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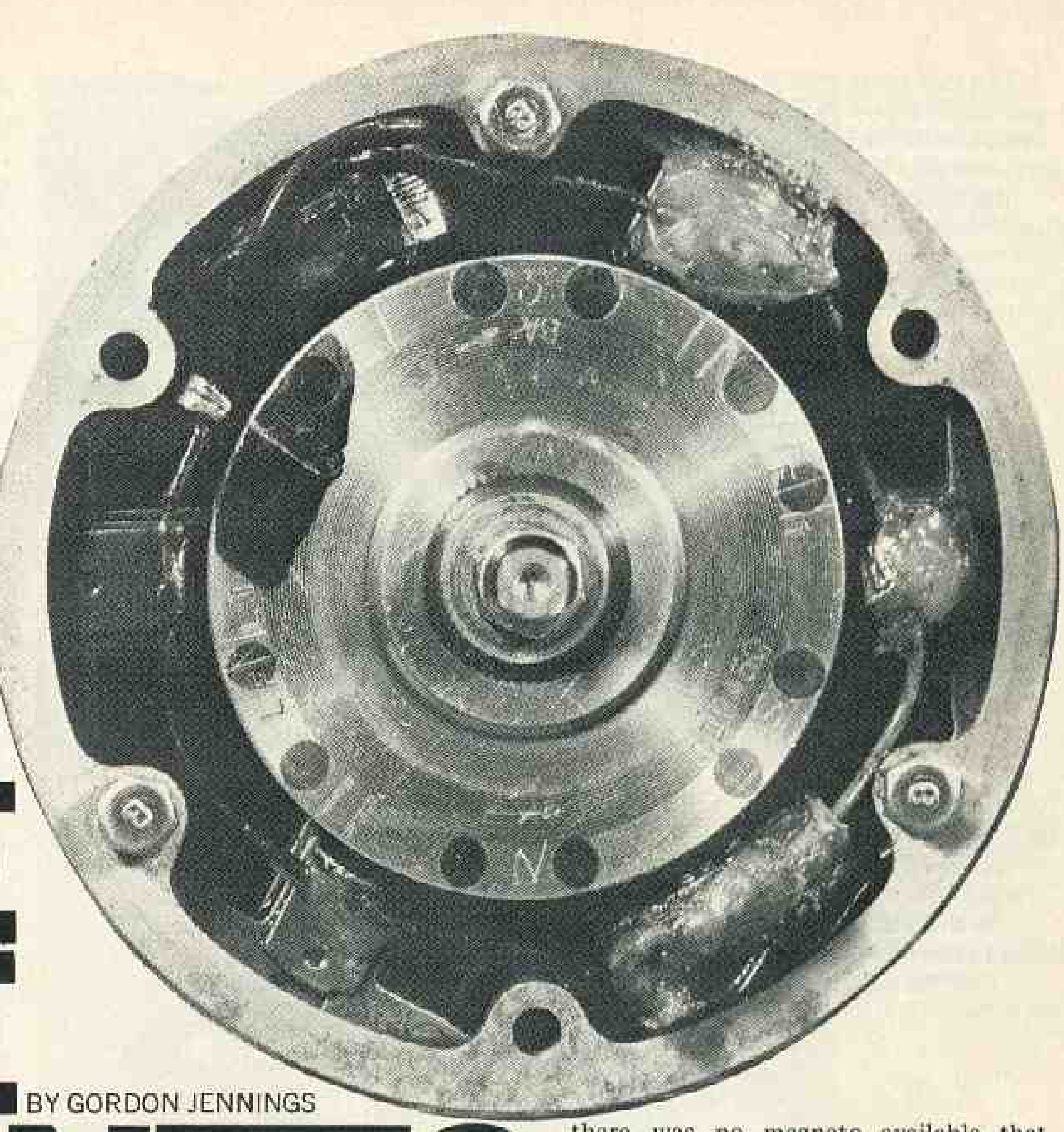


HOME MADE MAGNETO

BY GORDON JENNINGS

• One of these years I'm going to tire of playing Don Quixote to Jess Thomas' Sancho Panza. Jess very sensibly prefers to spend his time maintaining and fine-tuning factory-built racing bikes; I am always tilting windmills by creating my own racing equipment from a touring-motorcycle base. Predictably, Jess gets a good ride at nearly every race while I struggle with a seemingly endless sorting-out process. Still, all the problems and aggravations notwithstanding, I will probably continue, battling the windmills simply because there is so much to be learned in do-it-yourself.

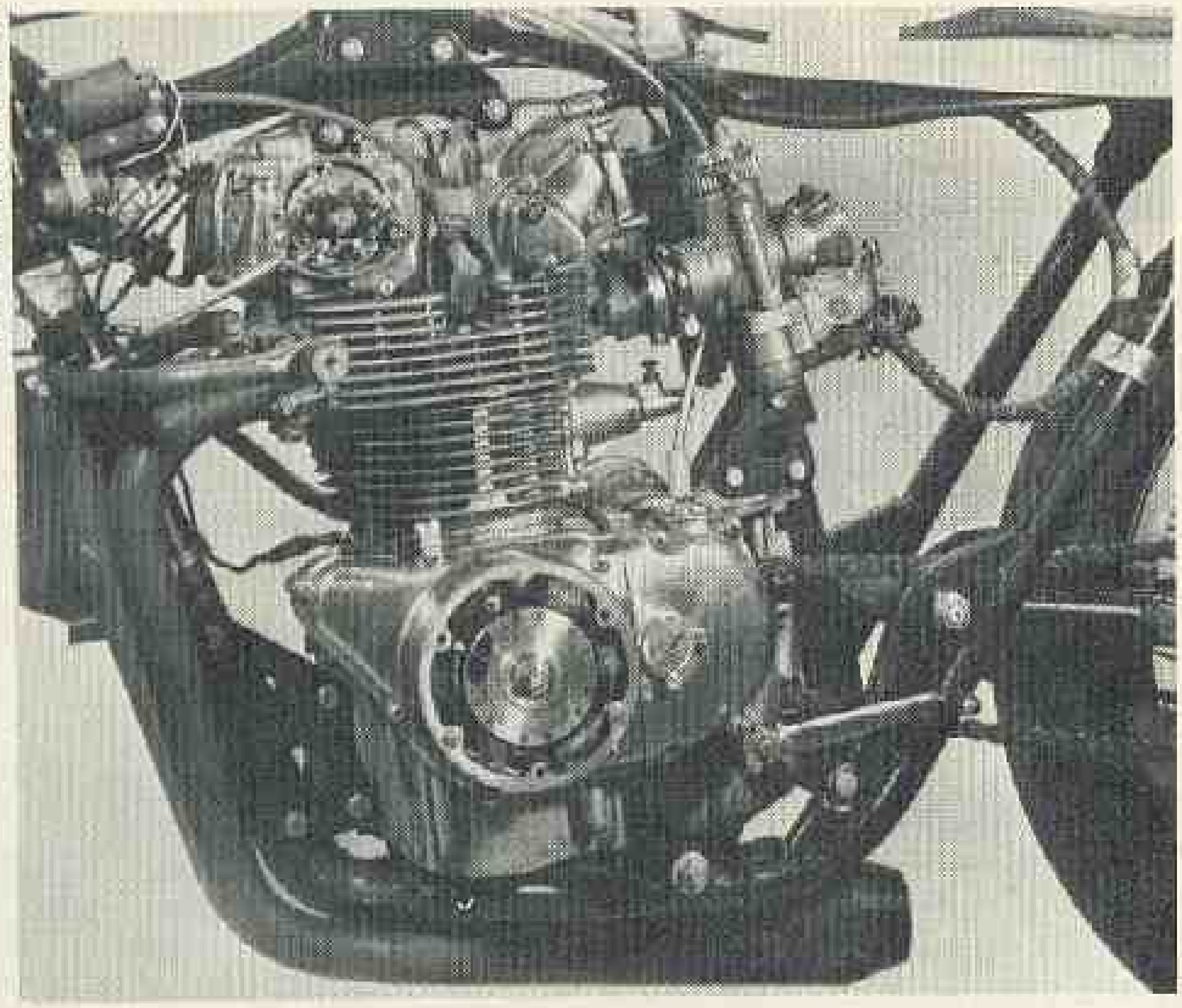
At this time last year, I began work on a new bike for the 1969 season: a Honda CB450-based road racer. My reasons for selecting this particular bike were one: it offered considerable potential, with double overhead camshafts and a five-speed transmission, and two; it was known for having a high degree of reliability. It was available (we had obtained one for a road test) and I thought it was about time for another try with a four-stroke engine after so many months with the window-valve wonders.

When embarking on a project of this sort, a lot of fundamental decisions must be made as to the shape things will take. But in this instance, most decisions had been made for me by others. The AMA rules require that near-standard frame and forks be used—unless you can get approval from those who manufactured your motorcycle to substitute. Honda has never approved anything but Honda equipment except for brakes, and I knew that the frame and forks that came with the bike would have to suffice, for better or for worse. Honda did, however, approve installation of a Fontana four-shoe front brake. I found that the tank, seat and fairing made for Harley-Davidson's KR would fit the Honda—although it was necessary to make a new bottom for the tank to fit down over the Honda frame. All the rest would be Honda, slightly modified.

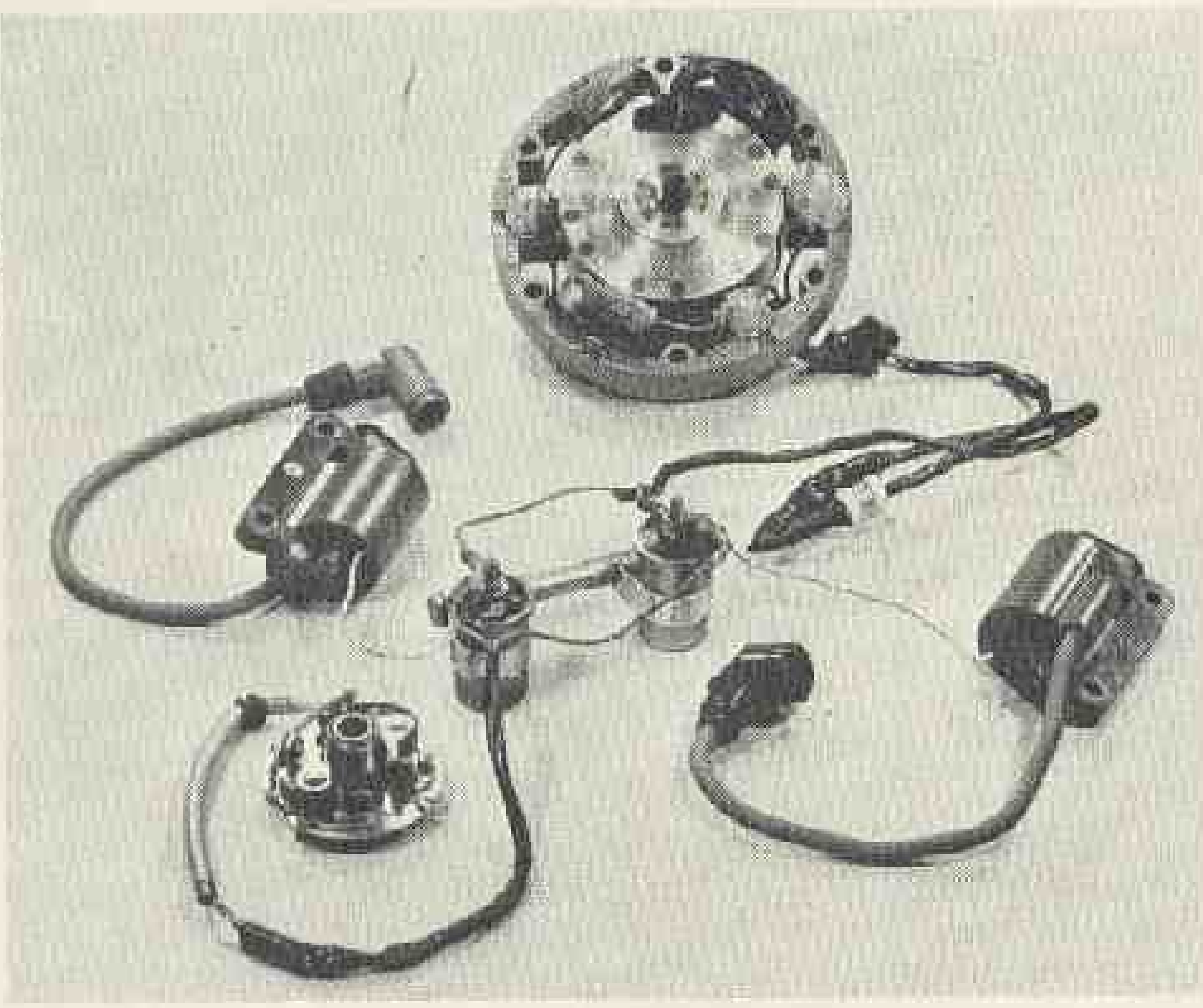
This gave me all the basic hardware. It was still necessary to work out the details for the various systems, like carburetion and ignition. This last was most bothersome, because while I did not want to carry a battery on the bike, there was no magneto available that would fit without a lot of machining. The lads at Precision Machining had faced the same problem when building their very successful 450, and had ultimately used a Yamaha magneto—which required the fitting of special seals and cutting a new taper on the end of the Honda crankshaft.

One of the primary reasons PM had for going to that crankshaft-mounted magneto was to dispense with the stock Honda points and breaker-cam setup. They had used a standard battery/coil system, and found a serious misfire up in the 10,000 rpm range that would not go away. Changes in coils, and condensers, and points had no effect; the misfire was still with them. It was eliminated when they switched to the magneto.

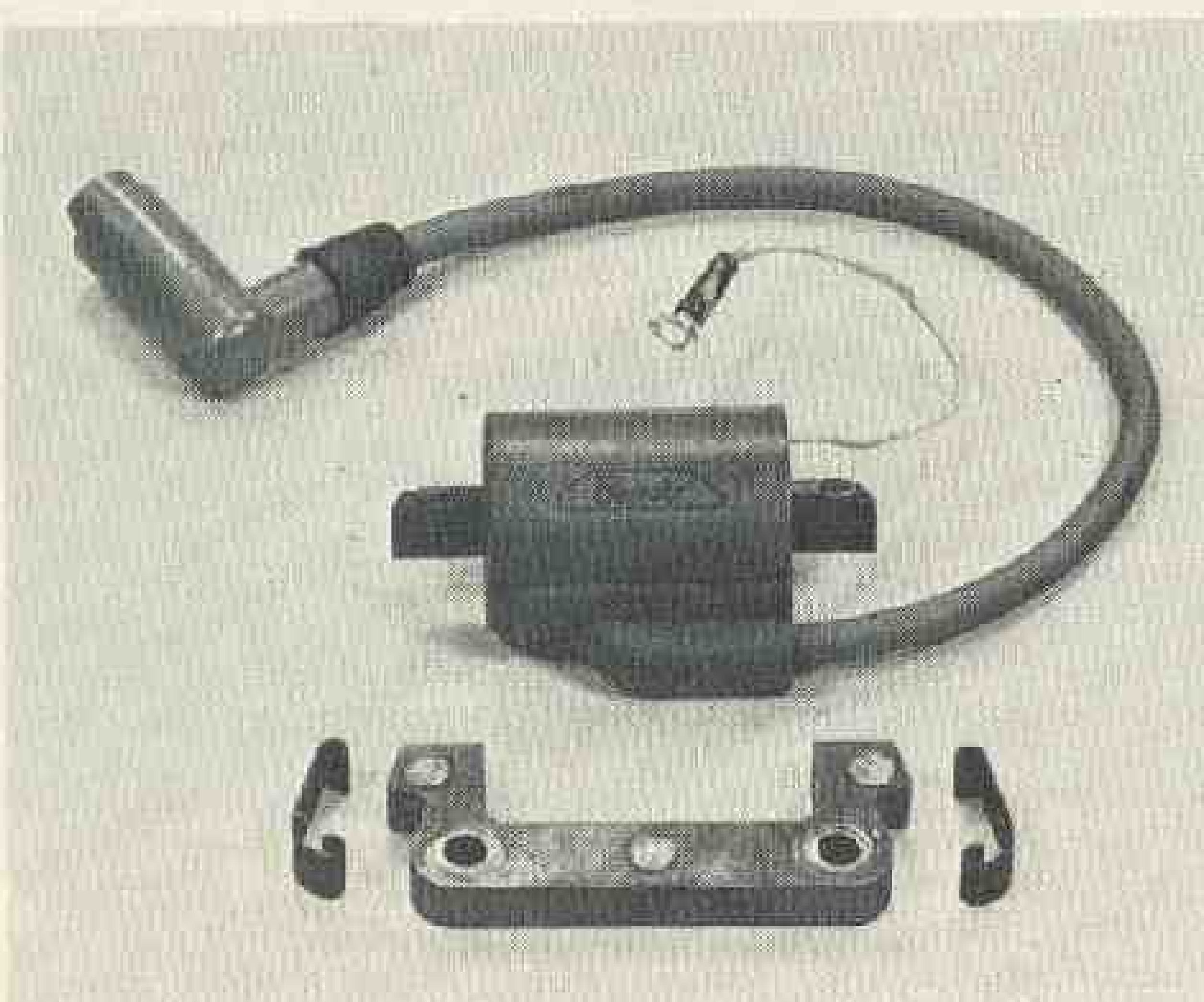
But for all the machining required, I might very well have done the same. Unfortunately, I didn't have that much time to devote to an ignition system; an alternative would have to be found. The question was: *what* alternative? It was obvious that I could not expect good results with the standard ignition system. PM had tried that without success, and I knew that my CB 450 would misfire like mad if taken past the 9700 rpm red line. And there was my clue: it seemed just a little too pat that the misfire would occur so near the red line; perhaps Honda had built in the misfire



The two coils and condensers can be mounted anywhere on the bike, but the spark leads must be as short as is possible.



Gathered here is the complete ignition system, "powered" by a pair of coils in the stock Honda alternator at the top.



This Bendix coil sells for only twelve dollars, and though made to fit inside an H-D magneto will work in an E.T. system.

PHOTOGRAPHY: STUART DAVIS

to prevent people from over-revving their engines.

PM's story was that the misfire was being caused by the exhaust camshaft (which carries the breaker cam on its extended left end) and was upsetting the timing at high engine speeds. That did not seem likely to me, as the Honda's camshafts have a really hefty diameter, and lobes running right next to the support bearings. It *had* to be something else. And it was.

The 450's ignition breaker cam has an unusually steep opening ramp, and whacks the points open very smartly. A good thing in terms of easy starting and prolonging point life (a fast, clean break minimizes arcing), but definitely ungood at high engine speeds. Get that cam turning fast enough, and the points begin to float and bounce and in general misbehave very badly. At such times, you can get a whole volley of sparks from the ignition system–none of them occurring when they should.

There is a cure. You take a fine stone, and roll a bit more radius into the curve that joins the cam's flank and nose. Then with an even finer stone, you restore the cam's surface polish–which is necessary unless you want a rough spot on the cam that will file away at the breaker blocks. You must go very slowly in modifying that cam profile. Remove just a touch of material, widening the radius ever so slightly, and then put everything back together and ride the bike to see what the result has been. There is not much point in moving the point-of-misfire up beyond the engine's operating range. My 450 Honda will go to 12,000 rpm without missing a beat, but you are asking for trouble if you take it much above 10,500 rpm. The Honda will go along with this foolishness a few times, but eventually there will be a big blow up. (For reasons that will be explained when I get around to the subject of cams and Honda's torsion-bar valve springs.)

That takes care of the point float; we still have to deal with the rest of the spark-producing system–which will probably sound complicated to you, but is easily managed if you understand what it is you are trying to accomplish. All you have to do is to make your own magneto, and that is–believe it or not–easier than fitting some existing mag' on the Honda engine.

The magneto I made for my 450 is of the "energy-transfer" variety, which is to say a magneto with separate low-voltage generator (engine driven) and high-voltage spark coils. For the low-voltage generator coils, I simply used the "daytime" coils in the Honda's alternator. The actual spark is produced by a Bendix magneto coil. You need a pair of these Bendix coils, and you can get them from Harley-Davidson, part #29576-63R. For this particular application, you must add to each coil a Lucas C lamination (to complete the magnetic loop) and these carry Lucas' part #54441946. The Bendix coils are a perfect fit in the Lucas C lamination, and are held with Lucas clips, part #54441104. (Four are required.) Finally, get a pair of Mallory condensers (the big fat kind, with a terminal lug on top) and a few feet of insulated, multi-strand copper wire. A couple of blade-type connectors will be useful, but are not an absolute must.

If the motorcycle is to be used for racing only, you may remove four of the six generating coils on the alternator's stator—which is done by straightening the tabs that hold them in place, cutting the wires, and pulling them off of their pole pieces. The two coils you will be using for the ignition system are those connected to the yellow lead. This is one of three leads on the alternator stator; another, pink, lead connects with the four "night" lighting coils. The third, common, lead is brown. It connects the ground side of all the coils.

Those daytime coils are 180° apart on the stator, and are connected in series. You will want to use them as separate generating units, so it is necessary to scrape a bare spot on the bit of insulated wire running between them and ground it on the stator. The least complicated way of accomplishing this is to crimp one of the coil-holding tabs over on the bare spot, and then apply just a drop of solder between wire and tab to insure a good electrical connection. This done, you locate the leads coming out the other side of each coil and solder on long wires to carry the coil output up to the coils, condensers and breaker points.

The coils can be located anywhere on the bike. I chose to bolt them right against the frame strut that holds the stock coils. The hole pattern through the frame is not the same as in the Lucas C laminations, so you must drill an extra hole through the frame. You could drill through the laminations to make their holes match the frame, but in doing that, you will smear the metal in each individual plate enough to make an electrical connection between them and that will reduce the coil output some amount. Why? Because when the coils are operating, a magnetic field is flashing through those laminations and generating electricity there. Connect between the plates and you allow the current to flow and part of your field strength will be lost. Things like coil cores and stators are laminations made of many individual thin sheets, insulated from each other, for precisely that reason. The eddy currents generated in a

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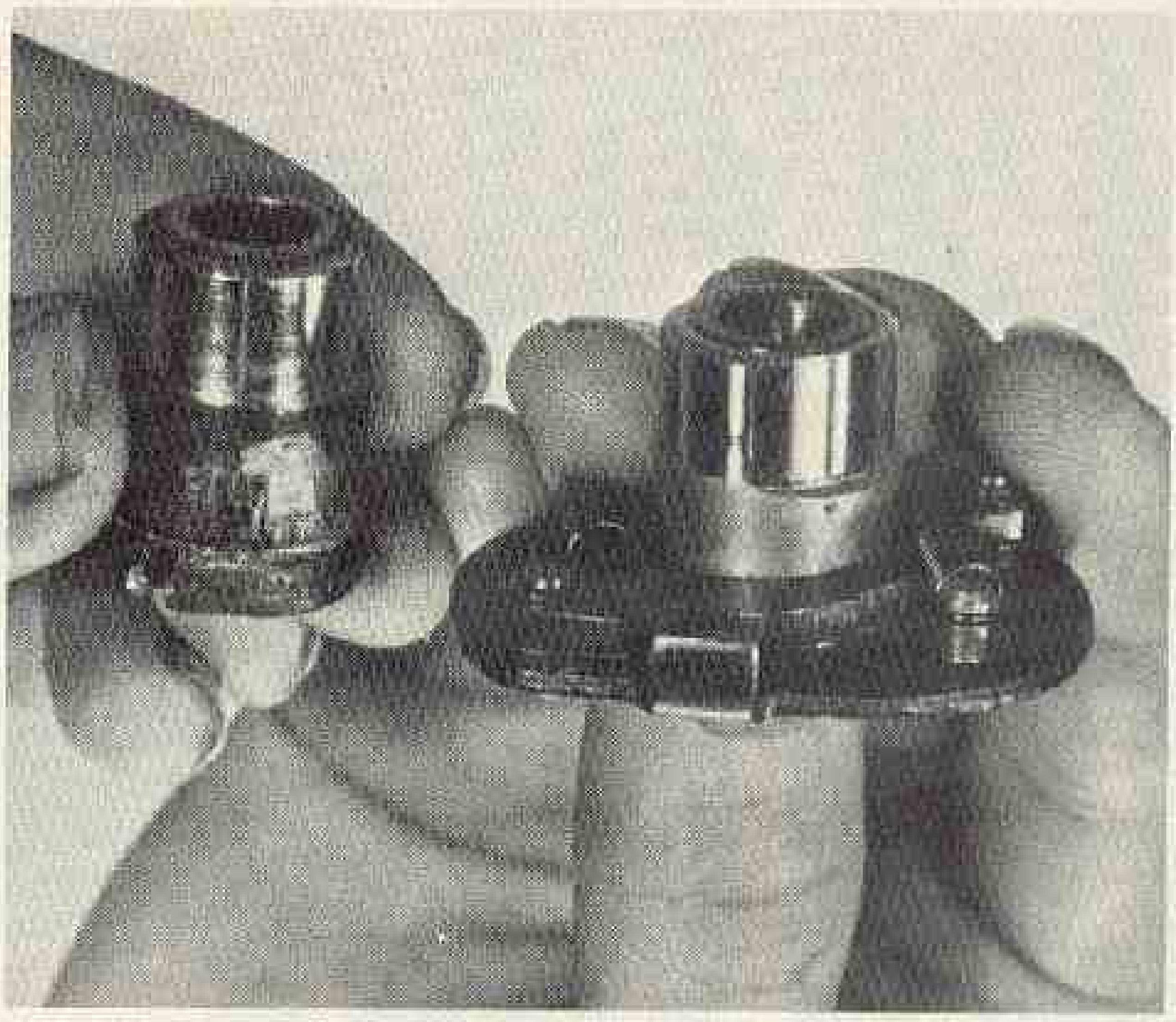
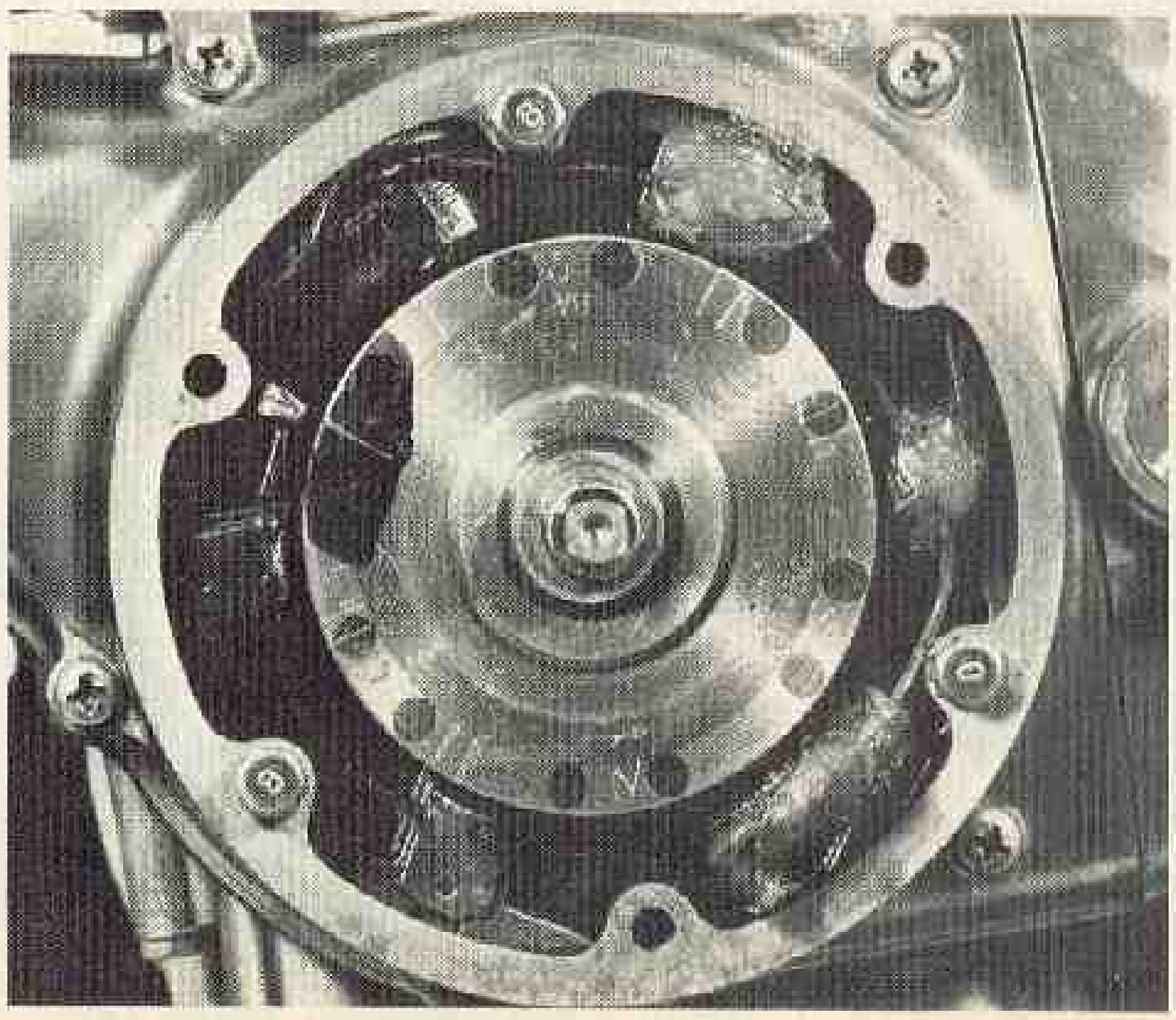


To keep the alternator output phased with the points you must lock or remove entirely the automatic advance device.

You can remove redundant coils by bending the retaining tabs, cutting a few wires and sliding them off the pole-pieces.



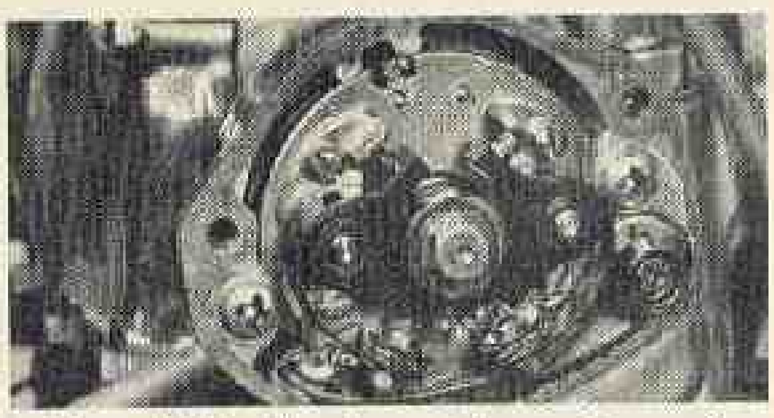
A new TDC mark scribed on the alternator rotor will be a big help in timing the ignition to be required 45-degrees.

MAGNETO *Continued from page 41*

solid core would do bad things to the magnetic field. Don't upset what the engineers have worked so hard to accomplish.

For convenience, I used the same bolts securing the coils to the frame to hold the Mallory condensers. And, also for convenience, I used the condenser terminals as terminal posts for all the wires. You don't even need a wiring diagram for this job; all leads—from coil, points and alternator—attach at the condenser terminal. In other words, everything is wired in parallel. Of course, you have to treat the whole lash-up as two separate systems, but you can use either of the generating coils in the alternator to spark either cylinder. Just don't do any cross-wiring between sides, or the spark disappears. In fact, this is how you rig a kill-switch: take an ordinary two-lead toggle switch and attach each lead to a terminal. When the switch is "on" it makes a direct short between the two sides of the system and presto! The spark is gone.

Now then, with the wires hooked from alternator to condenser to coil to points, you can "time" the engine. To do this job, you must remove the alternator rotor and stator, and bolt a degree wheel to the end of the crankshaft. Reach down through the sparkplug hole



with a dial indicator and ease the engine over to find top dead center, then "zero" your degree wheel. After that, you proceed in the usual fashion: backing the crank by the number of degrees of spark advance you want. Stock full advance is 40° and that is best for mid-range running. Mid and upper range performance is better with the timing at 45-48° BTC, and that is what you want for racing.

Having backed the crank into "firing" position, you are almost ready to set the ignition timing. "Almost" because you must first rework things to eliminate the automatic advance mechanism. This centrifugal device swings the timing 35° between 2000 rpm and 3500 rpm, and the pulses coming up from the alternator don't last that long. So, if you leave the advance mechanism intact, you will have an engine that starts—but won't get much past idle; or you can have one that will run after it is cranked up past 3500 rpm—but you can't be started in a normal manner.

You can simply pull the advance over to full-advance, and weld it in place. I chose to remove weights, springs and everything else, and then silver-solder the breaker cam to its shaft (which is really a tube that fits over the end of the exhaust camshaft). The sequence here is to slip everything into place on the end of the exhaust camshaft, and then install the points plate right in the middle of its adjustment range. You then rotate the breaker cam with your fingers until it just begins to lift the points to your left (which fire the left cylinder) and then mark, with file or punch, the breaker cam and its tubular shaft. The purpose here is to get the breaker cam timed to the crank, and the marks allow you to assemble cam and shaft with proper indexing while you silver-solder them together.

With all that out of the way, you get to the tricky business of phasing the alternator to the points. Before removing the degree wheel from the crank, you must lock the crank securely at 45° before top center. Good luck to you with this job. I made a ring that fits under the oil-filter cover and jams the filter sleeve (which is bolted to the end of the crankshaft) when the cover is replaced and tightened. Don't try to get without securing the crank in "timed" position;

the Honda 450 engine is incredibly free turning, and easily nudged out of position.

Having locked the crank, you may proceed with assembling and timing the alternator. Slide the stator in place and tighten all the screws first, then you can install the rotor. There is a keyway in both rotor and crankshaft, and a key—which is discarded in this application. Just slide the rotor onto the tapered end of the crankshaft, and turn it so that the LF (Left Fire) mark is aligned with the pointer Honda has so thoughtfully provided on the stator. This sets the rotor phasing with the stator so that you get full strength output with the crank set at 45°BTC. That's why you must have the crankshaft locked in position during this phasing operation. If the crank moves, full wave strength will occur at some other point. In any case, you get it when those marks are in alignment, and as the points must be set to open with the rotor/stator timing marks, the rotor must go on the end of the crank just right.

You will probably worry about having discarded the key. Don't give it a thought. That key is strictly for indexing. Wipe the taper, and the matching tapered hole through the rotor, and pull the end bolt up tight to seat the rotor solidly on the taper. It won't slip. In fact, the only way you can get the rotor off is by using the appropriate Honda puller.

And now, at long last, you will be ready to set the points, which is done just as outlined in the Honda manual. You set the points to break just as the rotor/stator timing marks swing into alignment, and unless you have made a mistake somewhere along the line, you will get a nice, fat spark. It doesn't need a high cranking speed; you'll see a spark at the plug even if you merely stick a wrench on the rotor bolt and swing the crank around by hand.

The way the whole thing works is as follows: With the points closed, and the rotor swinging into position, the magnetic flux generates electricity in the alternator coil, and because there is a direct path to ground through the points, there is not much voltage but a lot of current. Which does a strange thing: an electrical current flowing through a coil creates a magnetic field, and the magnetic field created in the stator coil pushes back against the rotor's magnetic field. (And, incidentally, this will happen no matter what the system's polarity, so don't worry about which magnet is working on what coil.) Anyhow, the magnetic fields push against each other and the rotor's field gets bent back, until the points open. Right then, with the direct path to "ground" having suddenly been eliminated, current in the stator coil substantially disappears and with that a lot of things happen in a hurry. First, the retarding induced magnetic field evaporates, which leaves the rotor's field free to surge through the stator coil, and it does so with such rapidity that electrical pressure in that coil zooms sky-high—to about 400 volts, I believe. Now if there was not a condenser in the system to soak up this voltage, it would arc across the points (at this time no more than barely open) and would be lost. But because there is that condenser, the voltage surge is captured momentarily while the points are opening a bit farther, and then both alternator and condenser hit the coil with a big, 400-volt jolt—and it does make a considerable spark. Those who know how a conventional battery/coil system works will see that this is an entirely different process, and that's why you must use special coils. I chose Bendix magneto coils "converted" to E.T. (Energy Transfer) operation; you can use Lucas E.T. coils. Ordinary coils may work, but they will work badly and they probably won't work for long.

A season of racing experience with the Honda 450 racer (Grandson of Secret Weapon?) has revealed a number of short-comings; none of these are in the ignition system, which has been a marvel of reliability and effectiveness. I run the coldest plug Champion supplies, the N52R, without fouling problems. Starting, after sorting out the carburetion, has been very easy and the only time I have heard a misfire was when vibration was doing funny things to the float chamber (twice) or when a valve fell down into the engine (thrice).

The only peculiarity of my homegrown E.T. magneto is that (a) it is very sensitive to timing (the points must be working with the alternator) and (b) it is even more sensitive to anything that would come under the general heading of "crud" on the points. This last is understandable, as dirty points create a resistance that drops the current in the generator coils in those critical moments just before the points open, which in turn flattens the voltage surge that follows points-opening.

Neither of these things are a problem if you know about them and they are common to all magnetos. What remains a problem is a defect built into the 450 engine: the camshaft bearings, plain aluminum bushings, are a loose-ish fit around the camshaft journals, and that means a bit of wobble at the breaker cam when the engine is running. You set the spart at 45° BTC—and the wobble sends it dancing about 5° either side of nominal at 8000 rpm. You can assume that sparks happen somewhere between 40 and 50°. It seems as though there is room for improvement here—maybe with a near-zero clearance ball bearing at the "ignition" end of the exhaust camshaft. Maybe I'll get around to giving it a try. ◉