TWO CHANNEL DETECTOR, COMBINING NEUTRON BACKSCATTERING AND ACTIVE ELECTRO-MAGNETIC METAL DETECTION

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INTRODUCTION

The detection of personal mines is one of the most discussed problems today. Have these mines any metallic components a sensitive metal detector can give some indication. The false alarm rate is high. Combining the signal of this method with that of a neutron backscatter detector, which reflects the possible presence of explosives, the information is improved and false alarms should be reduced. A 2 channel detector is discussed. If there are personal mines without metallic parts than only a nbs-detector has a chance to give an information.

METHODICAL

(1) Neutron backscatter detector

The idea is to use the slow down of fast neutrons by collisions with hydrogen nucleids, which are a part of the chemical content of explosives. Being in a surrounding of material, which has a lower hydrogen concentration, these mines can be detected by means of the backscattered thermalized neutrons.

As neutron sources are available isotopic neutron sources as ^{252}Cf and $^{241}Am/Be$-types neutron sources with a neutron flux of 10^6 neutron per second. The mean energies of the emitted neutrons are 2 MeV and 8 MeV respectively. A much more intensive neutron source is a neutron generator, giving a mean flux of 10^8 neutrons per second. The used equipment is schematically shown in fig. 1.

The used detectors for thermalized neutrons are boron coated gauges, in which the n,α-reaction is used to produce the signal. This is proportional to the flux of incoming thermalized neutrons.

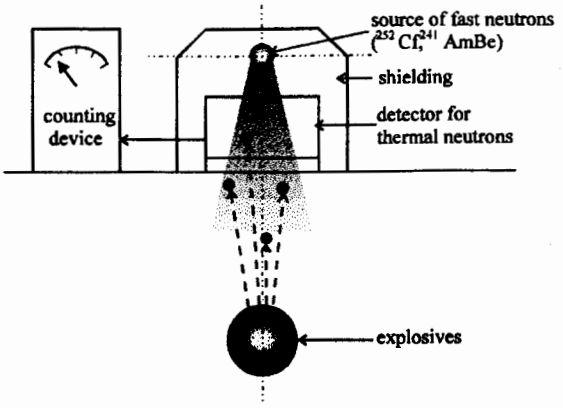

Fig. 1: Scheme of the neutron backscatter arrangement for explosive detection

(2) Metal detector

The pulse remance [1] principle is used for the detection. A dc-current is fed to the transmitter coil via an electronic swith (fig. 2). By this current a magnetic field is built up around the transmitter coil. When the current has reached the steady state, the switch is opened, and the magnetic field decays. By the decaying magnetic field eddy currents are induced in metallic bodies inside the field. These eddy currents generate secondary magnetic fields decaying slower than the original magnetic field. The secondary fields are detected by a receiving coil. It's time dependend output voltages contain information on the coordinates, the volume, the receptivity and - to some extend - the shape of the metallic objects. In order to reach a good sensitivity of such a device it is necessary to have a high field strength of the original magnetic field and a very rapid decay of the field after swith off the current.

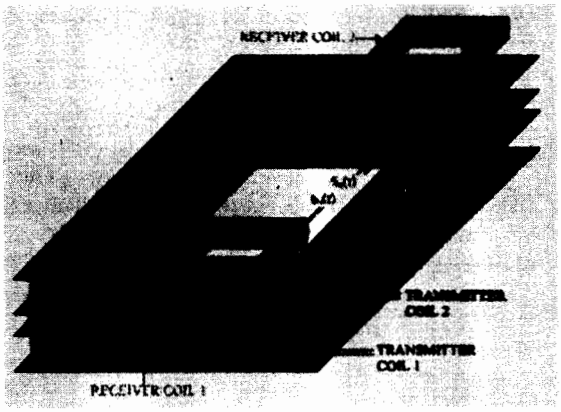

Fig. 2: Scheme of the used remanence system: transmitter coil and 2 receiver coils

RESULTS

(1) Neutronbackscatter

Fig. 3 shows the number (a.u.) of backscattered neutrons produced by an 100 ml water flask covered by 5 cm sand. The maximum flux is registered in the perpendicular direction above the object. There was done some comparision between water and explosives, the hydrogen content of them is relatively lower. The minimal detectable amount of explosives is about 100 g TNT, covered by 5 cm dry sand.

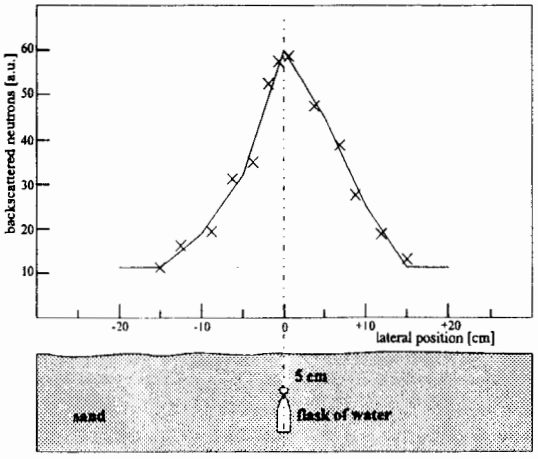

Fig. 3: Number (a.u.)of backscattered neutrons produced by an 100 ml water flask covered by 5 cm sand

The fig. 4 shows 5 letters filled with different amounts of TNT equivalent. The backscattered neutrons are able to identify the explosive down to 20 g TNT. 5 letters are as follows: paper only, paper + plastic bag, plastic bag, paper + plastic bag + 15 g TNT, and finally paper + plastic bag + 250 g TNT.

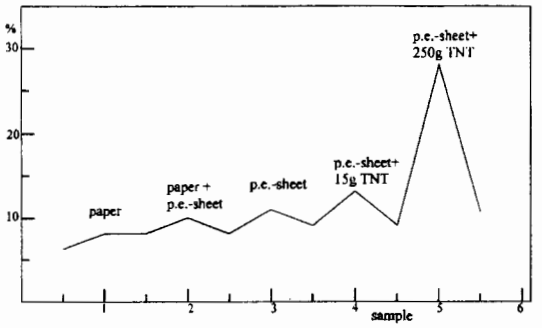

Fig. 4: Letters with TNT - detected by means of backscattered neutrons

(2) Metaldetector

The time dependence of the signal, S (t), is given in fig. 5 for different objects shapes: steel ring, shell in 3 positions and also a sphere. The conclusion is that the decay time T of the signal reflects some information about the shape of the object. Also it is shown that the sphere is a good approach to describe shells in the horizontal positions.

An other result is the correlation between the local half width of the received signal with the depth of the object. The agreement between theory and experiment is better than ± 10 %.

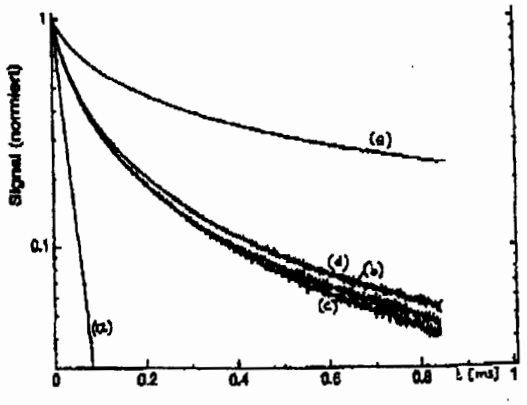

Fig. 5: Dependence of the signals of objetcs with different shapes on the fime: a) steel ring, b) steel sphere (10 cm), c) shell in horizontal position along the motion, d) shell in horizontal position - perpendicular to the motion, direction, e) shell in a vertical position.

CONCLUSIONS

The method is well applicable in many cases as follows:

(1) for the monitoring of personal mines on dry sand surfaces - especially in deserts - and may be in luggage.

(2) for the monitoring of personal mines in incoming letters, parcels, etc.

(3) the combination with the active electro magnetic detector allow the install 2 channel detectors, which are detecting both - metallic and non-metal objects.

The practical use of this 2 channel methods is limited by some restrictions:

- Explosives without metallic components can't be detected in a wet surrounding
- The user of equipment must have the permission to handle neutron sources.