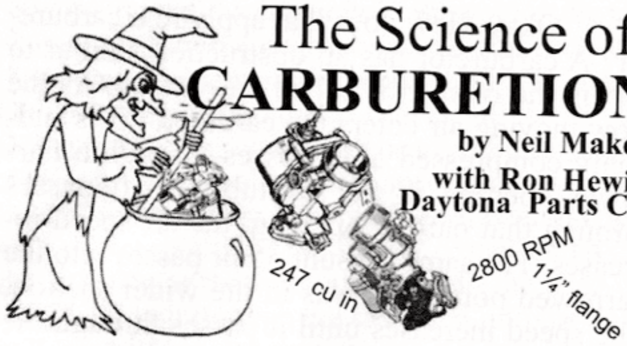
The Science of CARBURETION

by Neil Maken
with Ron Hewitt
Daytona Parts Co.



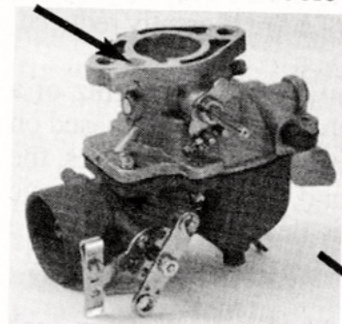
Carburetion is a science. To fully understand how a carburetor works, what the variations and exceptions are, and how to properly and correctly match a carburetor to a particular engine means experiencing thousands of carburetors and their applications over many years. Several companies specialize in carburetors. Just carburetors. And they've been doing it for years. They could regale you for hours with carburetor stories. There is no possible way that we can make you expert within these pages.

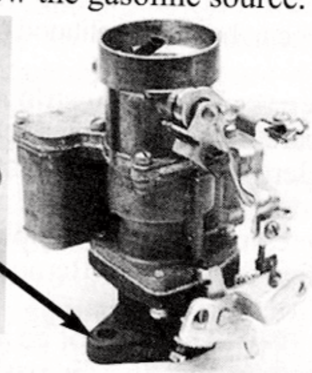
What we can do is show you the basics and give you hints on rebuilding and adjusting your carburetor – and we've been doing this for years; see our series on carburetors, Orest's Carburetor School, beginning in the February 2011 issue of *Skinned Knuckles* and continuing through the October 2012 issue. Plus, throughout the years we have looked at almost every type of carburetor used on our old cars and trucks.

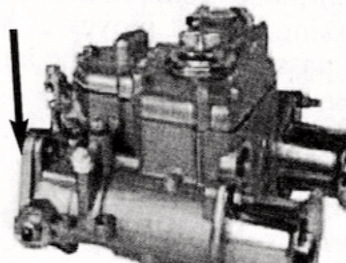
Let's very briefly cover what a carburetor is and what the principles of its operations are. Liquid gasoline will not burn in our engines. Our cars and trucks were designed to use a mixture of vaporized fuel and air. The ratio of gas to air is critical. Too much air and the mixture is known as 'lean,' and too little air and the mixture is 'rich.' Neither one is good for optimum performance and can actually hurt the engine.

> In an ideal situation, the ratio of air to gasoline would be 14.7 parts air to 1 part gasoline. That's ideal, but in practice it doesn't happen. Whereas gasoline's Stoichiometric Fuel/Air Mixture is 14.7:1, ethanol is 9:1. Ethanol already carries oxygen in the alcohol molecule - that's why, when adding it to gasoline the fuel is now called 'oxygenated.' The percentage of alcohol mixed with gasoline automatically alters the 14.7 Stoichiometric Fuel/Air Mixture. Plus, of course, that figure assumes an absolutely 100% efficient engine. That doesn't exist.

Essentially, there are three primary types of carburetors: the downdraft carburetor, the updraft carburetor and the sidedraft carburetor. The downdraft carburetor, found primarily on cars and trucks after the early 1930s, sits above the intake manifold, and the fuel/air mixture feeds downward into the intake manifold. The sidedraft carburetor is not commonly found on automobile engines. Today it is fairly often used for small engines like lawn mowers or on special-application auto engines. The updraft carburetor was a very common application for cars and trucks before the early '30s, but was used on quite a number of truck applications up into the 1950s. It would be mounted below the intake manifold and often below the gasoline source.







Clockwise from top left:
1) updraft carburetor,
2) downdraft carburetor,
3) sidedraft carburetor

Designation indicates the position of the mounting flange (arrow) in relation to the intake manifold.

Updraft, sidedraft, or downdraft has little to do with how the fuel gets to the carburetor. It was not unusual, for example, for fuel to reach an updraft carburetor directly by gravity (Model T Fords and Model A Fords are two very good examples), through an intermediary fuel reservoir (a vacuum tank is a good example) or through a mechanical, and later an electric, fuel pump. All systems worked, and all had their own strengths and weaknesses.

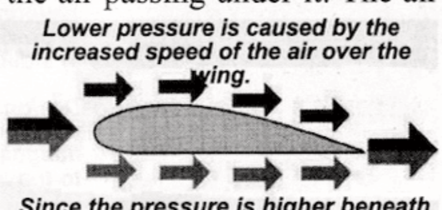
Starting an engine with an *updraft* carburetor should entail use of the choke rather than the throttle. A rich mixture is required to start a (cold) engine. By pumping the accelerator pedal, gas flows into the carb body, and if the amount of fuel is too great, it will run out the overflow or directly out of the air intake throat. This could be dangerous, especially if an air cleaner or flame arrestor is mounted on the throat of the carburetor. That 'puddle' of gas could ignite in the case of a backfire through the carburetor.

The better choice is to use the choke in starting. By closing the choke butterfly, the rich mixture is sucked into the combustion chamber providing a very rich mixture for initial starting.

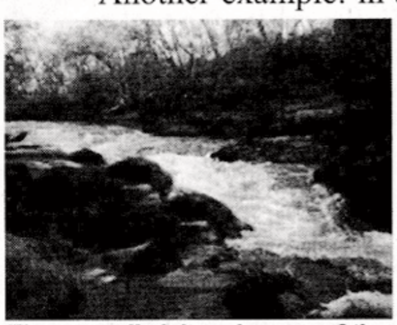
This applies to an updraft or sidedraft carburetor. With a downdraft carb, the excess fuel flows into the intake manifold. Flooding could occur, but the likelihood of a fire is greatly reduced.

When you strip away all of the glitz of a carburetor, it is a relatively simple device based on Bernoulli's principle that the faster air moves, the lower its static pressure and the higher its dynamic pressure. Sounds complicated. Let me give you a few examples of Bernoulli's theorem:

The wing of an airplane is curved in such a way that the air passing over it moves at a faster rate than the air passing under it. The air pressure on top of the wing is lower than under it. The higher pressure keeps the plane up.

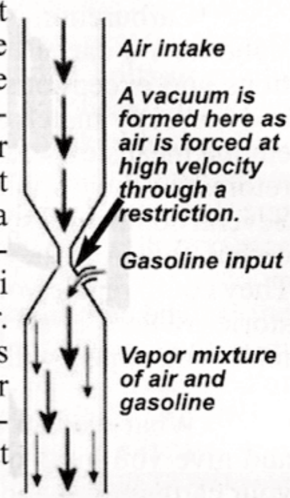


Another example: in a river the flow of water is leisurely, until it comes to a narrow spot. There the water is forced to flow through a narrower passage and the flow speeds up. As it passes the narrow area it slows down again to its normal leisurely pace.



The normally leisurely pace of the river is disrupted by a narrowing. The same amount of water passes through the narrow area as in the wider areas, but the flow is much faster.

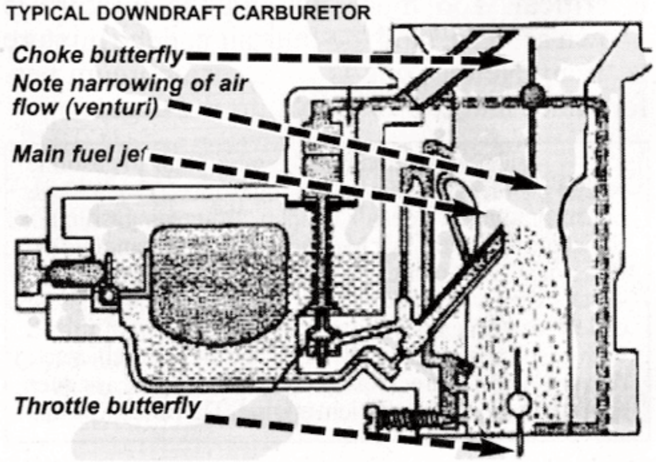
Okay. How does that apply to a carburetor? A carburetor has an obstruction similar to that in the river. It is called the venturi. As the slow moving air enters the carburetor it is suddenly compressed as it passes through a narrower opening in the air tube. As it passes through that narrow opening, the air speed increases. The same amount of air passes into the narrowed portion as was in the wider section. The speed increases until it passes through the narrow passage, and as it enters the wider section the speed slows down but the pressure increases. A vacuum is formed as the air fills the space, and that vacuum 'sucks' fuel from a small tube (the main discharge jet) in the venturi and mixes it with the air. The main discharge jet's other end fits in a reservoir of fuel which is continuously filled through a float system.



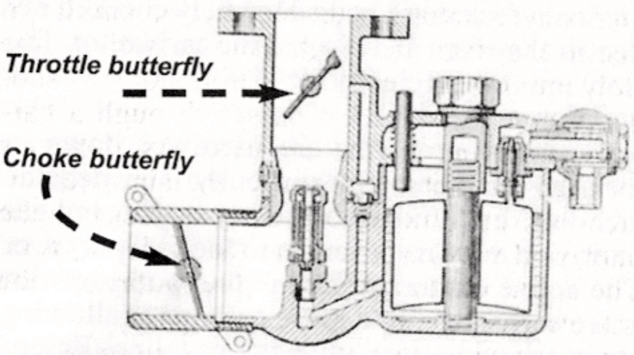
The amount of air allowed into the venturi is controlled by a butterfly valve known as the 'choke.' The more air, and the faster that it passes through the narrow segment of the venturi, the more fuel that the air flow 'sucks' out of the main discharge jet. A second butterfly valve – the throttle - allows more or less air/fuel mixture into the intake manifold of the engine.

Despite the amount of air coming into the venturi, the fuel is still a measured amount. At

TYPICAL DOWNDRAFT CARBURETOR



TYPICAL UPDRAFT CARBURETOR

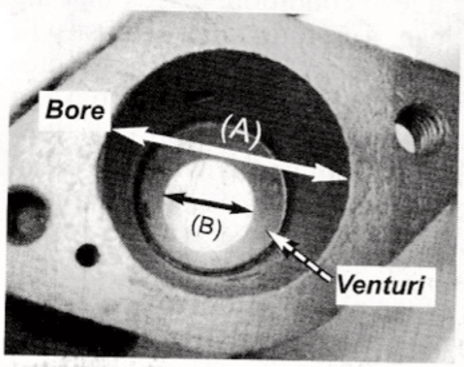


idle, a separate circuit takes over supplying the minimal amount of fuel needed for idle. Upon rapid acceleration, a separate circuit, called an accelerator pump, forces more fuel into the system until the air/fuel mixture can catch up and maintain the added demand.

The carburetor is a lot more complicated than that, consisting of metering valves, air tubes, check valves, accelerator pumps, needle valves and much more, but the basic principle remains: the flow of air mixes with a certain amount of fuel and converts it to a vapor which is burned in the cylinders.

Each engine varies. Each has its own requirement for the amount of air/fuel that it needs to use effectively. That is the reason that there are thousands of variations in brands, models and specifications of carburetors.

Let's get several fallacies out of the way immediately. First of all, just because a carburetor fits the mounting flange does not mean that it is the right carburetor for that engine. Second, the flange or bore opening does not have anything to do with the venturi size. Finally, even though a particular brand and model of carburetor is specified for a particular engine, the internal components of that carburetor (venturi size, jet sizes, float levels, etc.) could have been designed for a similar engine and may not be correct for your engine.



It is evident in this photo that the venturi size and the bore size differ. The bore size is the opening in the flange (A) while the venturi is a narrowing in the bore (B). Throttle disc is removed for photo clarity.

There are five standard updraft flange one-barrel sizes (plus a number of lesser-used variations), but as indicated, the flange size is not the only, or even the primary, indicator that a carburetor is correct for a particular engine.

FLANGE SIZES

(from The Gasoline Motor by P.M. Heldt, 1920)

S.A.E Size	Center-to-Center Mounting Holes	Bore Size	Carb Size
1/2"	1 11/16"	1 ¼"	
5/8"	1 13/16"	1 7/16"	
3/4"	2 1/8"	1 5/8"	
7/8"	2 1/4"	1 ¾"	
1"	**2 3/8"**	**1 7/8"**	**#1**
1-1/8"	2 3/8"	2" *	
1¼"	**2 11/16"**	**2 3/16'**	**#2**
1-3/8"	2 11/16"	2 5/16" *	
1½"	**2 15/16"**	**2 ½"**	**#3**
1¾"	**3 5/16"**	**2 13/16"**	**#4**
2"	**3 9/16"**	**3 ½"**	**#5**

BOLD TYPE - standard sizes * interpolated

There is a greater variation in downdraft carburetors, single, two, and four barrel flange sizes and configurations.

As indicated, the flange size has little to do with the venturi size (although it is obvious that if the engine requires a 2½" venturi, a size #1 carburetor will not suffice). There are air consumption charts which determine, based on the cubic displacement of the engine and RPM, how much air is required for optimum performance. (See pages 40-42) The volumetric efficiency is determined by the size of the engine (cu. in.) and by RPM. Merely putting a larger carburetor on the engine is not going to necessarily improve performance.

In addition to flange size, there is another variable that has to be considered. Early auto manufacturers - let's say, up to about 1930 or so - used a variety of bolt patterns. So although the flange size might be correct, the bolt pattern may be less-than-common. Often, because of space limitations or other engineering demands, adapter flanges were used to mount the carburetor in a vertical, horizontal, 45° or other position. After 1930 bolt patterns became more standardized.

There are a number of reasons for replacing, rather than rebuilding, a carburetor. Physical damage is a main one. If any part of the casting is broken, cracked or otherwise damaged, it should be replaced. Modifications to the engine is another reason. Increasing the cubic capacity of the engine requires that the carburetor be re-engineered to work properly with those modifications. Changing or replacing an engine with a different size or style is another reason. You cannot properly guess at what size carburetor you need. I'll repeat, "Carburetion is a science." It is time to toss the problem into the laps of the experts.

Generally the simplest way to solve a carburetor problem is to purchase a new, correctly sized and constructed carburetor to fit your engine. A lot of factors will be considered: engine size, engine use, type of carburetor required, and flange size. The flange size is often one of the least important factors. A variety of adaptors are available, or can be constructed, to fit a certain carburetor to an intake manifold.

Before we get to the types and options of a replacement carburetor, let's look at the most common problems associated with 'fuel delivery.'

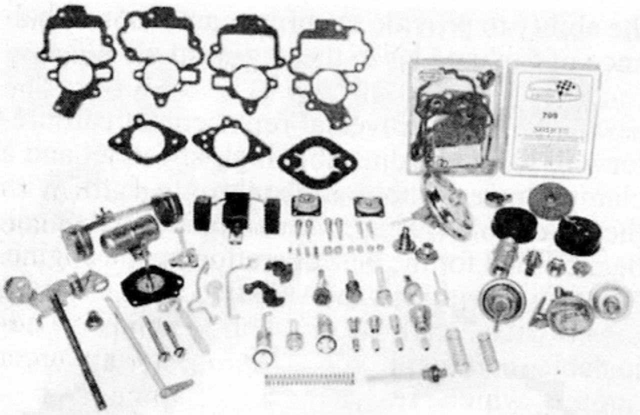
Please keep in mind that "most carburetor problems are electrical." Sure sounds like an oxymoron. Carburetors are mechanical, and as such are (generally) either good or bad. But if inadequate electricity reaches the spark plugs, the fuel supplied by the carburetor will not burn. Before blaming the carburetor, everything, I mean everything, within the electrical circuit must be checked and found to be in perfect condition. Please re-read the second half of From My Perspective in the May issue of *SK*. I, too, despite the warnings from Ron Hewitt of Daytona Parts Company, felt that I had adequately checked my electrical system and blamed the carburetor. The problem(s) were electrical!

If the problems are narrowed down to fuel, the most common difficulty is inadequate fuel delivery. It might be a dirty or plugged gas filter, or a dirty filter screen in the fuel pump, or a defective diaphragm in the fuel pump, or dirt in the carburetor, or a loose carburetor allowing too much air to mix with the gasoline. Essentially minor problems.

Many years ago I was on an antique car tour which took us along a dry river bed with roads extremely rough and rutted. All of the cars were well bounced around. That evening, on the way to the club's banquet, my engine died. It would start right up but would not run. I naturally thought of the worst possible problems, but my (automotively) naïve daughter suggested that the bouncing around may have caused the problem. I ignored her. It turned out that she was absolutely correct. Some crud in the gas tank must have broken loose and something plugged the high speed jet. The car would start because the idle jet was clear, but the blockage prevented the second jet from operating.

Before blaming the carburetor, re-read the article on fuel pumps in the April issue of *SK*. Check to be sure that adequate fuel is being delivered by the fuel pump to the carburetor. Then, if all proves well with the fuel pump, check that the mounting bolts on the carburetor are tight and that the gasket between the carb flange and the intake manifold is not leaking. If it has been crushed or cracked, too much air will enter the system causing a lean condition. Check that the air cleaner is clean. Too much dirt or dust will prevent adequate air from entering the carburetor. Finally, if the jets are accessible from the outside of the carburetor, remove each and check that they are clear (do not use a drill bit to clean the jet because it is too easy to change the jet's size by mistake).

If none of the above solutions work, you may want to try to open the carburetor and try to



A Daytona Parts Company rebuilding kit will contain everything you need to rebuild your particular carburetor. Since there may be variations available for a particular model carb, there may be more than one type of part in each kit so that you have the right part for your carburetor.

locate the problem. Before you begin to disassemble the carburetor though, purchase a rebuilding kit from Daytona Parts Company (see their ad on page 43). Many of the gaskets are extremely thin and delicate and will tear or break when removed. You will need new gaskets and possibly an improved needle valve and seat which will be found in the rebuilding kit.

Check the float bowl first for signs of dirt or rust. If you find evidence of loose rust or other dirt particles, there is a very good chance that a small piece has entered one of the tiny passages within the carburetor and is impairing the carb's operation.

Follow the precise directions that came with the rebuilding kit. Disassemble and clean every single part. Make careful notes as you proceed. The carburetor contains many parts that can easily be lost or incorrectly re-installed. Compressed air will clear the passages within the carburetor. Clean everything! Don't take any shortcuts. If you cannot remove a jet or other fitting within the carburetor, don't force it. You will cause more damage. The brass screws and jets within the carb are delicate, and trying to force them with a screwdriver will strip the slot but will not get the screw removed. It is a job for a professional carburetor shop; one with knowledge and experience with your type of carburetor.

Editor's note: I had a discussion with Mr. Hewitt of Daytona Parts Company some time ago, and I asked him if those 'frozen' brass fittings could be removed. "Not a problem for us," replied Ron. "After disassembling everything that we can, we use a very powerful ultrasonic cleaner which removes even dirt and corrosion which cannot be seen by the naked eye. Generally that solves the problem. If not, we can use extreme cold or localized heat to free the part. We'll get it out."

That's fine, for as far as it goes. But what if the car is missing a carburetor, or the existing carburetor has problems which you are not able to remedy?

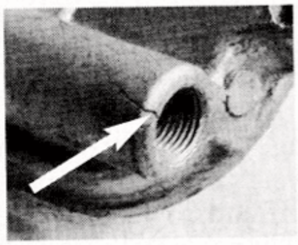
As the carburetors age - and many of them are already 70, 80 or 90 years old, replacement parts are getting more difficult ro locate. The early zinc cast (white metal or pot metal castings) simply wear out. When you stop to think about the thousands of start-up auto manufacturers which abounded in the 'teens and 'twenties, many of which were building cars on a super-tight budget, they often used less than top-quality parts. Carburetors were a perfect example.

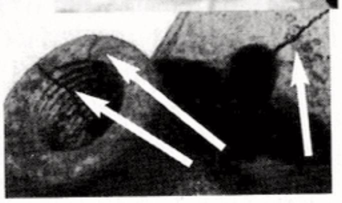
Editor's note: In January, 1931 Chrysler introduced a new model 6-cylinder car. They called it the CM series. When first introduced the engine was fitted with a Stromberg UR-2 carburetor. Stromberg was an old and respected name in carburetors, but they were - as were many other manufacturers - experimenting with die-casting. The science of metallurgy was not nearly as far a long as it would be just a few years later, and many problems began to show up with the white metal parts. Today we realize that 'pot metal' does not have the longevity or stability of cast iron, bronze or brass. But at the time it was a quick way to manufacture parts inexpensively.

Within just a couple of months, Chrysler switched from the Stromberg UR-2 carburetor to a cast iron Carter BB1a carburetor.

The January 1931 edition of the CM owner's manual pictured the Stromberg carb. I know of one car built in April 1931 which was fitted with a Stromberg. The April 1931 edition of the CM owner's manual pictured the Carter carburetor, and my own CM (built in May 1931) was fitted with the Carter.

As many of the early die-cast carburetors age, the metal becomes unstable, brittle, warps, cracks or becomes porous. They are simply unsafe to use. Cast iron, too, has a tendency to crack. Welding is not generally a practical solution.

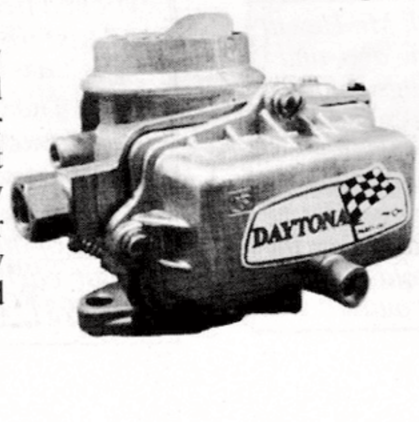




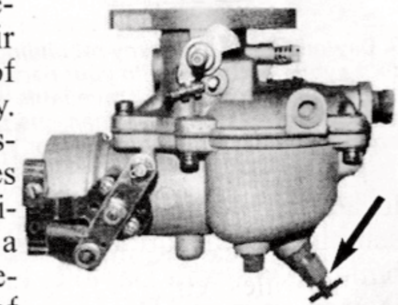
Even better quality brand-name carburetors are suffering today from the inability to get parts. A perfect example is the Carter BB1a updraft carburetor. It is a great carb. It's highly in demand because of its reliability, and it is often used as a replacement carburetor for many applications (the BB1 was made in a tremendous variety of internal configurations to suit the engine to which it was going to be fitted). The accelerator pump in the BB1 is metal - brass - and replacements are simply not available. That's one of the reasons that a Carter BB1 updraft (the BB was also made as a downdraft carburetor for years) is in such high demand and often commands unrealistically high prices.

That is one of the very serious drawbacks in attempting to replace an original carburetor with the same make/model. If the carb from your car has begun to suffer from 'old age' ailments - cracking or disintegrating pot metal, or broken hard-to-find parts, etc, those carburetors that you might find probably have the same or similar problems, and if not, more than likely command extremely high prices.

What is the answer? A new replacement carburetor. As stated earlier, just because a carburetor fits the mounting flange does not mean that it will work efficiently with your engine. The carburetor has to have the correct air flow standards, the correct jet sizes and the ability to provide the proper amount and balance of fuel and air to the engine at all RPMs.



An ideal universal replacement carburetor will have an adjustable high-speed jet and a clamp-type assembly on the throttle shaft. With the adjustable main jet, the air/gas mixture can be modified for the best operation on the engine. Again, you will not be satisfied with a small, low-capacity carburetor, even if it has an adjustable main jet, if you try to use it on a larger engine which requires more air than the venturi of the carb can supply. The clamp-type assembly provides much greater flexibility in fitting a universal carburetor to a variety of automotive throttle set-ups.



An adjustable main jet (arrow) is an extremely desirable feature on a universal replacement carburetor.

This is where I (we) turn to a carburetor expert like Ron Hewitt. Ron owns Daytona Parts Company; he lives and breathes carburetors. He has probably forgotten more than I will ever know about them. My recommendation is that you discuss your carburetor problem with him. He will hit you with a bunch of questions: type of car, type of engine, cubic displacement, special use (is the vehicle used for street driving? racing? heavy hauling?) and others. Then he can recommend a suitable replacement carburetor based on your engine's needs. Generally, updraft carburetor replacements are available for displacements up to about 300 cu. in. In some cases, a special mounting flange might have to be used because of an oddball flange size or mounting configuration, but that's the exception rather than the rule.

Daytona Parts Company is a distributor of new Zenith carburetors. Zenith has been in the carburetor business about 100 years, and has always been considered a quality product. A new Zenith updraft carburetor is probably available for your application. And the cost will be somewhere around what a complete professional rebuild would cost.

We are advocates of authenticity. It is our credo and our hallmark. But safety pre-empts everything else. If a carburetor (or fuel pump, or fuel line, or gas tank) leaks or is defective, it must be repaired or replaced. There are no two ways about it! A gasoline fire is disastrous. It happens fast, it happens hot, and there often isn't time to react and save the car (not to mention lives).

To this point, we have been discussing (primarily) updraft carburetors. Almost everything written about updraft applies to the later downdraft carburetors as well. With newer engines there are often many more variables that can be engineered into a downdraft carburetor: multi-barrels, vacuum assists, even starter switch assemblies can be incorporated onto the carb. But the rules remain the same: how big (cu. in.) is the engine, what is the rated horsepower, what RPMs does it run at, how much air does it require for maximum efficency and proper operation? Then, of course, come flange size, bolt configuration, and all of the other things that we have been discussing for updrafts.

Zenith makes a line of replacement downdraft carburetors, too. Again, don't try to just find something that fits. Ask Daytona to help determine your specific needs. It will save a lot of aggravation in the future.

Okay, here it gets a little technical. As indicated, two major factors are used in determining the correct carburetor. Engine revolutions per minute (RPM) and cubic displacement in inches of the engine (cu. in./CID) Most likely the displacement can be found in the owner's manual. If the cu. in. is not given, the bore and stroke will be supplied, or can be found in a copy of Motor's Manual or Chilton's Manual. Please refer to the charts on the following pages. One page is for four (and eight) cylinder engines, and the other is for six (and twelve) cylinder engines. Locate the cylinder bore size in the column on the left side of the page, and the stroke along the top of the page. Where the two columns intersect is the cubic displacement in inches. The third chart offers air consuption. Locate the cu. in. displacement in the left column, the rated RPM across the top and where the columns intersect is the air consumption. The chart is rated at 75% Volumetric efficiency. It is extremely unlikely that any engine is going to approach the 100% efficiency figure. Typically, a mid-1920s and later engine will be somewhere around 75% as indicated on the chart which follows..

A formula for determining the needed cubic feet per minute of air is:
CFM= (cu. in. x RPM)/(1728 x 2) x VE
CFM represents Cubic **FEET** per minute
cu. in. represents Cubic **INCHES**
RPM revolutions per minute (intake is on every other revolution of the crankshaft)

To convert cubic INCHES to cubic FEET means a factor of 1728 (a cubic foot is 12"x12"x12" = 1728 cubic inches), and the number 2 represents the fact that intake is only on every other rotation of the crankshaft.

Let's consider a 1928 Buick 6 cylinder engine with a bore of 3½" and a stroke of 5". According to the chart on page 41, the displacement is 289 cu. in. The engine is rated at 3,200 RPM. The printed chart assumes a volumetric efficiency of 75%

The required cubic feet of air for that engine would be:

(289 x 3200) divided by (1728 x 2) times 75%
(924,800/3456) x .75 = **200.7 cu. ft. per minute**

S.K.

Please continue to the **piston displacement** *and* **air consumption/flow charts** *on the following pages.*

Piston Displacements in Cubic Inches for 4-Cyl. Motors

For 8-Cylinder Motors, Multiply Given Displacement by 2

Cylinder Bore in Inches	STROKE IN INCHES																												
	3	3⅛	3¼	3⅜	3½	3⅝	3¾	3⅞	4	4⅛	4¼	4⅜	4½	4⅝	4¾	4⅞	5	5⅛	5¼	5⅜	5½	5⅝	5¾	5⅞	6	6¼	6½	6¾	7
2½	59	61	64	66	69	71	74	76	79	81	83	86	88	91	93	96	98	101	103	106	108	110	113	115	118	123	128	132	138
2⅝	65	68	70	73	76	79	81	84	87	89	92	95	97	100	102	106	108	111	114	116	119	122	124	127	130	135	140	146	152
2¾	71	74	77	80	83	86	89	92	95	98	101	104	107	110	113	116	119	122	125	128	131	134	137	140	143	148	154	160	166
2⅞	78	81	84	88	91	94	97	101	104	107	110	114	117	120	123	126	130	133	136	140	143	146	149	152	156	162	169	175	182
3	85	89	92	95	99	103	106	110	113	117	120	124	127	131	134	138	141	145	148	152	156	159	163	166	170	177	184	191	198
3⅛	92	96	100	104	107	111	115	119	123	127	130	134	138	142	146	150	153	157	161	165	169	173	176	180	184	192	199	207	214
3¼	100	104	108	112	116	120	124	129	133	137	141	145	149	153	158	162	166	170	174	178	183	187	191	195	199	207	216	224	232
3⅜	107	112	116	121	125	130	134	139	143	148	152	157	161	165	170	175	179	183	188	192	197	201	206	210	215	224	233	242	251
3½	115	120	125	130	135	140	144	149	154	159	164	168	173	178	183	188	192	197	202	207	212	217	221	226	231	241	250	260	269
3⅝	124	129	134	139	145	150	155	160	165	170	176	181	186	191	195	201	206	211	217	222	227	232	237	243	248	258	268	279	289
3¾	133	138	144	149	156	160	166	171	177	182	188	193	199	204	210	215	221	226	232	237	243	249	254	260	265	276	287	298	309
3⅞	142	147	153	159	165	171	177	183	189	195	200	206	212	218	224	229	236	242	248	253	260	265	271	277	283	295	307	318	330
4	151	157	163	170	176	182	189	195	201	207	214	220	226	233	239	245	251	258	264	270	277	283	289	295	302	314	327	339	352
4⅛	160	167	174	180	187	194	201	207	214	221	227	234	241	247	254	261	267	274	281	287	294	301	307	314	321	334	348	361	374
4¼	170	177	184	191	199	206	213	220	227	234	241	248	255	262	269	277	284	291	298	305	312	319	326	333	340	355	369	383	397
4⅜	180	188	195	203	211	218	226	233	241	248	256	263	271	278	286	293	301	308	316	323	331	338	346	353	361	376	391	406	421
4½	191	199	207	215	223	231	239	247	255	262	270	278	286	294	302	310	318	326	334	342	350	358	366	374	382	398	414	429	453
4⅝	202	210	218	227	235	244	252	260	269	277	286	294	302	311	319	328	336	344	353	361	370	378	386	395	403	420	437	454	470
4¾	213	222	230	239	248	257	266	275	284	292	301	310	319	328	337	346	354	363	372	381	390	399	408	416	425	443	461	478	496
4⅞	224	233	243	252	261	271	280	289	299	308	317	327	336	345	355	364	373	383	392	401	411	420	429	439	448	467	485	504	523
5	236	245	255	265	275	285	295	304	314	324	334	344	353	363	373	383	393	403	412	422	432	442	452	461	471	491	511	530	550
5⅛	248	258	268	279	289	299	309	320	330	340	351	361	371	382	392	402	413	423	433	444	454	464	475	485	495	516	536	557	578
5¼	260	271	281	292	303	314	325	336	346	357	368	379	390	400	411	422	433	444	455	465	476	487	498	509	520	541	563	584	606
5⅜	272	284	295	306	318	329	340	352	363	374	386	397	409	420	431	443	454	465	477	488	499	511	522	533	545	567	590	613	635
5½	285	297	309	321	333	345	356	368	380	393	404	416	428	440	451	463	475	487	499	511	523	535	546	558	570	594	618	641	665
5⅝	298	311	323	336	348	360	373	385	398	410	422	435	447	460	472	485	497	509	522	534	547	559	572	584	596	621	646	671	696
5¾	312	325	338	351	364	377	390	403	416	429	441	454	467	480	494	506	519	532	545	558	571	583	597	610	623	649	675	701	727
5⅞	325	339	352	366	380	393	407	420	434	448	461	474	488	502	515	529	540	556	569	583	596	610	623	637	651	678	705	732	759
6	339	354	368	382	396	410	424	438	452	467	481	495	509	523	537	551	566	580	594	608	622	636	650	664	679	707	735	763	792
6¼	368	384	399	414	430	445	460	476	491	506	522	537	552	568	583	598	614	629	644	660	675	690	706	721	736	767	798	828	859
6½	398	415	431	448	465	481	498	514	531	548	564	581	597	614	630	647	664	680	697	713	730	747	763	780	796	829	863	896	929
6¾	429	447	465	483	501	519	537	555	573	590	608	626	644	662	680	698	716	734	752	769	787	805	823	841	859	895	930	966	1002

Piston Displacements in Cubic Inches for 6-Cyl. Motors

For 12-Cylinder Motors, Multiply Given Displacement by 2

Cylinder Bore in Inches	STROKE IN INCHES																														
	3	3⅛	3¼	3⅜	3½	3⅝	3¾	3⅞	4	4⅛	4¼	4⅜	4½	4⅝	4¾	4⅞	5	5⅛	5¼	5⅜	5½	5⅝	5¾	5⅞	6	6¼	6½	6¾	7	7¼	7½	7¾
2½	88	92	96	99	103	107	110	114	118	122	125	129	133	136	140	144	147	151	155	158	162	166	169	173	177	184	191	199	206	214	221	228
2⅝	97	102	106	110	114	118	122	126	130	134	138	142	146	150	154	158	162	166	171	175	179	183	187	191	195	203	211	219	227	235	244	251
2¾	107	111	116	120	125	129	134	138	143	147	152	156	160	165	169	174	178	183	187	192	196	201	205	209	214	223	232	241	249	258	267	276
2⅞	117	122	127	131	136	141	146	151	156	161	166	170	175	180	185	190	195	200	205	209	214	219	224	229	234	243	253	263	273	283	293	302
3	127	132	138	143	148	154	159	164	170	175	180	186	191	196	201	207	212	217	223	228	233	239	244	249	254	265	276	286	297	308	318	329
3⅛	138	144	150	156	161	167	173	178	184	190	196	201	207	213	219	224	230	236	242	247	253	258	265	270	276	288	299	311	322	334	345	356
3¼	149	155	162	168	174	180	186	193	199	205	212	218	224	230	236	243	249	255	261	268	274	280	286	292	299	311	324	336	348	360	373	385
3⅜	161	168	174	181	188	194	201	208	215	221	228	235	242	248	255	262	268	275	282	289	295	302	309	315	322	336	349	362	376	389	403	416
3½	173	180	188	195	202	209	216	224	231	238	245	253	260	267	274	281	289	296	303	310	317	325	332	339	346	361	375	390	404	418	433	447
3⅝	186	194	201	209	216	224	232	240	247	255	263	271	278	286	294	302	309	317	325	333	340	348	356	364	371	387	402	418	433	449	465	480
3¾	199	207	215	224	232	240	248	256	265	273	282	290	298	307	315	323	331	340	348	356	365	373	381	389	398	414	431	447	464	480	496	513
3⅞	212	221	230	239	248	257	266	274	283	292	301	310	318	327	336	345	354	363	371	380	389	398	407	416	425	442	460	478	495	514	531	549
4	226	236	245	254	264	274	283	292	302	311	320	329	339	349	358	368	377	386	396	405	415	424	434	443	452	471	490	509	528	546	565	585
4⅛	241	251	261	271	281	291	301	311	321	331	341	351	361	371	381	391	401	411	421	431	441	451	461	471	481	501	521	541	561	581	601	621
4¼	255	266	276	287	298	308	319	330	341	351	362	372	383	394	404	415	426	436	447	458	468	479	490	500	511	532	553	575	596	617	638	659
4⅜	271	282	293	305	316	327	338	350	361	372	383	395	406	417	428	440	451	462	474	485	496	507	519	530	541	564	586	609	631	653	677	700
4½	286	298	310	322	334	346	358	370	382	394	406	418	429	441	453	465	477	489	501	513	525	537	549	561	573	596	620	644	668	692	716	740
4⅝	302	315	328	340	353	365	378	391	403	416	428	441	454	466	479	491	504	517	529	542	554	567	580	592	605	630	655	680	706	730	756	781
4¾	319	332	346	359	372	386	399	412	425	439	452	465	479	492	505	518	532	545	558	572	585	598	611	625	638	665	691	718	744	770	798	825
4⅞	336	350	364	378	392	406	420	434	448	462	476	490	504	518	532	546	560	574	588	602	616	630	644	658	672	700	728	756	784	812	840	868
5	353	368	383	398	412	427	442	457	471	486	501	515	530	545	560	574	589	604	619	633	648	663	677	692	707	736	765	795	825	854	884	913
5⅛	371	387	402	418	433	449	464	489	495	511	526	542	557	573	588	603	619	634	650	665	681	696	712	727	743	774	805	836	866	897	928	959
5¼	390	406	422	439	455	471	487	504	520	536	552	568	585	601	617	633	649	666	682	698	714	731	747	763	779	812	844	877	909	941	975	1008
5⅜	409	426	443	459	476	494	510	527	545	562	579	596	613	630	647	664	681	698	715	732	749	766	783	800	817	851	885	919	953	987	1021	1056
5½	428	445	464	481	499	516	535	553	570	588	606	624	641	659	677	695	713	731	748	766	784	802	820	838	855	891	927	962	998	1033	1069	1105
5⅝	448	466	485	504	523	540	559	578	597	615	634	653	671	690	709	728	746	765	784	802	821	839	858	876	893	932	970	1007	1044	1082	1119	1156
5¾	468	487	506	526	546	565	585	604	624	643	662	682	702	721	740	760	780	799	819	838	857	877	896	916	935	974	1013	1052	1092	1130	1170	1209
5⅞	488	509	529	550	570	590	610	631	651	671	692	712	732	753	773	794	814	835	855	875	896	916	936	957	977	1018	1059	1099	1140	1180	1211	1261
6	509	530	552	573	595	615	636	658	679	700	722	743	764	785	806	828	849	870	891	912	934	955	976	998	1019	1060	1101	1142	1184	1226	1270	1314
6¼	553	575	598	621	645	667	690	713	736	760	782	805	828	852	875	897	920	944	967	990	1014	1038	1060	1084	1106	1152	1199	1245	1292	1339	1384	1429
6½	598	623	647	672	697	722	747	772	796	821	846	871	896	921	946	971	996	1020	1044	1068	1093	1118	1143	1169	1195	1246	1296	1346	1395	1445	1495	1544
6¾	644	670	696	724	750	777	804	831	858	885	911	938	965	992	1020	1047	1075	1101	1128	1155	1182	1209	1236	1263	1289	1342	1398	1452	1505	1558	1612	1666

AIR CONSUMPTION CHART

Piston Displ. Cu. In.	REVOLUTIONS PER MINUTE									
	1800	2000	2200	2400	2600	2800	3000	3200	3400	3600
175	68	76	84	91	99	106	114	121	129	137
180	70	78	86	94	102	109	117	125	133	141
185	72	80	88	96	104	112	120	129	137	145
190	74	82	91	99	107	115	124	132	140	149
195	76	85	93	102	110	119	127	135	144	152
200	78	87	96	104	113	122	130	139	148	156
205	80	89	98	107	116	125	133	143	151	160
210	82	91	100	109	118	128	137	146	155	164
215	84	93	103	112	121	131	140	150	159	168
220	86	95	105	114	124	134	143	153	162	172
225	88	98	107	117	127	137	146	156	166	176
230	90	100	110	120	130	140	150	160	170	180
235	92	102	112	122	133	143	153	163	173	184
240	94	104	115	125	135	146	156	167	177	187
245	96	106	117	128	138	149	160	170	181	191
250	98	108	119	130	141	152	163	174	184	195
255	100	111	122	133	144	155	166	177	188	199
260	102	112	124	136	147	158	169	181	192	203
265	103	115	126	138	149	161	172	184	195	206
270	105	117	129	141	152	164	176	188	199	211
275	107	119	131	143	155	167	179	191	203	214
280	109	121	134	146	158	170	182	194	206	218
285	111	124	136	148	161	173	185	198	210	222
290	113	126	139	151	164	176	189	201	214	226
295	115	128	141	154	166	179	192	205	218	230
300	117	130	143	156	169	182	195	208	221	234
305	119	132	146	159	172	185	199	212	225	238
310	121	135	148	161	175	188	202	215	229	242
315	123	137	150	164	178	192	205	219	232	246
320	125	139	153	167	181	194	208	222	236	250
325	127	141	155	169	184	198	212	226	240	254
330	129	143	158	172	186	200	215	229	243	258
335	131	145	160	175	189	203	218	232	247	262
340	133	148	162	177	192	206	221	236	250	266
345	135	150	165	180	195	209	224	239	254	269
350	137	152	167	182	197	212	228	242	258	274
355	139	154	169	185	200	215	231	245	262	277
360	141	156	172	187	203	219	234	250	265	281
365	143	158	174	190	206	222	238	254	269	285
370	145	161	177	193	209	225	240	257	273	289
375	147	163	179	196	212	228	244	261	277	293
380	148	165	181	198	214	230	247	264	280	297
385	151	167	184	201	217	234	251	267	284	301
390	152	169	186	203	220	237	254	271	288	305
395	155	172	189	206	223	240	258	275	292	309
400	156	173	191	208	226	243	260	277	295	312
405	158	176	194	211	229	246	264	281	299	317
410	160	178	196	214	231	249	267	285	303	320
415	162	180	199	216	234	252	270	289	306	324
420	164	182	200	218	236	255	273	291	310	328

AIR CONSUMPTION CHART

Piston Displ. Cu. In.	REVOLUTIONS PER MINUTE									
	1800	2000	2200	2400	2600	2800	3000	3200	3400	3600
425	166	185	203	221	239	258	276	295	313	332
430	168	187	206	224	243	262	280	299	318	336
435	170	188	208	227	246	265	283	302	321	340
440	172	191	210	229	248	267	286	305	324	344
445	174	193	212	231	251	270	289	308	328	348
450	176	195	214	234	254	274	292	312	332	351
455	178	198	217	237	257	277	295	316	336	355
460	180	200	220	240	260	280	300	320	340	360
465	182	202	222	242	262	283	303	323	343	364
470	184	204	224	245	265	286	306	326	347	367
475	186	206	227	247	268	289	309	330	350	371
480	188	208	229	250	270	291	312	333	354	375
485	190	211	231	253	273	294	315	336	358	379
490	191	213	234	255	277	298	319	340	362	383
495	193	215	236	258	279	301	322	343	365	387
500	195	217	239	260	282	303	326	347	369	390
505	197	219	241	263	285	307	329	351	372	394
510	200	222	244	266	288	310	332	354	376	398
515	202	224	246	269	291	313	335	357	380	402
520	204	225	248	271	294	316	338	361	383	406
525	206	228	250	274	296	319	342	364	387	409
530	207	230	253	276	298	322	344	367	390	413
535	209	232	255	278	301	325	348	371	394	417
540	211	234	257	281	304	328	352	375	398	421
545	213	237	260	283	307	331	355	378	402	425
550	214	238	262	286	310	334	358	382	405	428
555	217	241	265	289	313	337	361	386	410	434
560	218	243	267	292	316	340	364	389	413	436
565	220	245	270	294	319	343	368	392	417	440
570	222	247	272	296	321	346	370	396	420	444
575	224	249	274	299	324	349	374	400	424	448
580	226	252	277	302	327	352	377	402	428	452
585	228	254	280	306	330	355	381	406	432	456
590	230	256	282	307	332	358	384	410	435	460
595	232	258	284	310	335	361	387	413	439	464
600	234	260	287	312	338	365	390	416	443	468
605	236	262	289	315	341	368	393	419	446	472
610	238	265	291	318	344	370	397	423	450	476
615	240	267	294	320	347	374	400	428	454	480
620	242	269	296	322	350	376	404	430	457	484
625	244	271	299	325	352	379	406	433	463	488
630	246	274	300	328	355	383	410	437	465	492
635	248	276	303	330	357	386	413	440	468	496
640	250	277	305	333	361	388	416	444	472	500
645	252	280	308	336	364	392	420	449	476	504
650	254	282	310	338	367	395	423	452	480	508
655	256	284	313	341	370	398	425	455	483	512
660	258	286	315	343	372	401	429	458	487	515
665	260	289	317	346	375	404	432	461	490	519
670	262	291	320	349	378	407	436	464	494	524

PLEASE NOTE: Most older (updraft) engines will only use 75% or often less of the optimum 100% air flow figure. This chart is calculated at 75%, not 100%. Please bear that in mind when determining air flow. Volumetric efficiency is [probably the main factor in matching a carburetor to an engine for maximum performance. S.K.