A RADIO POSITION FINDING EQUIPMENT FOR DEPTH SURVEYING

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The equipment I want to report on has been developed according to the special demands of the Wasserstrassen- und Schiffahrtsämter. All our inland waterways have to be surveyed from time to time to get information on possible changes in depth. This is done by taking profiles across the river at intervals of approx. 100 yds. For this purpose special depth sounders, so-called Vermessungslote, are used which give a high degree of accuracy as to the depth indication. In the former version of these sets the depth is plotted versus time on Teledeltos paper. There is, however, an urgent need for referring the depth values measured to the corresponding sites on a map. This reference was formerly made by point by point soundings taken in relation to geodetically well-known marking points ashore. For measuring the distances, measuring tapes and optical distance finders were used making the procedure rather tedious.

Great advantage was gained by introducing a combined acoustical range and depth finder, the so-called « Akustisches Ortungslot ». By this set a semi-automatic plot of depth versus distance was achieved. The distance finding was based on the following : Every second, a short whistle signal is transmitted by the survey vessel. This is received by the shore station and retransmitted to the ship by radio. The acoustical transit time is measured on board by well-known echo-sounding methods and presented by a « red-light indication ». Moving the ship also causes a movement of the red-light. This movement can be followed by a motor-driven follow-up pointer. If an operator carefully makes the pointer follow the red-light by adjusting the speed of the drive motor which simultaneously controls the recording-paper-speed, a true plot of depth versus distance is achieved.

The maximum range of this system is limited to approx. 800 yds. In evaluating the transit times the influences of wind speed, wind direction, atmospheric pressure and humidity on the velocity of sound have to be taken into account. Moreover one person is needed for operating the follow-up control. Disregarding these inconveniences the system performed well and helped to cut surveying time.

The main reasons for developing an electromagnetic method were the the demands for greater range, for independence from wind and atmospheric influences, and for a fully automatic paper drive according to the elapsed distance. The development carried out by Stedtnitz at Atlas-Werke, Bremen, is based on the integration of the « Dopplereffekt » as proposed by Wolmann during the last war. The system is operated in the VHF band on about 35 Mc/s and about 70 Mc/s (8 m and 4 m wavelength respectively). The board transmitter radiates a cw wave on 8 m via an omnidirectional antenna. This is received by a similar shorebased antenna and amplified in a portable shore station, where it is frequency-doubled, LF-amplitude-modulated and retransmitted via the same antenna. The new 4 m-wave reaches the board receiver via its antenna and is there mixed with the also doubled frequency of the local oscillator. As long as the distance between

ship and shore is constant this mixing results in a voltage of the same frequency as the amplitude depending on the phase relation between the two mixed RF's, i.e. on the distance between the ship- and the shore-stations. When this distance is changed, e. g. by moving the ship with constant speed, the low frequency becomes amplitude-modulated by the Doppler frequency corresponding to the ship's speed and the RF used. The Doppler frequency caused by the normal speed of survey vessels would range between 0 and 2 c/s max. Modulating the RF in the shore station, however, shifts these extremely low frequencies to about 400 c/s which can be handled much more easily and can directly be used to run a servo system. The servo system consists of a resolver, a servo amplifier and a servo motor. One revolution of the resolver corresponds to a change of distance of about 2 yds, the direction of rotation being reserved with increasing or decreasing distance respectively. The servo motor drives the recording paper carrier. The inner accuracy of the system is of the order of 20 cm. From the above it will be clear that elapsed distances only can be measured with this high precision. The initial distance between the ship- and shore-stations will be uncertain, in other words the system has no identification. Identification, of course, could be made also by electromagnetical methods, but these would require a large frequency bandwidth especially for measuring small initial distances. On the other hand there is no sense in relating high precision elapsed distance measurements to insufficiently exact known initial values. Therefore the initial distance is measured once by an exact optical method. After this has been done the ship- and the shore-stations may change their mutual distance at will without requiring new calibration.

Proper operation of the equipment can be easily checked by the fact that making a closed loop with one of the stations will necessarily bring back exactly to zero a mechanical counter coupled to the servo motor. This has often been tried making loops of several thousand yards' length and over long periods with good success, thus proving the reliability of the equipment.

Operating in the VHF-band, the system is restricted to almost line-of-sight propagation. Even obstacles like big ships entering the path of propagation do not disturb the measurement. The maximum ranges achieved changed between 1.5 NM and 8 NM depending on the type and height of the antennas. Transmitter power used was 3 watt (shipborne-station) and 0,5 watt (shore-station). The power of the shore-station was limited by the use of portable batteries. Even the smallest range of 1,5 NM will be absolutely sufficient for river surveying. For river-mouth-and close-in coastal-surveying, a range of 8 NM, which can be obtained at quite moderate expense, will suffice in most cases. In survey regions of some NM expansion, it is difficult, if not impossible, to let the survey vessel follow a straight line. Therefore, a two-dimensional system is urgently needed for those regions. The above method lends itself to this task also without excessively increasing the expense. An additional shore-station has to be supplied which differs from the first one only by the modulation frequency, which is 600 c/s instead of 400 c/s. Thus no additional RF is required, the band-width of the system still remaining within the limit of 4 kc/s requested by the Bundespost. The volume of the shipborne-station will be increased by one third by adding two amplifiers. A recorder for plotting the covered route is being developed.