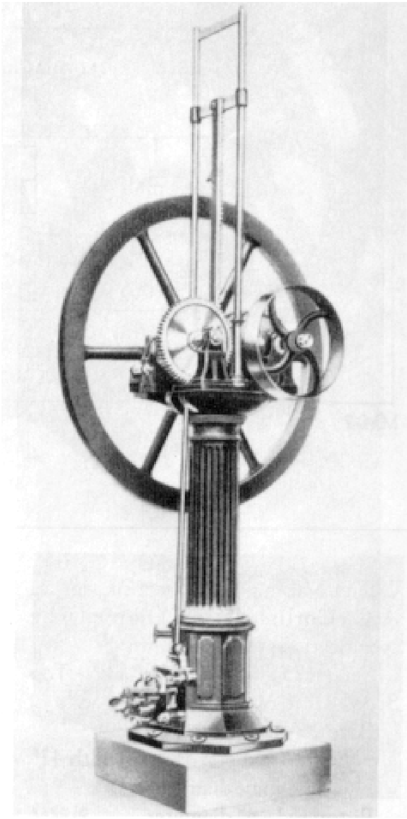
BACKGROUND

Probably the most historically significant engine ever in production was the Otto-Langen atmosphere engine, designed and produced by Nicolaus Otto and Eugene Langen between 1864 and 1878. It was an important stepping stone for the introduction of the 4 stroke cycle engine later developed by Otto in 1876. Several unique mechanisms appeared in this engine (see fig. #1). . Most famous was the overriding, or roller-wedge clutch that engaged only the downward movement of the piston and rack assembly, which resulted with the spinning of the main shaft and flywheel (see photo #2). Secondly, the free piston concept: where the piston movement was independent of the main shaft. As the engine fired, the piston was allowed to travel as far as the explosion carried it. The rack, connected to the piston in conjunction with a gear, housing the directional clutch, made this mechanical movement possible-similar to a rack and pinion gearing system engaging in only one direction. Use of a crankshaft was unnecessary with this system. Another mechanism was the noncontinuous rotating cam. Even though the camshaft itself spun continuously with the main shaft, the cam and follower only cycled at one revolution intervals, at such time the piston returned to its lowest point. As this happened, a spring loaded pawl engaged a ratchet, thus spinning the shaft. Nearing one complete revolution, a tail on the pawl caught a lever, disengaging it and ending the cycle. Slide valve operation and piston/rack lifting (for the intake stroke) were both controlled by this momentary operation.



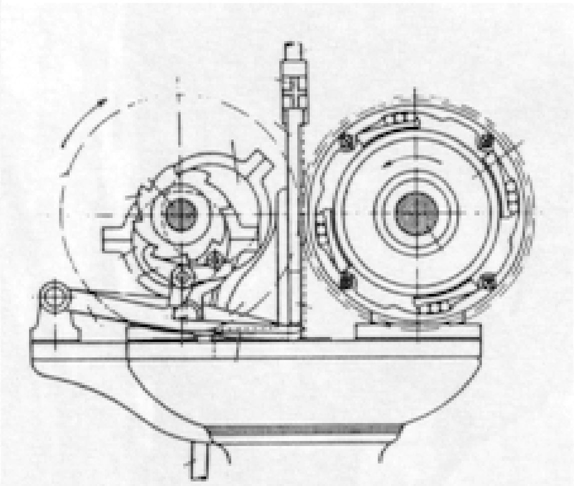


Fig. 1 (Left) Original style Otto-Langen engine shown at the Paris Exposition of 1867, utilizing vertical cross head rods and depicting the original patent.

Fig. 2 (Right): Overriding roller clutch cut away showing internal arrangement and relationship to the piston rack. The right shaft is the main power shaft containing the overrunning clutch. A Pawl and Ratchet can be seen with the followers on the left or cam shaft.

OPERATION

Otto-Langen atmospherics use a gaseous fuel for combustion and flame ignition in conjunction with a slide valve for ignition. The operational cycle of this engine develops its power from atmospheric pressure rather than from the explosion itself. Otto and Langen's cycle is neither 4 cycle, 2 cycle, sterling, nor any other common form of engine operation. This German based cycle is both noncompression as well as atmospheric. Gas and air are introduced into the cylinder by a vertical movement of the piston via a chamber contained within a flat sliding valve affair, under negative pressure conditions. At this point, the slide valve closes, capturing within it a flame (lit from an external pilot) to the cylinder, exposing it to the air-gas mixture. Compression of the air/gas mixture does not happen in this cycle, rather ignition occurs immediately after the intake of air and gas (hence the term, noncompression). Upon ignition, the piston rockets upward, with momentum carrying it beyond the expansion point of combustion, creating a substantial negative pressure or vacuum within the cylinder. At the apex of the piston's travel, atmospheric pressure, as well as the piston/rack assembly's weight, takes over pushing the piston downward for the cycle's useful power stroke of approximately the first half of its travel. Downward motion and energy of the piston is captured to the main shaft by means of the directional roller clutch contained within the main shaft gear, in which the piston's rack gear meshes. Remainder of the piston's downward movement creates a slight positive pressure within the cylinder. This positive pressure is released through an adjustable hand valve, located on the face of the slide valve assembly. Adjustment of this valve regulates speed of the engine. Restricting this outward exhaust flow retards the engine speed by slowing down the piston velocity for the last half of its downward stroke. As the piston approaches the cylinder bottom, a boss near the top of the piston rack depresses a lever, releasing the pawl that engages the cam shaft, revolving it for one revolution. With the cam now in motion, two important things happen. First, the piston/rack assembly is raised (about 1/10th of its stroke), and secondly the slide valve is raised exposing the cylinder inlet ports thus drawing in a mixture of air and gas. As the cam nears half of a revolution, the flame is reintroduced to the cylinder repeating the above cycle. (fig #3). Carburetion for this engine consists of merely an air port and a valved gas port both leading to an area adjacent to the inlet of the engine. As the slide valve raises, a chamber contained within it unites the air inlet, gas inlet and the cylinder opening together. Upward motion of the piston draws air and gas through the chamber into the cylinder.

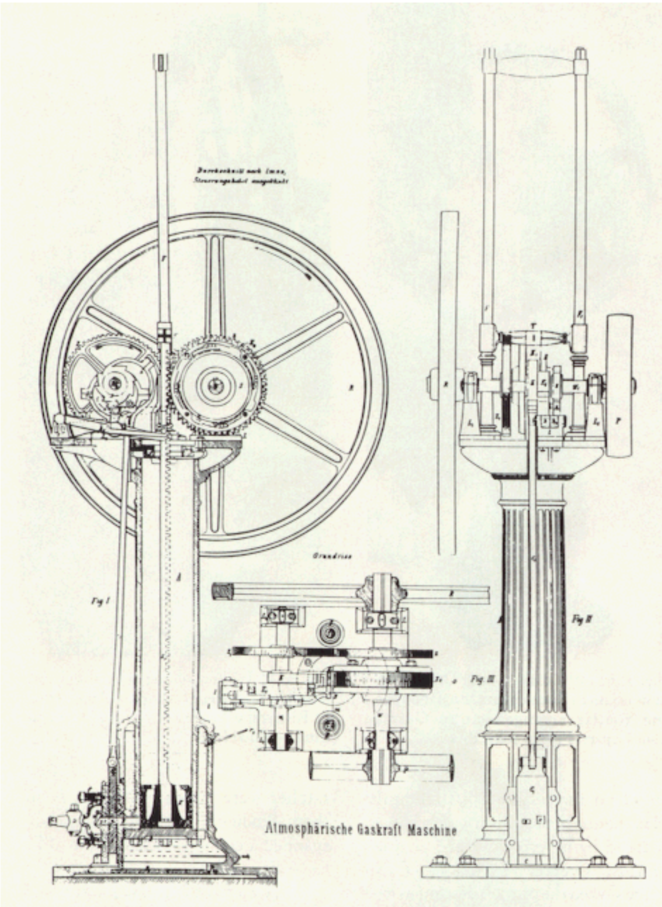


Fig #3 : Shown, a copy of the German Patent for the Otto-Langen Engine. (Only one existing with the exact configuration shown). Within the authors archives is an earlier unpublished patent drawing showing some very curious mechanical linkages that preceded the overrunning clutch.

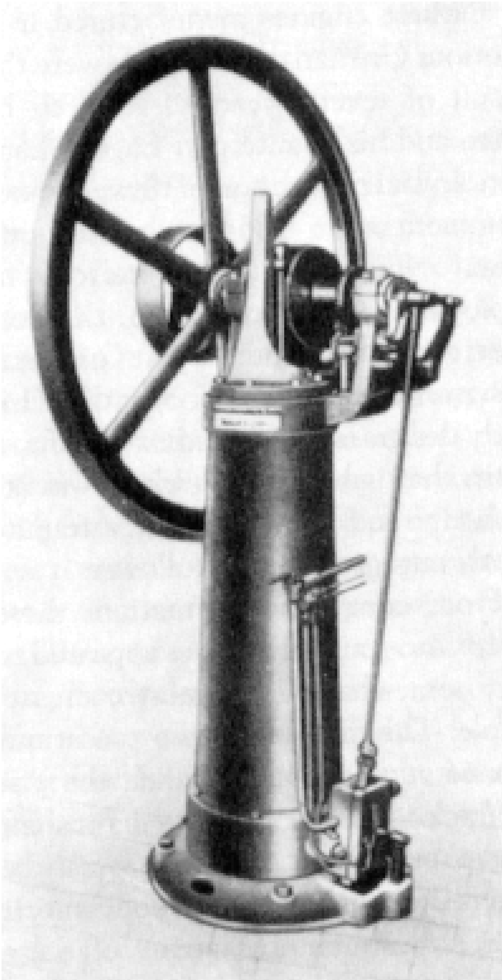
HISTORY

Earliest engines manufactured in a glorious Grecian ionic column style were the result of several years of research by Otto and his counterpart Eugene Langen. Initial production of these engines commenced in 1864 and continued until 1872 from their factory in Cologne, Germany. Langen, the cosmetic mastermind of the project, designed the Greek pillar cylinder. This early design incorporated two shafts, a main shaft which the flywheel was attached to and a cam shaft that intermittently engaged the cam followers. From compiled information, these early Otto-Langen engines appeared to vary somewhat with almost each example. The first couple used a precarious pair of vertical rods to guide the piston/rack assembly with the main shaft gear. Acting as a crosshead it can be assumed that this system was very prone to maladjustment by jarring of these rods. The most famous and important of the Otto-Langen examples incorporated this design; it was exhibited in the Paris Exposition of 1867 and was almost overshadowed by the Lenoir noncompression engine. Fortunately for the German duo, engines were judged by efficiency and performance. After several long tests, the grand prize was awarded to them. For its day it was the most efficient gas engine ever produced. None used less fuel per HP per hour, a consequence of the free piston, allowing unrestricted expansion of the gasses. Complete expansion utilizes more power from the expansion and allows for cooler operation. As strange as this engine appeared, not to mention its spastic running characteristics and reportedly loud operation, the beginning of its success started here. Some were produced with two slide valves, the second valve controlling incoming gas to the main slide valve. Later versions were manufactured without vertical "cross head" rods and incorporated a simple notched bar contacting the smooth side of the rack to maintain gear contact. Some versions had spoked gears, some had individual bearing pedestals, etc. All early units were built without governors.

A graceful engine, it was not. With a piston and rack assembly well in excess of 100 lbs. for the 1/2 HP unit, the descending piston hammering or pyle driving against the cylinder bottom raised havoc with buildings and foundations (a major disadvantage of the free piston concept). Taking this into consideration, as well as the weight and height, it is not surprising production engines never exceeded 3 HP. Technical books from the late 1800's make mention of the need for a good solid foundation under the engine. Second floor installations usually were inadequate. A 2 HP engine weighed in at a whopping 4,000 lbs. and stood an impressive 10 1/2 feet tall! Hammering of the piston was, however, reduced by a petcock at the engine's exhaust. Greater restrictions of this valve slowed the piston's descent as well as reducing the speed.

After several years of production, a less cosmetic, more mechanically developed version was offered (fig #4). The Grecian column styling was removed, as was as the cam shaft. However, a governor and improved overrunning clutch were added. A shorter, squattier machine was the newer concept. Governing of this engine was accomplished by means of a cam gear driven fly ball governor, interrupting the pawl from re-engaging the cam. This version is, in fact, the first internal combustion hit & miss engine. Many parts, such as the cam and followers, pawl and ratchet were relocated to the main shaft. Production of this later version spanned a course of 6 years from 1872 to 1878. Success of these engines was noted by many manufacturers. Crossley of the UK was one of these that managed to get its foot in the door. Patent rights were granted to this English company for the building of atmospheric engines, becoming the dawn of a world renowned engine manufacturer.

Initial examples from Crossley (their first attempt in engine construction), incorporated the use of a governor serving dual function. Exhaust gas restricting by a valve and interruption of the pawl engagement were both governor controlled. Resembling very closely the early German engines in mechanical layout and operation, the Crcssley, built Units had a smooth sided column without the added expense of casting a Greek column. Vertical Cross head rods were never used (Fig #5). Crossley, famous for its high quality products, made several improvements and design changes over the years resulting in many variations of the original concept. Even greater than the Otto-Langen deviation between existing examples, Crossley appeared to have spent extensive research on improving the pawl, slide valve and governing operation. During the approximate fifteen years of atmospheric engine production, Crossley built almost half as many engines as Otto-Langen. Total production of these engines by all manufacturers is estimated to be less than 5000.



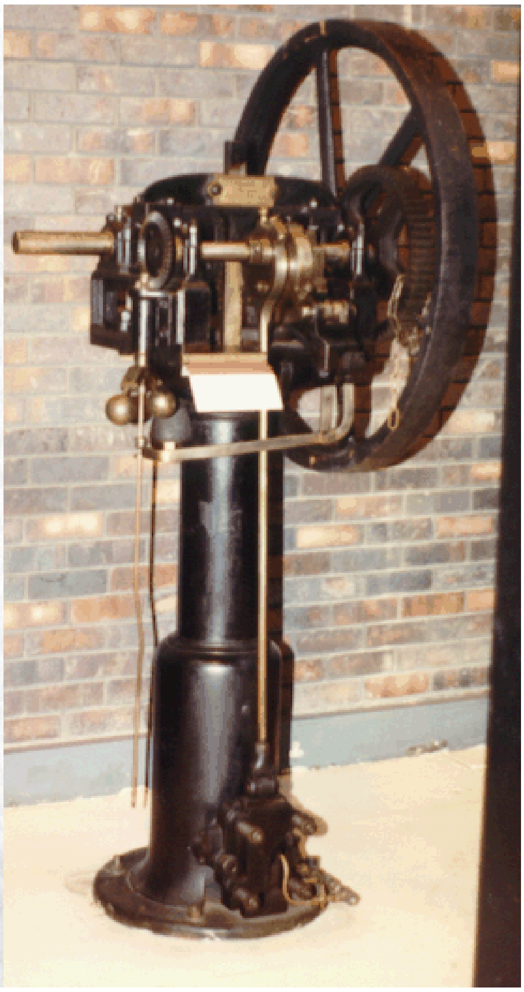


Fig. 4: (Left) Second generation Otto-Langen showing simpler construction, governor and redesigned slide valve assembly. (Original documentation)

Fig. 5: (Middle) 1/2 HP Crossley,built Otto-Langen at museum in Birmingham, England showing similar arrangement to German counterpart. Photo: John Rex.

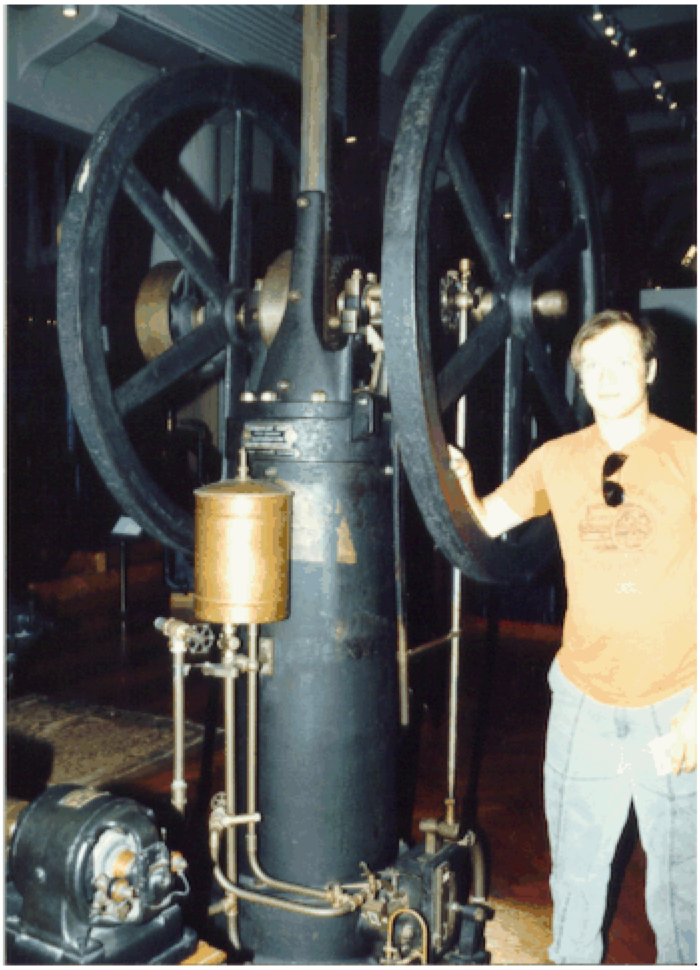
Fig. 6: 1/2 HP Otto-Langen at Rough and Tumble Engineers Historical Association of Kinzers, PA. One of the earliest of its kind worldwide. Photo: Author

TODAY

Today, a good estimate would be less than six examples of the original Grecian column Otto-Langen version survive worldwide, with only a couple in operating condition. Rough and Tumble at Kinzers, PA has the oldest Otto-Langen engine in North America, and perhaps the oldest internal combustion engine in the United States. Being an extraordinary example, it is comforting to know that each August at their annual show it is displayed in its full running glory (see fig. #6). This engine has been restored and is operated by John Wilcox. Its unorthodox operation, dual slide valve arrangement, and flame ignition attract crowds of people all day long.

It is most unusual to view engines of such importance anywhere. The fact that less than 5000 Otto-Langen engines were manufactured in all versions, 125 years ago, and in Europe, contribute to its rarity. Henry Ford Museum at Dearborn, Michigan has a Crossley-built engine of the 3 HP size. Although a static exhibit, its monstrous size, improved design and originality make it a most worthwhile exhibit (see fig #7). The Smithsonian Institution in Washington, D.C. has at least two examples, one being an earlier Crossley (fig #8) and the other a later Otto-Langen. Operational status of these two is not known. Several other examples appear in museums throughout Europe, where it is understood some are run on a regular basis.

An attempt was made here to give a brief overview of a great stepping stone for the 4 stroke-cycle engine used almost exclusively today. Information on the above was gathered through a multitude of books and sources. I would like to thank the following for their assistance: Rough and Tumble Engine Association at Kinzers; Woody Sins, New Hartford, New York; John D. Rex, Chelmsford, Massachusetts; William E. Worthington, Jr., Smithsonian Institution; John Bowdich, Henry Ford Museum.



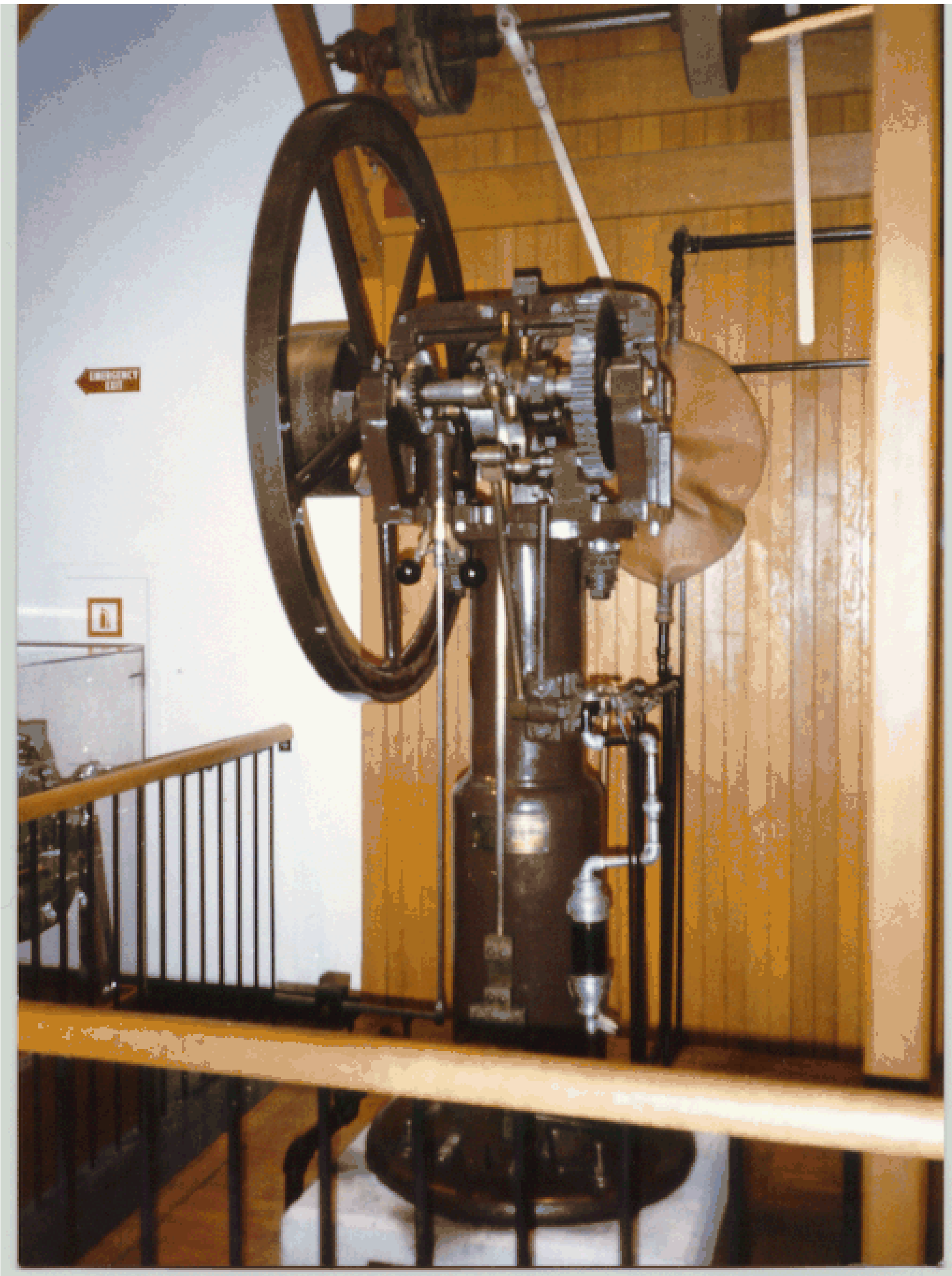


Fig. 7: (Left) 3 HP Crossley Otto-Langen, showing improved design, incorporating double flywheels, simplified construction. Author standing alongside to demonstrate the massiveness of this machine. (Author photo)

Fig. 8 (Right) Crossley Engine on display at the Smithsonian Institution in Washington DC. (Author photo)