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SOLUTION FOR AN EQUIPMENT OF RAILWAY BRIDGE MONITORING

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Abstract. *This paper presents a solution for the railway bridges monitoring based on the use of already existing equipments in the railway installations and some new equipments based on photo-elements, as well. This kind of equipments can function in continue and discontinuous regime, means of them tracking down if the bridge piles suffered movements by different reasons. This aspect can put in danger the safety of the circulation on that bridge.*

Keywords: Safety of the railway circulation, muff, optical fiber, track circuit, relay

1. Introduction

In practice, the piles of a railway bridge can suffer displacements if they are coming in collision with big objects, like ships or because of the lack of the quality of the execution. This is a very dangerous situation which can lead at disasters, railway – naval accidents.

This equipment can be used as supplementary way to detect the bridge pile bridge displacement. In practice this is detected with two methods:

- using specialized sensors, like accelerometers, inclinometers;

- using trained personnel with safety of the railway circulation, which can monitor, in some situations, already mounted TV cameras.

Safety of the railway circulation is primordial, all the measures must be taken, for minimize the probability apparition of an accident.

There are situations in practice when the trained personnel can't be sent outside to check, that's why detection equipment is required.

Such an accident took place in the US and caused a lot of human victims.

In the *figure 1* it is a picture caught at the accident's place.

The mechanism of the accident was as follows: a big naval ship entered in collision with one of the bridge piles, thing which loosed the resistance of the bridge, but the railway line remained intact, but with bending. The train derailed on the bridge and the locomotive and some carriages reached into water. [1]

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Fig. 1. The place of the naval-railway accident.

2. Actual status of the bridge monitoring in Romania

There are efforts and preoccupations in this field in our country, too.

The railway bridges are under the administration of the Romanian Railways – C.F.R. – and they are monitored using trained personnel for this purpose with duties related with the *safety of the railway circulation*.

There are, also, case studies with practical implementation related with this subject which belongs to some Romanian PhD engineers.

This is including a system for bridge monitoring includes sensors, network and the data transmission system. [2]

The *figure 2* shows a schematic – block of this system.

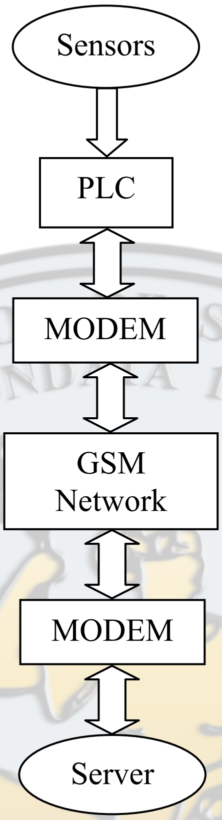

Fig. 2. The schematic – block of a Romanian bridge monitoring system.

3. Actual status of the bridge monitoring in the world

The status of the bridge in the world depends, first of all, by the development of every country. Not everywhere in the world we can find the same level regarding the *railway safety*. Like everywhere, railway bridge monitoring depends of the budget allocated for this and of the priority for this. The equipments for this issue are expensive.

The equipments used in the bridge monitoring are:

- sensors for acceleration – accelerometers – used to monitor shocks, vibrations;
- humidity sensors;
- temperature sensors;
- inclinometers – used for the measurement of some inclination of some components from the bridge structure.

These components are mounted under the bridge. In the *figure 3* it is an example about how these components are mounted.

Fig. 3. Example of how bridge monitoring elements are mounted.

Another example of a structural monitoring of an overpass it is given in the *figure 4*, an application example. [3]

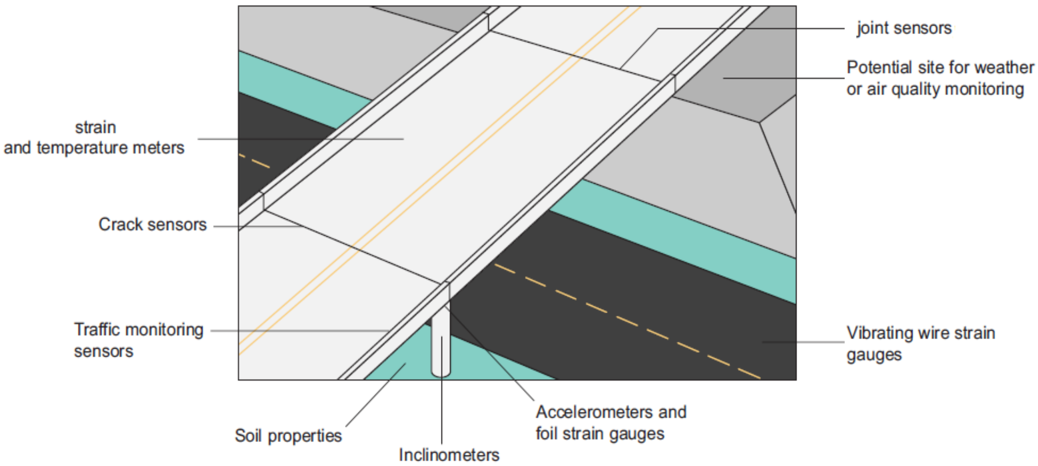

Fig. 4. Example application: structural monitoring of an overpass.

4. Solution for a railway bridge monitoring equipment:

This solution is containing components used at the pulses *track circuits*. It is about the *track circuits* in two code sequences which are using an electromechanical encoder. [4]

This information given by the equipment can be used to be transmitted further or used in the already existing interlocking installations.

A block – schematic with the use of the information in the interlocking installations is given in the *figure 5*.

Fig. 5. The information from the execution relay is used in the already existing interlocking installations.

In the block – schematic is represented in the *figure 6*, the use of the same information further into a data acquisition system which is containing a computer with software based on the *safety of the circulation*.

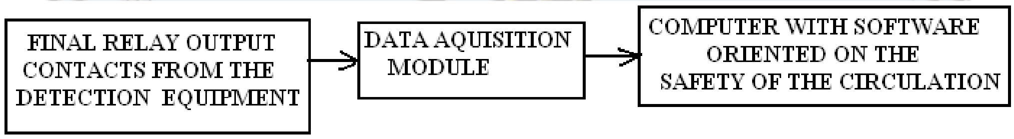

Fig. 6. The use of data into a data acquisition system

After the step with the displaying and processing of the data, this can be sent eve further using a data transmission network at a remote location, by instance.

The principle used in the functioning of this equipment is the following: the *optical fibers* allows to the light to travel along with some loses and on some distances.

The equipment can be implemented using laser emitters, laser receivers, but this can be in some case dangerous for the health, because the laser used can provoke accidents to the personnel and other people if it manipulated by the persons without the necessary training and without adequate protection equipment.

This *optical fiber* will be connected in some key – points, at the bridge piles, with the rest of the bridge, and it will contain a special *muff* which will allow to the fiber to interrupt the connection in case in which this will be stretched because of a sudden bridge pile moving.

There are situations in practice in which the *track circuits* are not detecting this, because the rail lines are not interrupted or broke. This is a very dangerous situation which can appear in practice and can lead to accidents.

In the *figure 7* is represented the way how this equipment is installed on a railway bridge.

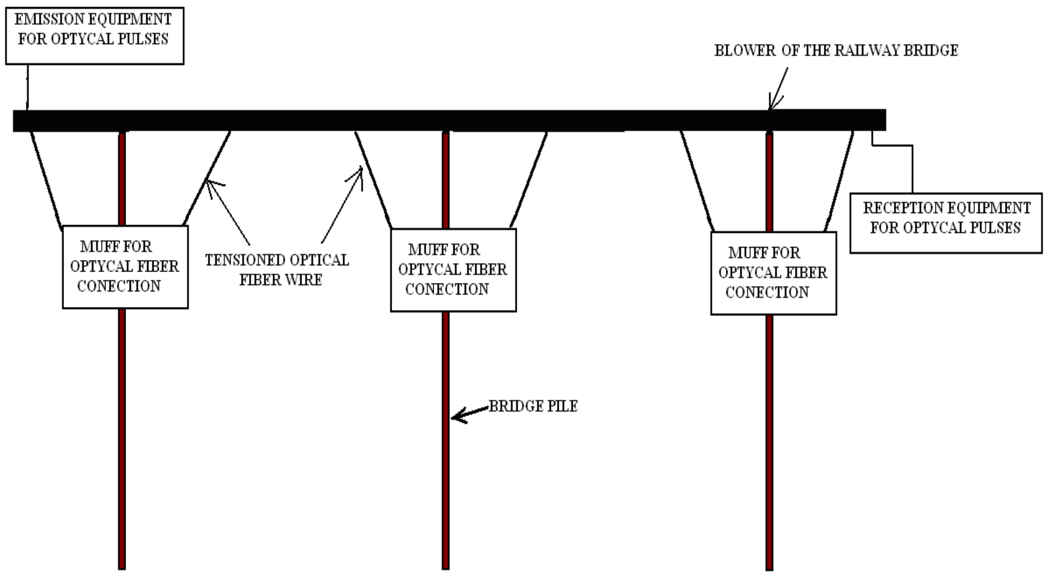

Fig. 7. The representation of the equipment mounting on a railway bridge.

In the moment in which the pile of the bridge will suffer a movement because of a collision, by instance, the 2 ends of the *optical fiber* will be wrested from the special *muff* and will interrupt the light flow.

This will lead at the loss of the input light of an optical module which will transmit further this info as damage appeared.

The *figure 8* shows such a special *muff*. [5]

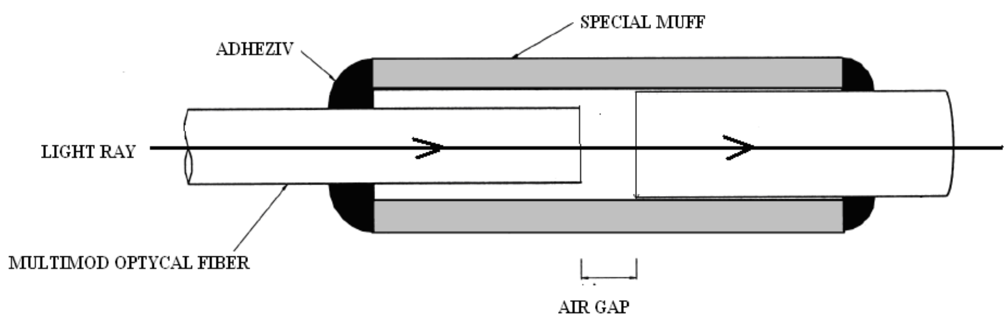

Fig. 8. Special *muff* used for the *optical fiber*

A block – schematic of the entire equipment is given in the *figure 9*.

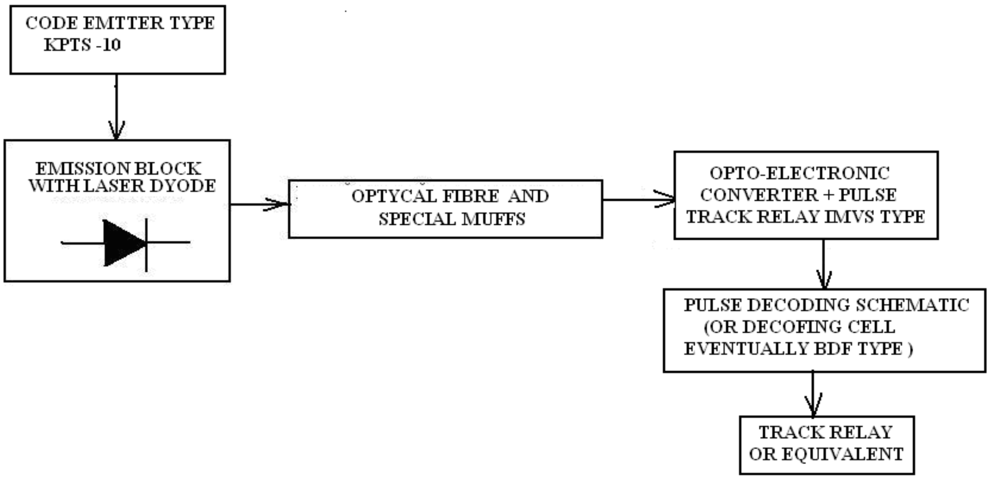

Fig. 9. Block – schematic of all the equipment.

All the functioning of the equipment is based on the optical fiber and the special *muffs*. If this is not allowing the interruption of the optical continuity of the fibers, the equipment will not function correctly.

Everything depends of this aspect related of the *optical fiber muffs* and the mechanical tensions with which the fiber must be installed.

The optical converter can be a specialized laser diode.

The laser pulses are transformed in electrical pulses which are transmitted further to the track-pulses *relay* type IMVS.

The electrical connections of this *relay* are given in the *figure 10*. [4]

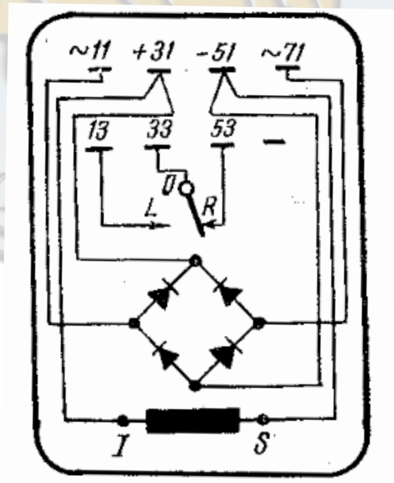

Fig. 10. Electrical connections of the IMVS – 110.

Then they are introduced into a decoding cell, which is, in fact, an electrical charges pump.

There are a lot of schematics for a charge pump circuit. In the *figure 11* is shown a principle schematic of a charge pump. [4]

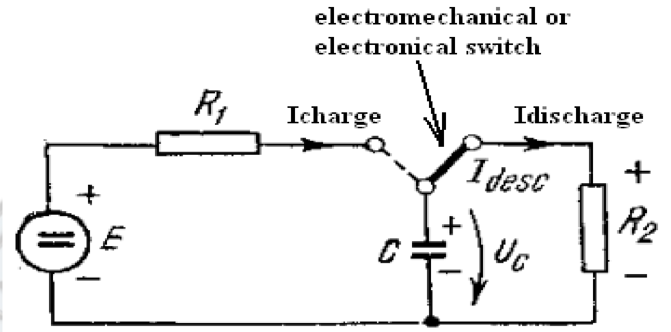

Fig. 11. Principle schematic of a charge pump.

The functioning principle of functioning is as follows: the switch is changing his position all the time. Let's suppose that this switch is on position of charging, in this case the capacitor *C* will be charged with the shown polarity through the resistor R_1. Then the switch is changing his position, the capacity will discharge on the R_2 resistor, the switch will be back again, will charge again the capacitor, then it will commute, will discharge and so on. In practice, the time constant of the circuits must be correlated with switching period and, because the voltage on the R_2 resistor must not drop under a specified limit.

This schematic which is using the charge pump is the point of departure for another schematic which is using a track *relay*, but is not used in the real field interlocking installations. This schematic is shown in the *figure 12*. [4]

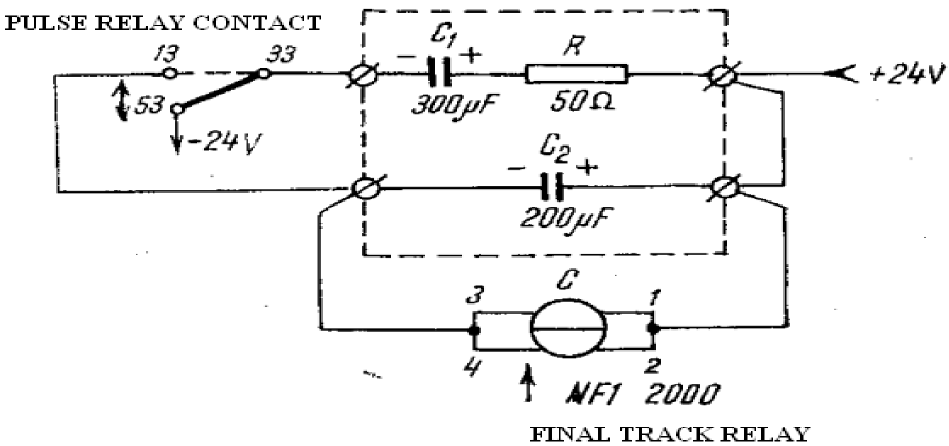

Fig. 12. Principle schematic of a decoding module

In the schematic from the *figure 12*, the place of the resistor R_2 is taken by a *relay* used in the interlocking installations: NF1-2000 – this is used as a *track circuit relay*.

Functioning: let's suppose that the pulse relay contact is establishing contacts 33-53, in this case the capacitor C_1 will be charged on the following circuit:

(+) 24V -- R -- C_1 -- (53-33) IMVS relay contact -- (-) 24V

After this, the pulse *relay* contact will switch and will establish contacts 13-33 and the capacitor C_1 will discharge on the C_2 | | (in parallel) relay NF1-2000, on the following circuit:

C_1 (+) -- R -- C_2 | | (in parallel) *relay* NF1-2000 -- (13-33) IMVS ------- relay contact--C_1 (–)

Note: the | | means in parallel; -- means an electrical connection, a wire for instance.

The voltage at relay terminals must not drop under the falling voltage, that's why the time constants of the circuits and the pulsing period of the pulses *relay* must be calculated.

The relay NF1-2000 is a Class 1 safety relay, this meaning his mobile armature will fall under the gravitational force, when the voltage at its terminals will fall under a certain value which is maintaining the relay drop. This relay contains two coils, and his connection diagram is given in the *figure 13*. [4]

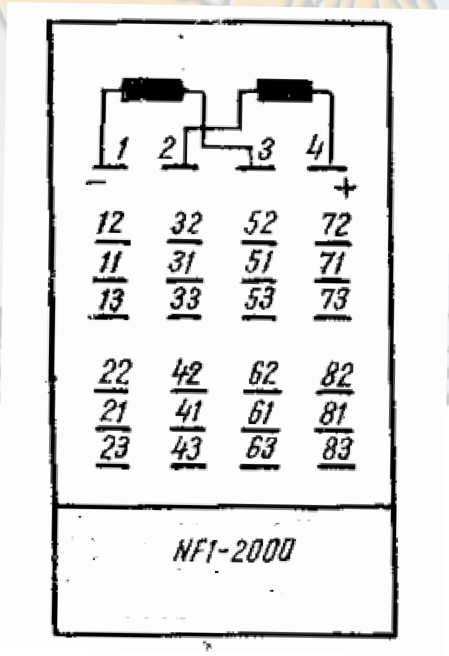

Fig. 13. Electrical connections diagram of the relay NF1-2000.

5. Conclusions:

- This equipment for the railway bridge monitoring is not so hard to be assembled, because it is using some components from already existing equipments.
- This equipment is only a proposal, a solution for railway bridge monitoring.
- It can control short distances, maximum 50 meters and a good idea is that to use for every bridge pile one *muff* with its components.
- The equipment can function continuously or with interruptions.
- The equipment can help the actual personnel for the railway bridge monitoring.
- If the pulses transmitted by the *optical fiber* don't have the right period or the capacitors inside the decoder module are damaged, the final *relay* NF1-2000 with not respond correctly, this is a disturbance case. The safety of the circuit is assured by its components from the *track circuits*, if the pulse relay contact will block in one position or another, this is also a disturbance, and the final relay will not be up.
- The equipment respects the reliability of the equipments used in transportation, because it has a serial reliability schematic.

R E F E R E N C E S

[1] http://channel.nationalgeographic.com

[2] Bridge Spy Monitoring System, http://azfreesoft.com/

[3] Monitoring, http://www.campbellsci.com/

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