POLICE RADAR

- *How it Works*
- *Accuracy and Reliability*
- *Checking and Cheating*
- *Speed Limit Traps*

Michael Rignall (left), one of the original team of three who designed the radar meter, shows the speed indicator unit to authors Stuart Bladon and (right) Geoffrey Howard. The big Marconi sign on the aerial unit does not feature on police sets

"CAN you please tell me the maximum speed which a 1963 Hillman Minx would reach after 350 yards acceleration from rest, on a gradient of 1 in 7?" "What would be the effect on a radar speedmeter if a car went through the beam towing a trailer carrying a boat made of ALUMINIUM?" These are the sort of questions we are receiving with increasing frequency, and which all boil down to the same simple issue: that someone has been caught in a radar trap and is trying to wriggle out of it.

No doubt there have been, as there always will be, a few cases of erroneous prosecution—occasions when motorists have been wrongly convicted or when they have rightly managed to obtain an acquittal. Without doubt, however, there have been other times, when because of the newness of radar, and the readiness of courts to be suspicious and doubtful of it, cases have been dismissed on the flimsiest defence. Perhaps the success of a few has encouraged others trapped by radar to contest cases where they were not convinced of their guilt.

Genuine doubt appears to have resulted about the accuracy of the radar speedmeter, so to find out once and for all whether it can be trusted or not, arrangements were made to borrow a set from the manufacturers, the Marconi Co. Ltd. To see fair play, as well as to fill in important background information, Marconi sent along not only their press officer, Dan Boyle, but also a man for whom many might have an unkind word to say if they met him—Michael Rignall, one of the three designers who worked on the project.

It was original dissatisfaction with foreign makes of speed measuring equipment which prompted Lancashire police way back in 1958 to approach Marconi with a request for an instrument which would measure vehicle speeds from the roadside. It had to be a "fail safe" instrument, which meant that it would always either not read at all or read low if anything went wrong, and it had to work without need for wires laid across the road. The team of three, headed by Mervyn Morgan, now assistant director of engineering and research at Marconi, went to work and the first set was finished and passed out in 1960.

It has since been sold to over 60 police forces throughout Great Britain, while 84 sets have been purchased by the Home Office and are loaned or hired to police which do not have their own equipment. Other sets have gone to road research units, and some 30 radar speedmeters have been exported to nine countries overseas including Jamaica, Holland, Australia, Rhodesia, Malaya and Singapore. Exactly 204 sets so far have been made. All but two of them have been sold and are presumably in regular use, so it is clear that, in spite of the formidable cost of £560 per set, the chances of coming across a radar trap on the road are high indeed. Police are unlikely to make so large an investment and not get full use from the equipment.

How it Works

The Marconi speed measuring radar set is called PETA (Portable Electronic Traffic Analyser) and it works on the Döppler effect. This is a familiar phenomenon, audible when a fast moving car passes with its horn blowing. As the noise approaches the sound waves are speeded up in proportion to the speed of their source and take on a slightly higher pitch. When the car is level with us we hear the true note, and then as it fades away the pitch is lowered by the same amount as it was raised before.

ON TRIAL

by **STUART BLADON** *and* **GEOFFREY HOWARD**, B.Sc. (Eng.)

In the case of PETA, an ultra high frequency radio beam is directed across the road at an angle of 20deg with the kerb, and when this hits a moving car some of its energy is reflected back at a different frequency. This change in frequency is proportional to the speed of the vehicle, and the function of PETA is to compare the returning signal with the one it sent out and convert the difference to give a direct reading in miles per hour on a suitably calibrated meter. As only the difference in frequency is being analysed, the system works equally well for vehicles approaching or leaving the beam.

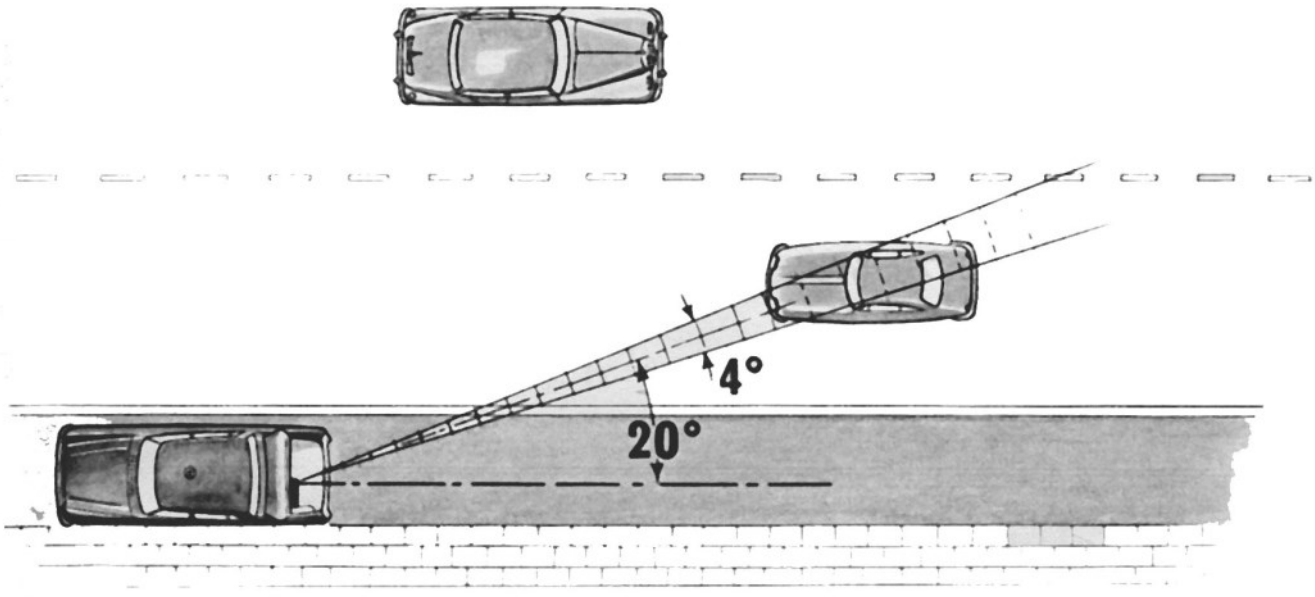
In its complexity, but not in the quality of the components and methods of construction, PETA is about as involved as a domestic television receiver. A lot of the circuitry is transistorized with printed wiring boards, and only three valves are used. The frequency is in the band from 10,675 to 10,699Mc/s and the beam is only 4deg wide, with a working range of 150ft. In terms of distance along the road parallel to the kerb the beam spans only 5ft at a point 8ft out from the meter (a typical installation in a boot of a parked car) and 25ft away from it. Allowing for the length of the vehicle, at built-up area speeds the car will be in the beam only about 0·2sec—amply long enough for the complete measuring cycle.

The 20deg angle of the beam is a compromise. If the apparatus had been designed to point down the road, vehicles would enter the beam farther away, but there would be less obvious separation between them. If the beam pointed across the road more, there would be better separation but a much shorter time in which to measure the speed. The effect of wrong installation has been very carefully studied and allowed for. Pointing the beam directly parallel to the kerb gives very confused results and long periods of meter inactivity which immediately suggest that something is wrong, but the greatest possible error in readings is 6 per cent high—53 m.p.h. instead of 50 m.p.h. This is the only way high readings can be registered, all other faults give a low error; this drops sinusoidally with the angle so that a 10deg error in setting up gives rise to only 2 per cent optimism. Pointing the beam too much across the road will give correspondingly low readings.

Just to check on people's idea of what is a right angle and the sort of errors the police would be likely to make in setting up, the Marconi engineers tried a cross-section of their staff (even canteen washers-up) in a simple test with the PETA aerial unit—an aluminium box 9 × 9 × 27·5in. They were asked to set it up by eye with the long side at right angles to the kerb and the results came within a surprisingly narrow spread. It is as easy as putting a picture straight on the wall.

The electrical supply is from a normal 12-volt car battery, which feeds a power unit providing a stabilized 9-volt output even if the battery voltage drops to 10·5 volts. The consumption is only 3·5 amp, so that a light-duty battery would serve well for several hours. There is a protective diode (a one-way electrical switch) which prevents the apparatus →

In this typical set-up the police car is parked on the verge beside the road with the radar aerial unit working from its open boot. Both cars shown on the road could give readings, but it is likely that the one going from left to right will pass through the beam before the meter has switched on again after holding the first car's speed for 1·5sec



POLICE RADAR ON TRIAL

from being damaged by connecting up the wrong way round —positive to negative.

PETA takes 5min to warm up, and then the calibration can be checked by operating a "check" switch at two readings, 40 and 70 m.p.h. The needle should then register between 38 and 42 for the 40 m.p.h. check, and between 68 and 72 for the 70 m.p.h. one—the specified tolerance of ± 2 m.p.h.

For police use a special hold provision keeps the needle at its reading for a full 1½sec after the car has passed through the beam. There must then be a clear 1/10th second without another vehicle hitting the beam before the next reading is registered—otherwise the needle remains at zero. In this way there is plenty of time to take a careful reading of one car without confusing it with others following it closely. On top of the aerial unit a large red arrow points in the direction of the beam, and with these two aids we had no difficulty at all in picking out which car's speed was being indicated. For traffic surveys and average speed measurements the holding circuit can be switched out so that flash readings of each vehicle are displayed for only as long as they are in the beam, regardless of how close together they are—but this is not for police use.

The actual meter scale is marked in m.p.h. from 0 to 80 with figures for each 10 and a needle thickness fine enough to read to the nearest whole m.p.h. There is no risk of readings being exaggerated by parallax.

Testing for Accuracy

Of course, we are by no means the first to put the radar speedmeter to the test. Quite apart from the endless research and cross-checking carried out by the manufacturers, there have been police tests and demonstrations before magistrates. Even the daily press have carried out their own stop watch checks. However, we felt that it must be possible to produce a system of checking not only to measure the accuracy of the instrument, but also to make the result perfectly clear and eliminate all personal prejudices and sources of error.

The system evolved was to carry a photographer in a test car—in this case a staff Mini-Cooper S—with instructions to photograph our Smiths electric speedometer at the exact moment when the car arrived at the radar beam. Simultaneously another photographer by the roadside took a picture of the speedmeter showing its reading. Numbers on the front of the car and on the windscreen identified each run for subsequent cross checking. The electric speedometer in the car is one of three sets used always by *Autocar* for road testing, and checked regularly by the manufacturers. It is driven by a free-running fifth wheel trailed behind the car.

The results of eight runs are summarized in the following table:

RESULTS OF TEST RUNS

Speed which Driver was Trying to Hold	Actual Speed Recorded by Photograph of 5th Wheel Speedometer within Car	No. of Run	Actual Speed Recorded by Photograph of Radar Meter	Speed Read from Radar Meter and Written Down by Its Own Designer
m.p.h.	m.p.h.		m.p.h.	m.p.h.
32	32	1	33	33
45	44	2	45	45
60	62	3	61	61
82	84	4	Off scale	80+
52	52	5	53	52
28	28	6	28	28
38	38	7	37	37
70	68	8	69	68

Speeds were chosen completely at random by the driver, and the radar observers had no idea what speed to expect next

Reliability in Police Hands

Except at the one speed of 84 m.p.h., which took the radar needle off its 80 m.p.h. scale, all the tests confirmed the makers' claim that the error will not exceed a maximum of 2 m.p.h. high, and on all the runs the meter was either accurate or within 1 m.p.h. of the speed shown by the fifth wheel speedometer.

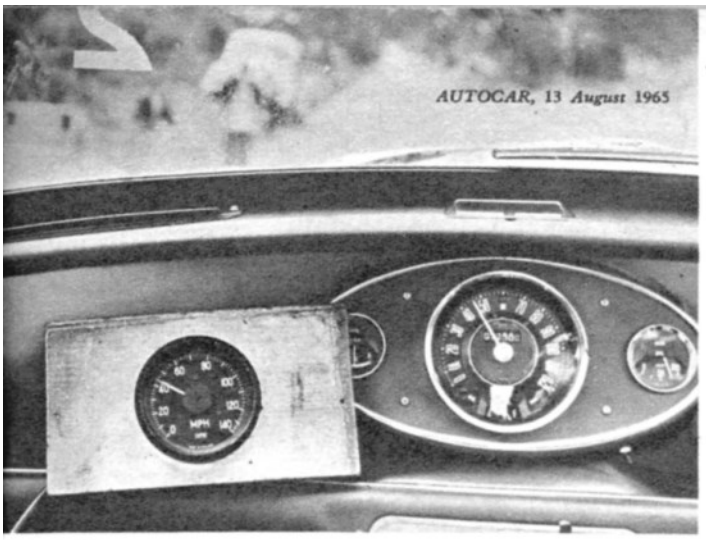
We were not sceptical of the instrument before carrying out the tests; indeed, we would have been astounded if the two readings had not tallied in the manner shown. Even so, it was interesting to see the radar speedmeter in action; its consistent readings, the clarity of its dial, and the elimination of any confusion over which car was in the beam on a busy road, are most impressive.

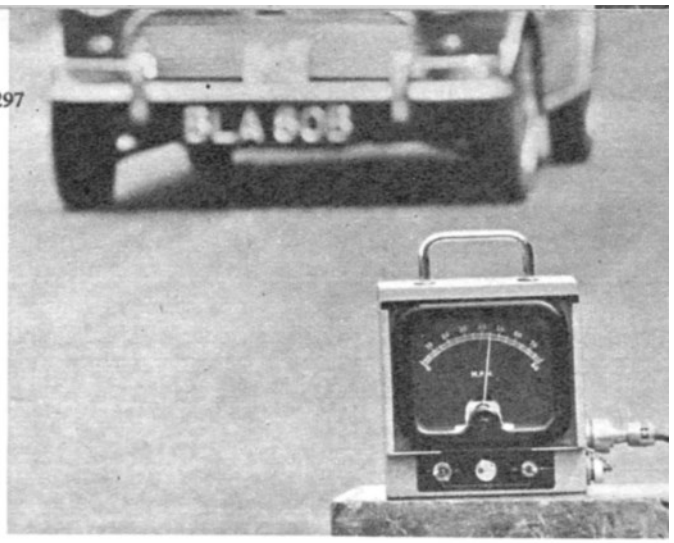
Many people are surprised to learn that the speed is shown on the instrument for only 1½sec, and that the police have to read the position of the pointer in that short time. Anyone who doubts the practicability of this should first assess the length of time which 1½sec really is. An easy way is to count "One-thousand-two" in steady, deliberate manner; and study the secondhand of a watch while doing so. One will then realize that this is amply long enough even for the position of a watch secondhand to be pinpointed as it sweeps the two divisions which mark a second on the dial.

The instrument is also safeguarded against giving false, high readings, by inbuilt provisions which ensure that the failure of any components will either stop the instrument or give a lower figure than the true value. We actually saw this in an unrehearsed breakdown of the equipment which meant that we had to "call it a day" and meet again on another date, after the fault had been rectified. In the middle of tests on a busy road, the needle suddenly scored up a succession of readings of 15 m.p.h. when speeds were obviously much higher. Then it stopped working altogether, suffering—we were informed—from failure of its Klystron.

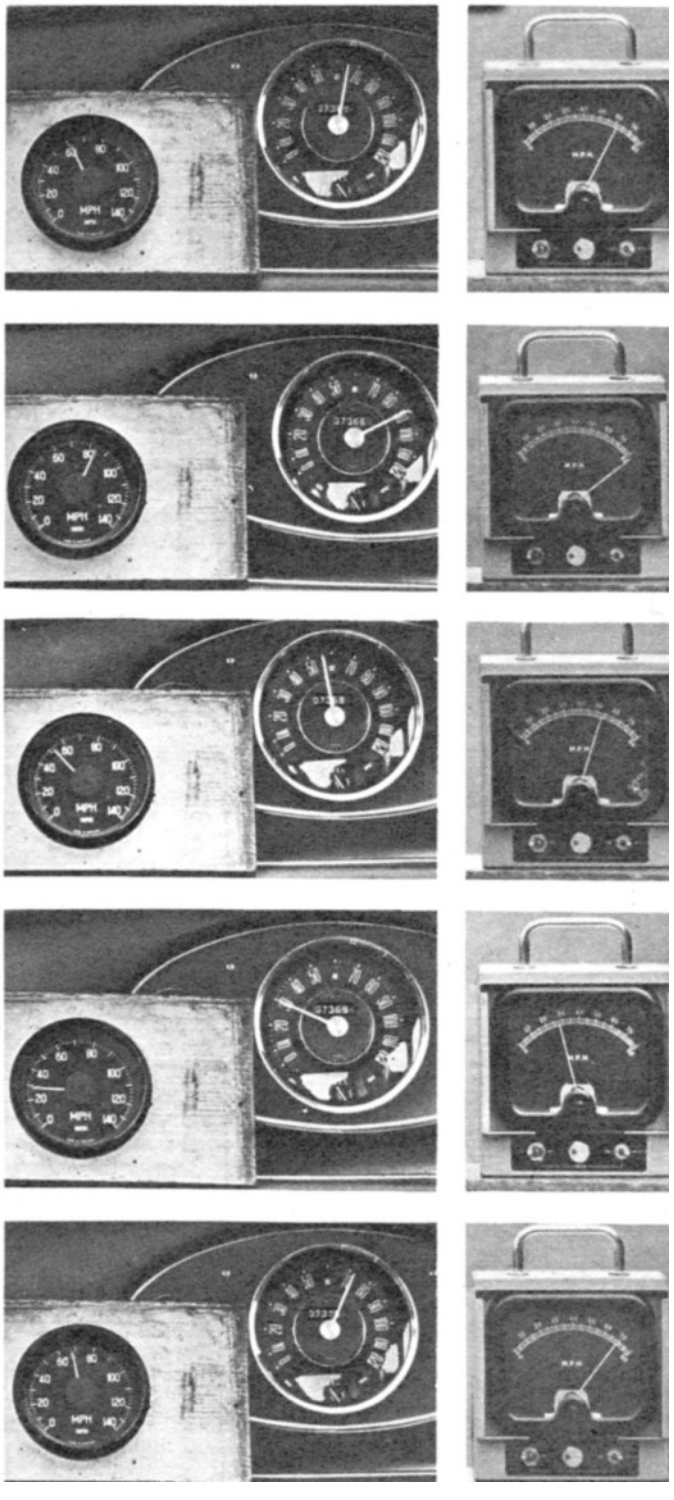
It was interesting also to compare the photographed meter reading with the one read at the time; they tied up in all but two cases where a figure 1 m.p.h. lower than the

Driver's eye view of a typical set-up, showing how even a Mini can obscure a police trap, with the aerial unit in the boot of the Consul; there must always be at least one observer near enough to the aerial to be able to look along the path of the radar beam.





Photographic illustration of accuracy: one photographer in the Mini-Cooper took a picture of the fifth wheel electric speedometer in the car at the moment of entering the radar beam; simultaneously another camera was exposed to show the reading on the radar unit



true value had been written down—a small error in favour of the culprit.

We understand that instructions given to police are that a particular vehicle's speed must be indicated on the meter to warrant prosecution and that it is not sufficient to assume that each of a string of vehicles is travelling at the same speed as the leader—the only one whose speed will have been indicated on the meter. Where one vehicle overtakes another just at the point of entering the beam, the speed indicated will always be that of whichever breaks the beam first, and the reading will not be affected by arrival of the second vehicle.

Presumably it would be reasonable for police to assume that a vehicle overtaking another which is already exceeding the speed limit, must be going faster still and hence its driver must be even more culpable; but even these cases usually are ignored. There is no shortage of isolated "paying customers."

Provided these safeguards are observed, police using the radar speedmeter undoubtedly can measure vehicle speeds with greater accuracy than by any other method available to them, and any errors will always favour the motorist. Allowance always is made for the 2 m.p.h. admissible margin of accuracy. It is certainly a far more reliable method than the time-honoured one of pursuing the victim far enough away to be practically indiscernible in his driving mirror.

What Hope or Cheating?

Understanding of how the equipment works makes one realize that nothing can be done to cheat the police. The speeding motorist who swerves in to the kerb when he spots the meter gives himself perhaps two or three feet extra braking before his vehicle enters the beam, and the result is the same. Further, as the beam goes across the road at an angle and is very narrow it is impossible to design any sort of detector which would give advance warning. Similar myths about false readings resulting from wobbly number plates, corrugated iron, tinfoil on the radiator grille, aluminium boats, birds flying about in the path of the beam, and the talk about radiation dangers, are all completely without foundation.

If You Were Caught

"If you were stopped by police who claimed that your Zephyr had gone through the radar beam at a certain high speed" we asked the designer, Michael Rignall, "and you knew from observation of your own corrected speedometer that this figure was wildly wrong, what explanation would you look for in the way the police were using your radar speedmeter?" His immediate reply was: "The somewhat unlikely one of a policeman who was perjuring himself." On further questioning, however, we evolved the following notes to guide anyone who really thought at the time that he had been wrongly accused of speeding. →

Deliberate wrong alignment of the aerial to send the beam straight down the road can increase readings by up to 3 m.p.h. at 50 m.p.h.; for accuracy the oblong box with the Marconi sign should be at right angles to the kerb

POLICE RADAR ON TRIAL

It should be quite permissible to walk back and inspect the set-up, and you should see that the main box of the meter, called the aerial unit, is roughly at right angles to the road, and the red arrow on the top of the box should be pointing across the road at the 20 deg. angle shown in the drawing. It is most unlikely that police would point the arrow straight down the road, but if this were the case it could form grounds for a defence, as this is the only way in which the meter can be made to read high. Even then the error is small.

One should then study the behaviour of the meter unit, and you should see the needle rise to indicate a speed as a vehicle approaches, and then stay at that position for the 1½ sec. interval, before returning to zero. In the very unlikely case of a needle moving erratically up and down the dial, indicating the speed of every vehicle approaching but not showing any reading for more than a fraction of a second this would show that the meter was wrongly set on the "hold-off" position which is provided for surveyors and traffic engineers who want a rough guide to the speed of all approaching vehicles. Police are recommended never to use the meter in this way, because the reading is too abrupt to be read with certainty; we repeat that, as it involves partly dismantling the meter unit to eliminate the hold, anyone caught in a trap is most unlikely to find that police were using the instrument in this manner.

Finally, the only explanation of an error could be that the speed indicated was that of another vehicle; and it is most important to remember that the speedmeter indicates the speed of traffic going either way. Thus, if you were approaching the beam at the same moment as a fast car coming towards you, its speed could be the one recorded even though it was going away from the instrument. It is obviously up to the police to ensure there is no ambiguity in this way. To do so, we feel, they must be standing or sitting near enough to the aerial unit to be able to see along the arrow and thus know exactly what vehicle was in the beam when the speed was indicated.

All You Might See

It would not be right for us to try to "tip off" readers on how to spot a radar trap; but we do feel that all should know how very easily a radar trap could be concealed. Often there will be a vehicle, and there must be the operator, who must be near to the aerial unit. Only one policeman would be needed to observe the instrument for successful prosecution, but usually two at least are employed so that one can be radioing or signalling for vehicles to be stopped, while the other concentrates on the meter; but all this can very easily be concealed behind a wall or hedge. If a vehicle is used, it may well be an unidentifiable "Q" car.

The familiar technique used at the moment is to site the equipment in the back of either a van or an estate car with the door open. If the police really wanted to be beastly, they could even have a false boot panel or tail gate made up in glass fibre and painted, and the meter beam would pass through it perfectly satisfactorily! Most police would probably reply that there was no need for this sort of subterfuge—that they can find plenty of customers even if they sit the equipment on a table in full view. Many of them have a power socket built into the back of a police car, so that it is not necessary to heave a car battery about, or to have a boot open.

Having seen it in action, and used it ourselves on a road with one of the new 50 m.p.h. speed limits, we are convinced that if police really wanted to, they could so conceal the meter that even the most alert driver would not spot it.

The Moral Issue

Many take the view that police working a concealed radar trap to catch speeding motorists are doing something highly "immoral" and underhand. Yet the same individual would probably be only too delighted to know that a policeman had prevented theft of his car by sneaking up in the dark and being similarly furtive. The important thing to remember is that it would be sufficient for prosecution for two policemen to state in court that, *in their opinion,* the speed of the accused's vehicle was in excess of the limit for that road. They need not have used any measuring instrument at all, and such a case would be extremely difficult to defend. Intelligent use of the radar speedmeter is fairer for the motorist, and more likely to give the correct result.

What does cause justifiable annoyance is use of radar in needless and quite unrealistic speed limits on clear, safe roads restricted only because of the haphazard presence of street lighting. The trap which a member of the staff witnessed on A5 in Hertfordshire some months ago, where speeds of vehicles were being measured within a few yards of arrival at the start of the restricted area on the north side of Radlett, certainly came into this category. It is this sort of pointless "go out and catch a few" approach which brings radar into disrepute and fosters ill will between motorists and police.

Summary

The old days of "Forty shillings, endorsed" have gone, and speeding is now an offence which puts a driver a third of the way towards losing his licence. We have shown that the radar speedmeter gives the police a convenient and, if used correctly, extremely accurate method of measuring vehicle speeds. If they wish, police can so conceal the instrument that drivers have little hope of spotting the trap before it is too late to reduce speed; and inevitably the question is asked "How can one avoid being caught speeding?" The answer, of course, is obvious. ■

"I think it's the Klystron"—and so it was, as it turned out; the set failed to respond to its designer's screwdriver, and put an end to the first day's researches. In case of breakdown of any component, the meter is safeguarded against giving high readings