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Steven R. Cole
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MOBILE RADIO SERVICES

By: H L Collins

Development of Mobile Radio Services

The Home Office Regional Wireless service had its origins in the early days of the last war when many of the existing wireless depots were set up as medium frequency transmitting sites. The first mobile radio equipment consisted of MF receivers only but in about 1942 a small number of MF mobile transmitters were introduced. Late in the war years a start was made in equipping forces with VHF radio systems and it says much for the engineers and planners of those days that the systems currently in use are built on the AM spaced carrier foundations that they laid.

Early VHF mobile radio sets consisted of separate transmitters and receivers which derived power from large rotary generators. The equipment was very heavy and bulky and nearly filled the boot of a car. A complete system comprised a number of separate units and due to the large number of interconnections, and the use of heavy control cable which was fitted in conduit, installation in a vehicle often took about 3 man days.

A big step forward occurred in 1949 when vastly improved mobile equipment started to emerge from an electronics industry which was beginning to adapt to peace time needs. The equipment, although big by present standards, was much more compact than that previously available. Reliability also improved and maintenance consisted mainly of adjustment, valve changing, and repair of rotary generators. The major design defect in this equipment was related to the use of valves which necessitated high current consumption from the car battery.

In the early 60s the attention of the electronics industry was focused on transistors which held out the promise of reduction in power consumption from batteries and also reduction in size of equipment. The first mobiles containing transistors were hybrid sets with transistors in stages consuming low power, and valves in stages where relatively high power levels were required. Intensive development in transistor technology culminated in the first all-transistor sets in the late 60s.

Transistors have proved a mixed blessing. Current consumption and equipment size has been reduced but engineering design with transistors is more complex than with valves, each valve being replaced by about 3 or more transistors. A typical valve-type mobile radio contained about 18 valves; the most recent mobile now being evaluated contains 70 transistors. Rotary generators were replaced in the late valve designs by compact but troublesome electro-mechanical vibrators but with the introduction of transistors reliable and compact d.c. converters became possible thereby eliminating an undesirable design feature.

Reasons for design changes

Apart from changes in design due to the introduction of transistors and other new components, the growth of radio services generally introduced new design problems due to the need to optimise use of the radio frequency spectrums. With the introduction of VHF services channel bandwidth was 200 kHz; this was later reduced first to a 100 kHz then 50 kHz, and at present the Home Office spaced carrier schemes work in channels of 25 kHz bandwidth. Each reduction in bandwidth makes it more difficult to reduce noise due to electrical interference. Sources of electrical interference have increased considerably over the last few years and have reached the point where it is futile to try to improve the sensitivity of wireless receivers. Because of bandwidth and electrical noise considerations design engineers have had to run hard to stand still.

Country wide introduction of VHF Broadcasts and TV has also brought many design problems. The wanted signal in a mobile receiver is often in the 1 to 5 micro-volt region but signals from broadcast services often impress signals into the early amplifying stages of 100,000 or more times the level of the wanted signal. Although it is possible to substantially eliminate the effects of high power broadcasting this can only be achieved at the expense of the wanted service. Practical design involves a compromise between sensitivity and selectivity. It is probable that the biggest problem facing radio users in future will relate to general pollution of the electro-magnetic spectrum by electrical noise and the continuing expansion of radio frequency services.

Mobile radio aeriels

Anyone buying a TV set for use in the fringe areas of reception would get very disappointing results if they used an inefficient aerial. From the appearance of the sky-line in urban areas the majority of viewers appreciate the logic of aerial efficiency. When it comes to mobile radio, the matter of aerial efficiency sometimes seems to be treated as a matter of little importance. There is only one place for the aerial in a car if optimum results are to be achieved and that is in the middle of the roof. Boot or bumper mounted aeriels have very noticeable directional effects in some circumstances and could result in a loss of range and noisy reception.

Multi-channel AM/FM sets

There is now a widespread operational need for wideband multi-channel mobile radio sets. The first multi-channel sets introduced were of narrow band pattern which accommodated all channels within a pass band of 0.8 MHz. Basically these are normal single channel sets in which additional crystal oscillator circuits have been fitted.

Although they give a measure of flexibility in operational use they do not fully meet the requirement of allowing any channel within the police band to be selected.

However a sophisticated but relatively expensive wideband AM/FM set, capable of being tuned to any channel within the band, was primarily developed to meet the needs of the Emergency Fire Service although some were provided against Regional Crime Squad requirements. These sets were introduced at a price which was hardly economic from the manufacturer's point of view and regrettably they went out of production.

For police purposes it became evident that a reasonable and cost effective method of providing an adequate multi-channel capability was by means of a 10-channel wideband set, and it was fortunate that a relatively new circuit trick making use of devices called varactor diodes now made this possible. The essential design difference between narrow and wideband multi-channel sets is that in the wideband set the radio frequency circuits are tuned for optimum performance on all channels, whereas in the narrow band set the radio frequency tuned circuits are optimised at the centre of the band. In the latter there is a fall-off in performance at off-centre frequencies and the degree to which fall-off is acceptable determines the limit to the pass band of the set.

Mobile repeaters

One of the most serious problems with police communications is that contact with Force HQ is often lost at the very time it is most needed, that is when

an officer leaves his car to deal with an incident or to make enquiries. In principle, communication is required to a man and not to a car and the concept of a mobile radio set attached to a car is dictated more by the state of equipment development than by operational needs.

There are a number of ways in which communication can be extended to an officer away from his vehicle. The most flexible is probably by means of a mobile repeater, comprising a VHF mobile on force frequency and a UHF mobile, which extends force communications in the area surrounding the vehicle to officers carrying UHF personal radio sets. An important advantage offered by this system is that a local talk-through network on UHF can be set up to control an incident such as a motorway accident without unnecessarily involving the main VHF scheme. If the vehicle is manned, both UHF and VHF schemes can be operated and monitored. In the "repeat" mode the personal set user effectively becomes another mobile on force frequency.

Trials are now in progress with a small number of repeaters called Force Radio Extension Devices (or FRED for those on intimate terms) intended for use with motor cycles. When the officer is away from his motor cycle, he receives a force channel on a VHF personal radio set and to reply he uses a UHF personal transmitter which works into a UHF personal receiver attached to the motor cycle. The UHF receiver is provided with a switching arrangement to operate the VHF transmitter, and the audio output of the UHF set is used for modulating purposes. The motor cycle's equipment therefore acts as a relay to force headquarters. Expected range of operation away from the motor cycle is about 100 to 500 yards depending on local screening.

Fire Service radio

The requirements of the Fire Service do not differ substantially from those of the police in terms of the basic communication facilities; there are however a number of areas where departure from a standard police mobile may be advantageous. The ambient noise in the cabs of fire vehicles is often at a high level and this necessitates a high level audio output from the receiver.

The voltage supply in many fire vehicles is 24 volts and this creates inconvenience with normally available mobiles which are designed for 12 volt operation. It would be helpful if new Fire Vehicles were fitted with a 12 volt supply specifically for radio purposes.

Radio sets fitted in Fire vehicles are often subject to more physical hazard than sets fitted in Police vehicles. In particular the control boxes can be physically knocked and subjected to spray from hoses. Ideally the control boxes should be robust, simple and waterproof.

Personal radio

The wide scale introduction of UHF personal radio was of considerable significance in relation to Police efficiency and, considering that the equipment was the first to go into very large scale production in this country, it has been remarkably successful. There are acute design problems in personal radio sets and in future the situation will be made more difficult by the need to reduce channel bandwidth. Reduction in bandwidth can be compensated to some extent by an increase in transmitter power output but a limit in this direction is set by the capacity of a battery of practical size.

It is probable that the next generation of personal radio sets will be of 3 channel single piece construction. There is at present no consensus of opinion as to how the 3 channels will be used operationally but the main

possibilities centre around use with one channel on the local divisional frequency and the other channels on neighbouring divisions or sub divisions. Alternatively one channel can be on local divisional frequency with the other channels on national or regional frequencies. In the latter case additional base stations would be required.

A number of forces have agreed to co-operate in field trials with new personal sets of varying pattern and it is hoped that by mid 1972 there will be agreement on the design most suited to police needs.

Future developments

It is interesting to speculate on the course that mobile radio development will take in future. There is at present an assumption that mobile radio relates to equipment which is permanently attached to a vehicle. However no one wishes to communicate with a vehicle, but with a man who may often be away from the vehicle. The trend towards miniaturisation in electronics will no doubt go on, aided by the more widespread use of integrated circuits. This will allow the development of smaller and lighter sets or alternatively greater design sophistication in a given space. It is conceivable that the mobile set will become a portable set which can accompany the man when away from his vehicle. The battery could be maintained in a charged condition by having a retaining cradle in the car which is provided with contacts to the car battery. The limit to possible size reduction may well be dictated by the physical size of controls, loudspeaker microphone and batteries.

There is now a growing interest in the use of vehicle availability systems with manual up-dating from control panels fitted in a vehicle. In present systems a separate control box is fitted and connected to the radio control box. If the use of such systems becomes widespread then logically the control panel should become an integral part of the radio control facility.

The trend in mobile radio development may be towards a compact multi-channel personal radio set with an inbuilt "man location", and a data facility with sufficient capacity to incorporate a number of standard messages including routine questions for the National Computer. To reduce the size of controls to manageable proportions it is conceivable that the data input could be arranged by a single finger-sized button with a small plunger at one end. The button would slide along a calibrated guide and a push on the button would then cause the plunger to activate one of a number of micro switches. This is at present a somewhat fanciful concept but the direction of future development must be related firstly to operational needs and secondly to engineering possibilities.

Mr H Collins is a Senior Wireless Engineer at Directorate of Telecommunications Headquarters and his present duties include preparation of equipment specifications and liaison on equipment design. His early experience includes work on Radar in the Air Ministry and later in the RAF. Since joining the Home Office he has served at a Regional Wireless Depot and the Central Communications Establishment.