THE RANA LONG RANGE RADIO LOCATION SYSTEM

Lecture given by Ingénieur hydrographe en Chef A. Le Fur of the French Navy at the 8th International Hydrographic Conference in Monaco, May 1962

The following text was prepared purely as a talk; therefore I do not intend to enter into details of technology which would be all the more difficult to explain, since the long range radio location system, called the L type, is still only at the planning stage. This situation offers the following advantage for this new system : possible criticisms can be made of the principle of the system but, for the moment at least, none can be made of the results actually obtained.

You are probably wondering why a new radio location system is necessary. In fact, you only need to look through the excellent Special Publication 39 of the International Hydrographic Bureau to see that hydrographers have at their disposal a very large selection of radio systems for position fixing at sea. The instruments with names ending in -an, -ac, -ist or -ix must number at least twenty. Consequently, attempts have been made here and there to classify the various systems : choosing a principle of classification is difficult, and to prove this I only need to quote, from memory, a passage I read in a recent book dealing with these problems :

" Radio location systems used thus far in hydrography are based on the following methods : circular methods, hyperbolic methods and ... other methods ".

Of course, the French Naval Hydrographic Office uses such instruments : two chains with three hyperbolic patterns ensure the determination of the position of sounding vessels as far as 150 to 200 kilometres from the transmitters with an accuracy of the order of 1/10 000th of that distance. The principle of operation of these instruments is already based on the Rana processes which are described in the IHB publication I mentioned earlier. One of these systems is Toran which, having undergone trials during numerous geophysical surveys, is now used by us to the greatest advantage, particularly in the difficult areas off the west coast of Africa.

These ranges of 200 kilometres are usually sufficient to reach and to go beyond the limit of the continental shelf. That is not the case off the west coast of France where the continental shelf stretches several hundred kilometres and forms, it must be said, a blank area on nautical charts. Consequently, if we want not only to eliminate these blank areas from our charts but also to carry out the observations required by modern science, we must have at our disposal a radio location system meeting the following specifications :

(*a*) Semi-mobile transmitters set up only along the French coast, to ensure, in particular, that their triangulation will be dependent upon a homogenious system of triangulation.

(*b*) Position fixing of any number of ships by three independent position lines.

(*c*) Assured range of 1 000 kilometres by day and night at all times of year.

(*d*) Accuracy of at least 1/10 000th of the range, that is at least 100 metres at 1 000 kilometres.

(*e*) Resolving ambiguity.

(*f*) Continuous readings at the receivers.

These are severe requirements : thus, having examined the large selection of systems I spoke of earlier, the French Naval Hydrographic Office had to admit that no such instrument was among them. It was therefore necessary to create one, and to do this, two years ago, they called on the inventors of the Rana process, Mr. HONORÉ and Mr. TORCHEUX, who, at the end of 1961, proposed a classic solution with one variant which was, on the other hand, quite revolutionary.

For those who are to some degree acquainted with the problems of radio location, the classic solution was fairly obvious : following the Rana principles, transmission by three pairs generating three hyperbolic patterns, but, in this particular case, transmission of pulses.

Knowing that the undesired sky waves do not arrive until at least 30 microseconds after the direct wave (which alone is used in the measurements), it was only necessary to limit the duration of the reception of each signal to the necessary 30 microseconds.

In this way we were able to satisfy the conditions imposed by transmitting only three frequencies in the 2 000-kilohertz band, for example, with a peak power of 100 kilowatts and an average power of 10 watts per frequency. Thus, the system, referring back to the classification mentioned earlier, would be of the hyperbolic type.

In order to understand now the principle of the variant that I described as revolutionary, I shall refer again to the general principles on radio location processes. Except for radiogoniometric systems, these processes are all based on the simple relationship :

$$D = V \cdot t$$

where D is a distance to be determined between a point A (the position of which we wish to determine) and a point B of known position.

V is the speed of propagation of the waves

t is the time taken by these waves to cover the distance D.

The speed V is what it is and we cannot alter it. Fortunately it is fairly constant for paths over the sea. We need only adopt the most likely value, check by careful calibration the validity of our choice ... and use a suitably placed control receiver.

On the other hand, the measurement of t is the most delicate part of the operation since, in order to measure the distance to within about ten metres, we must know the time to within 3/100 microsecond. For this there is only one solution : to have at our disposal an excellent clock at the actual position to be determined. This clock could be used in two different ways : either we use it to measure the duration of the path of a signal transmitted from the ship — the patterns are then all circular and they can only be used by the transmitting vessel; or this same clock can enable us to measure the differences in the duration of the paths of synchronized signals transmitted from the shore and the patterns will be hyperbolic and can be used simultaneously by several ships, but two transmitters are then necessary to obtain a single line of position.

But if we succeed in having not one, but two clocks at our disposal, one at the transmitter on shore and the other on board, both rigorously and continuously keeping the same time, we shall have created a circular system usable by any number of ships.

The second variant of the type L Rana is based on the latter principle and we can conceive that maintaining in coincidence to within a few tenths of microseconds two clocks separated by several hundred kilometres is a difficult problem to resolve.

Suffice to say that in type L Rana the problem is resolved by the reception on board of data in excess of that needed for the position fix only. An automatic computer ensures the coherence of this information by maintaining in synchronism the receiver clock and the transmitter clock.

In short, a Rana L chain will comprise on shore three or four exactly identical transmitters — it can, of course, comprise more. The distances of any number of receivers from these different transmitters will be determined continuously and without ambiguity.

To conclude, it should be said that using such a principle has only become possible very recently thanks to the progress in electronics which now enables very stable crystal clocks to be made.

This brings us back to the old problem which took up so much of our ancestors' time — I am speaking of the transporting and the keeping of time at sea. Soon, we shall undoubtedly have to watch our crystal clocks with the same care as the navigating officer regarded the chronometer carried on sailing ships. But the difference between the accuracies required, the ratio of which is of the order of one millionth, one second as against one microsecond, gives a good idea at least of technical, if not of scientific progress.