Dave Thomas - April 2001

TIMING - IGNITION and VALVES

These instructions make specific reference to Moto Guzzi 500 cc single cylinder bikes – Falcone, GTV etc.

(Most of the maintenance manuals I've read just gloss over the many intermediate steps in the timing procedures and Moto Guzzi are no exception. Just one diagram and a few words is all you get from Mandello factory literature. Having said that, none of what follows is remotely difficult. Getting it right requires only patience, care and quiet surroundings. And of course good tools and a well lit workplace always help matters).

Brief refresher

There are two **upward** strokes in each 4-stroke cycle.....one is the ***exhaust*** stroke where the rising piston pushes out the spent gas into the exhaust system.....the other is the ***compression*** stroke where the rising piston compresses the fresh incoming petrol/air mixture within the sealed combustion chamber – i.e. both valves now closed. (The two **downward** strokes are called ***induction*** and ***power)***. Just before the piston gets to the top of the compression stroke - with the gas now becoming heavily compressed - the magneto must be "timed" to produce a spark at the plug which fires the gas and forces the piston back down the bore. For obvious reasons, this stroke is known as the *power* stroke. The *induction* stroke – sucking petrol / air mixture into the engine - is the one that follows the *exhaust* stroke.

IGNITION TIMING: (A FEW SIMPLE POINTERS BEFORE YOU START)

WHEN SETTING OR CHECKING THE IGNITION TIMING YOU MUST HAVE THE ENGINE SET ON THE **COMPRESSION** STROKE . EQUALLY IMPORTANT, WHEN SEEKING THE POINT AT WHICH THE SPARK OCCURS [THE TIMING] YOU MUST ENSURE THAT YOU MOVE THE FLYWHEEL BY HAND IN THE CORRECT DIRECTION, DEPENDING UPON WHICH STAGE OF THE OPERATION YOU ARE UNDERTAKING (see later). WHEN THE ENGINE IS RUNNING THE FLYWHEEL REVOLVES CLOCKWISE WHEN VIEWED FACE ON. IT IS ALL TOO EASY TO FIND YOURSELF WORKING ON THE WRONG STROKE AND WITH THE FLYWHEEL MOVING IN THE WRONG DIRECTION.

VALVE TIMING: (THINGS TO GET CLEAR ABOUT BEFORE YOU START).

TO FIND THE INLET VALVE OPENING POINT YOU MUST ENSURE THAT YOU ARE NOT WORKING ON THE COMPRESSION STROKE. THINK ABOUT THE 4-STROKE CYCLE AND REMEMBER THE FOUR MOVES, IN SEQUENCE, ARE : -

- INDUCTION (down)
- COMPRESSION (up) - the stroke on which you set the "IGNITION"
- POWER (down)
- EXHAUST (up)

and so on and so on

IT FOLLOWS THAT THE INLET VALVE MUST START TO OPEN "TOWARDS THE END OF THE UPWARD EXHAUST STROKE" - SOME TIME BEFORE THE PISTON REACHES THE TOP OF THAT STROKE (T.D.C.) THE REASON IS THAT THE INLET VALVE HAS TO OPEN ***BEFORE*** THE INDUCTION STROKE BEGINS SO THAT THE PETROL/AIR MIXTURE CAN GET INTO THE COMBUSTION CHAMBER VIA THE INLET PORT AND THE NOW OPEN INLET VALVE. QUITE OBVIOUSLY, THE INLET VALVE OPENING MUST COME BEFORE IGNITION TAKES PLACE IN ORDER FOR THE SPARK TO HAVE SOMETHING TO IGNITE.

FOR PRACTICAL PURPOSES, YOU DO NOT NEED TO GO ON TO CHECK INLET CLOSING POINT NOR EXHAUST OPENING AND CLOSING POINTS BECAUSE BOTH INLET AND EXHAUST CAMS ARE "FIXED" HAVING BEEN MACHINED ON A COMMON CAMSHAFT AND DRIVEN BY A SINGLE GEAR. IN BRIEF, IF YOU SET THE INLET OPENING POINT ACCURATELY, THE OTHER TIMING POINTS CAN BE TAKEN FOR GRANTED ON ALL GUZZI PUSHROD SINGLES. AT ANY RATE, YOU CAN'T ALTER THEM WITHOUT MACHINING/GRINDING THE CAM ITSELF AND THAT'S REALLY OUT OF THE QUESTION FOR NORMAL ROAD WORK.

IGNITION TIMING PROCEDURE

Confirm that the contact breaker points are set at 15 thou when the fibre heel is positioned on the 'lift' segment of the internal cam. Move the handlebar lever to the fully advanced position (slack cable) and proceed to find exact T.D.C. of the piston on its compression stroke. To determine the compression stroke start by removing both the spark plug and the large cap nut which covers the tappet adjusters at the top of the pushrods. In this exercise you need bother only with the inlet valve pushrod which is the one nearest the primary drive side of the bike.

Turn the flywheel by hand in a clockwise direction [as you know, this is the running direction and you'll notice that the crank and the engine itself actually run backwards in normal operation]. Observe the rise and fall of the inlet tappet adjuster as the engine is turned over. Turn the engine over a few times to get the picture then watch for the adjuster starting to fall, signifying that the inlet valve is about to open. Pause now and gently insert a metal rod, pencil size, into the plug hole to a depth of about 3 or 4 inches.

Continue to slowly turn the flywheel in a clockwise direction and note that the inlet tappet adjuster will soon start to rise, signifying that the valve is closing - and, at the same time, the piston will be coming up the bore on its "compression" stroke. The reason for inserting the rod in the plug hole is to feel the piston, literally, as it travels upwards and then use the rod to find the topmost part of the stroke (known as T.D.C. - top dead centre). Finding a really accurate T.D.C. with a rod is a question of feel and experience but it can be done within a degree or two, with patience, by rocking the flywheel gently backwards and forwards - just an inch or two of movement on the rim and eventually you will 'sense' the point of T.D.C. When you are sure the piston is at T.D.C., mark the flywheel rim with a marker pen dead opposite the arrow embossed in the primary cover (should be found roughly in the 2 o'clock position)

TO CHECK ON WHAT YOU'VE DONE SO FAR :

Having made the mark to identify T.D.C. a useful check to confirm that you are now actually on the "compression" stroke is to move the flywheel back, gently, in an anti-clockwise direction for about 6 or 7 inches of movement on the flywheel periphery. Make sure you move anti-clockwise! Now place the middle finger of your left hand over the open plug hole to seal it and then move the flywheel back in the normal direction of travel (i.e. clockwise) for 4 or 5 inches - towards T.D.C. You should now hear and feel a distinct hiss of released pressure when you remove your finger from the plug hole, proving that you are indeed on the "compression" stroke.

If all is OK so far, go back to T.D.C. as per the end of the previous paragraph, that is, line up the arrow with your marker pen line.

FINDING THE POINT AT WHICH THE SPARK SHOULD OCCUR

You are now at the stage where the engine is set at the top dead centre of the compression stroke and you are looking to make a spark occur some time BEFORE this point. As a very rough guide, that point will be when the piston is about half an inch BEFORE the top of its stroke - with the ignition lever in the fully advanced position (= slack cable). However, we need to set it fairly accurately as per the measurement given in the maker's manual. In the case of the GTV, the factory give you two options. One is linear, that is in millimetres of movement measured on the periphery of the flywheel (110 mm), the other is in degrees (45) of flywheel revolution. In reality, they come down to the same thing of course. If you wanted to, you could get a similar though possibly less accurate result by measuring the fall of the piston through the plug hole. British bikes often utilised this method and some accessories firms made specially adapted plug-like tools to measure the fall by means of a central, spring-loaded measuring rod.

There is a snag with the two forms of ignition timing data given in Mario Colombo's book "FALCONE". On a Falcone Sport model with a "manual magneto" set up like mine the book specifies that the point at which the contacts should just start to open is 95mm before top dead centre measured on the flywheel periphery. It then goes on to say that the point at which the contacts open "at maximum advance" occurs at 45 degrees BTDC on the mainshaft - I take this to mean that 45 degrees of crankshaft revolution equals 95 mm on the flywheel circumference ..... it does not ! It actually equals 110 mm.

The reason is this : Standard flywheel diameter is given as 280 mm. Therefore the circumference is "pi" (3.1412) x diam. = 879.5 mm. Now 45 degrees happens to be exactly one eighth of a revolution i.e. 360 degrees divide by 45 degrees = 8. But an eighth of 879.5 is 110 mm, not 95 mm. For the record, 95 mm on the flywheel equates only to 39 degrees on the crankshaft. An obvious question arises : which is right - 95mm / 39 degrees or 110 mm / 45 degrees ? Who knows and does it really matter ?

THERE'S AN ADDITIONAL SNAG WITH MY OWN FALCONE : WORKING ON THE LINEAR FIGURE IN COLOMBO'S BOOK, HIS OPENING POINT OF 95 mm IS FOR BIKES WITH A STANDARD FLYWHEEL DIAMETER MEASURING 280 mm. - IN MY BIKE'S CASE THE FLYWHEEL HAS BEEN MACHINED DOWN TO A DIAM. OF 268 mm. THEREFORE, THE OPENING POINT ON MINE NEEDS TO BE REDUCED TO 91 mm. TO CORRESPOND TO THE REDUCTION IN FLYWHEEL CIRCUMFERENCE. (NATURALLY, THIS DOES NOT AFFECT THE "DEGREE" MEASUREMENT WHICH COMES OUT AT 39 DEGREES AS SHOWN BELOW).

On the standard flywheel the 879.5 mm circumference divided by 360 results in 1 degree equalling 2.443 mm of movement measured on the flywheel rim. So, on that basis, 95 mm of movement divided by 2.443 equates to 39 degrees on the crankshaft. Similarly, the figure of 842 mm of circumference on my own reduced flywheel divided by 360 degrees results in 1 degree equalling the slightly smaller figure of 2.339 mm of movement. So, 91 mm divided by 2.339 still comes out at 39 degrees as stated above. The question remains, however, is 39 degrees the right figure for this engine with standard C.R. and manual magneto ? On a point of interest, the factory gives 45 degrees as the figure for the more sluggish G T V with lower C.R. of only 5 to 1 and less efficient combustion chamber. In theory the livelier, more efficient Falcone Sport engine should call for less advance than the G T V so, all in all, I am inclined to think that 39/40 degrees is about right on my model.

To add to the confusion, there is a school of thought which claims (probably rightly) that ALL historic data for ignition timing is now 'wrong' because of advances made in the composition of today's fuels. The net effect of these developments results in significantly improved rates of burning in today's unleaded fuels (incidentally, these fuels also cause engines to run slightly hotter). It's claimed that this 'faster' combustion necessitates a reduction of at least 10% in the amount of advance stated in maker's original handbooks. For the iron-headed Guzzi GTV, this means a fully advanced firing point of no more than 40 degrees BTDC = only 98 mm on the standard flywheel rim as opposed to 110 mm quoted in the literature. Back to practical matters. The exact moment when the contacts open can be observed on the flywheel periphery and is usually determined with a fag paper placed between the closed points. Alternatively, you could rig up a 360 Degree Plate to the flywheel using a strongish magnet and fixing a matching pointer (made from stiff wire) to an adjacent part of the engine.

THE FIRING POINT

From the T.D.C. mark you've already made on the flywheel, measure back **anti-clockwise** - using a metal tape - for a distance of 95 mm (or in my case 91 mm) and mark the flywheel at the 95 mm (91 mm) point. What you are doing is marking the firing point in the fully advanced position which, remember, is BEFORE top dead centre on the COMPRESSION stroke

Open up the contact breaker points manually, against their spring pressure, and insert a cigarette paper or a strip of cooking silver foil in between the points - the paper may or may not be gripped by the points at this stage. It is worth stating at this point that the normal running direction of rotation of the contact breaker is identical to that of the flywheel i.e. clockwise. Now slowly move the flywheel back **anti-clockwise,** for about 6 inches of movement on the flywheel periphery and note that the points in moving backwards will close tightly on the paper. At this point you should be some way off the 95 mm (91 mm) mark. Now move the flywheel in its normal direction of rotation – clockwise - very gently, a tiny amount at a time whilst maintaining the lightest of pulls on the fag paper. If the ignition timing is spot on the contact points will release their grip on the paper { just start to open!} at exactly the point where the 95 mm (91 mm) mark coincides with the pointer on the cover of the primary drive.

WHAT COULD GO WRONG AND HOW TO PUT THINGS RIGHT

The most obvious problem you'll find is that the contact points open either too early or too late.

On my particular Falcone there is a manual advance/retard lever on the end of the magneto which is activated by cable from a lever on the left of the handlebars. This cable at its magneto end has an screw and locknut adjuster which can be used to move the arm of the cam-ring housing in order to correct small errors of late or early ignition. If you are confronted with an error either way which is larger than 20%, you will probably need to re-position the magneto drive pinion and to do this you'll need to remove the timing cover which does require a certain amount of routine dismantling.

Note that the magneto pinion is fitted with a Woodruff key on to a tapered armature shaft. Because the pinion and the shaft have only one keyway, this means in effect that the minimum amount of correction you can get in that location is 1 tooth. In other words, you cannot really fine-tune on the taper because you are inhibited by the single keyway. In practice, 1 tooth offers a fair amount of movement – often more than you actually need to get the ignition timing spot on. It may then be necessary to achieve a compromise by selecting the mag. pinion position which will give you correct timing on full advance with a slack cable ….. whilst allowing for a full – or near-full – amount of retard when the ignition lever is pulled to tighten the cable.

To remove the pinion from the magneto, you need to slacken off the securing nut a few turns and also slacken the mag retaining strap bolt so that the mag is loose on its cradle. Now give the pinion nut a light hammer blow with a properly sized punch or socket to free the pinion from its taper - the mag will jolt back a small amount from its entry point at the back of the timing cover. You can then carry on removing the armature nut and ease the pinion away from its neighbouring pinion. Go careful not to turn things round because all you're after doing is moving the mag pinion by one tooth - either way - whilst all other gears and the engine itself stays put. When correcting the ignition timing be sure to move the armature and the pinion in the appropriate direction, no more than one tooth, before re-engaging the pinion with the other gears and the key with the two keyways.

VALVE TIMING PROCEDURE

Essentially the same sort of operation as already described but this time you must work on the other "up" stroke – the EXHAUST stroke. Note that whereas the ignition point was 95 mm (91 mm) before top dead centre, on the GTV model the inlet valve opening point is at 60 mm before top dead centre. You already have you T.D.C. mark and now you need to make a mark 60 mm BEFORE T.D.C. exactly as per the procedure already described. In this exercise, the valve clearances also need to be re-set at 8 thou rather than the normal running clearances of 2 thou and 12 thou when cold. (IN THE CASE OF THE GUZZI GTV, DON'T FORGET TO RE-ADJUST THEM BACK TO 2 and 12 THOU WHEN FINISHED).

With the spark plug and pushrods cover plug removed as before turn the flywheel by hand clockwise to find the appropriate top dead centre. When you are satisfied that you have found T.D.C. on the EXHAUST stroke [which of course will be the one when the piston comes back to the top having turned the engine through and past the compression stroke] you can then turn the flywheel back anti-clockwise for 6 or 7 inches, beyond your inlet opening mark at 60 mm. Check the inlet valve clearance with an 8 thou feeler gauge and leave the gauge in situ whilst turning the flywheel clockwise ... and slowly...once again towards the 60 mm mark. Whereas the gauge was a sliding fit before, it should just start to become nipped right on the 60 mm mark or thereabouts to indicate that the inlet valve is right on the point of opening.

To correct any significant discrepancy i.e. a 10+% error, you'll need to withdraw the camshaft and its gear and turn it a tooth (or two ?) either way whilst the engine and all other gears stay motionless to achieve the necessary opening point of 60 mm before top dead centre. This is not quite as easy as it sounds because to get the camshaft to move outwards and along its spindle it's necessary to slacken the tappet adjusters right off so that the pushrods and more crucially the cam followers can be moved clear of the cam lobes to allow sufficient withdrawal. This is not a major problem but can be a bit of a fiddle. Go careful and be cautious.

Also note that the crankshaft pinion (the small one retained by a nut and known here as the half-time pinion) has three internal keyways to provide you with several options for obtaining accurate timing.

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