Top End Engine Team

Fig. 18
ENGINE AND GEARBOX UNIT
(Later pattern)

In order to clarify the main components, the screws and washers etc. have been omitted from this illustration. For clutch details see Fig. 29, page 61.
Four-Stroke Engine Overview

- Cycle is complete after two revolutions of the crankshaft
- Power stroke provides the crankshaft with the angular momentum for other 3 strokes
- Air-fuel mixture travels in from the carburetor into head
- Ideal Gas Law
  \[ PV = nRT \]
- Chemical potential energy to mechanical work

Balanced Chemical Equation for Combustion: \( 2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O + \text{Heat} \)
Valve Timing

- As the cam turns, the pushrods move and push on the rockers. The rockers then push on the valve spring and move the valves.

- The stiffness of the valve spring controls how fast the valves close and determines rpm
Key Terms from Class

Engine Knocking:
- A knocking sound of metal hitting metal within the engine
- May be caused by an incorrect air-fuel ratio or fuel may be igniting at the wrong time in the combustion cycle

Compression Ratio:
- The ratio of the maximum to minimum volume in the cylinder of an internal combustion engine
- 7:1 for our motorcycle
- In general, the higher the compression ratio, the more power output from the engine

Photo Credit: AutoProtips.com
Our Parts

Engine Head

Carburetor

Barrel
Carburetor

- This is where **fuel and air mix** through the use of jets.
  - Throttle - Controls speed by adjusting air and fuel
- Float controls amount of fuel let in.
- Pilot jet works till about 20% throttle.
- Main jet works at 80% throttle and above.
- Needle jet works between 20% and 80% throttle.
Science of our Carburetor: How does it work?

Bernoulli’s Principle states that an increase in the speed of a fluid occurs simultaneously with a decrease in static pressure.

- The venturi of a carburetor is a tube with decreasing cross sectional area
- When air flows through the narrowing tube, its velocity increases
- The static pressure in the tube decreases which creates a vacuum drawing in fuel
- $\Delta P \propto \Delta v^2$

* This model does not perfectly match our carburetor
http://ecoursesonline.iasri.res.in/mod/page/view.php?id=677
Restoration

- Almost all parts went into sonic cleaner, and then a wire brush was used to clean most of the brass parts.

- Aluminum surface — oxidized in the presence of air to have a coat of aluminum oxide on the surface.

- Sandpaper, Scotch Brite, and brushes were used to remove oxidation from the outside.
Our Carburetor v.s. Others

Throttle Adjusting Screw (Part #10)
- Springs and a nut are both used to maintain the screw’s position

Monobloc Carburetor
- Later carburetors will get rid of the two part carburetor and switch to a one part carburetor.
- **Head**

- Home of the valves and spark plug.

- **Combustion chamber.**
  - Spark plug starts the combustion that starts the motorcycle.
  - Valves let the air/fuel mixture in and let out the exhaust gases.

- Fun Fact: We had a wasp’s nest in here
Disassembly

- Utilized the jam nut technique in order to help free the rocker from the head.

- Used a spring compressor tool in order to push the valve spring down to remove the keepers.
- Rust shows that materials are beginning to decay
- “Rust begets rust” - Prof. Littman
- Sandblasted, emory paper
- We used WD-40 in order to remove rusty bolts that were stuck.
- Oil was stuck between fins

Photo Credit: Theisen’s
Valve Seat Cutting

Cutting Valve Seats: Ensures that the valves come into contact with the head in a way that maximizes the engines performance and reduces wear

- 3 angles
- Allow gasses to pass valves with less turbulence
- Heat is transferred from valves via conduction, and the angles cut determine the SA of the valve in contact with the head

Valve Seat Cutter Photo Credit: Spring 2011’s ‘63 Tiger Cub Top Engine Page
Diagram Credit: John Maher Racing
Lapping

- Used to create a sealing surface between the valve and its seat.

- With a gritty compound, we spun the valve around multiple times in order to make sure the two surfaces meet exactly.
Barrel

- Held on to the engine case with four large bolts

- Piston moves up and down inside the barrel

- Sandblasted to remove rust

- Painted black to return to factory appearance, most likely black, because color increases emissivity
Honing & Boring

Honing: Removes surface layer of metal to remove surface defects and ensure proper piston ring seating
- Used a lathe and paddle hone the MAE shop
- Cutting Fluid: Lard Oil

Boring: Repairs wear and tear due to friction in engine cylinders by widening and tapering it
- Used T-gages to determine that the cylinder was egg shaped and needed to be bored
- Prof. Northey bore our cylinder
- Was originally a standard bore of 63 mm
Piston and Rings

- Since our barrel was bored, we needed a larger piston and new rings
- Piston rings prevent fuel and combustion gasses from leaving combustion chamber and oil from entering it. Also transfer heat to cooling walls
- 3 rings: Two compression rings and one scraper
- Ring gaps should be offset from each other
- Ring gaps will close when the rings undergo thermal expansion

Removing our Piston 2/15/23

Photo Credit: University of Windsor
Evolution of the Barrel: Convective Heat Transfer

- We have a round barrel, but the shape of the barrel later changed to a square and then an oval shape.
- Based upon Convection heat transfer equation,
  \[ Q = hA\Delta T \]
  \[ Q \propto A \]
- The surface area of the fin is proportional to the heat carried away.
- Why not add more fins to have greater surface area?
  
  ----> Impedes flow.
Calculate the heat dissipating off 0.05 m cooling fin attached to our 1951 Triumph Tiger Cub motorcycle engine as it travels at 40 km/h. The ambient air temperature is 27°C and the surface temperature of the fin is 230°C.

\[ q' = \frac{\text{heat dissipation}}{\text{length}} = \frac{q}{L} = \frac{h L (T_s - T_{in})}{2} \]

Units: \( \frac{W}{m^2} \)

- \( h = \frac{N_v \, k_f}{L} \)
- \( N_v = f \left( \frac{\nu}{\eta} \right) \)
- \( \nu = 22.85 \times 10^{-6} \ m^2/s \)
- \( \eta = 0.69 \)

From a table:
- \( k_f = 0.0346 \ \text{W/m} \)
- \( \eta = 0.69 \)
Calculation Continued

We need to know if this is laminar to look up \( \overline{Nu} \) \[ Re = \frac{WL}{\nu} = 40 \times 10^3 \frac{m}{s} \times 0.05 \times 10^4 \frac{m^2}{s} = 1.995 \times 10^{11} \] \[ \frac{2.785 \times 10^4 \frac{m^3}{s}}{2} \left( \frac{2}{2} \right) L < 5 \times 10^{11} \text{ so this is laminar} \]

\[ \overline{Nu} = 0.664 \frac{Re}{Pr} \left( \frac{v_s}{\nu} \right)^0.25 = 0.664 \left( 1.995 \times 10^{11} \right)^{0.25} \left( 0.69 \right)^{0.25} = 82.87 \]

\[ \overline{h} = \frac{(82.87) \left( 0.0346 \frac{W}{m^2 K} \right)}{0.05 m} = 57.35 \frac{W}{m^2 K} \]

Now we have everything to plug in:

\[ q' = \overline{h} L (T_s - T_o) \]

\[ = 57.35 \frac{W}{m^2 K} \times (0.05 m) \times (236^\circ C - 27^\circ C) \]

\[ q' = 1198.65 \frac{W}{m} \]

\[ q' = \frac{q}{L} \]

\[ q = \frac{q'}{L} = 1198.65 \frac{W}{m} \times (0.05) m = 59.93 \frac{W}{m} \]

60 W
Bibliography


