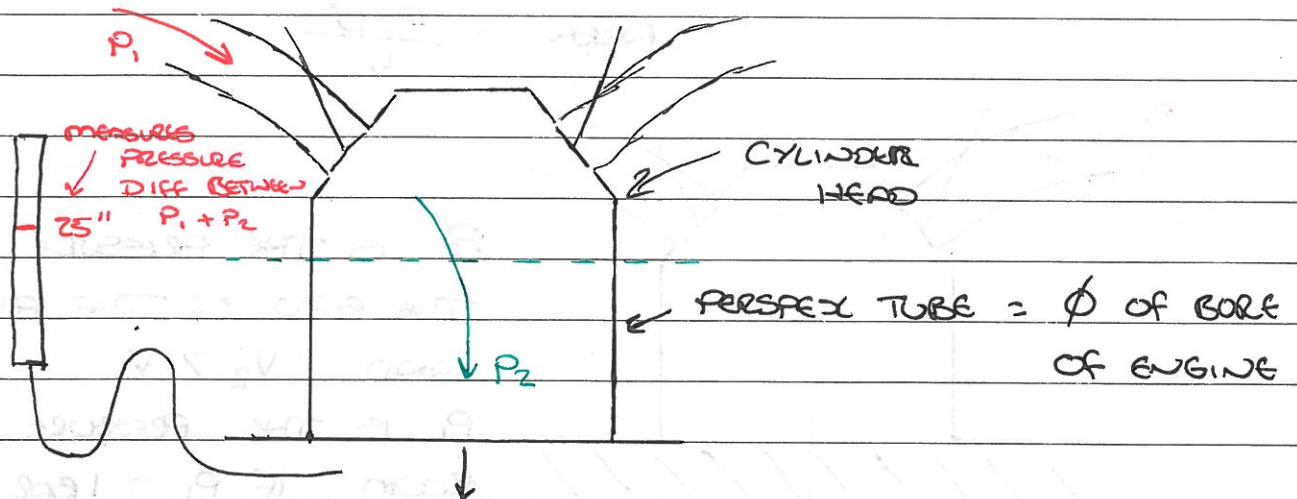


COMPETITION ENGINE PERFORMANCE

5/11/15

SHOW SETUP OF CAM - VALVE MOTION SIM.

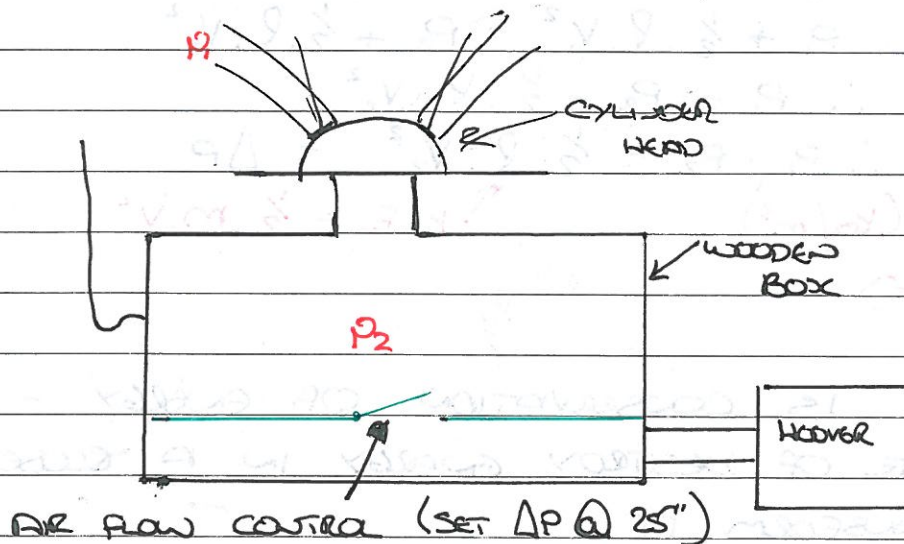
Flow Bench



$\Delta P = 25$ INCHES OF WATER

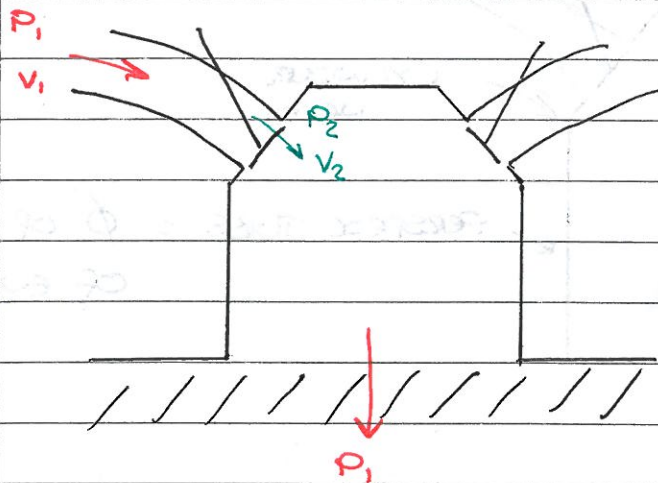
$$\Delta P = P_1 - P_2$$

THE PRESSURE DIFFERENCE CREATES SUCTION. BECAUSE THE BORE IS WIDE THE MAJORITY OF PRESSURE DROPS WITHIN THE INLET PORT.



YOU ADJUST THE FLOW RATE TO GET 25" PRESSURE DROP. ON P37 OF SUPERFLOW MANUAL THE PERFECT FLOW IS 138 CFM/IN². PEAK VELOCITY IS 331 FT/SEC

↑
THIS IN² REFERS TO THE VALVE/PORT AREA = $\frac{\pi \cdot D^2}{4}$



P_2 IS THE PRESSURE AT THE END OF THE PORT AND $V_2 > V_1$

P_1 IS THE PRESSURE IN THE ROOM. IF $P_1 = 1 \text{ BAR}$ AND $V_1 = 0 \text{ m/s}$.

$P_1 - P_2$ ACCELERATES THE AIR FROM 0 m/s (V_1) TO V_{max} (V_2) WHERE IT ENTERS THE CYLINDER.

FROM BERNOULLI'S EQUATION -

$$P_1 + \frac{1}{2} \cdot \rho \cdot V_1^2 = P_2 + \frac{1}{2} \cdot \rho \cdot V_2^2$$

BUT $V_1 = 0 \therefore P_1 = P_2 + \frac{1}{2} \cdot \rho \cdot V_2^2$

$$\therefore P_1 - P_2 = \frac{1}{2} \cdot \rho \cdot V_2^2 = \Delta P$$

$\rho = \text{DENSITY (kg/m}^3\text{)}$

$$1 \text{ m}^3 = 1.2 \text{ kg}$$

↑ $\text{K.E.} = \frac{1}{2} \cdot m \cdot V^2$

BERNOULLI IS CONSERVATION OF ENERGY - YOU CAN'T CREATE OR DESTROY ENERGY IN A CLOSED SYSTEM, ONLY TRANSFORM IT.

THE PRESSURE = POTENTIAL ENERGY OF 1m³

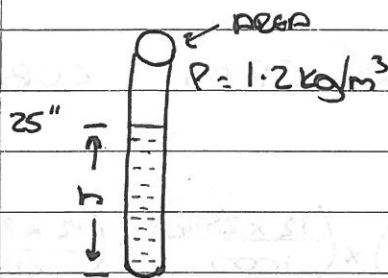
$\frac{1}{2} \cdot \rho \cdot V^2 = \text{KINETIC ENERGY OF 1m}^3$

$\Delta P = 25''$ OF WATER

$$1 \text{ BAR} = 10^5 \text{ N/m}^2 = 10^5 \text{ Pa}$$

$$\rho \text{ AT } 20^\circ\text{C} = 1.2 \text{ kg/m}^3$$

$$P_1 - P_2 = \frac{1}{2} \rho \cdot V_2^2$$



$$\text{WEIGHT} = m \cdot g$$

$$m = A \cdot h \cdot \rho \cdot g$$

$$\therefore P = \frac{A \cdot h \cdot \rho \cdot g}{A} = h \cdot \rho \cdot g \text{ (N/m}^2\text{)}$$

$$\downarrow F = mg = A \cdot h \cdot \rho \cdot g \text{ (N)}$$

$$25'' \text{ WATER} = \frac{25 \times 25.4}{1000} = 0.635 \text{ m WATER}$$

$$\rho \text{ WATER} = 1000 \text{ kg/m}^3$$

$$\therefore P = 0.635 \times 1000 \times 9.81 = 6229.35 \text{ Pa}$$
$$= 6.23 \text{ KPa}$$

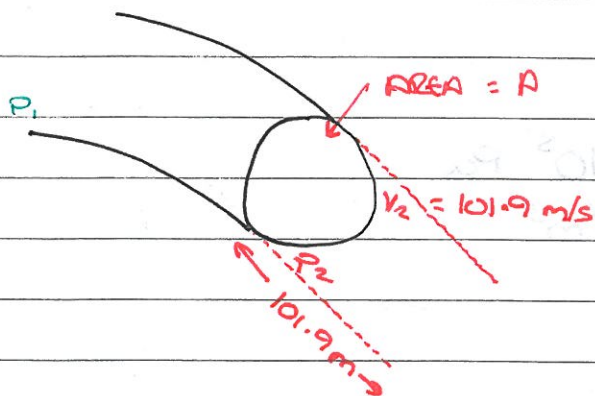
$$\Delta P = 0.06 \text{ BAR}$$

WHAT IS V_2 @ 25''

$$\Delta P = \frac{1}{2} \rho \cdot V_2^2 \quad \therefore V_2 = \sqrt{\frac{\Delta P}{\frac{1}{2} \rho}}$$

$$\therefore V_2 = \sqrt{\frac{6229.35}{\frac{1}{2} \cdot 1.2}} = 101.89 \text{ m/s} = \text{PERFECT VELOCITY}$$
$$= 334.3 \text{ ft/s}$$

"PERFECT" BECAUSE CONSERVATION OF ENERGY
ISN'T 100% DUE TO FRICTION IN THE PORT



$$P_1 - P_2 = 25''$$

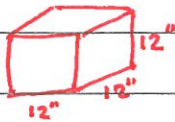
EVERY SECOND 101.9 m FLows
IS COVERED BY AIR

$$Vol/sec = A \times 101.9 \text{ m/s} = m^3/s$$

Flow Bench IS MEASURED IN CFM - CUBIC
FEET PER MINUTE.

$$1 \text{ Ft}^3 = 12'' \times 12'' \times 12'' = \left(\frac{12 \times 25.4}{1000} \right) \times \left(\frac{12 \times 25.4}{1000} \right) \times \left(\frac{12 \times 25.4}{1000} \right) m^3$$

$$= 0.028317 m^3 = 28.3 \text{ LITERS}$$



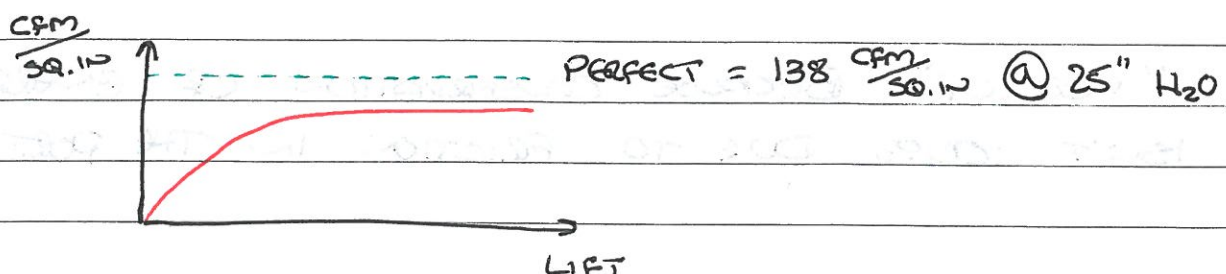
$$\therefore 1 \text{ CFM} = 28.3 \text{ L/min} = \frac{28.3}{60} \text{ L/sec} = 0.472 \text{ L/sec}$$

$$1 \text{ L/sec} = \frac{1}{0.472} \text{ CFM} = 2.12 \text{ CFM}$$

AS YOU OPEN THE INLET VALVE YOU NEED TO
ADJUST THE FLOW BENCH VALVE TO INCREASE THE
FLOW RATE TO MAINTAIN THE SAME ΔP OF 25"
 H_2O ALONG THE PORT. THIS IS NOW AN EASIER
PATH, LESS RESISTANCE DUE TO VALVE OPENING.

$$\frac{\text{CFM}}{\text{AREA}} = \text{FLOW EFFICIENCY ALONG PORT} = \frac{\text{CFM}}{\text{SQ. IN}}$$

THEN YOU NEED TO COMPARE IT WITH THE
PERFECT $\frac{\text{CFM}}{\text{SQ. IN}}$



$$\text{FLOW CO-EFFICIENT, } C_f = \frac{\text{MEASURED CFM/SQ. IN}}{\text{PERFECT CFM/SQ. IN}}$$

WHAT IS THE PERFECT FLOW THROUGH 1" ² OF VALVE @ 25" H₂O?

$$P_1 - P_2 = 25"$$

$$\text{PERFECT } V = 101 \text{ m/s}$$

$$\therefore \text{PERFECT FLOW/IN}^2 = 101 \times \left(\frac{25.4 \times 25.4}{10^6} \right) = 0.0652 \text{ m}^3/\text{sec}$$

$$= 138 \text{ CFM}$$

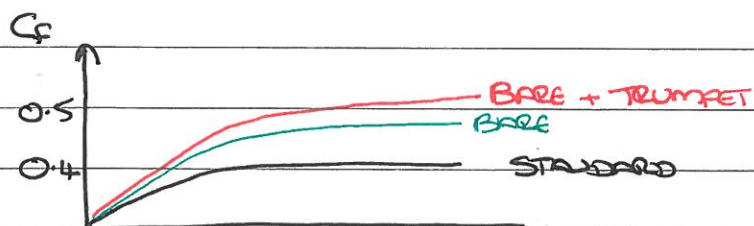
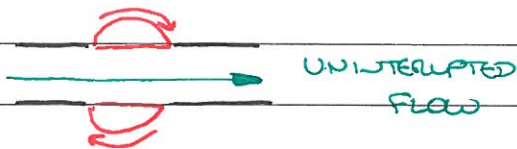
$$\therefore \text{PERFECT FLOW/IN}^2 = 138 \text{ CFM/IN}^2 \quad 0.0652 \times 2120 = 138 \text{ CFM}$$

↑
P.43 SUPERFLOW
HANDBOOK

STANDARD BUTTERFLY DISTURBS FLOW EVEN AT FULL THROTTLE. ON KAWASAKI WE TOOK UPPER BUTTERFLY PLATES OFF TO IMPROVE FLOW.



ROUGH BARREL THROTTLE ALLOWS UNINTERRUPTED FLOW AT FULL THROTTLE.

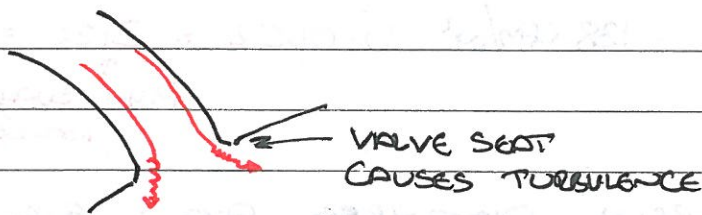
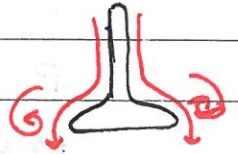


PRACTICAL TUNING
TARGET $\approx 0.6 C_f$

How could you get O.b G?

VALVES CREATE TURBULENCE SO YOU COULD -

- GET VALVES WITH SLIMMER STEMS
- REMOVE PROTRUDING VALVE GUIDES
- CHANGE SHAPE OF PORT
- CHANGE SURFACE FINISH OF PORT.



IDEAL VALVE SEAT FOR FLOW WOULD BE RADIAL, SMOOTH HOWEVER THIS IS NOT GOOD FOR HEAT TRANSFER AWAY FROM VALVE. CLOSEST POSSIBLE IS 3 RANGLE SEAT.

