The Effect of Carburetor Refurbishing on Emissions, Performance, and Fuel Economy in a Classic Pickup Tested Using Real-World Tests

by

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Submitted to the Department of Mechanical Engineering in Partial Fulfillment of the Requirements for the Degree of

Bachelor of Science

at the

Massachusetts Institute of Technology

June 2010

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ABSTRACT

This project investigated how refurbishing the carburetor of a 1952 Chevrolet Pickup would affect emissions, performance, and fuel economy. The test used were real-world tests that anyone, with or without access to a laboratory, can perform. The design of the real-world tests is important for ascertaining good results. Thought should go into how to perform the tests safely while still eliminating as many variables as possible.

The emissions at idle improved by reducing the carbon monoxide percentage from 4-6% to 2-3%. The hydrocarbon levels were reduced from 800-1000 ppm to 500-600 ppm. The results of the emissions test were unclear at cruise.

The performance data showed that the vehicle had a slower acceleration after the refurbishing. The time to go from stopped to 100 feet in first gear was 5.46 s before refurbishing, and 6.48 s after refurbishing. It is possible that the vehicle was running lean at wide-open throttle after refurbishing.

The fuel economy improved with the refurbished carburetor. The initial fuel economy was 10.7 mpg and the final fuel economy was 15.2 mpg.

Once the results from the tests are collected, they need to be scrutinized to see if they are plausible using empirical data.

Even with extreme care it is difficult to get precise measurements using real-world tests. The emissions data at cruise was not consistent with idle and could not be used. The fuel economy tests and emissions tests at idle show that the engine was running less fuel rich after refurbishing.

Thesis Supervisor: John B. Heywood

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Author Biography

Jacklyn Holmes was born in 1988 to parents John Holmes Jr. and Julie Holmes. She was raised on a cattle ranch in the west-central mountains of Idaho. It was during her upbringing on the ranch that she became interested in machines and decided to major in Mechanical Engineering. She graduated top of her high school class in 2006 before coming to MIT. She is expecting to get her Bachelors in Mechanical Engineering in June of 2010.

Acknowledgements

The author would like to thank Professor John B. Heywood for his guidance through this project. The author also thanks John Holmes Jr. for his assistance with running the tests and refurbishing the carburetor, and John at Tune Tech in Ontario Oregon for running the Emissions Testing. The author would also like to thank Ed Pollard for loaning the author a fan so she could continue with the tests.

Table of Content

Introduction

My car is a 1952 Chevy pickup. I chose to do this project to improve how my pickup runs and preserve its quality. It would have been easy to refurbish the carburetor without running the tests, but I wanted to quantify the affect the refurbishing had on my vehicle. I wanted to use this experience to improve my problem solving skills by working on a full system in the "real world." The validity of real-world tests was also examined during the project to see if good results were possible.

Figure 1: The 1952 Chevy Pickup used for the testing

Most individuals that have classic vehicles do not have access to sophisticated lab equipment to test how their work is improving their vehicle. The real-world tests are used to get a general understanding of how things are working. They are run in the environment where the vehicle is being used, and with many uncontrollable variables.

Appendix A is information about the vehicle and engine from the *Chevrolet Truck Shop Manual: 1948 to 1953 Models*. (1950). The pickup has the 216 cu. in. straight-6 engine.

The 216 engine has the model B downdraft carburetor. The carburetor is used to control the fuel flow into the engine. It is also used to mix the fuel with air to obtain proper combustion. The air flows through a venturi, which is a converging-diverging nozzle. The pressure difference caused by the air flowing through the nozzle is used to control the appropriate fuel flow rate into the engine (Heywood, 1988, p. 282). Appendix B is from the *Chevrolet Truck Shop Manual: 1948 to 1953 Models*. (1950), and it shows the components of the model B downdraft carburetor.

Refurbishing

The refurbishing of the carburetor involved removing the carburetor, cleaning surfaces, and replacing certain components that were included in a refurbishing kit. The following is a list of components that were replaced:

- Power valve spring and ball
- Pump plunger
- Pump discharge-guide, spring, and ball
- Bowl cover gasket
- Body flange gasket
- Float and lever assembly
- Needle, seat, and gasket assembly

Appendix C a portion of the *Instruction Sheet: Rochester Carburetor – Models -"B", -"BC", -"BV"* (1982) from the carburetor refurbishing kit. The Instruction sheet shows an exploded view of all of the components of the carburetor, and all of the adjustments done during the refurbishing process. The *Operator's Manual: For 1952 Chevrolet Light Medium and Heavy Duty Trucks* and *Chevrolet Truck Shop Manual: 1948 to 1953 Models* were referenced if any questions arose during the refurbishing process.

The following pictures are from the carburetor refurbishing.

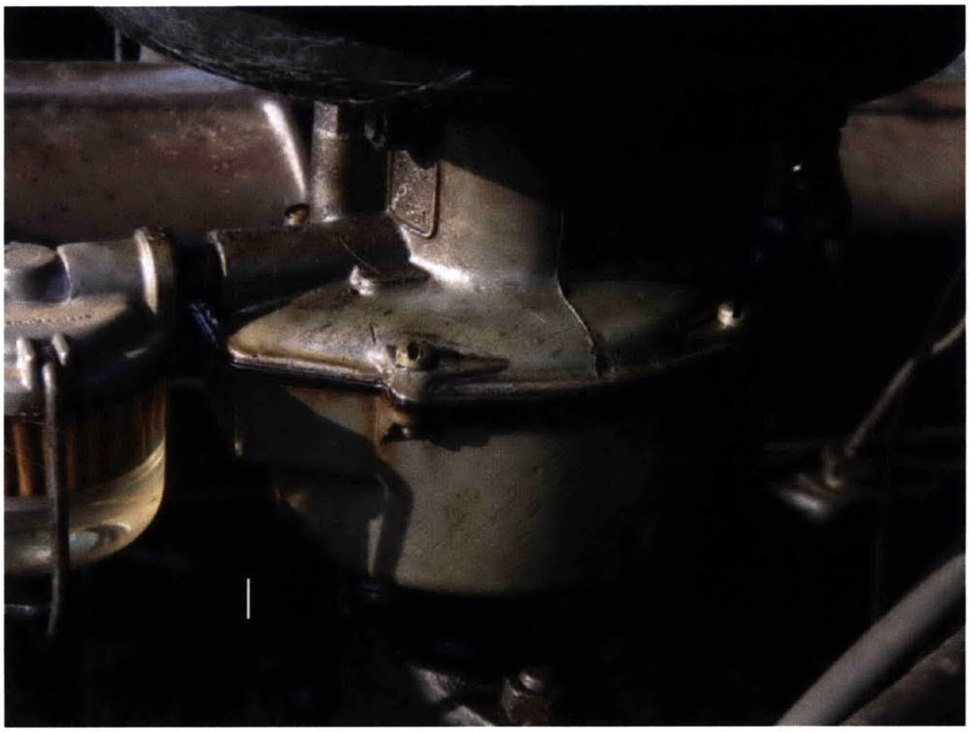

Figure 2: Carburetor installed on the engine before refurbishing. The outer surface had a shine that could have been caused by fuel leakage.

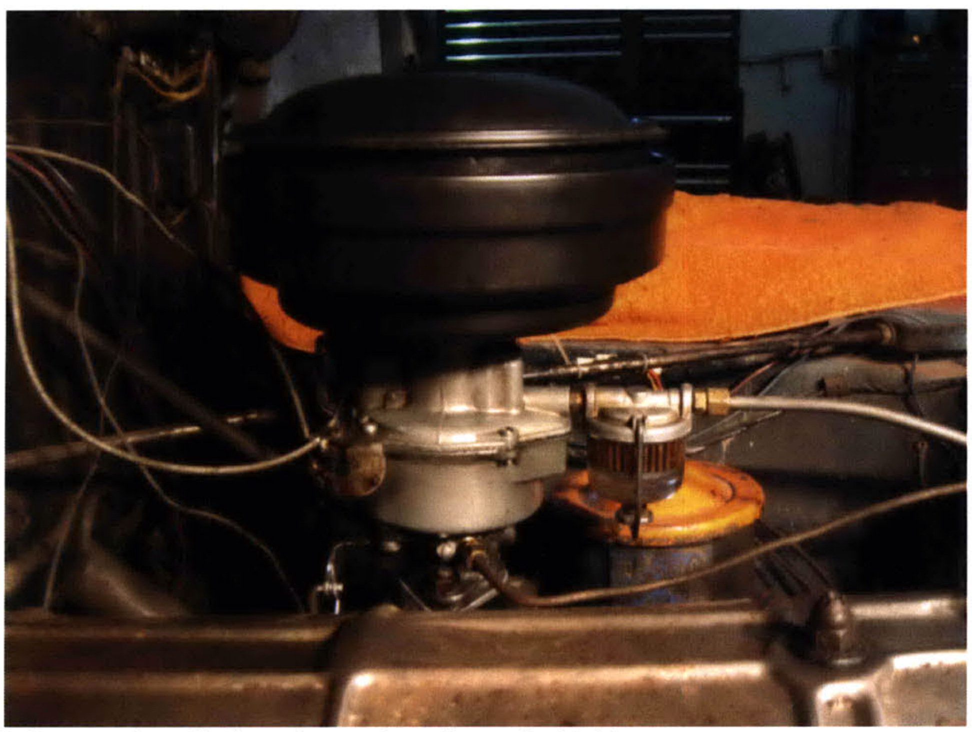

Figure 3: Carburetor installed on the engine after refurbishing.

Figure 4: Carburetor removed from the engine before refurbishing. There is noticeable buildup on the surfaces of the carburetor.

Figure 5: Carburetor after refurbishing.

Figure 6: Carburetor bowl before refurbishing. Notice sediment left in the bottom after fuel was poured out.

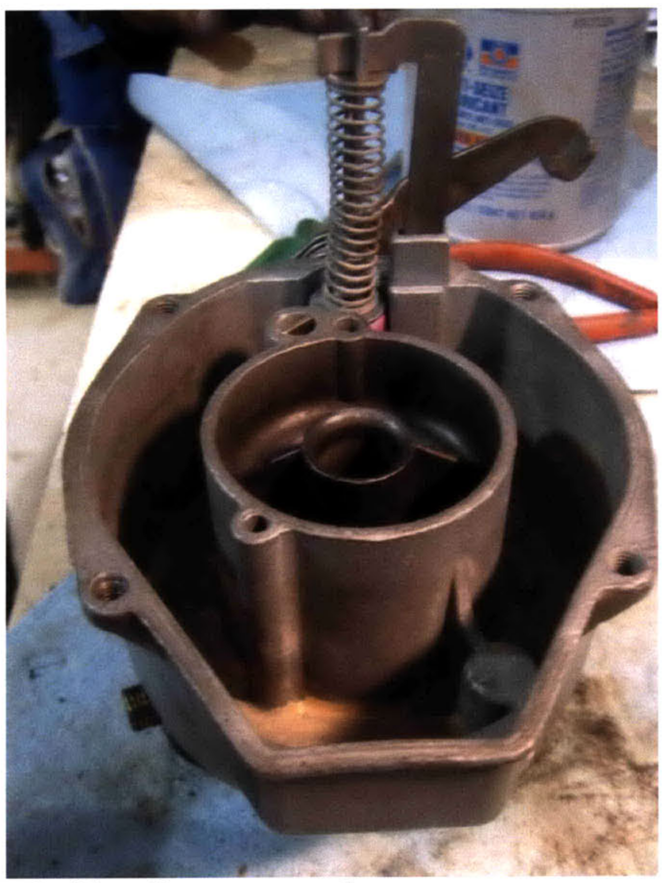

Figure 7: Carburetor bowl with sediment removed.

Figure 8: Bottom of carburetor before refurbishing. Notice gasket had stuck to the surface.

Figure 9: Bottom of carburetor after refurbishing. Old gasket removed, and surface cleaned.

Figure 10: Old pump plunger with signs of wear.

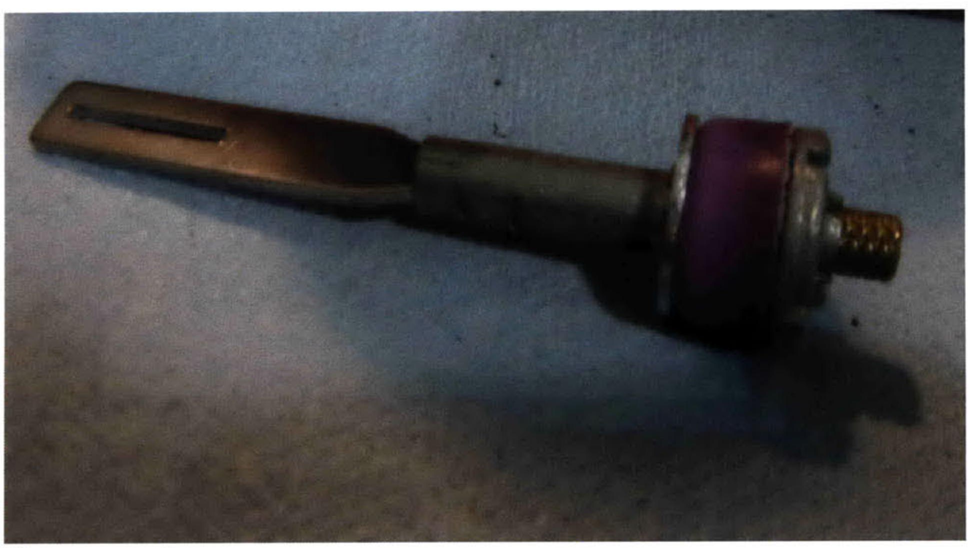

Figure 11: New pump plunger.


Figure 12: Exploded view of old power valve assembly. Notice spring failure.

The carburetor was found to have been put together using Teflon tape on the threads. This was difficult to remove, and possibly could have sent particles of the tape through the carburetor which would then end up in the engine.

Safety

Safety is critical for every experiment. The classic pickup presented additional safety concerns such as the lack of seat belts and turn signals. These vehicles were not designed to operate at the speeds that new cars travel on interstate roads. Therefore, the choice of roads was critical.

I installed seatbelts for the driver and passenger. And the flasher was replaced to fix the turn signals that a previous owner had installed.

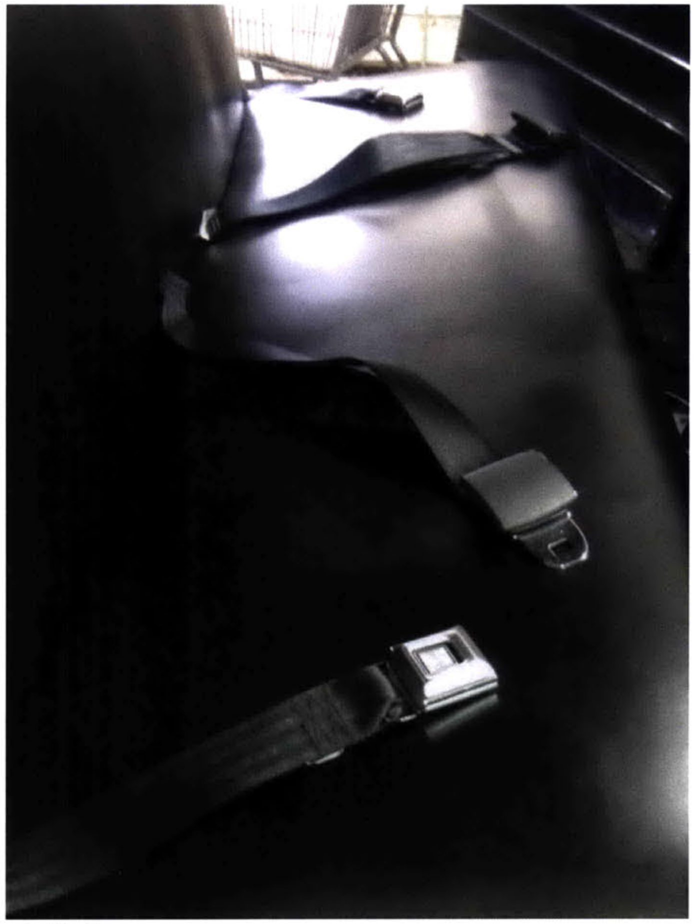

Figure 13: Seatbelts installed.

Figure 14: New flasher used to fix the turn signals.

Other safety measures involved doing the testing on rural roads where the speeds were lower and there was very little traffic. All of the roads were paved and dry. The tests were performed in good weather when there was no snow or rain.

The engine, excluding the carburetor, was in a fair condition prior to any testing. All engine fluid levels and tire pressures were checked and maintained in the proper range.

Tests & Results

For this project, three types of tests were used to evaluate how the carburetor refurbishing affected the pickup. The three tests quantified emissions, fuel economy, and performance. The results were then examined to see if they agreed with other experimental results obtained in a more controlled environment.

Emissions

The first test was is the emission test. This test is more of a "lab test" than any of the others. A trained technician, John, at Tune Tech in Ontario Oregon, performed it. The equipment measured the amount of hydrocarbons and carbon monoxide in the emissions. This test did a very good job of eliminating variables from outside sources, but the equipment could only measure up to 10% on the carbon monoxide.

This test shows what the emissions are for the vehicle at idle and at cruise. Hydrocarbon (H-C) and carbon monoxide (CO) were measured and analyzed. Hydrocarbon emissions occur when there is incomplete fuel combustion. Hydrocarbon is measured in parts per million (ppm) but the measurement is dependent on what gas was used to calibrate the instrument. The instrument used for this test was calibrated using Hexane (contains six carbons per molecule). The reading is inversely proportional to the number of carbons in the calibration gas. For example, a C_1 reading could say 1800 ppm , the C_3 reading gives 600 ppm, and the C_6 reading gives 300 ppm. Carbon monoxide occurs when the emissions do not form the proper compounds during combustion. It is measured as a percentage of the emissions.

Before the test could be run, the vehicle needed to be warmed up. This was accomplished by the drive from Weiser to Ontario (approximately 15 miles). The following table contains the results from the test.

Table 1
Emissions test results

	Idle		Cruise	
	Before	After	Before	After
H-C (ppm)	800-1000	500-600	1200	1200
CO	4-6%	2-3%	Off Scale	Off Scale
RPM	~1000	~750		

Performance

This test was used to see how the vehicle responded by accelerating from a stopped position. Accelerating quickly to meet the flow of traffic can be important factor while driving because driving slowly impedes the flow of traffic.

The performance test was done on a straight stretch of paved road with excellent visibility. 100 feet of road was marked off to be the test path. In order to perform this test safely, my father drove the vehicle while I timed the runs. We kept our roles the same throughout the testing to insure that we didn't add an additional variable.

Steps were taken to eliminate as many variables as possible. The tests were performed with a set distance of 100 feet. The test was run at wide-open throttle (floored the gas pedal). All of the tests were performed in first gear. This eliminated shifting as a variable. The roads were dry. The vehicle had been sufficiently warmed up before the testing occurred. Finally, the same people performed the driver and timer rolls.

However, not all variables could be eliminated. It is possible that human error could have come from the person driving, my father, and the person timing, the author. During the first set of tests, a breakdown occurred that possibly could have made us more cautious for the testing after the carburetor work. The results from the testing are listed below.

Table 2
Average time & standard deviation including all of the runs

	Average Time (s)	Standard Deviation (s)
Before	5.27	0.49
After	6.48	0.26

Table 3
Times for each run of the performance test.

Test	Time (s)
Before-1	5.3
Before-2	5.6
Before-3	4.3
Before-4	5.5
Before-5	5.3
Before-6	5.6
After-1	6.9
After-2	6.5
After-3	6.2
After-4	6.6
After-5	6.5
After-6	6.2

After the data was collected, the Before-3 test seemed to be unreasonable. Removing this data point gives a new average and standard deviation shown in the following table along with the coefficient of variation, and acceleration. Acceleration was calculated making a simplification that it was constant during the test. The acceleration calculated will be referred to as an average acceleration.

Table 4
Average time, standard deviation, coefficient of variation, and average acceleration for the performance tests without the outlying data point.

	Average Time (S)	Standard Deviation	Coefficient of Variation	Average Acceleration (m/s2)
Before	5.46	0.15	0.0278	2.05
After	6.48	0.26	0.0407	1.45

The change in acceleration may not seem like a lot, but using the acceleration to estimate an approximate 0-60 miles per hour (mph) time more clearly shows the difference. Initially the pickup was showing a 0-60 mph time of 13.1 s. After the refurbishing the 0-60 mph time was 18.5 s. That is an increase of 5.4 s from before to after the refurbishing. These 0-60 mph times are only to show how much of a difference there is in the results. The vehicle does not easily go to 60 mph.

This test was designed to show how the vehicle responded to the driver accelerating from a stopped position. There were some difficulties with the test that could explain the behavior that was seen.

This test proved to be very difficult. While running the "before tests" the fan broke and severed the fan belt. The heating coil then was leaking an excessive amount. This occurred on the seventh run of the initial testing, and caused the engine to heat up. The broken fan was discovered to be from a 1955 model engine. It was replaced with the correct 1952 version from Ed Pollard. The heating coil was bypassed for the "after tests."

On the following page are pictures of the fan that broke during testing and the fan that was used in the tests after refurbishing.

Figure 15: 1955 model fan that broke during testing.

Figure 16: 1952 model fan obtained from Ed Pollard.

Fuel Economy

Recently with the spike in the price of gasoline, fuel economy has become very important. Car owners often perform this test in order to know how their vehicle is running. Those tests are performed in "every day" driving, and the results can vary a great deal from what is tested in a laboratory.

For this project, the most accurate result possible was desired without access to a laboratory. Much thought went into the selection of the road, and how to eliminate as many variables as possible. The test conditions used to eliminate variables are:

- Same driver
- Same passenger
- Same road
- Same fuel pump
- Good weather conditions
- Vehicle warmed up prior to testing
- Tire Pressure checked and adjusted to meet specifications
- Fluid Levels checked and kept in the correct range

It is impossible to eliminate all variables in real world testing. The variables that remained for the tests run are listed below.

- The refurbished carburetor (The variable desired)
- Other drivers- slowing the test down
- Fuel pump variation (at the gas station)
- Time (49 minutes to 54 minutes)
- Weather (Temperature & Humidity)
- Different fan- from Ed Pollard. (used the fan that was supposed to be on this 216 engine, the first tests had a fan from a 1955 model)
- No Heating coil in the after tests
- Running hotter during after tests

The results of the fuel economy test were surprising. There seemed to be a significant increase in the miles-per-gallon after the refurbishing of the carburetor. Calculating the average fuel economy was done by using the total miles driven during the set of tests divided by the total distance driven in that set of tests. During the before tests the vehicle ran about 10.7 miles per gallon. The after tests showed about 15.2 mpg. This translates to a reduction of fuel consumption of 30 percent.

Table 5

Data from all test runs. Shows the time variation and what fuel pump is used.

	Miles traveled	Gallons used	MPG	Time (min)	Pump	Test
Before	31.7	2.831	11.20	52	3	B1
Before	31.6	3.098	10.20	51	3	B2
Before	31.7	2.85	11.12	51	3	B3
Before	31.7	2.32	13.66	50	4	B4
Before	31.6	3.192	9.90	51	4	B5
Before	31.7	3.477	9.12	49	4	B6
After	31.7	1.881	16.85	54	3	A1
After	31.7	2.308	13.74	52	3	A2
After	31.7	1.857	17.07	54	3	A3
After	31.7	2.071	15.31	51	3	A4
After	31.6	2.064	15.31	50	3	A5
After	31.7	2.34	13.55	49	3	A6

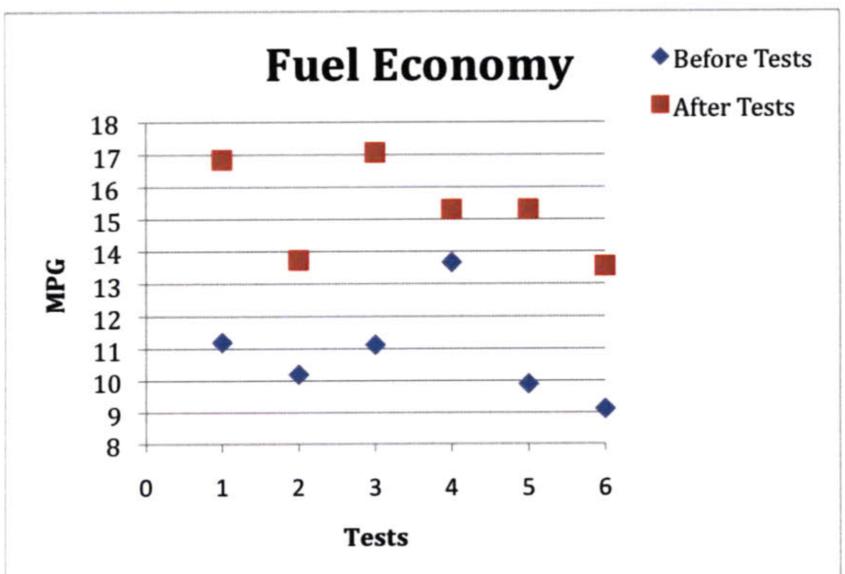

Figure 17: Graphical representation of the MPGs calculated for each test run. This shows the variation in the tests runs.

Table 6

Total mileage and total gallons were used in calculating the MPG.

	Total Miles	Total Gallons	MPG
Before	190.0	17.768	10.69
After	190.1	12.521	15.18

Discussion

These emissions results give a great deal of information. The vehicle improved at idle. Unfortunately it is impossible to tell the effect the refurbishing had at cruise. The revolutions per minute of the engine at idle was reduced by 250 by refurbishing the carburetor and adjusting the settings. It is unclear why the H-C values were so large and stayed the same at cruise.

The acceleration results show that the vehicle was slower after the carburetor work. This result can possibly come from running the engine much leaner. It is possible that after the carburetor work was performed the engine was running lean of stoichiometric for wide-open throttle. The result may also be skewed by the cautiousness of the driver and timer during the tests after the carburetor was refurbished.

With the fuel economy results, a substantial improvement was measured. The tests show that there is significant variation with real-world testing, and multiple tests are needed to attempt to average out some random errors. The unexpected changed to the engine operation could have also had an affect on the fuel economy tests.

The smaller replacement fan and removing the heating coil in the cab caused the engine to run warmer during the after tests. The engine was running about 15 degrees warmer. This would heat the oil making it less viscous which would reduce the friction in the engine. The smaller fan would also cause less friction when it is running. The older engine will have higher friction than new engines by about 30-50 %. Figure 18, shows how friction mep (kPa) changes with varying oil temperatures. During the before tests the vehicle was running about 68 C and after was about 76 C, this corresponds to a mechanical friction reduction of about 8% from Figure 18. Multiplying 8% by 1.4 (in order to scale to an older engine) gives a reduction of mechanical friction of 11%. The reduced friction helped improve fuel economy.

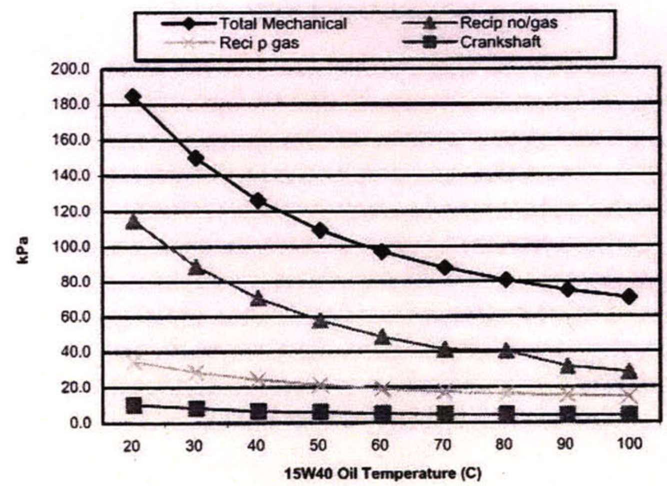

Figure 18: Friction mep (kPa) for varying oil temperatures. This is Figure 11 in *An Improved Friction Model for Spark-Ignition Engines* Sandoval and Heywood (2003).

This real-world tests were designed to be run easily, but difficulties were still faced. These difficulties came from uncontrollable variables. Even though the road was rural and lightly trafficked, there were a few runs that had a slow vehicle increase the time for a fuel economy test. The weather was also a huge factor as to when the tests could be run. All of the testing dates were in good weather with dry roads. The fan breaking during the initial performance test made it impractical to run more tests before refurbishing the carburetor. It was also discovered that the gas station had been having problems with the pumps being accurate. It is impossible to determine whether these difficulties affected the results for this set of tests because of the limited time and resources.

The results obtained can give insight into the system and how the vehicle is performing. Starting with the CO emissions data at idle an air fuel ratio can be estimated using Figure 17.

Table 7

The relative air/fuel ratio found given the carbon monoxide % using Figure 18.

	Idle Before Refurbishing	Idle After Refurbishing
CO	4-6%	2-3%
λ (from Figure 17)	0.86	0.93

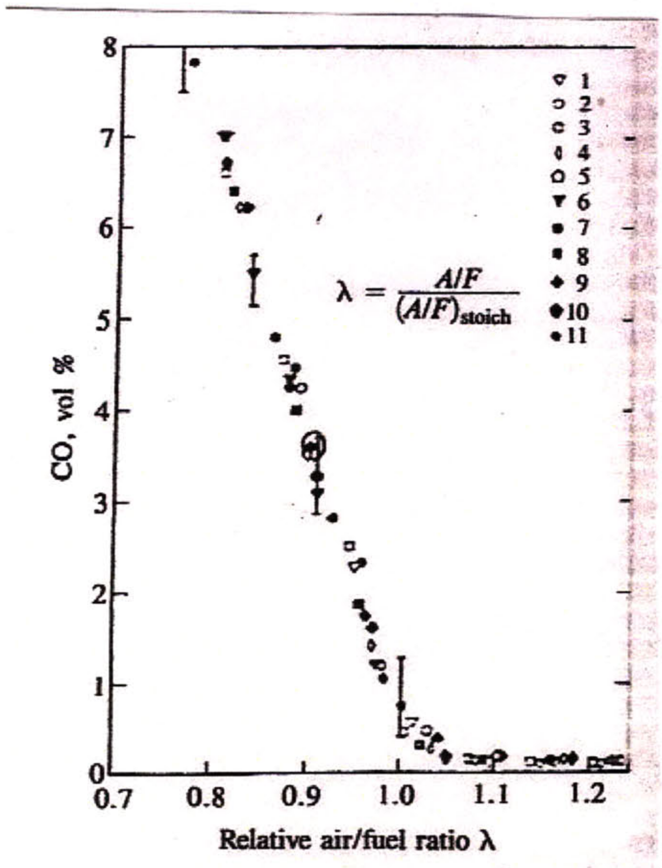

Figure 19: Graph used to take a CO percentage and find the corresponding relative air/fuel ratio (λ). This is Figure 11.20 (b) in John B. Heywood's book *Internal Combustion Engine Fundamentals* (1988, p. 592).

Now that we have a relative air/fuel ratio, an air/fuel ratio (A/F) can be found by using the following equation:

$$\frac{A}{F} = \lambda * 14.6 \tag{1}$$

The relative air/fuel ratio (λ) is multiplied by 14.6 because 14.6 is the air/fuel ratio when an engine is running stoichiometric (stoichiometric is when there is just enough air and fuel during the combustion for the fuel to be fully oxidized to CO_2 and H_2O.)

Table 8

Air fuel ratios found using equation 1.

	Before Refurbishing	After Refurbishing
A/F (from eqn. 1)	12.6	13.6

Now that we have an A/F ratio, Figure 19 can be used to find the break specific heat consumption (bsHC). However, the vehicle was running on the rich side of the graph, so the curve was extended out to give an estimate for the bsHC.

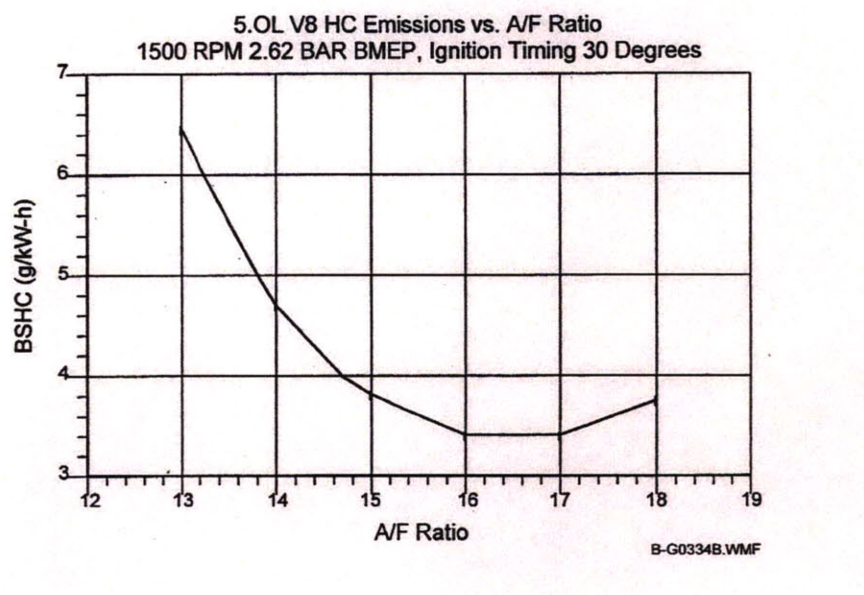

Figure 20: BSHC vs A/F Ratio. Note. Graph from *Effects of A/F, EGR, and Spark on HC* from John B. Heywood's course 2.61 at MIT (2009).

The bsHC estimated with Figure 19 came out to be:

Table 9

Estimates for bsHC

	Before Refurbishing	After Refurbishing
bsHC (g/kW-h)	7.3	5.4

All of this analysis gives us a lot of information about how the engine behaves at idle, but what is happening at cruise is also important. Because the CO readings at cruise were off-scale, this same analysis can be used in reverse along with the H-C reading to estimate what the CO reading could have been.

From Table 1 the average H-C at idle (including before and after) was 725 ppm. At cruise the H-C was 1200 ppm. The ratio of cruise to idle was 1.66. Using the average bsHC at idle of 6.4 g/kW-h and the ratio of 1.66, a bsHC at cruise of 10.6 g/kW-h is found. Following the analysis in reverse gives the following values at cruise:

Table 10
Values for cruise using analysis.

	Cruise
H-C (ppm)	1200
bshc (g/kW-h)	6.4
A/F	11.6
λ	0.79
CO	7.5 %

Using this kind of analysis, a CO percentage of 7.5 was obtained. This is too low, because the measured value was off the scale (>10%).

Another approach was used to try to make sense of the results using plausible numbers for how fuel rich the vehicle was running. The first assumption was with the refurbished carburetor the engine was operating at 10% fuel rich. This gives a fuel to air ratio (ϕ) of 1.1. Older vehicles were designed to run slightly fuel rich. Using the following figure, the indicated specific fuel consumption (isfc) should be about 253 g/kW-h.

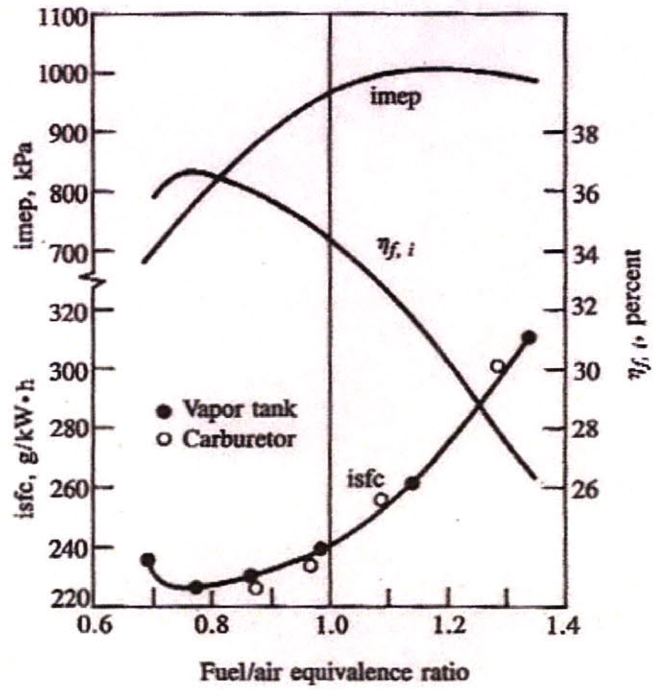

Figure 21: This is Figure 15.4 in John B. Heywood's book *Internal Combustion Engine Fundamentals* (1988, p 831). Use this graph to find the indicated specific fuel consumption (isfc) from a given fuel/air ratio (ϕ).

To determine what the isfc we would have seen before the refurbishing process, we used a ratio of the fuel economy. The "after" mpg was divided by the "before" mpg to get a mpg ratio of 1.42. The mpg ratio multiplied by the "after" isfc to give the "before" isfc. The isfc we expect before the refurbishing should be around 360 g/kW-h by estimating using figure 20. This isfc translates to a ϕ of 1.4-1.5. This is very rich, but could be valid. The air/fuel ratio (1/ϕ) is approximately 0.7. Using figure 18, that gives CO estimation of 10.4% which would be off the scale. At 10% fuel rich the CO should have dropped to 3.5% after the refurbishing. This was not what was seen in the test.

Conclusions

Many interesting conclusions can be drawn from these tests and analysis. When measuring fuel economy or fuel consumption, even with extreme care, it can be difficult to get precise measurements using real-world tests. The before fuel economy tests varied by 4.6 mpg, and the after tests varied by 3.5 mpg.

The emission data for cruise are not constant with the before tests being more fuel rich than after. The cruise condition was not well defined because we don't know how much the rpm was increased for the cruise test or how that would affect the results. Using the emissions data at idle to scale the results to cruise shows that the CO percentage should have been 7.5%. Using the change in fuel economy and isfc predicted a drop of CO to 3.5%. The measured cruise emissions data cannot be used because it is inconsistent that the after condition of the engine would be running that extremely fuel rich.

From the fuel economy tests showing an increase of about 40% in the average mpg, the engine must be running significantly "less rich" after rebuilding. Plausible numbers that would explain this were developed in the discussion. The increase in temperatures of 15 C from the changes made after the breakdown decreased the mechanical friction by 11%. The carburetor refurbishing was not the only change that would affect fuel economy.

The emissions data show that at idle the engine was running richer during the before test than the after test. The engine wasn't running absurdly richer before. But the relationship at cruise between A/F, λ, ϕ do not scale as they did at idle. Values like A/F = 11.6, $\lambda = 0.79$, and others can give an initial estimate that can be very useful to the owner.

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Appendixes

A- Engine Specifications

B- Carburetor Layout

C- Instruction Sheet

ENGINE SPECIFICATIONS

Type ... Valve-in-Head

Number of Cylinders ... 6

Piston Displacement—
- 216 Engine ... 216.5 cu. in.
- 235 Engine ... 235.5 cu. in.

Bore—
- 216 Engine ... 3½"
- 235 Engine ... $3\frac{9}{16}$"

Stroke—
- 216 Engine ... 3¾"
- 235 Engine ... $3\frac{15}{16}$"

Compression Ratio—
- 216 Engine ... 6.6:1
- 235 Engine ... 6.7:1

Horsepower (S.A.E.)—
- 216 Engine ... 29.4
- 235 Engine ... 30.4

Firing Order ... 1-5-3-6-2-4

Cylinder Block
- Bore Size—
  - 216 Engine ... 3.4995"-3.5015"
  - 235 Engine ... 3.5620"-3.5640"

Crankshaft—
- Number of Bearings ... 4
- Bearing Journal Diameter—
  - Front ... 2.6835"-2.6845"
  - Front—Intermediate ... 2.7145"-2.7155"
  - Rear—Intermediate ... 2.7455"-2.7465"
  - Rear ... 2.7765"-2.7775"
- Thrust Taken ... Rear Intermediate
- End Clearance ... .003"-.009"
- Connecting Rod Journal Diameter ... 2.311"-2.312"
- Journal Out-of-Round ... .001" Max.
- Runout—At Intermediate Journal ... .002" Max.
- Crankshaft Main Bearing—
  - Bearing Clearance ... Selective Fit
  - Undersize Bearings Available ... .002"-.010"-.020"-.030"

Connecting Rod—
- Center to Center Length ... $6\frac{13}{16}$"
- Upper Bearing ... Locked on Pin
- Lower Bearing ... Cast Babbitt
- Bearing Bore Diameter ... 2.3135"-2.3140"
- Connecting Rod Bearing—Lower
  - Bearing Clearance ... Selective Fit
  - Clearance Rod to Crankpin checked at upper half of bearing ... .004"-.012"
  - Clearance Rod to Piston Pin Boss ... .025" Minimum

Piston—
- Diameter Clearance at Skirt—
  - Pass on ... .0015" Feeler
  - Hold on ... .003" Feeler
- Oversize Pistons Available ... .005"-.010"-.020"-.030"-.040"
- Piston Pin—
  - Diameter ... .8645"-.8650"
  - Oversize ... .003"-.005"-.010"
  - Piston Pin Fit ... Thumb Push Fit
- Compression Ring—
  - Quantity ... 2
  - Type: 216 Engine ... Both Taper-Face
    - (1948-49) 235 Engine ... Both Taper-Face
    - (1950-51) 235 Engine ... Upper, Twist-Type, Lower Taper-Face
  - Width: Taper-Face ... .1235"-.1240"
    - Twist-Type ... .093"-.0935"
  - Gap ... .005"-.015"
  - Ring and Groove Clearance ... .0015"-.003"
- Oil Ring—
  - Quantity ... 1
  - Type ... Wide-Slot
  - Width ... .1860"-.1865"
  - Gap ... .005"-.015"
  - Ring and Groove Clearance ... .002"-.0035"
- Ring Gap Spacing ... 120°

Camshaft—
- Number of Bearings ... 4
- Bearing Journal Diameter
  - Front ... 2.0282"-2.0292"
  - Front—Intermediate ... 1.9657"-1.9667"
  - Rear—Intermediate ... 1.9032"-1.9042"
  - Rear ... 1.8407"-1.8417"
- Runout at Intermediate Bearing ... .002" Max.
- Thrust Taken ... By Thrustplate
- Camshaft End Clearance ... .001" to .005"
- Camshaft Bearings
  - Type ... Steel Backed Babbitt Lined
  - Front ... 2.0307"-2.0317"
  - Front—Intermediate ... 1.9682"-1.9692"
  - Rear—Intermediate ... 1.9057"-1.9067"
  - Rear ... 1.8432"-1.8442"
- Bearing Clearance ... .002"-.004"
- Camshaft End Plug
  - Assemble in Crankcase ... Flush to $\frac{1}{32}$" Deep

Intake Valve—
- Lash—Hot—
  - Normal Operation ... .006"-.008"
  - Heavy Duty Operation ... .010"
- Seat Angle ... 30°
- Diameter—Head
  - 216 Engine ... $1\frac{41}{64}$"
  - (1948-49) 235 Engine ... $1\frac{41}{64}$"
  - (1950-51) 235 Engine ... $1\frac{15}{16}$"

Length—Overall—
- 216 Engine .... 6.260"-6.290"
- (1948-49) 235 Engine ..... 6.260"-6.290"
- (1950-51) 235 Engine ..... 6.364"-6.394"

Diameter—Stem .... .3410"-.3417"
Guide Ream .... .3427"-.3437"
Stem to Guide Clearance ...... .001"-.003"
Intake Opens .... 1° A.U.D.C.
Intake Closes .... 39° A.L.D.C.
Intake Period .... 218°
Width of Seat (in head) ...... 3/64"-1/16"

Exhaust Valve—

Lash—Hot—
- Normal Operation .... .013"-.015"
- Heavy Duty Operation ..... .020"

Seat Angle: (1948-49) Engines .. 30°
(1950-51) Engines .. 45°

Diameter—Head:
- (1948-49) Engines .... 1 15/32"
- (1950-51) Engines .... 1 1/2"

Length—Overall:
- (1948-49) Engines .... 4.839"-4.869"
- (1950-51) Engines .... 4.902"-4.932"

Diameter—Stem .... .3400"-.3407"
Guide Ream .... .3427"-.3437"
Stem to Guide Clearance ...... .002" to .004"
Exhaust Opens .... 42° B.L.D.C.
Exhaust Closes .... 9° A.U.D.C.
Exhaust Period .... 231°
Width of Seat (in head) ...... 1/16"-3/32"

Valve Guide—

Extend Above Head—	Intake	Exhaust
216 Engine	1 1/16"	61/64"
(1948-49) 235 Engine	1 1/16"	61/64"
(1950-51) 235 Engine	1"	55/64"

Valve *Lifter*—

Diameter .... .989"-.990"
Clearance Block to Lifter .... Selective Fit

Valve Spring—

Free Length .... 2 1/8"
Lbs. Pressure at 1 1/2" .... 124-140 lbs.

Valve Rocker—

Rocker Shaft Diameter .... .7910"-.7917"
Rocker Arm Bore .... .7922"-.7935"

Timing Gears—

Backlash—
- 216 Engine (Bakelite) ...... .003"-.005"
- 235 Engine (Aluminum) .... .004"-.006"

Crankshaft Gear—

Material .... Steel
Teeth 27
Runout .... .003"

Camshaft Gear—

Material:
- 216 Engine .... Bakelite and Fabric with Steel Hub
- (1948-50) 235 Engine ...... Aluminum with Steel Hub
- (1951) 235 Engine .... Aluminum

Teeth 54
Runout .... .004"

Oil Pump—

Type and Drive .... Driven by Tang on Distributor Shaft
Lbs. Pressure at 2000 RPM .. 14 lbs.

Spark Plugs—

Make, Model, Size:
- (1948) Engines .... AC, 104, 10 mm.
- (1949-51) Engines .... AC, 44-5 Com. 14 mm.

Gap:
- (1948) Engines .... .040"
- (1949-51) Engines .... .035"

Front Engine Mounting—

Support Clearance .... 3/64"-5/64"

Distributor—

Point Gap—
- Readjust .... .018"
- Adjust New Points .... .022"

Point Spring Tension .... 17-21 Ounces

Idling Speed .... 450-500 RPM

Vacuum Reading at Idling Speed .... 17-21 inches

***Fan Belt Adjustment*—**

Deflection Midway Between Pulleys .... 3/4"

Clutch Housing Pilot Hole—

Runout .... .008" Max.

Flywheel—

Runout .... .008" Max.

TORQUE WRENCH SPECIFICATIONS

ENGINE BOLTS AND NUTS

Cylinder Head Bolts .... 70-80 ft. lbs.
Valve Rocker Shaft Support Bolts and Stud Nuts .... 25-30 ft. lbs.
Manifold Center Clamp Bolts .. 15-20 ft. lbs.
Manifold End Clamp Bolts ..... 25-30 ft. lbs.
Connecting Rod Nuts (with oiled threads) .... 40-50 ft. lbs.
Main Bearing Cap Bolts (with oiled threads) .... 100-110 ft. lbs.
Crankcase Front End Plate Screws .... 15-20 ft. lbs.
Timing Gear Cover Screws ..... 6-7 1/2 ft. lbs.
Clutch Housing Attaching Bolts . 45-55 ft. lbs.
Flywheel Mounting Bolts ...... 50-65 ft. lbs.
Oil Pan Flange Bolts .... 6-7 1/2 ft. lbs.
Oil Pan Corner Bolts .... 12 1/2-15 ft. lbs.
Clutch Cover to Flywheel Bolts . 25-30 ft. lbs.
Push Rod Cover Screws .... 6-7 1/2 ft. lbs.
Oil Distributor Cover Screws ... 6-7 1/2 ft. lbs.
Water Pump Attaching Bolts ... 25-30 ft. lbs.
Fuel Pump Attaching Bolts .... 15-20 ft. lbs.
Spark Plugs: (1948) Engines ... 12-15 ft. lbs.
(1949-51) Engines . 20-25 ft. lbs.

Note. Appendix A is pages 6-47 and 6-48 from *Chevrolet Truck Shop Manual: 1948 to 1953 Models*. (1950). USA. General Motors Corporation.

Appendix B

ENGINE ASSEMBLY 6-63

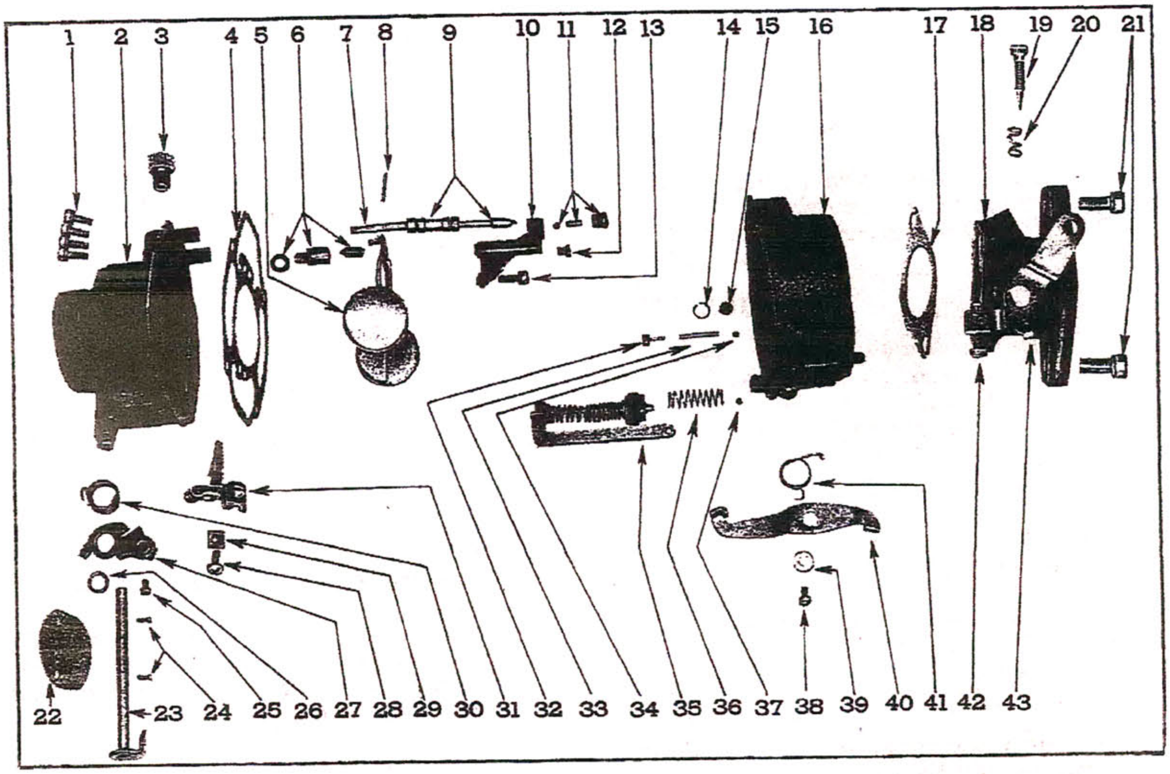


Fig. 83—Carburetor—Layout

1. Screw—Cover Attaching
2. Air Horn
3. Fuel Inlet Fitting
4. Gasket—Air Horn
5. Float
6. Float Needle, Seat, Gasket Assy.
7. Power Spring
8. Float Hinge Pin
9. Power Piston
10. Main Well Support
11. Power Valve Assembly
12. Main Metering Jet
13. Screw—Attaching
14. Retainer—Pump Screen
15. Pump Screen
16. Float Bowl
17. Gasket—Throttle Body
18. Throttle Body Assembly
19. Idle Adjusting Needle
20. Spring—Idle Needle
21. Screw—Throttle Body
22. Choke Valve
23. Choke Shaft
24. Screw—Choke Valve
25. Screw—Choke Lever
26. Retainer—Choke Lever
27. Choke Lever
28. Screw—Bracket
29. Nut—Bracket
30. Spring—Choke Shaft
31. Choke Bracket
32. Guide—Pump Discharge
33. Spring—Pump Discharge
34. Ball—Pump Discharge—3/16 Steel
35. Pump Plunger Assy.
36. Spring—Pump Return
37. Ball—Pump Check—5/32 Aluminum
38. Screw—Throttle Kicker
39. Washer—Throttle Kicker
40. Throttle Kicker
41. Spring—Throttle Kicker
42. Screw—Throttle Valve
43. Throttle Shaft

Note. Appendix B is Figure 83 (p. 6-63) from the *Chevrolet Truck Shop Manual: 1948 to 1953 Models*. (1950). USA. General Motors Corporation.

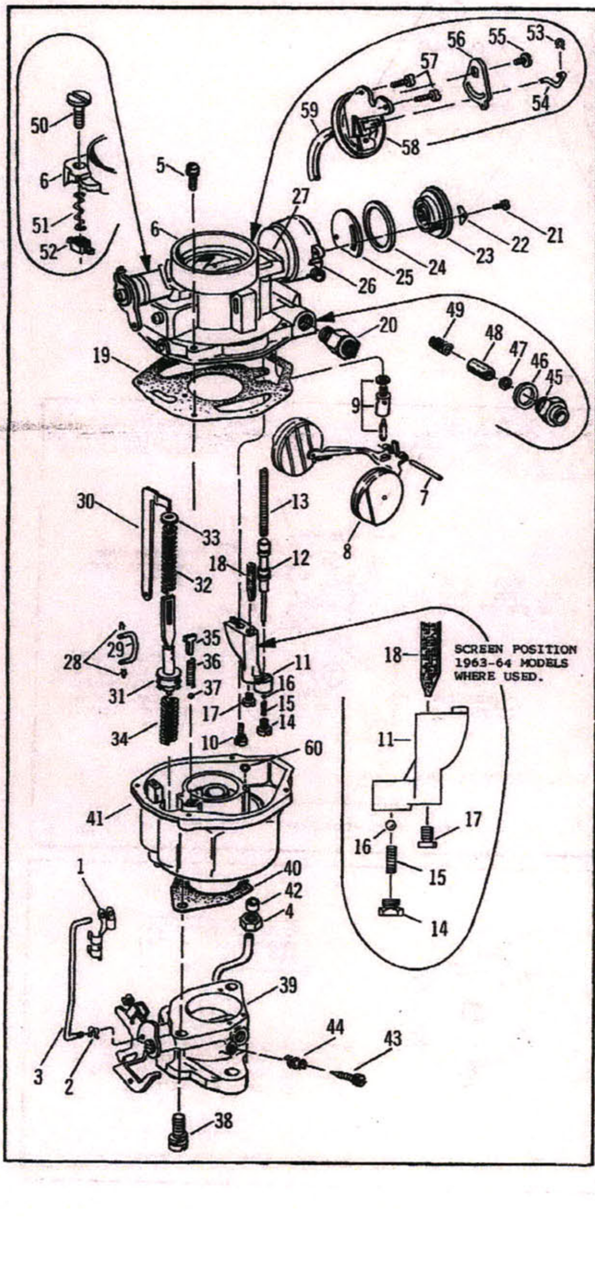
INSTRUCTION SHEET

FORM NO. 50-366

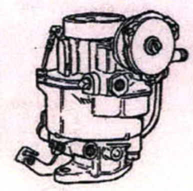
ROCHESTER CARBURETOR – MODELS-"B",-"BC",-"BV".

GENERAL EXPLODED VIEW

THE GENERAL DESIGN AND PARTS SHOWN WILL VARY TO INDIVIDUAL UNITS COVERED ON THIS INSTRUCTION SHEET



MODEL "B"
HAND CHOKE
TYPE.



MODEL "BC"
AUTOMATIC CHOKE
VACUUM PISTON AND
STAT COVER TYPE.

MODEL "BV"
AUTOMATIC CHOKE
VACUUM BREAK TYPE
WITH IDLE VENT VALVE.

DISASSEMBLY

USE EXPLODED VIEW AS A GUIDE. THE NUMERICAL SEQUENCE MAY GENERALLY BE FOLLOWED TO DISASSEMBLE UNIT FAR ENOUGH TO PERMIT CLEANING AND INSPECTION. NOTE: AUTOMATIC CHOKE MODELS USUALLY ONLY REQUIRE REMOVAL OF STAT COVER OR VACUUM UNIT. MANUAL CHOKE (NOT SHOWN) REQUIRES NO DISASSEMBLY. CAUTION: IF CHOKE SHAFT REQUIRES REMOVAL, CHOKE VALVE SCREWS ARE STAKED OVER. STAKING MUST BE FILED OFF BEFORE SCREWS ARE TURNED.

NOMENCLATURE

REF. NO.

1. RETAINER-CHOKE ROD (UPPER)
2. RETAINER-CHOKE ROD (LOWER)
3. ROD-CHOKE
4. NUT-CHOKE SUCTION TUBE
5. SCREW & WASHER-BOWL COVER
6. BOWL COVER ASSEMBLY
7. PIN-FLOAT LEVER HINGE
8. FLOAT & LEVER ASSEMBLY
9. NEEDLE, SEAT & GASKET ASSY.
10. SCREW & WASHER-MAIN WELL SUPPORT
11. SUPPORT ASSY.-MAIN WELL
12. PISTON-POWER
13. SPRING-POWER PISTON
14. PLUG-POWER VALVE
15. SPRING-POWER VALVE
16. BALL-POWER VALVE
17. JET-MAIN METERING
18. SCREEN-MAIN WELL SUPPORT
19. GASKET-BOWL COVER
20. FITTING-FUEL INLET
21. SCREW-STAT COVER
22. RETAINER-STAT COVER
23. STAT COVER & SPRING ASSY.
24. GASKET-STAT COVER
25. PLATE-CHOKE BAFFLE
26. CHOKE HOUSING
27. GASKET CHOKE HOUSING (NOT SHOWN)
28. RETAINER-PUMP LINK
29. LINK-PUMP
30. ROD-PUMP
31. PUMP PLUNGER
32. SPRING-PUMP PLUNGER
33. WASHER-PUMP SPRING
34. SPRING-PUMP RETURN
35. GUIDE-PUMP DISCHARGE BALL
36. SPRING-PUMP DISCHARGE BALL
37. BALL-PUMP DISCHARGE
38. SCREW & WASHER-THROTTLE BODY TO BOWL
39. THROTTLE BODY ASSEMBLY
40. GASKET-BODY FLANGE
41. BOWL-FLOAT
42. PACKING-CHOKE SUCTION TUBE.
43. NEEDLE-IDLE ADJUSTING
44. SPRING-IDLE ADJUSTING NEEDLE
45. FITTING-FUEL INLET
46. GASKET-FUEL INLET FITTING
47. GASKET-FUEL FILTER
48. FILTER-FUEL INLET
49. SPRING-FUEL INLET FILTER
50. VALVE-IDLE VENT (BV)
51. SPRING-IDLE VENT VALVE (BV)
52. NUT-IDLE VENT VALVE (BV)
53. RETAINER-VACUUM CONTROL ROD (BV)
54. ROD-VACUUM CONTROL (BV)
55. SCREW-STAT ROD LEVER (BV)
56. LEVER-STAT ROD (BV)
57. SCREW-VACUUM CONTROL ATTACHING (BV)
58. VACUUM BREAK CONTROL (BV)
59. HOSE-VACUUM BREAK CONTROL (BV)
60. O-RING-VACUUM CHANNEL TUBE (PARTIAL-STARTING 1965 MODELS)

CLEANING

CLEANING MUST BE DONE WITH CARBURETOR DISASSEMBLED. SOAK PARTS LONG ENOUGH TO SOFTEN AND REMOVE ALL FOREIGN MATERIAL. USE (1) A CARBURETOR CLEANING SOLVENT, (2) LACQUER THINNER OR (3) DENATURED ALCOHOL. MAKE CERTAIN THE THROTTLE BODY IS FREE OF ALL HARD CARBON DEPOSITS. WASH OFF IN SUITABLE SOLVENT. BLOW OUT ALL PASSAGES IN CASTING WITH COMPRESSED AIR AND CHECK CAREFULLY TO INSURE THOROUGH CLEANING OF OBSCURE AREAS. CAUTION: DO NOT SOAK RUBBER, LEATHER OR PLASTIC PARTS IN SOLVENT.

REASSEMBLY

REASSEMBLE IN REVERSE ORDER OF DISASSEMBLY. NOTE SPECIAL INSTRUCTIONS AND FOLLOW NUMERICAL OUTLINE IN MAKING ADJUSTMENT. SEE OTHER SIDE.

SPECIAL INSTRUCTIONS

PLUNGER (31) REMOVE PAPER SLEEVE FROM LEATHER CUP IF USED. FLEX LEATHER OUTWARD SLIGHTLY. SOAK CUP IN GASOLINE, KEROSENE OR OIL FOR A FEW MINUTES PRIOR TO PLACING IN CARBURETOR.

WHEN INSTALLING THE IDLE ADJUSTING NEEDLE, LIGHTLY BOTTOM THEN BACK OUT 1 1/2 TURNS.

WHEN INSTALLING MAIN WELL SUPPORT NO. 11, MAKE CERTAIN THE POWER PISTON NO. 12 MOVES FREELY IN VACUUM CYLINDER AND OPENS POWER VALVE BALL CHECK NO. 16.

PUMP ROD SETTING
MODEL "B" - 1963 PONTIAC TEMPEST L-4 OUTER HOLE
MODEL "BC" - 1963 PONTIAC TEMPEST L-4 INNER HOLE

SPECIAL INSTRUCTIONS

"BV" VARIATIONS ON CHOKE ROD SETTING. (SEE FIG. 5, PAGE 3)

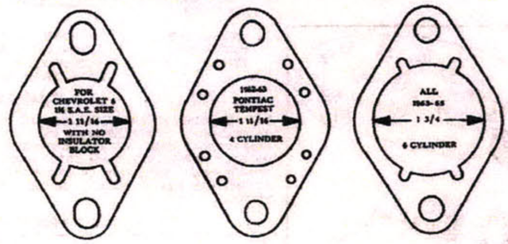
LEANER SETTING CAN BE MADE BY HAVING THE ROD SLIDE FREELY INTO THE HOLE.

RICHER SETTING. EQUIVALENT TO 2 NOTVHES RICH. CAN BE MADE BY HAVING THE ROD END 2 ROD DIAMETERS ABOVE THE HOLE.

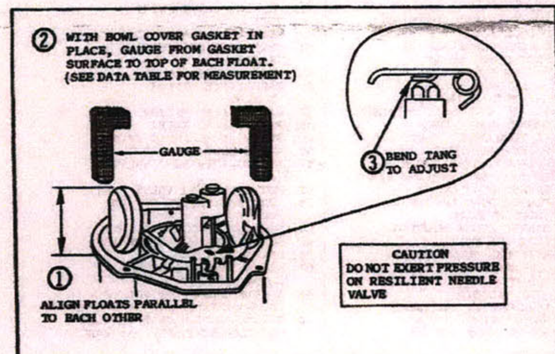
NOTE: AFTER MAKING ANY CHANGES IN CHOKE ROD LENGTH, CHECK FOR FREE OPERATION, AS INTERFERENCE MAY EXIST AT THE MANIFOLD END OF THE ROD. MAKE SURE THAT IT IS POSSIBLE FOR THE CHOKE VALVE TO FULLY CLOSE AT THE NEW SETTING.

FLANGE GASKET DATA

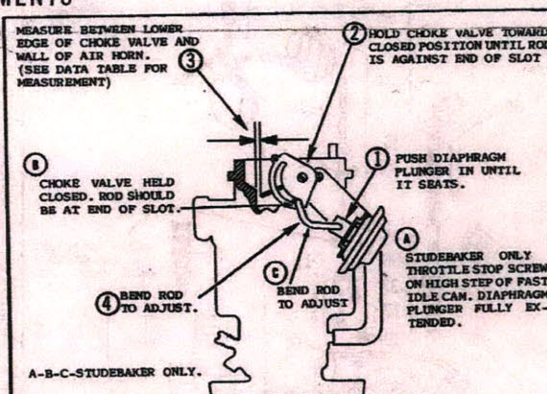
MEASURE STUD CENTERS TO IDENTIFY S.A.E. SIZE
2 11/16" STUD CENTERS = 1 1/4" S.A.E. FLANGE SIZE
2 15/16" STUD CENTERS = 1 1/2" S.A.E. FLANGE SIZE
CHEVROLET 6 CYL. (ALSO PONTIAC 6-CANADA) WITH HEAT INSULATOR BLOCK DOES NOT REQUIRE A FLANGE GASKET.



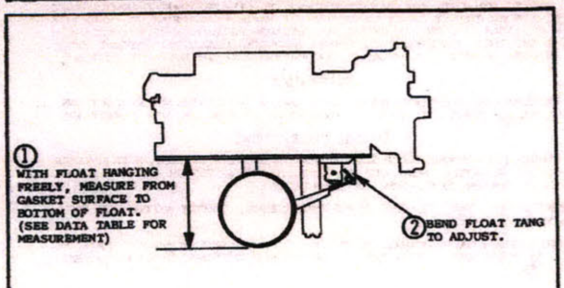
ADJUSTMENTS



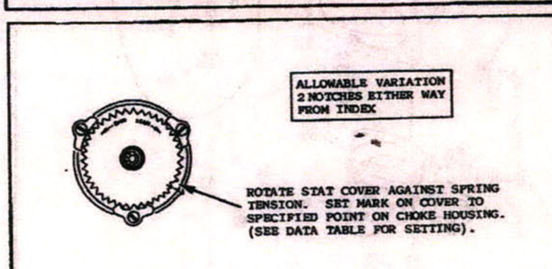
FLOAT LEVEL ADJUSTMENT Fig. 1



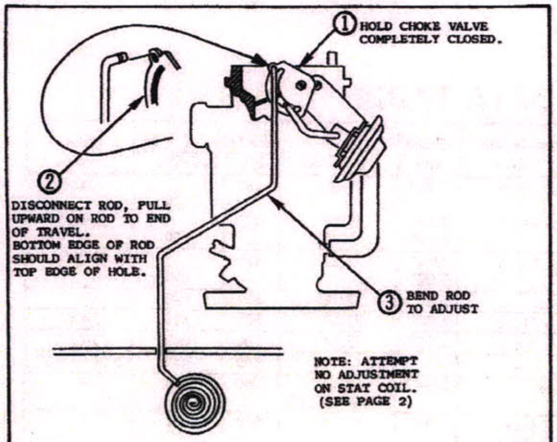
VACUUM BREAK ADJUSTMENT - "BV" TYPE Fig. 3



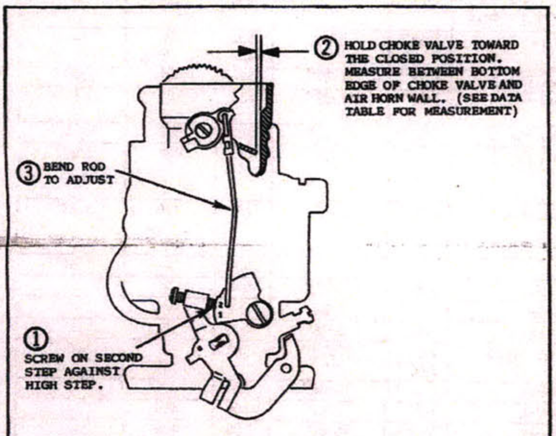
FLOAT DROP ADJUSTMENT Fig. 2



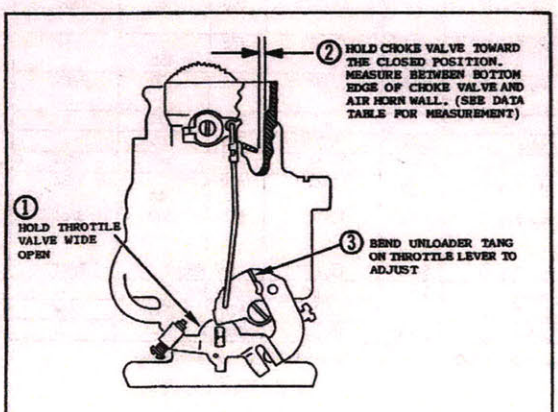
AUTOMATIC CHOKE ADJUSTMENT - "BC" TYPE Fig. 4



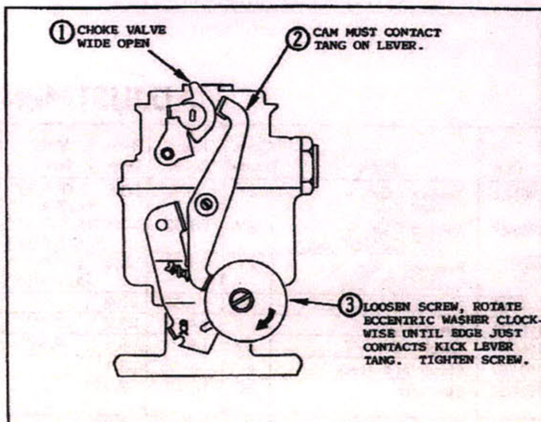
AUTOMATIC CHOKE STAT ROD ADJUSTMENT - "BV" TYPE. Fig. 5



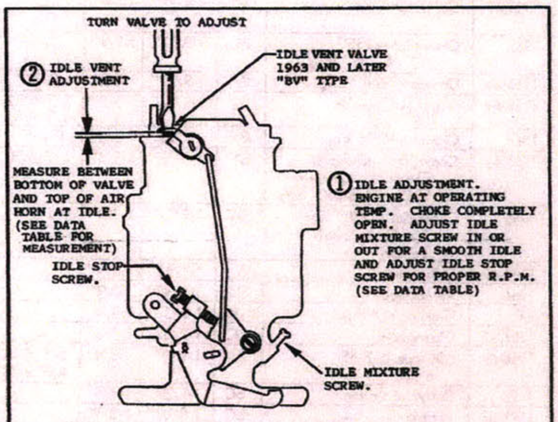
CHOKE ROD ADJUSTMENT Fig. 6



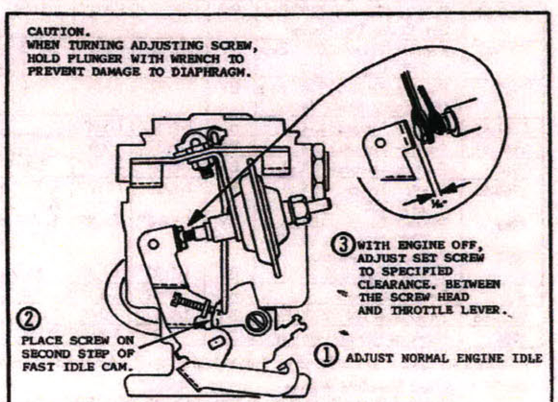
CHOKE UNLOADER ADJUSTMENT Fig. 7



MANUAL CHOKE POSITIVE IDLE STOP ADJUSTMENT
1961-63 PONTIAC TEMPEST 4 CYLINDER. Fig. 8



IDLE AND IDLE VENT ADJUSTMENT
ON CAR ADJUSTMENTS. Fig. 9



SLOW CLOSING THROTTLE CONTROL ADJUSTMENT
1961-63 PONTIAC TEMPEST 4 CYL. WITH AUTOMATIC TRANSMISSION Fig. 10

Note. Appendix C contains select pages from *Instruction Sheet: Rochester Carburetor – Models -"B", -"BC", -"BV"*. (1982). USA.