Gist—

Tuning forks be tested, that speedometers be calibrated and that stop watches be calibrated. All with certification within a reasonable period of time. That period being six months.

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370 S.W.2d 731

CITY OF ST. LOUIS, Plaintiff-Respondent,

v.

Forrest BOECKER, Defendant-Appellant.

No. 31278.

St. Louis Court of Appeals, Missouri.

Sept. 17, 1963.

Forrest Boecker, St. Louis, for defendant-appellant.

Thomas J. Neenan, City Counselor, H. J. Dodson, Asst. City Counselor, St. Louis, for plaintiff-respondent.

DOERNER, Commissioner.

Defendant was arrested and charged with violating an ordinance of the City of St. Louis which limited the maximum speed of automobiles to 30 miles per hour. He was tried and found guilty in the City Court,

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and thereafter appealed to the St. Louis Court of Criminal Correction. A trial by jury in that court resulted in a verdict and judgment finding defendant guilty and assessing as penalty a fine of $25. From that judgment defendant prosecutes this appeal.

Defendant was arrested by Officer John Hoffman of the St. Louis Metropolitan Police Department on June 1, 1961, about 11:35 A.M., on Lindell Boulevard, an east-west street in the City of St. Louis. The only evidence tending to prove that defendant was exceeding the lawful speed limit was that given by Hoffman, over the timely and proper objections of defendant. The officer testified that he was operating a radar speedmeter mounted in the trunk of his police car, and that as defendant's automobile, proceeding westwardly, passed through the beam projected from the radar machine the dial of the radar speedmeter indicated defendant's speed as 40 miles per hour. On cross-examination the officer admitted that defendant's car was 'lagging behind' other automobiles which were proceeding westwardly on Lindell ahead of defendant.

It has been said that normally there are four basic issues involved in the conviction of an accused for a speed violation detected by radar: (1) the accuracy of the device as a scientific instrument; (2) the proper functioning of the particular machine used; (3) the identification of the accused as the speed violator; and (4) hearsay evidence as it may relate to the testing and setting up of the unit, to identification, and to the arrest of the accused. 1 To those we suggest the addition of a fifth, that of the training and experience of the operator. However, in this appeal defendant has raised only one of the foregoing issues, and accordingly our review will be confined to that question. In brief, what the defendant here contends is that Officer Hoffman's testimony as to the speed registered on the radar speedmeter was not admissible, and that without it no submissible case was made, because there was

no evidence that the radar device had been adequately tested or that it was functioning properly at the time defendant was arrested. The City, of course, contends to the contrary.

The only evidence of any test made of the radar device was that given by Officer Hoffman. Asked by the City's counsel whether on the day of the arrest he had tested the radar machine in any way before he took out the police car in which it was installed, he stated:

'Well, there is a tuning fork, as they call it, used specifically for checking this instrument, this unit. And this fork is used in a manner that you can turn it on, then you flip this fork and you touch it lightly, cause a virbration in it. And you hold it to the rear where the box would be that is picking up this--shooting out this beam, and that makes a reading on your visual meter of thirty miles an hour. And when it holds that reading for several seconds, then we are told that the machine is in perfect operating condition.'

Defendant objected to the hearsay involved in the latter part of the officer's answer and moved that it be stricken, but the record fails to show any ruling by the court.

Sergeant Herbert Bosch, supervisor of the Communications Technical Section of the Police Department, who was licensed by the Federal Communications Commission to service radar units and was in charge of the maintenance and repair of the Police Department's machines, testified that the tuning fork used to test the radar devices was very similar to a tuning fork used by a piano tuner; that it is cut to a certain audial frequency; that when held in front of the radar instrument and vibrated, it has the same effect on the radar as a car going through the beam at 30 miles per hour; that if the dial registers 30 miles per hour it is considered a test of the accuracy of the machine; and that it is an accepted test, recommended by radar engineers. On cross-examination

the Sergeant stated that the Police Department had two tuning forks, one calibrated for 30 miles per hour and the other for 60. He also stated that he had no personal knowledge of when, either before or after defendant's arrest, the unit used by Officer Hoffman had been tested.

Both the defendant and the City cite and rely on the only reported Missouri case involving radar, State v. Graham, Mo.App., 322 S.W.2d 188, decided by the Springfield Court of Appeals in 1959. In that case the state troopers had tested their radar machine shortly before defendant's arrest, and at the point where the arrest occurred, by what is called the run-through test, in which a car was driven through the beam at speeds of 50 and 70 miles per hour (as indicated on the automobile speedometer) to determine whether corresponding speeds were registered on the dial of the radar speedmeter; and also by the use of two tuning forks calibrated to register 50 and 70 miles per hour on the radar speedmeter. The defendant, who was charged with going 65 miles per hour in a 50 mile per hour zone, raised among others the same points as does the defendant here, namely, that there was no proof that the radar had been properly tested or that it was functioning properly at the time of his arrest. The court stated that it was a matter of common knowledge that an automobile speedometer reflects only approximate speed and that there is considerable variance in the speedometers of different cars. It noted that there was no evidence that the speedometer in the patrol car used to check the accuracy of the radar device was itself accurate, or had ever been checked. But it held (l. c. 197 of 322 S.W.2d):

'* * * If such a situation existed in a close case, where there was a slight difference between the allowed and actual speed, we might question the admissibility of such speedometer evidence; but here there was an excess of 15 miles per hour. In addition, there was the confirmation of the tuning fork test. These tests we think were sufficient to make the evidence of the radar speedmeter admissible.'

The court further held that (l. c. 197 of 322 S.W.2d), '* * * the dual tests made almost immediately before the occasion * * *' was prima facie proof that the machine was functioning properly at the time of defendant's arrest.

Defendant argues that it was held in effect in that case that a run-through test by a moving vehicle is absolutely essential to establish the accuracy and proper functioning of a radar speedmeter, and that the court relied entirely on such a test. On the other hand, the City asserts that the court in State v. Graham, supra, recognized the sufficiency of the tuning fork test, standing alone, as prima facie proof of the accuracy and proper operating condition of the radar unit. In our opinion neither view is correct. As the foregoing quotations illustrate, the court based its decision on the duality of the tests made. We think that the important principles to be deduced from State v. Graham, supra, are three-fold: First, the acceptance as a matter of judicial knowledge, '* * * that a radar speedmeter is a device which, within a reasonable engineering tolerance, and when properly functioning and properly operated, accurately measures speed in terms of miles per hour.' (l. c. 195 of 322 S.W.2d); Second, the recognition as a matter of judicial knowledge that the device may not operate properly upon occasions and for various reasons, and that it is therefore, '* * * the obligation of the proponent who uses it to establish prima facie that the machine was properly functioning * * ' *(l. c. 197 of 322 S.W.2d); and Third, that* ' * * the value of such tests (of a radar speedmeter) would depend upon the accuracy of the measuring device against which it is checked. * * *' (l. c. 197 of 322 S.W.2d).

Unlike the situation which existed in State v. Graham, supra, dual tests were not

made in the present case; in fact, Officer Hoffman testified that the Police Department ceased making the run-through tests some years before, when the use of the tuning fork began. The only test made of the accuracy of the radar unit here involved was the tuning fork test made by Hoffman 'on the morning' of the day of the arrest, before he took the police car 'out,' presumably at the start of his tour of duty on that day. The record is totally devoid of any evidence of the time when, and the place where, such test was made. No evidence was introduced as to the nature and extent of the movements of the car during the period of unknown length which intervened between the making of the test and the arrest of defendant. Nor is there any testimony as to the manner in which Hoffman set up the unit at the site on Lindell Boulevard, the procedure he followed when he activated the device, or the length of time the set had been in operation before the arrest was made. In fact, when his testimony regarding the test (heretofore quoted in full) is read carefully it will be noted that he did not even state that the radar speedmeter read 30 miles per hour when he tested it with the tuning fork; all that he actually did was to describe in the abstract the nature of and the principle underlying the tuning fork test. For the purposes of this case, however, we will infer from his testimony that the radar device read 30 miles per hour at the time he tested it with the tuning fork.

Bearing in mind the principle stated in State v. Graham, supra, that it is the obligation of the proponent who uses the radar speedmeter to establish prima facie that the machine was accurate and functioning properly at the time the accused's speed was checked, the ultimate question presented is whether by the foregoing evidence the City sustained its burden of proof. We are constrained to hold that it did not. The reasons which impel us to reach that conclusion are based upon the nature and characteristics of the radar speedmeter.

The courts customarily adopt a conservative attitude toward accepting scientific advances or developments, 2 an inherent disposition which has been referred to as a 'cultural lag.' 3 While some reluctance to accord judicial recognition to the radar speedmeter was at first exhibited, 4 within the relatively short time since its use began numerous courts have taken judicial knowledge that a radar speedmeter is a device operating on scientifically sound principles, which when properly functioning and operated will accurately measure the speed of a moving vehicle within a recognized and relatively small tolerance. 5 It has been suggested that the important role played by radar during World War II greatly accelerated the judicial acceptance of the radar speedmeter: 'The war-time reputation of radar has created an impression, through name alone, of such perfection in design or performance integrity, that psychologically everyone is impressed.' 6 What is perhaps not generally recognized, however, is that the radar used by the military during the war is a completely different type instrument, operating

on a totally dissimilar scientific principle, than the device called a radar speedmeter. 7 The military unit is a pulse type radar which transmits microwaves at

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controlled intervals. A wave, coming in contact with a target, is reflected back to the receiver. Since the wave travels in both directions at the speed of light, approximately 186,000 miles per second, by computing the elapsed time the distance of the target can be ascertained. Also, since the beam projected is a relatively narrow one, the bearing of the target from the transmitter may be determined. The military unit does not indicate the speed of the target; that fact, as well as the target's direction of travel, must be computed by tracking and plotting the changes in distance and bearing over a period of time.

In contrast, the radar speedmeter does not send out microwaves at intervals or as short disconnected pulses. Instead, a continuous flow of microwaves is transmitted at a theoretical frequency of 2455 megacycles, or 2,455,000,000 cycles per second. When the beam of waves strike a target, part of the beam is reflected back to the receiver. According to what is called the Doppler effect, if the object is moving then the frequency of the reflected or echo wave will be different from the frequency of the outgoing wave; greater in frequency if the target is moving towards the transmitter, diminished in frequency if the target is receding. Because it would be extremely difficult to measure the difference in frequencies between one which already amounts to 2,455,000,000 cycles per second and another of an even greater number (if the target is advancing), a second phenomenon is invoked. This is the phenomenon of 'beats,' used in tuning stringed musical instruments. Thus, if two adjacent notes on a piano are struck simultaneously, the combination of the two tones will have alternate increases and decreases of intensity, the throbbing of the sound being called 'beats'; the number of beats per second being equal to the difference of the frequencies of the two vibrating sources. In the same way that beats occur with sound waves of different frequencies so can they also occur with radio waves of different frequencies. In the case of the radar speedmeter, the antenna receives the outgoing wave transmitted at the theoretical frequency of 2,455,000,000 cycles per second, as well as the echo wave, which has been modulated to a still higher frequency (if the target is advancing), and by measuring the number of beats set up by the two frequencies, transposes such beats into the miles per hour speed of the target; the result being indicated on a dial. Dr. John M. Kopper, who has testified as an expert on behalf of police departments in a number of the reported cases, states that a radar speedmeter '* * * is in essence a beat frequency meter, whose readings are given in miles per hour instead of in beats per second. 8 * * *'

We have used the phrase 'theoretical frequency' of 2,455,000,000 cycles per second because of the controversy which appears to exist as to the precision and accuracy to which the transmitter in a radar speedmeter may be tuned. 9 Dr. Kopper states that the frequency of the transmitter can be set to within plus or minus 0.05 per cent of 2,455,000,000 cycles per second. Carosell and Coombs, who are highly critical of the radar speedmeter as an accurate device, point out in effect that such a margin of error would amount to 1,227,500 cycles more or less than 2,455 megacycles, which they consider excessive. Variations in the frequency would, of course, affect the accuracy of the radar unit as a speed measuring device. We have been unable to learn from the literature we have examined what increase of frequency of the echo wave is necessary, when measured against the transmitter's frequency, in order to produce one beat. We do learn, and both authorities agree, that despite the astronomical number of cycles with which a radar speedmeter deals, there are only 7.31 beats for each mile of speed which it records. Hence, a car traveling at 30 miles per hour would generate

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219.3 beats, while one going 40 miles per hour would produce 292.4; or a difference of only 73.1 beats.

An exhaustive research of the authorities has failed to disclose any case, and none has been called to

our attention, in which it has been held that a test of a radar speedmeter made solely with a tuning fork is sufficient to establish the accuracy of the radar device. In his comprehensive article to which we have referred Dr. Kopper does not even mention such a test. Carosell and Coombs in their paper refer to it only in connection with their criticism that a radar speedmeter is susceptible to microphonic error from outside sources, such as a diathermy machine, an automobile radio, or the closing of the door of a car. The expert witness who appeared on behalf of the city in the instant case, David F. Winter, former professor of electrical engineering at Washington University and the holder of patents in radar circuitry, testified only as to the scientific principles and merits of the radar speedmeter, and was not asked a single question about the reliability or accuracy of the tuning fork test.

We share the opinion expressed in State v. Graham, supra, that the value of any test of a radar speedmeter depends upon the accuracy of the measuring device against which it is checked. That is true whether the measuring device used is an automobile speedometer, a stop watch, or, as in the instant case, a tuning fork. All are the products of human endeavor and therefore subject to error in manufacture, or to subsequent impairment and damage. We do not question the use of a tuning fork to test a radar speedmeter as a matter of principle. We accept the testimony of Sergeant Bosch that such a means is an accepted test, recommended by radar engineers. The same statement would undoubtedly apply to a test by an automobile speedometer, or a stop watch. But the value of such a test would obviously depend upon the accuracy of the particular tuning fork used. In the light of the number of cycles per second involved and the precise measurement which must be made, it is apparent that any imperfection in the tuning fork would materially affect the speed registered on the radar dial. Because of the absence of any evidence that the tuning fork used in the instant case was itself accurate, we entertain grave doubts that the City's evidence was sufficient to establish prima facie that the radar speedmeter was functioning properly, even at the time such test was made.

We prefer, however, to rest our decision upon another aspect of the case, one about which there cannot be the slightest doubt. As stated in State v. Graham, 1. c. 196 of 322 S.W.2d in the colorful but wholly accurate language used by the writer of that opinion, a radar speedmeter is '* * * an instrument constructed by human hands, dealing with delicate measurements, and having a rather feminine need for primping * * .' *Some indication of the amount of 'primping' required may be gathered from Sergeant Bosch's testimony that although the Police Department owned only four machines it employed eleven radio technicians who spent at least part of their time* ' * * fixing these units, calibrating them, testing them, keep it in service.' That the accuracy and proper functioning of a radar speedmeter may easily be affected by its movements from place to place is acknowledged by Dr. Kopper, who states that, 'It is important to check the meter for accuracy each time it is set up for use; if the meter is to be used at two sites in one morning then it should be checked at each site to avoid the contention that the meter was thrown out of adjustment during transit. 10 * * *' The necessity for proving that the radar device was properly set up and tested for accuracy at the place where, and immediately prior to, the defendant's arrest was recognized by the Supreme Court of Appeals of Virginia in Royals v. Commonwealth, 198 Va. 876, 96 S.E.2d 812. A

statute had been enacted in that state making the rate of speed as shown on a radar machine admissible in evidence without the necessity of proving by expert testimony the theory and scientific principles on which the device operates to measure speed. Nevertheless, that court held that the statute, '* * * does not eliminate the necessity for the Commonwealth to prove that the machine used for measuring speed had been properly set up and recently tested for accuracy * * *' (l. c. 816 of 96 S.E.2d), and it reversed a conviction where such evidence was not adduced.

Here, as in that case, no test of the radar speedmeter used to determine defendant's speed was made at the site of or immediately preceding his arrest. The only test made was at some unknown time and at some undisclosed place. Even if it is assumed that the radar unit was operating properly at that time, such evidence would have no probative force to establish that it was accurate and functioning properly

after what may have been (for all the evidence shows) a great number of individual movements, to a far distant site, over a substantial period of time.

Our views in this respect are strengthened by a comparison between the apparent operational procedures employed in the instant case and those recommended by Dr. Kopper. All that appears from the evidence here is that Officer Hoffman parked his police car, flipped the switch which activated the unit, and immediately began to check the speed of approaching motor vehicles. Dr. Kopper recommends: (1) That the set be allowed to warm up for a period of five to ten minutes before being put to work; (2) That the dial then be checked to be certain that it reads zero; and that the set be adjusted accordingly if it does not; (3) that since diathermy machines, swinging signs, swaying trees, and other outside sources can give false readings, that the meter be examined and watched for such indications; (4) that the accuracy be checked by the run-through test, both before and after the period of observation of traffic, by having a car with a calibrated speedometer run through the zone twice, once at the maximum legal rate of speed, and once at a speed 10 or 15 miles per hour greater; and (5), that if the difference between the speedometer reading and the radar meter reading is greater than 2 miles per hour, (due to the engineering tolerance inherent in the radar set) that a further check and any necessary adjustment be made. One court has gone so far as to adopt the substance of Dr. Kopper's recommendations as a requirement for conviction. People v. Sachs, 1 Misc.2d 148, 147 N.Y.S.2d 801, 809. It would appear from State v. Graham, supra, that the state highway patrol makes both the run-through test and the tuning fork test at the site where traffic is to be checked.

We are not unmindful that excessive speed is a dominant factor in the appalling amount of injury and death which occurs daily on our streets and highways. Nor are we unaware of the difficulties encountered by the authorities in the enforcement of the traffic laws and ordinances. Such efforts are to be encouraged, and not hampered. But the requirement that proof be adduced that a radar speedmeter was tested and found to be operating properly at the site of and reasonably close to the time of an arrest should not place an undue burden on the prosecution, and should at the same time protect the rights of motorists against the possibility of error in this device which makes 'delicate measurements.' State v. Graham, supra.

It is unnecessary to discuss other points raised by defendant. For the reasons stated it is apparent that the judgment must be reversed. If the record indicated that other evidence as to defendant's speed could be produced, we would remand the case for a new trial. Here, however, it is clear from the record that no other evidence of the speed of defendant's automobile would be available to the City. Officer Hoffman, a traffic officer with years of experience, testified

on cross-examination that in the long block he followed defendant before he apprehended him he never once looked at the speedometer of his own car; and when invited on cross-examination to estimate the speed at which his own or the defendant's car was traveling, steadfastly maintained that he could not do so. The judgment should therefore be reversed. The Commissioner so recommends.

PER CURIAM.

The foregoing opinion by DOERNER, Commissioner, is adopted as the opinion of this court. Accordingly, judgment is reversed.

WOLFE, Acting P. J., ANDERSON, J., and JACK P. PRITCHARD, Special Judge, concur.

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1 Hough, 24 Mo.L.R. 197 (1959).

2 For example, although the use of fingerprints as a means of identification was known long before the

birth of Christ, it was not until 1905 that fingerprint evidence was first introduced in an English court. Baer, Radar Goes to Court, 33 N.C.L.R. 355, 356 (1955); Stacy v. State, 49 Okl.Cr. 154, 292 P. 885.

3 Baer, 33 N.C.L.R. 336; Britt, 21 Minn.L.R. 671 (1937).

4 State v. Moffitt, 9 Terry 210, 48 Del. 210, 100 A.2d 778; People v. Offermann, 204 Misc. 769, 125 N.Y.S.2d 179.

5 See the wealth of cases cited in State v. Graham, supra, including the parent case of State v. Dantonio, 18 N.J. 570, 115 A.2d 35, 49 A.L.R.2d 460.

6 Carosell and Coombs, Radar Evidence in the Courts, 32 Dicta (Colo.) 323, 324 (1955).

7 49 A.L.R.2d 470.

8 Kopper, The Scientific Reliability of Radar Speemeters, 33 N.C.L.R. 352 (1955).

9 Compare Carosell and Coombs, 32 Dicta (Colo.) 329 (1955) with Dr. Kopper's article, 33 N.C.L.R. 343.

10 33 N.C.L.R. 353.