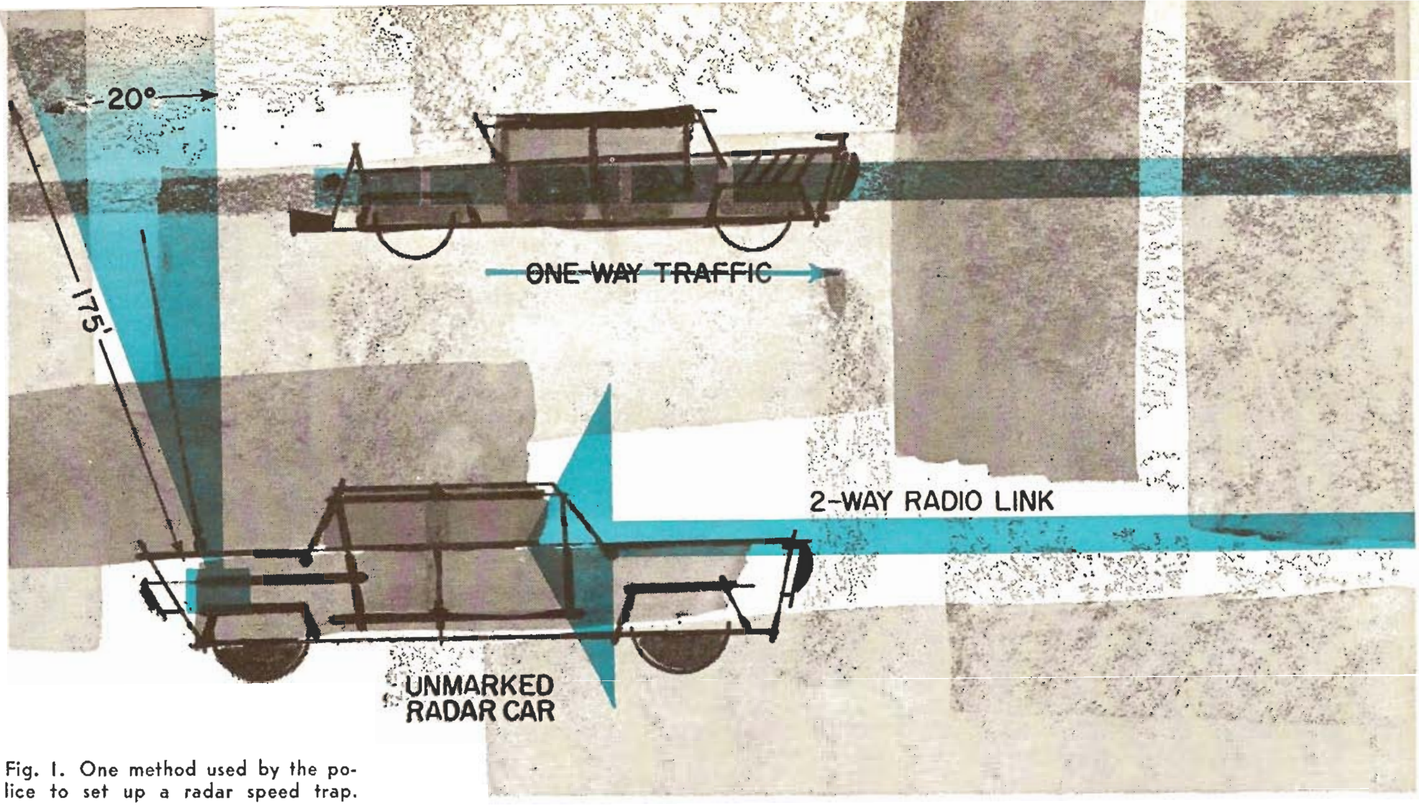



Fig. 1. One method used by the police to set up a radar speed trap.

# Radar Speed Meters &

THE days of the white-gloved policeman whose whistle and arms control traffic may be numbered and even the dashing motorcycle officer, nemesis of the speeder, may soon cease to haunt the highways. Instead of the practiced eye of the traffic patrolman, an electronic computer now scans the traffic in all directions and makes on-the-spot decisions on the timing of signal lights. Instead of the motorcycle chase, the argument, and eventual traffic ticket, radar equipment simply, positively, and without a chase hands out tickets with the speed recorded automatically, impersonally, and beyond argument.

The ever-increasing number of cars using our outmoded and overcrowded roads is a major headache to practically every community. While the building of highways always lags behind need, the art of electronics at least permits the most efficient use of available roads.

Second to the problem of congestion is the appalling accident rate. Statistics show that most serious accidents can be attributed either to speeding or driving while intoxicated. Radar is used to reduce speed and even the degree of intoxication can be determined by electronics.

## Speed Control Radar

Most of our readers are familiar with the "Doppler effect"—a phenomenon named for the German physicist who discovered it. Doppler's theory states that waves that are radiated or reflected from moving objects will be changed in frequency in accordance with the speed of the moving object.

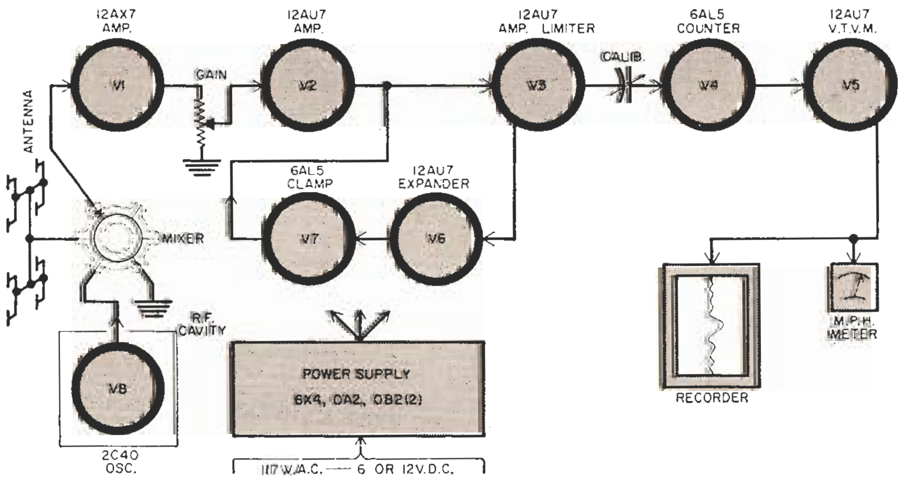
An everyday example of this is the changing pitch of a train whistle heard by an observer who is standing near the train crossing. This change of frequency is a function of the sound frequency and speed of the train. In speed-control radar a high-frequency signal is beamed down the road and the reflections from moving vehicles are compared with the original frequency. The "difference" frequency is directly related to the car's speed. In a typical radar, such as used by New York City and State police, the transmitter operates at 2455 mc. and the "difference" frequency for a 10-mile slowpoke will be 73.1 cps while a 100-mph speeder will ring up 731 cps on the electronic speedometer.

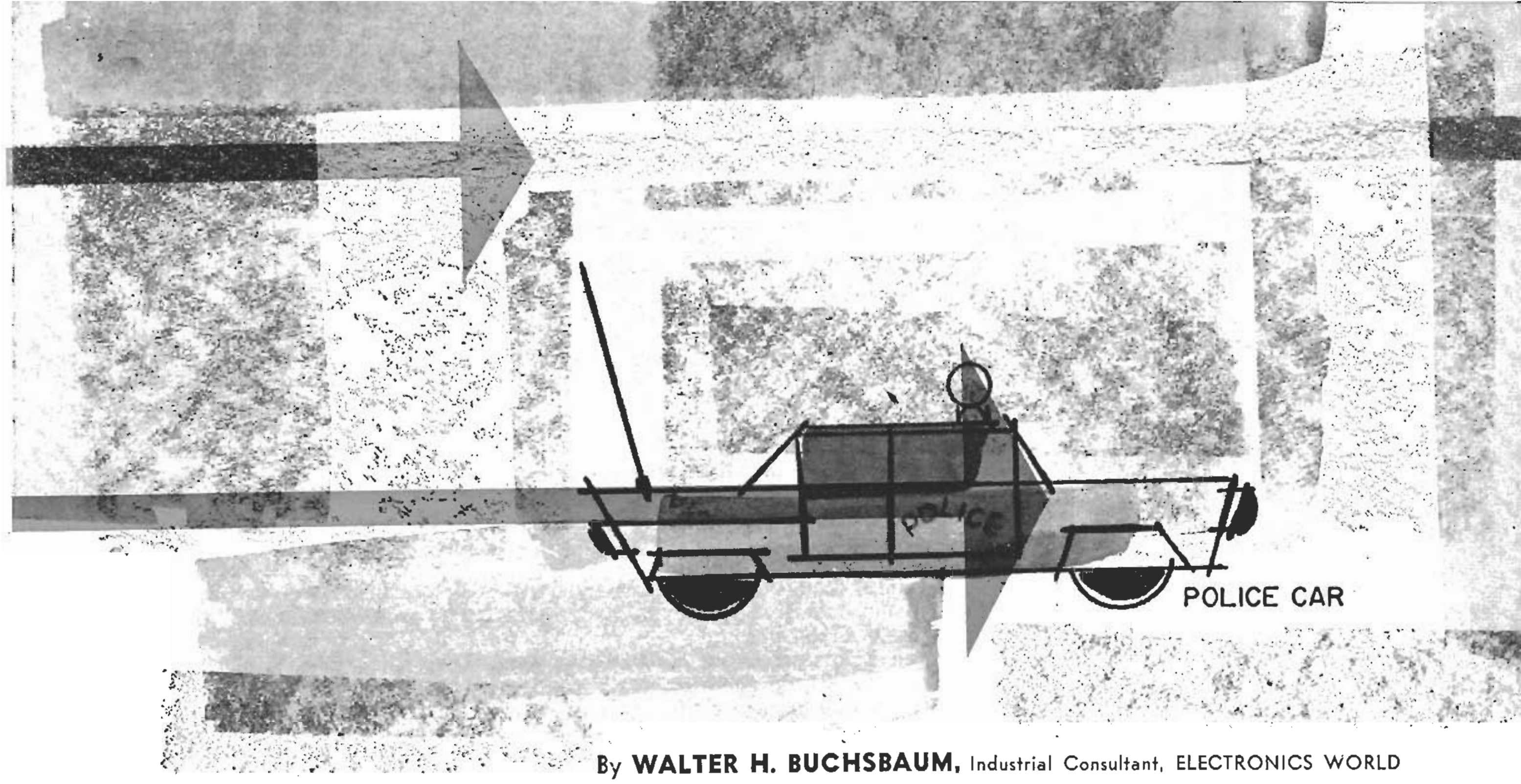
The advantages of radar over the conventional "chase" are many. For one thing, chasing a speeding car is dangerous and often results in serious accidents to innocent motorists as well as the participants. In many states the chase must last for at least a mile in order to validate a summons. Even then, arguments and court procedures involve the officer in time-wasting litigation which has the effect of reducing available police manpower—often to a critical point.

When radar is used, there are usually warning signs and the psychological effect alone helps to reduce speeding. Most apprehended speeders plead guilty when presented with a graphic record of their offense and, in New York City at least, radar results in about 95% convictions of those pleading "not guilty." Practically all states have now accepted evidence provided by radar and, in a recent decision, the New York Court of Appeals ruled that radar is a reliable, accurate instrument for measuring the speed of vehicles.

The block diagram of Fig. 2 shows *Eastern Industries'* (East Norwalk,

Fig. 2. Block diagram of the S-band (2455 mc.) speed radar discussed in text.






By **WALTER H. BUCHSBAUM,** Industrial Consultant, ELECTRONICS WORLD

# Traffic Controls

**How radar speed traps and speed meters work, and other electronic devices used to control traffic.**

Conn.) Model S-2 speed-control radar set. Its operation is typical of most equipment now on the market and is used as an example of the circuits involved in speed-control radar. The 2C40 lighthouse tube furnishes the 2455 mc. signal at about 120 milliwatts of power. A resonant cavity maintains the frequency accurately during the life of the tube. The r.f. signal is applied to an 8-element dipole array which acts as both transmitting and receiving antenna. By using a ring-type power divider some of the transmitted r.f. and some of the reflected signal are mixed in the 1N21 crystal diode and the resulting low-frequency beat is the Doppler, or speed-indicating, signal. This signal, ranging from zero to about 800 cps, is amplified and clipped by the limiter and then passed through a diode and capacitor frequency-counter circuit. The resultant d.c. voltage corresponds to the frequency and thus to miles-per-hour.

A v.t.v.m. circuit with a remote d.c. meter and, as optional equipment, a strip-chart recorder are calibrated in mph and indicate the speed.

One of the refinements incorporated in this model is the expander and clamping circuit which prevents weak reflections from being passed into the frequency-counting circuit. Unless the output of the $V_3$ amplifier is sufficient to provide complete limiting, the expander and clamping section will load down the output of $V_2$. This assures that a speed reading is obtained only on clear, strong signals and discriminates in favor of the fastest car in a bunch.

The power supply contains a vibrator which is not used when 117-volt, 60-cycle a.c. is available, as is the case in the service shop. Depending on the model, either a 6- or 12-volt battery serves as the power source.

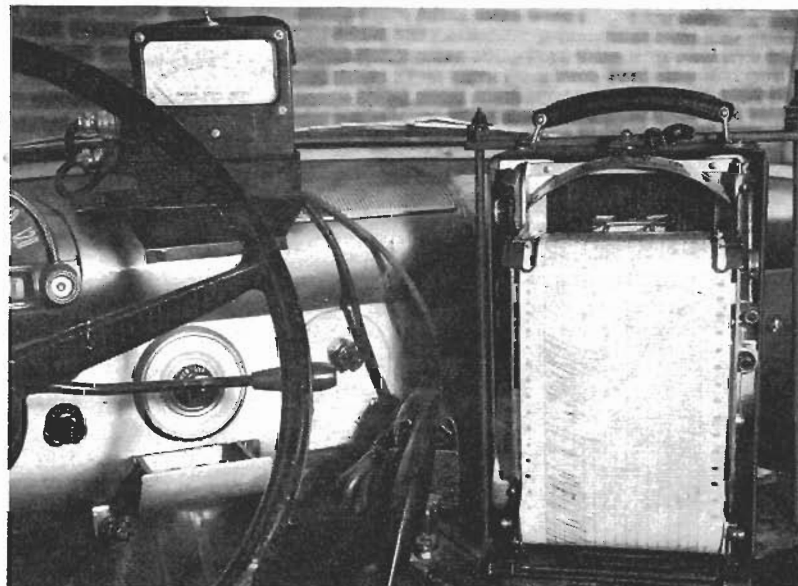
### Speed Radar Installation

The photograph of Fig. 3 shows a radar unit installed in the trunk of an unmarked car belonging to the New York City police. The complete radar unit, including antenna, is contained in a single box, with the antenna section aimed to the rear. To permit operation with the trunk closed, a section of the trunk has been cut out and covered with a plastic which serves as a radome. This arrangement allows the driver to respond to an emergency call without incurring a delay to close the trunk or dismantle the tripod on which the unit is sometimes mounted.

New York State police operate the same radar but with the trunk open because the state resells its police cars and large cut-outs in the trunk would

Fig. 3. Radar set installed in trunk compartment of car.

Fig. 4. Speed-meter indicator and chart recorder employed.



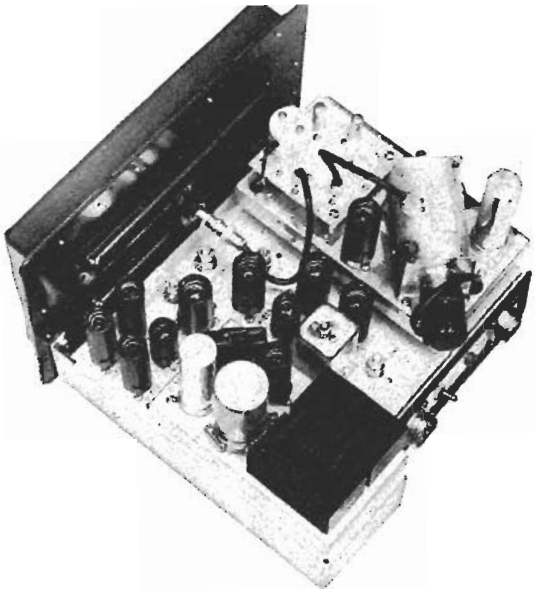


Fig. 5. Top view of the S-band radar. Oscillator cavity is at right rear.

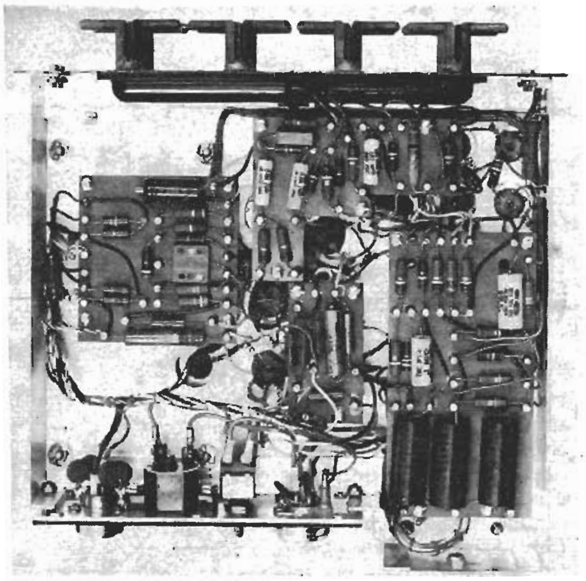


Fig. 6. Under-side of radar. Antenna array has been uncovered in this view.

virtually kill their used-car value. In a typical installation, a newly charged battery is used every day and a separate one is used for the communication radio. New York operates a total of seven radar cars with excellent results in the apprehension of speeders.

A close-up of the meter and strip-chart recorder, as mounted next to the driver, is shown in Fig. 4. Note the telephone for the two-way radio link which connects the speed-control radar operator with the apprehending patrolman. A typical set-up is shown in Fig. 1. This system is frequently used on a divided roadway where traffic moves in only one direction.

The procedure is for the unmarked car to get into position and calibrate the speed indicator by having the patrol car pass at a fixed speed. Since all patrol car speedometers are calibrated every week, this serves to check out the radar-speed indicator. Another method would involve the use of a tuning fork, but police prefer the patrol-car check since its validity is more likely to be accepted in court. Once the radar car is set up and its gear calibrated, the operator just waits for those who disregard the warning signs "Radar Speed Check Ahead."

When the meter and recorder indicate a speed above the limit, the operator merely picks up the telephone and gives a description of the car and possibly the license number to the policeman waiting ahead. To clinch the case, the description and license number is noted right on the chart, next to the incriminating evidence.

Fig. 7 shows a typical scene of this type only here the radar set is installed on a tripod outside of the car, in plain view of the speeder.

An interview with responsible officers of New York City's radar unit indicates that, surprisingly, servicing is no more of a problem than with their communications gear. When tubes get weak or the battery runs down, the speed indications will be lower than the actual speed, hence this excuse doesn't hold up in court.

Actually, the most frequent maintenance is replacement of the 2C40 oscillator tube. The cavity is designed so that aging of the tube or frequency drift kills the oscillation because of the perfect match and high "*Q*" that is required. Replacement of this tube and other service work is performed by qualified personnel who must hold at least a 2nd class FCC ticket. Figs. 5 and 6 show top and bottom view of the radar set and will give our readers an idea of the relative simplicity of the circuitry.

Another widely used speed-control radar is made by *Traffic House, Inc.* of Marshall, Michigan. It operates in the X-band at 10,525 mc. This unit features an r.f. and antenna unit which can be mounted in place of the spotlight at the side of the car. A typical installation of the antenna unit is shown in Fig. 8. The antenna consists of two dielectric rods, driven by short waveguide sections. Inside the car the speed meter hangs from the rear-view mirror. This particular unit uses transistors instead of the amplifier tubes. The complete unit, including the power supply and accessory tuning-fork calibrator, is shown in Fig. 9.

In some cases, the X-band speed radar is used in a single-car set-up. It can be mounted on a patrol car, as in Fig. 8, and when a speeder is detected the officer can give chase at once. Another arrangement would set up the meter outside the car and the officer can then wave the speeder down as he approaches. This type of equipment has a range of up to 600 feet and because of the higher r.f., 10 mph equals 310 cps. Graph recorders can be used with any of the different speed-control radars.

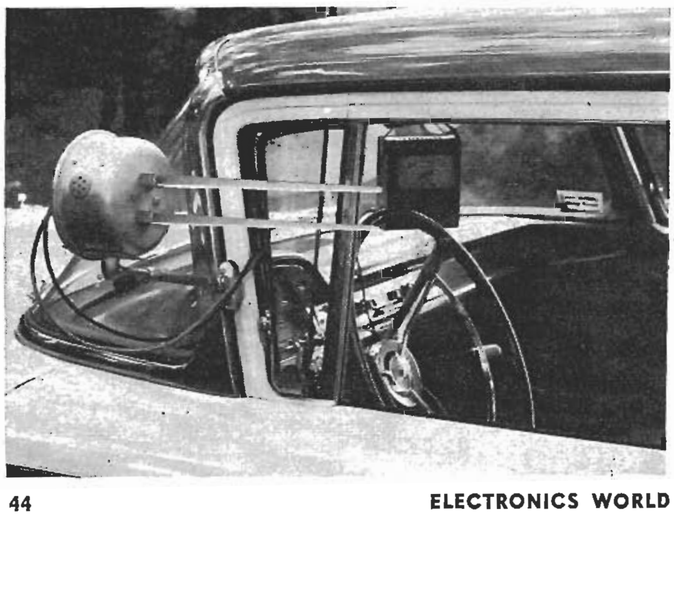
## Traffic Control Systems

Up to a few years ago, traffic lights were actuated by a timer located inside the control box and, on certain crossings, by a pedestrian push-button or vehicle-operated weight switch which would provide a green signal for an otherwise rarely used side street. The first step towards improving the flow of traffic on one-way streets was the synchronization of light-control timers to permit cars traveling at an optimum speed to continue on green lights all the way. After the value of this scheme was recognized, new methods for controlling traffic according to requirements of the traffic were tried.

Radio-controlled traffic lights which

Fig. 7. Officer is calling ahead by radio to stop the speeder.

Fig. 8. Installation of r.f. unit of X-band (10,525 mc.) radar.



can be set from a transmitter in a moving fire truck or ambulance were tried. Another radio-control scheme is scheduled for introduction in New York City in the near future. This makes use of a central radio transmitter which would control traffic lights along different main arteries. The idea here is not to turn all lights red or green at the same time but, rather, control the flow of traffic according to the requirements of the morning or evening rush hours, special events, accidents, detours, etc. Receiving gear is already installed along one major road which will serve as a "proving ground" for the entire system.

*Eastern Industries* supplies a variety of intersection-controlling equipment, ranging from traffic-actuated, time, and manually operated lights up to complex computing systems. One such device is the radar vehicle detector shown in Fig. 10. This unit can be mounted on the overhead arm of a lamp post and contains a complete 2455-mc. Doppler radar set. Its operating principle is the same as that of the speed-control radar, but its circuit is simpler because instead of measuring speed, only the presence of motion is detected. This radar can be used as the sensing element for many different types of traffic-control systems. In its simplest form it is mounted above the approach to an intersection. As a vehicle passes under it, the relay in the radar unit starts to cycle the traffic light into providing the green light for that lane. A timer in the traffic-light control box can make sure that traffic from any one lane cannot tie up the intersection.

This radar unit is also used on turnpikes to count the number of cars. By adding relays for low- and high-speed limits, the radar unit can serve to indicate when traffic in any one lane slows down, when traffic is lighter, etc. This information can then be used to open or close other lanes to accommodate the changing traffic pattern, to indicate toll booth requirements, and warn of dangerous traffic conditions.

Combinations of radar units and traffic-control boxes can provide the

Fig. 10. The overhead radar detector.

optimum red and green cycling for a number of neighboring intersections, as the changing traffic pattern requires. A typical traffic-light control box, based on volume density, is shown in Fig. 11. This unit controls a rather complex intersection and permits adjustment of the number of cars and the time they have to wait, as well as the traffic density at which one or the other direction should be favored. Even the minimum length of the green time and the duration of the change-over period can be determined accurately.

Coupled with overhead radar detectors, magnetic vehicle detectors, and weight-actuated switches, a complete city-wide electronic traffic control can be designed. This system would be able to compute the optimum green time for different main roads at different times of the day, control the side-street traffic lights accordingly and provide alternate green-light routes when traffic piles up in one of the major arteries. Traffic density could be recorded automatically so that planning of one-way and express streets is not delayed by lengthy and costly surveys. In the event of an emergency the over-all traffic computer would have a program ready to clear traffic from vital access roads and expedite the movement of emergency vehicles.

The city of Baltimore has recently installed such a complete traffic-control system, the main control room of which is shown in Fig. 12. This system contains a master computer which accepts information from 32 overhead radar detectors and is capable of directing over 200 traffic lights in a wide variety of different green-time patterns. Coupled with this system is an emergency communications network which links fire, police, and other emergency stations. Up-to-date weather information is also available and this data can be combined to slow down traffic, speed it up, block certain roads, reduce the number of cars coming into

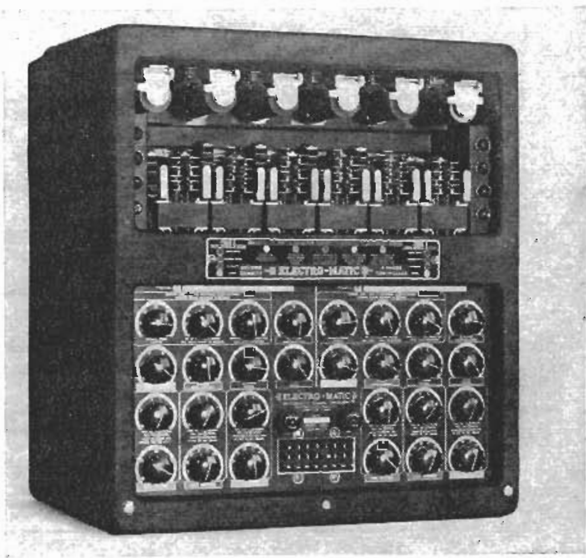


Fig. 11. Front panel of the versatile traffic controller described in text.

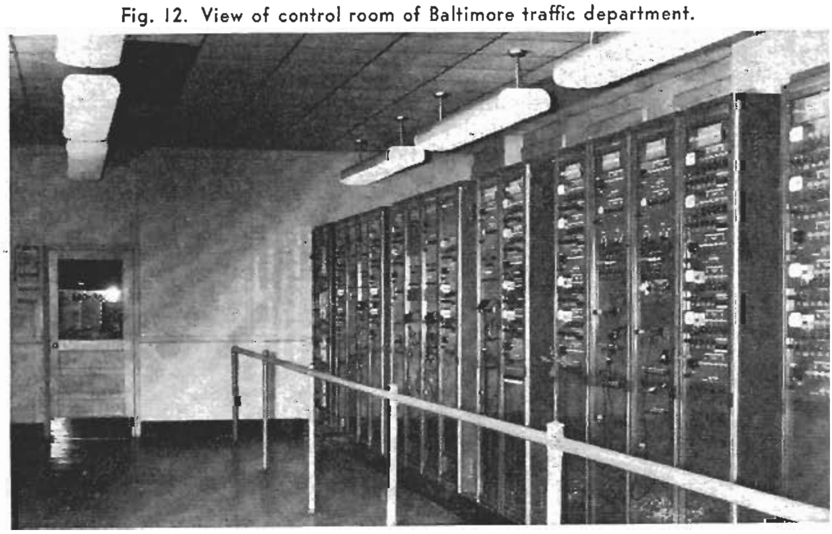
a particular section, detour traffic around obstructions, etc.

The Baltimore installation is tied in by means of connecting cables but another master traffic system using u.h.f. radio to transmit the control signals is also available. Stable, seven-watt transmitters, operating at 980 mc. and using FM, transmit information and control signals between the intersections and the central computer. The predicted range of this system is 3 to 5 miles, but by using a 25-watt ampli-

(*Continued on page* 117)

Fig. 9. Complete X-band radar. Note dielectric antenna rods.

Fig. 12. View of control room of Baltimore traffic department.



## Radar Speed Meters

(*Continued from page* 45)

fier, this range can be increased.

### What's Ahead

Future applications of electronics to traffic control include the use of anti-collision radar and electronic car guidance. Various types of radar mounted on the front bumper of a car have been tried out as collision warning. In some of the models a small computer is included which automatically calculates the minimum safe distance, based on the car's speed, and flashes a warning light when the gap is too short. In addition to the warning light, the car's brakes can be actuated automatically if the warning light is not heeded within a pre-set time. To allow for curves, the position of the steering gear is either accounted for in the computer or else the steering gear moves the radar antenna as well as the car.

Electronic steering and speed control of cars travelling on futuristic high-speed roads have been described before. Either buried cables or a series of radar sets above or alongside the highway will receive and transmit control signals which will guide cars within a given lane and steer them as required. A small computer in the car can be programmed by inserting a punched card so that the car is steered to the desired exit. Computers working with the external guidance system would determine the best lane and speed and control all cars to avoid collisions. While this type of electronic traffic control may smack of science fiction, some kind of electronic guidance system for automobiles will undoubtedly be used in the near future.

### Conclusion

With little fanfare but with telling effect, electronics has invaded the traffic-control field in recent years. Used in the form of FM radar, electronics has turned into an incorruptible speed control and provides highway police with a safe, simple, and definite means of catching the speeder. Actually, the mere existence of speed-control radar has been a strong deterrent and its use helps to cut down excessive speeds both directly and indirectly by its psychological effect.

The familiar traffic jam is another spot where the electron may help to untangle what the automobile and the highway planners have enmeshed. By controlling the cycling of traffic lights, reporting traffic conditions automatically, and computing optimum traffic patterns, the electronic equipment can provide valuable aid in reducing the traffic snarl. Only the construction of sufficient highways or a reduction in the number of cars using them can ultimately solve the traffic problem, but in the meantime electronic traffic control systems alleviate the situation and promise a smoother traffic flow on the highways of tomorrow. —30—