THESIS

on

THE DESIGN OF AN AUTOMOBILE GASOLINE ENGINE

Submitted to the Faculty

of the

OREGON AGRICULTURAL COLLEGE

for the degree of

Bachelor of Science

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DESIGN OF AN AUTOMOBILE GASOLINE ENGINE.

In designing a machine of any kind, considerations must be made regarding the kind and amount of work it will be required to do, the foundation for its support, and the amount of space available for its occupancy.

An engine which is to be used for driving an automobile must be light, consistent with strength, compact in order to take up as little room as possible, balanced so that the amount of vibration shall be very small.

For vehicles using gasoline engines developing fifteen horse power, or less, the two cylinder horizontal opposed engine with the cranks set at an angle of 180° with each other, has been found to be the most efficient. The engine here treated is of this type and has air cooled cylinders, thus dispensing with the usual water jacket radiator pump, and piping as used on a water cooled machine. The bore and stroke are each four inches and this gives, by the A. L. A. M. (American
Licensed Automobile Manufacturers) formula $2.5, \frac{12.8}{N}$ H. P. Where $d$ is the diameter of the cylinder, $N$, the number of cylinders and 2.5 is a constant which corresponds to a factor of safety. This formula is based upon 1000 ft. piston speed which means with a four inch stroke, 1500 R. P. M.
The crankshaft of a four cycle gasoline engine must be made much larger than that of a steam engine giving the same rated power. This is because the strain upon it is about four times the delivered power as it is applied during only one fourth the time. The diameter \( d \) of the crankshaft may be derived from the following formula:

\[
d = 0.059 \times D^{\frac{3}{4}} \\
\]

where \( D \) is the diameter of the cylinder and \( M \) is the maximum pressure per sq. inch within the cylinder which is in this case, about 300 lbs.

\[
d = 0.059 \times 4^{\frac{3}{4}} \times 300 \\
\]

\[
d = 1.5 \text{ inches.} \\
\]

Each cylinder is cast integral with half the crank case, the cylinder head and the valve chamber, thus reducing the amount of machining to a minimum.

The cylinders, cylinder heads and valve chambers are covered by thin ribs or flanges which present a great amount of surface from which the heat generated by the combustion of the gas within the cylinders, is radiated into the air, thus keeping the cylinders cool enough to allow proper lubrication. The best temperature for cylinders has been found by practice to be about the boiling point of water or 100°C.

Radiation is assisted by a draught of air thrown upon the cylinders by the fan shaped spokes of the flywheel. The radiating surface for the two cylinders is about 1100 sq. in.

The cylinder walls should be made as thin as pos-
sible, consistent with strength so that the excess heat may be readily radiated. For a four inch cylinder 5/16 in. has been proved by practice to be a safe thickness for the walls.

The length of the pistons should be at least equal to the length of stroke and is more efficient if longer. In this case the pistons are made equal to one and one fourth times the length of stroke or five inches. Each piston is equipped with three piston rings which aid in holding the compression. Each ring is turned eccentric and is made slightly larger than the bore of the cylinder. The rings are sawed into at the thinnest part and when in place, spring out against the cylinder walls, making a perfect fit which prevents the escape of gas. They are so placed that the joints do not come opposite each other, otherwise there would be considerable loss of power due to leakage of gas through the joints.

The connecting rods are made slightly longer than twice the length of stroke. They are dropped forged I beams with a bronze bushing for the crank pin bearing. The piston pin is held stationary with the connecting rod and has its bearings in the piston walls thus making a rigid construction possible.

The valves, both the intake and the exhaust, are mechanically operated.

Since the speed of an engine depends a great deal
upon the rapidity with which the charge is admitted and the exhaust expelled, a high speed engine should have large valves. The valves may be designed from Roberts' formula:

\[
d = 0.00527 \frac{D \sqrt{RL}}{L} \quad \text{and}, \quad d' = 0.0057 \frac{D \sqrt{RL}}{L},\]

in which \(d\) equals the value of the inlet valve, \(d'\) equals the diameter of the cylinders in inches, \(L\) equals length of stroke, and \(R\) equals R. P. M. of crankshaft.

\[
d = 0.00527 \times 4 \sqrt{6000} = 1.7 \text{ inches},
\]

\[
d' = 0.0057 \times 4 \sqrt{6000} = 1.8 \text{ in.}
\]

The valve seats are ground to an angle of 40°, which has been proved by practice to give good results for high speed engines.

The cams which actuate the valves should be so made that they allow the valves to remain open through an angle of about 230° of the crankshaft circle. The cam design is shown in Fig. 7. About \(O\) as a center, describe a circle with radius \(OC\). This determines the concentric portion of the cam. About the same center, \(O\), describe an arc with radius \(OD\), making \(CD\) equal to the amount of clearance and lost motion of the valve rods. Draw \(OA\) and \(OB\), making an angle of 115° with each other. With centers on \(OA\) and \(OB\) describe circles, equal in size to the fallower rollers, tangent to the arc whose radius is \(OD\). Tangent to circle \(OC\) and tangent to each of the smaller circles \(A\) and \(B\), draw lines \(HF\) and \(KE\), forming the sides of the cam. Describe an arc with radius \(OG\), making \(GD\) equal to the
left of the valve. The corners at E and F are rounded off with any suitable radius.

SPECIFICATIONS.

In figure one is shown a half sectional elevation. The sectional part is cut in several different planes in order to show the construction of the various parts.

A--------cylinder.
B--------piston.
C-------connecting pin.
D--------connecting rod.
E--------Piston pin.
F--------Valve, either inlet or exhaust.
G--------Crank Case.
H-------Combustion chamber.
I--------Air cock.
J-------Flywheel.
K--------Cam.
L-------Follower roller.
M--------Valve rod.
N--------Valve spring.
O--------Spark plug.
P--------Cam shaft gear.
Q--------Crank shaft bearing(babbit).
R--------Bolts holding crank case.
S--------Bolts holding gear case.
T--------Port (exhaust or inlet).
U--------Lubricator connection.
V--------Flange for base.
W--------Bolts holding connecting rod bearing.
X--------Flanges for air cooling.
Y--------Oil connection for crank case.
Z--------Piston rings.

In figure two is shown a half sectional plan, showing the general arrangements of parts.

Figure four is a sectional view of the Schebler Standard Carburetor.

A--------Compensating air valve.
B--------Float chamber.
C--------Mixing chamber.
D--------Spraying nozzle.
E--------Needle valve.
F--------Float.
G--------Reversible union.
H--------Float valve.
I--------Float connection.
J--------Float hinge.
K--------Throttle.
L--------Float chamber cover.
M--------Air valve adjusting screw.
N--------Cork gasket.
O--------Air valve spring.
T--------Drain cock.
U--------Float cap.
Flushing pin.

OPERATION.

Gasoline enters through valve at I, and is kept at a constant level, nearly as high as the spraying nozzle.

Air is drawn, by the suction of the engine, through an opening to one side of valve A and passes through the mixing chamber, picking up gasoline from the spraying nozzle and then passes on to the engine through the throttle K. As the speed of the engine increases, valve A is lifted and more air rushes through thus increasing the charge.

Figure five is a diagram illustrating the action of a "jump spark" coil as used on most automobile engines.

A--------Battery (dry cells or dynamo)
B--------Contact maker on engine camshaft.
D--------Tension screw on coil vibrator.
E--------Platinum contact points.
G--------Vibrator hammer.
H--------Core of coil.
J--------Hand switch.
K-L------Condenser.
P--------Primary winding on coil.
S--------Secondary winding on coil.
OPERATION.

Current from the battery is admitted to the coil by means of the contact maker and the vibrator. The current magnetizes the core of the coil and it, attracting the vibrator hammer, breaks the current. A spring brings the vibrator back into contact and the operation is repeated.

The magnetization of the core induces a high current in the small wire of the secondary coil. This high tension current causes the spark which ignites the charge of gas within the cylinder of the engine.

In figure six is shown the wiring diagram.

A--------Sparking coil.
B--------Battery.
C--------Double throw switch.
D--------Dynamo.
E--------Ground connection.
F--------Contact maker.
G--------Spark plugs.

The engine is started on the batteries as shown and, after it is in motion, the switch is thrown over and thereafter the dynamo furnishes the necessary current, letting the battery rest, thus increasing its life very much.

Figure three illustrates a simple yet efficient muffler. The gas enters, through D, into A, passes A
and out through the holes E into B, thense back to the other end of the muffler and through holes similar to those in A, into C and thense, in a like manner, into the atmosphere, thus effectively silencing the noise caused by the exhausts from the engine.
Fig. 1.  
Half Sectional Elevation.  
Scale, Half Size.