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1. At the end of 1949 and early in 1950, Dr. Rudolf Kaiser received an order from the SAG hydrogenation works in Boehlen to develop ultrasonic devices for the purpose of studying the conditions of soil where coal deposits are located. This order was motivated by the fact that stones located in the soil above coal deposits (Abraum) would frequently destroy the shovels of excavators. Kaiser and his assistant, Fritjof Buhr, carried out experiments in the Boehlen coal deposit area in order to test the possibility of using ultrasound for an examination of geo-physical soil conditions. A number of microphones were introduced into the soil over a large area, and a test explosion was touched off. The ultrasound waves of the explosion, after having been converted into electrical values in the microphones, would show on a cathode ray tube. In other experiments ultrasound oscillators of 30 kcs were used to generate the waves. The result of these experiments showed that ultrasound could be used for a study of the physical conditions of the soil and particularly for the spotting of obstructions hampering excavation. The Boehlen experiments were discontinued with the understanding that Kaiser would receive a research order through official channels for the development of ultrasonic devices for this purpose.

2. Late in 1951, the Zentralamt fuer Forschung und Technik (ZAFT) assigned an order for the development of ultrasound devices to Kaiser, who in the meantime had become a member of the scientific staff of Funkwerk Koepenick. He has since carried out this research in an ultrasonic research laboratory of the Funkwerk.

3. The research aimed at converting ultrasound into visible effects without making use of the conversion principle of the Pohlmann cell. 1/ It was found that the Pohlmann cell can be used for the testing of material quite generally, and investigation of soil condition in particular with the desired degree of sensitivity, only after a relatively long adjusting time, which takes minutes. In testing of materials, adjusting time of a few seconds at the utmost is desired. In this case, the Pohlmann cell not only decreases its sensitivity, but also requires relatively high energy. Kaiser's task was to develop devices of high sensitivity and low adjusting time. He developed two devices: a converter tube (Ultraschallbildwandler) and an electron switch (Elektronenschalter).

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4. The essential part of the converter tube is its "front wall screen" (Vorderwandmosaik) which, when the tube is in operation, is placed in xylol or in water with the object to be tested. The screen is made of a semi-conductor of unipolar conductivity. After a number of trials, Kaiser ultimately chose cuprous oxide with admixtures of sulfides. The screen is composed of forty thousand squares with a side length of about 0.5 millimeter; they are connected with each other by small strips of the same material but each of them acting as an individual oscillator. An electron beam within the vacuum tube scans the screen and "translates" the oscillation of the squares caused by ultrasound into electrical values. The converter tube is connected with a television tube over two amplifiers; a picture of the interior of the object under investigation appears on the television tube. Obstructions appear dark. The practical arrangement for the testing of material will be as follows: an ultrasound source will be placed against one side of the object under investigation; a "camera" (a water filled tube with a lens in it) is placed on the other side of the object opposite the ultrasound source. The converter tube is connected to the camera so that the screen is in contact with the water in the camera. Two amplifiers and a television tube connected with the converter tube complete the arrangement. The ultrasound source can also be placed on the same side as camera and converter tube; in this case the reflected ultrasound radiation will be converted. For the special purpose of spotting stones and other obstructions in coal mining, the following arrangment will be applied: a converter tube will be fixed at the shovel of the excavator so that it moves along with the shovel. The tube is connected with a shower which uninterruptedly pours water between the tube and the soil. 2/ Ultrasound generated by an oscillator is projected into the soil by three projectors. The converter tube is synchronized with a television tube on which the reflected ultrasound radiation appears as a picture; obstructions appear dark in the picture. As soon as an obstruction shows, the operator of the excavator presses a button which will release red paint from a jet, and the location of the obstruction will thus be marked. Projectors and converter tube will be fixed in such a way that obstructions appear in the picture before the excavator shovel hits the spot where they are located. The operator thus can avoid such spots.

5. In late 1952, a screen with twenty times twenty squares was completed. In late April 1953, a screen with forty thousand "picture points" was completely developed. However, the vacuum part of the converter tube has not yet been built because of the lack of adequate vacuum equipment. The sensitivity of the screen - so far without vacuum - is high: ultrasound radiation with a pressure of three milliwatt per square centimeter causes a change of current of five microampere with a closed circuit current of twenty-five microampere. In the absence of an electron beam - as long as the vacuum part of the tube is not completed - the scanning has been performed with needles with a cross-sectional diameter of about 50 m.

6. The "electron switch" does not serve the purpose of converting ultrasound into electrical effects, but of relaying the converted ultrasound to a television tube where the picture will appear. Conversion from sound to electrical values takes place in forty thousand microphones which can be distributed over a large area in an operation destined to provide a picture of the geophysical condition of the interior of the soil in this area. The microphones are connected with forty thousand wires which end in a tightly packed bundle. The ends of the wires are polished off; they are arranged in a square of two hundred by two hundred. The wires are of electrically oxidized aluminum; 3/ the oxide layer serves as insulator. Every wire end has a square cross section of 0.5 by 0.5 millimeter. The "mosaic" formed by the wire ends forms the inside of the front wall screen of an oscillograph tube; the screen is scanned by an electron beam. The electron switch is connected with a television tube where a picture relayed from the microphones over the switch will appear if the microphones are subjected to ultrasound radiation in the soil where they are planted. The obvious advantage of this device is that relatively large areas can be investigated. Development of the screen of the electron switch is complete; here, too, lack of adequate vacuum installations has made impossible the construction of the vacuum parts of the tube so far.

7. Development of both the converter tube and the electron switch is to be completed by the end of 1953. Dr. Gerhard (fnu), chief of the Central Institute for the Technology of Wireless Communications, is currently attempting to make the necessary vacuum equipment available so that completion of the development will suffer no delay.

25X1 1/ [redacted] Comment. Dr. Phil. Reimar Pohlmann, formerly with Siemens-Halske and now with the Federal Technical University in Zurich, Switzerland, invented the device named after him in th 1930's. It is a container with a metal [illegible] the front end and a glass disc at the rear. The container is filled with xylol in which small aluminum discs of about 10 mu diameter and 1.5 mu strength carry out the Brown movement. When ultrasound is directed upon the discs, those of them which are hit take a position vertical to the direction of the radiation. Light which falls on them through the rear glass will be reflected by those discs which have undergone this directional effect. This conversion, however, takes a relatively long adjusting time to become fully efficient.

25X1 2/ [redacted] Comment. The soil, in this case, is an oblique earth wall along which the excavator moves.

25X1 3/ [redacted] Comment. "Eloxierter Aluminiumdraht" has been translated here as electrically oxidized aluminum. "Eloxiert" stands for "elektrisch oxydiert."