INDUCTION PORT OBSTRUCTIONS

by George Templin

Introduction

One of the most common problems encountered in British motorcycles is induction port obstruction (IPO). Since the potential for this malady exists in most carbureted engines, it has been found in varying degrees in each of the common British marques and also in both Japanese and American motorcycles. This flaw came with some bikes directly from the factory, while others had it added by various wrench-wielding owners and mechanics. It is found today in bikes ranging from mung and drool laden beaters to professionally over-restored show bikes. The symptoms IPO produces, such as hard starting, rough running and cylinder misfiring, have often caused it to be mis-diagnosed as a defective carburetor or ignition system. The most difficult part of the problem is its diagnosis, the easiest part is the fix and the best part is the improvement in performance the fix provides.

Since most of the British bikes currently being restored and/or ridden are equipped with the Amal Monobloc or Concentric carburetor, the specifics of this discussion will be confined to these two instruments, however, the basic principles involved can be applied to other types of carburetors.

Description

An IPO exists when any portion of the intake port downstream from the carburetor interferes with and adversely disturbs the air-fuel mixture coming from the carburetor. The most significant disturbance of the mixture occurs when the obstruction is located in the lower ⅛ cross-section of the port, with the most critical area being the center of the bottom of the port near the two small holes drilled in the bottom of the carburetor venturi. At idle to ⅛ throttle, the carburetor feeds practically all of the air-fuel mixture through the pilot jet circuit into these two small ports. The mixture enters perpendicular to the passing air stream and immediately makes a 90° turn along the bottom of the carburetor throat. It flows with and eventually blends into the air stream unless there is an obstruction for it to smack into. The smaller the carburetor slide opening and the closer the obstruction is to these ports, the more severe the mixture disturbance and the more exaggerated the resulting symptoms become. As the throttle is increased from idle through ¼ open, the aperture under the slide enlarges which proportionately diminishes the effect of the size and position of the obstruction. From ⅛ to full throttle, the carburetor feeds practically all of its fuel mixture through the needle and main jet circuits and injects it via a raised stand pipe into the central part of the venturi, where a small obstruction anywhere around the circumference of the intake port has little or no adverse effect on it.

It is important to understand that a carburetor internally mixes air and fuel into an emulsion before it introduces it to the air stream in the venturi to be further atomized. This entire vaporization process allows the fuel to be burned more completely in the combustion chamber resulting in more power and less residue. The goal is to maintain this fine dispersion of tiny fuel droplets all the way to the spark plug. An obstruction in the intake port causes these tiny fuel droplets to ram into each other and to coalesce back into larger ones, which leads to a more incomplete burn in the combustion chamber resulting in less power and more residue production. This residue contains elemental carbon which is a good conductor of electrical current. As an engine with a problematic obstruction is run at idle to ⅛ throttle, this residue builds up in varying degrees on the spark plug porcelain and short circuits away ever-increasing amounts of current until the point is reached where not enough electrical energy is available to jump the gap and ignite the compressed air-fuel charge in the combustion chamber. The resulting cylinder misfire is constant or intermittent depending on other variables.

Diagnosis

In a warm engine with new spark plugs and all systems in good tune, the first symptom of an IPO is usually, but not always, a slight to moderate amount of visible black smoke in one or more exhausts when idling or when the throttle is cracked open slightly. The more black smoke seen, the more severe the obstruction and the sooner other symptoms may occur. Hard starting, desensitized idle mixture screw, roughness at idle to partial throttle, poor fuel economy and misfiring at high speed or under load are the usual symptoms which can occur in any sequence and in any combination. These are all due to the carbonizing of the spark plug porcelain. Running the engine at ⅛ to full throttle at high speeds under light loading sometimes alleviates the problem by halting and burning off most of the carbon deposition. But in the real world of street riding, it never gets burned off completely because we are constantly returning to a closed or partial throttle position where the

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obstruction causes more carbon to be deposited. This cycle of carbonizing/decarbonizing eventually causes a hardcore, burn-off resistant, deposition of carbon to form that penetrates the small pores and cracks in the porcelain insulator and causes the symptoms to be more varied and severe. In most cases of IPO, a change to fresh spark plugs improves the immediate symptoms but does not address the cause, and the whole carbonizing cycle starts again.

Magneto ignition systems are usually more sensitive to carbon on the spark plugs during starting and lower RPM's than coil/battery systems because a magneto produces less electrical energy than a coil in the lower RPM range.

A change to a hotter than normal heat range spark plug does not usually have any remedial effect where IPO's are the cause of carbonizing. The gross deatomizing effect of most obstructions exceeds the relatively limited capacity of the hottest plug to effectively burn off carbon deposits on its porcelain insulation.

A helpful diagnostic technique can be used on an engine that has been run long enough to have produced a dark colored backflow residue on the walls of the carburetor throat and intake port. After the pilot jet fuel mixture exits the small ports in the carburetor venturi, the path it takes along the floor of the intake port can easily be seen because it keeps the dark residue cleaned away. In a non-obstructed induction port the path will be cleanest at the small exit ports and will gradually taper away as the mixture rises from the floor into the passing air steam. The path will be straight and parallel to the centerline of the port floor, and will be seen to divide equally between the two intake ports in the case of a Y-manifold. In an obstructed induction port, the path can be seen to flow away at an angle from the centerline and/or disappear abruptly after it encounters the obstruction, and in the case of a Y-manifold, an unequal distribution between the ports might be visible. Think flow; if the path does not look straight, smooth and gradual, you probably have a problematic IPO.

Repair

The best situation for diagnosis and repair is with the head off the bike. It usually makes it easier to see down the carburetor throat into the intake port and to perform any metal removal; however, removing and installing the head is often more work than simply repairing the IPO with the head in place.

One of the most difficult type of bikes to work on with the head attached is a single-carbureted twin where the carburetor is situated directly in front of the rear frame downtube. Be resourceful and patient and use a variety of lights, mirrors and probes to analyze the possible obstruction. A bore-light with a small diameter high-intensity bulb at the end of a long slender flexible shaft is much better than a standard flashlight in most cases. A six-inch long wooden applicator stick (a fondue stick with blunt ends) can be very useful to feel an obstructive ledge. This feeling method can sometimes be more sensitive than looking for the ledge due to inadequate lighting and/or poor eyesight. If you can see or feel any ledge or obstruction, chances are that it is a significant problem and must be removed.

When checking for an IPO, unbolt the two carburetor mounting nuts or bolts enough to allow the carburetor, phenolic spacer, drip shield (if so equipped) and gasket to drop via gravity to the lowest position to which they can possible be installed. The plan is to port blend at least the bottom ⅛ cross-section of the intake port with all the parts fixed in the position they will automatically assume when installed on the head. If the parts do not automatically line-up well via the carburetor flange studs or bolts, they can be located with two 1/16" steel alignment pins drilled and installed in the areas below and to the inside of the stud holes before any port blending is done.

If metal has to be removed from the intake port, sandpaper cartridge rolls chucked in a drill motor or a straight or angle die grinder works very well. The angle die grinder is especially handy when the head is still on the bike. Lacking those tools, a fine job can be done with a round file and sandpaper wrapped around a wooden dowel. When porting, remember that you are trying to remove any step-up ledge or rise in the floor of the port. A slight step-down or gradual drop in the floor is okay and actually preferable. The surface of the finished port should not be polished, as this tends to encourage fuel coalescence and droplet formation on the port walls; the finish left by medium grit sandpaper or cartridge rolls is good and usually matches the existing factory finish very well. If the grinding is to be done with the head on the bike, rags or paper towels can be stuffed down the port to prevent debris from entering the cylinder. After the porting is completed, compressed air blown into the spark plug hole and through the open intake valve will keep debris out of the cylinder and clean the port as the rags or paper are removed.

The phenolic insulator must be reckoned with. If its aperture is too small, grind it; if it is too big or the mounting holes are too sloppy, get another one. Since this and the paper gasket has the greatest chance of being reinstalled incorrectly in the future and causing an obstruction

problem, do whatever it takes to prevent it now. One method of fool-proofing this is to contact cement a thin paper gasket of the proper thickness (approx. 0.015") to the head side of the phenolic spacer and port match both the top and bottom of the spacer aperture to the bottom of the intake port opening in the head. The slight mismatch that might occur at the top of the port with the spacer ported this way poses no practical consequence. Since all British motorcycle owners know that the "O" ring in the carburetor mounting flange does not require a gasket between it and the phenolic spacer, and all BSA pre-unit owners know the drip shield is to be installed between the head and phenolic spacer, there is no chance of the spacer being installed incorrectly. A thin paper gasket should also be contact cemented and trimmed to the drip shield on the head side after the shield has been port matched to the head.

Over-tightening of the carburetor mounting nuts or bolts can bend the carb mounting flange forward causing the carburetor throat to be deformed from round to oval, with the long axis in the vertical plane. This has the effect of dropping the floor of the carburetor throat and exposing the edge of the bottom of the phenolic spacer. A simple repair would be to grind the spacer and head port accordingly. But, the best approach by far is to place the stripped carburetor body in a special fixture, heat to 350°F, and pull it back to its original shape. The fixture is simple to make from a ⅝" steel plate, an aluminum bar approximately the size of the slide and an appropriate length cap screw and nut to pull the two pieces toward each other.

After the carburetor has been straightened would be a good time to treat yourself and your carburetor to a sleeve job. The benefits of this are hard to over emphasize. The short story is that even new Amal carburetors had too much diametrical clearance (approx. 0.009") between the soft potmetal slide and soft potmetal bodies which increased quickly with use. This allows air to be leaked around the entire length of the slide instead of being forced down and across the pilot jet exit ports in the floor of the venturi, during idle and partial throttle, to aid in the complete atomization of the partially emulsified pilot jet mixture. A "Catch-22" situation occurs when the air leaking around the slide causes the engine to see a lean condition, actually a reduction in the amount of completely atomized fuel, and to begin to falter. The tuner, in turn, opens the slide and/or richens the pilot jet mixture so that the engine will get enough completely atomized fuel to run properly. However, this causes an increase in the amount of incompletely atomized fuel, which then starts the spark plug carbonizing cycle in exactly the same manner as an IPO. This is the reason for an apparent paradox: people with worn out, air-leaking carburetors experience carbon coated spark plugs on a regular basis. A steel sleeve job decreases the slide-to-body clearance to approximately 0.004", and since a hard metal running against a soft metal is metallurgically compatible, the wear is practically non-existent. It is obvious that a worn carburetor can mimic the symptoms of an IPO and make the best porting and matching job appear to have been a waste of time.

Examples

The following is a list of motorcycles in which an IPO has been diagnosed and corrected within the last six years. The examples have been selected specifically to illustrate the many different types of obstructions and the variety of symptoms they can cause.

1) 1956 BSA DB34 Gold Star Clubman

The engine in this professionally restored bike was a real bitza. It sported a large Concentric MK I carburetor on a cylinder head with an intake port 3/16" smaller in diameter, which, when coupled with excessive clearance in the carb flange holes and the downward pull of gravity during installation, caused a ⅛" high perpendicular wall at the bottom center of the port for the pilot jet fuel mixture to ram into. The owner reported that it ran okay at highway speeds but loaded up and ran very rough under 35 MPH. After three or four start and stop cycles, the only way it could be started was to replace the carbon coated spark plug with a fresh one. With the head still on the bike, the port was blended back about 1½" into the head as a temporary fix. A full intake porting was postponed until the next valve job. The bike started and ran fine, time after time, and the spark plug color remained a normal honey-brown.

2) 1960 BSA A-10 Super Rocket

This bike usually started well but exhausted a visible amount of black smoke at idle and under light throttle, with the quantity increasing in direct proportion to altitude. Low speed acceleration was not stellar and the spark plugs showed light traces of carbon, but they never really fouled enough to create a misfire. The carburetor was found to have a leaner slide, pilot jet, float level, and needle jet setting than factory recommendations, and the idle mixture screw had little effect when screwed in or out. The actual problem was that both carburetor mounting flange holes in the Monobloc were too large

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for the mounting studs, causing the whole carburetor to be mounted low and exposing approximately 1/32" of the bottom center edge of the intake port edge. The edge was ported to a match while still on the bike, and the carburetor was returned to factory specifications. The idle mixture screw became very responsive at one turn out, acceleration performance increased, all the adverse symptoms disappeared, and the fuel mileage increased approximately 10%.

3) 1961 Triumph TR6

During reinstallation of the single Monobloc carburetor, the owner replaced the torn, thin (0.015") factory paper gasket between the phenolic insulator and the intake manifold with a properly planformed, homemade gasket made from 1/16" (0.063") thick after-market gasket material. The bike ran fine for a while until the idle became rough. The idle mixture screw became less sensitive, and the carburetor mounting nuts were tightened because they were found to be excessively loose. The roughness at idle and partial throttle got progressively worse and a tinge of black smoke appeared in the exhaust. The problem was that the thick gasket material had been compressed and extruded circumferencially into the intake port. The obstruction was at its worst at the critical bottom center because the idle fuel mixture impacting the gasket at that point had teased the paper fibers apart into a hairy fuzz. Replacement with a thin gasket did the trick.

4) 1962 BSA Rocket Gold Star Twin

Desensitized idle mixture screw, rough idle, visible black smoke only from the right side exhaust at idle or when the throttle was cracked open sharply, and occasional intermittent misfire under load and at high speed, characterized this low mileage, fairly original bike. The left-side spark plug was always clean. The right-side spark plug was always coated with soft black carbon soot after five minutes of idle and/or part throttle running on a fresh plug. The root cause was a factory machining error common to some of the late-model A-10 Big Valve heads with casting part number 67-1549. The left-side carburetor mounting stud hole was drilled and tapped approximately 1/16" low in the head. This caused approximately 1/32" of the lower left-side intake port face of the head to be exposed for the pilot jet mixture to run into. At reduced throttle openings, the fuel mixture was disproportionately diverted away from the left side of the Y-manifold into the right side. The manifold was port-matched while still on the bike and all the problems disappeared. Both plugs subsequently developed an equal honey-brown color.

The A-10 heads with this particular manufacturing defect are fairly easy to spot while still on a bike, since the carburetor, as mounted, is cocked slightly to the left.

I have heard it rumored from an "old timer" (i.e. anyone who has had 50 or more birthday parties) that this apparently unequal distribution of intake charge to the two cylinders, as evidenced by conflicting spark plug color, was an on-going intermittent problem throughout the pre-unit twin's production run. I have been told that the factory made an angled spacer to fit between the carburetor and the head to "point" the carburetor in the direction of the lean cylinder. I have never seen one, but I would like to gaze at one of these examples of engineering nonsense before I, too, become an "old timer".

5) 1962 BSA A-10 Super Rocket

After an engine rebuild, this bike emitted distinct black exhaust smoke from idle to partial throttle and the plugs carbon-fouled so badly that once stopped, the engine could not be easily restarted without a change to fresh plugs. During the rebuild, the owner had substituted a reproduction carburetor drip shield for the missing original. The intake port aperture in the reproduction shield was smaller than the carburetor throat and, when mounted in position, presented approximately a 1/16" perpendicular wall for the pilot jet fuel mixture to impact. Port-matching the shield cured the problem.

6) 1963 Matchless G12 CSR

This low mileage bike had the optional twin carburetor kit installed. Unlike the right cylinder, the left cylinder produced black-tinged exhaust from idle to part throttle, and the spark plug accumulated excess carbon causing rough running and occasional misfiring. The left-side carburetor was found to have the lip between the "O" ring channel in the mounting flange and the throat bent up at a 20-degree angle into the venturi about 1/16" at the bottom of the carburetor directly in the path of the pilot jet fuel mixture. The carburetor was stripped, the bare body was heated to 350°F, and the lip was tapped back in place with a hammer and steel mandrel.

7) 1963 BSA Rocket Gold Star Twin

With fresh spark plugs, this low mileage bike with a professionally rebuilt engine would start hot or cold and run fine for three to four engine start/stop cycles of five-to-thirty-mile duration, after which it became

progressively harder to start. No black smoke was noticeable out of the exhaust, but both plugs developed a dry mottled black stain of carbon. The bike was found to have a combination of obstructions comprised of the following: a factory machining error (see example #4), gaskets, head insulator block, and a drip shield, each of which intruded into the intake port and caused the pilot jet fuel flow to be disrupted equally to each cylinder. A clean-up of all the obstructions produced a bike that now starts reliably every time.

8) 1966 BSA
A65 Thunderbolt

Desensitized idle mixture screw, visible black smoke from both exhaust pipes from idle to partial throttle, occasional misfiring under load, and carbon-coated spark plugs, were all a direct result of severely over tightened carburetor mounting nuts on this bike. The carburetor mounting flanges were bent forward causing the throat to be deformed from round to oval. This dropped the floor of the throat and exposed approximately 1/16" of the edge of the bottom of the intake port face. After the carburetor body was straightened to its original shape and sleeved, the problems disappeared.

9) 1975 Norton
850 Commando

After a ring-and-valve job, a sleeve job on both carburetors and some minor surgery to correct factory-caused cylinder head flaws, this bike ran fine except for an unhappy idle. The left-side cylinder maintained clean spark plugs and good sensitivity to idle mixture adjustment. On the right-side cylinder, the spark plug developed a light carbon coating, the idle mixture adjustment was vague, and no trace of black smoke was visible in the exhaust. The carburetor-to-intake port match was excellent on both sides. The problem turned out to be in the 2" long, bolt-on intake port extension piece which curved downward connecting the carburetor to the cylinder head. Inside the right-side extension there was a slight rise in the short-side radius, or floor, of the intake port. The pilot jet fuel mixture coming from the carburetor was hitting this bump and was being forced to flow up and over it, causing deatomization in the process. The floor was ported to remove the bump and maintain a constant dropping radius, which resulted in a good idle and a clean spark plug.

Conclusion

The physical size of most IPO's may seem tiny and insignificant to the uninitiated, but the problems they can cause can make even an "old timer" cry. So, if you ride your bike hard daily, or if you only start and run it once a year, you owe it to your bike and yourself to spend the small amount of time and effort necessary to inspect it for an IPO. Any British motorcycle owner with even the most rudimentary mechanical ability and hand tools should be able to diagnose and repair this problem. The payoff can be a big one in terms of decreased frustration and increased fun with your motorscooter.

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