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AUTOMATIC CONTROL OF PUMPS FOR WATER PUMPING DRAINAGE ON THE BASIS OF TIMER 555

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ABSTRACT

A simple and reliable control scheme of two pumps for water pumping drainage on the basis of timer 555 has been suggested in the paper. High reliability, simple construction and low price make the scheme applicable instead of specialized computer system.

INTRODUCTION

The scheme of water pumping drainage in a mine depends on the shaft depth, the number of levels, water inflow etc. The simplest scheme is that with one water pumping drainage equipment.

Main, additional and transferring water pumping drainage equipment which pump out water from the water - collectors are localized in special chambers usualli above water level. Chamber under water level are also being used in order to make automatization easier, to supply constant flow ower pumps and to increase the efficiency.

Automatic mine water pumping drainage system according to (Melkumov, 1973; Volotkovski, 1983) shuld supply the folluing:

- automatic control - starting the pumps with preliminarily owerflouing and stopping depending on water level in the water-collector;
- manual control;
- serial pump operation and distaht control;
- switching on additional pumps at increase of water level;
- automatic surtching on reserve pump;
- automatic switching out of pump at productivity lost;
- Blockages at switching on at unowerflounpump;
- hidrolic defence;
- signalling pumps operation and alarm switching out.

The equipement in our mines is mainly Russian:

- AB - 5, AB - 7 - equipement for sectional waterr pumping drainage;
- ABH - 1M - equipement for automatic control of three pumps;
- UAB - universal equipement for automatic control of 16 pumps;
- VAV - equipement for control of 9 pumps with high ang low voltage motors.

The element basis of the mentioned equipement comprises relays, motor relays, and manual switches with mechanical contacts. Modern technical solutions are realized by microprocessor command-controllers and noncontact operational mechanisms.

We suggest an example of a scheme for automatic control of two pumps for water pumping drainage on the basis of Timer 555. It can demonstrate the realizing possibilities of comparatively simple schemes for automatic pump control by the same Timer.

CONTROL SCHEME SYNTHESIS

The aim is to realize a control scheme for two pumps which do not need overflowing. Such are the submerged pumps and pumps set in chambers under water level in the water-collector.

As block scheme in Fig.1 shows pump 1 is the basic one and it is switched on at water level 1 by trigger "level 1". The block "debit control" checks up in time T from switching on pump 1 by a debit transducer. If its debit is normal pump 1 continues operating. At some defect in pump 1 its debit decreases, the block "debit control" switches it out and switches on pump 2. In case of increased water flow in the water-collector the operation of one pump is insufficient and at water increase above level 2, pump 2 is being switched on operating together with pump 1.

Scheme in Fig 2 has been synthesized on the basis of this block scheme. Four Timers LM555 have been used. Integral scheme LM555 consists of precise input divider, two comparators, RS trigger, output amplifier and charged transistor. Through outer RC group integral scheme LM555 usually operates as a timer of single impulses or as a generator. IC can be applied also as a trigger with two level switch on and switch off.

Electrode transducers at three levels have been put into the water-collector connected respectively to the inputs of triggers I and II. When the transducer is wet its potential is high as it is connected by a resistance to the supply pole. When the transducer is in water, through water resistance it is connected to earth and its potential is low.

Trigger I is switched on at water level reaching water-collector to level H1. Its output 3 reaches high potential and brings to operation relay P1 the last switching on pump 1. Water is being pumped out and at down level H_O the transducer H_O remains wet, trigger I is switched out and the pump is also switched out by relay P1.

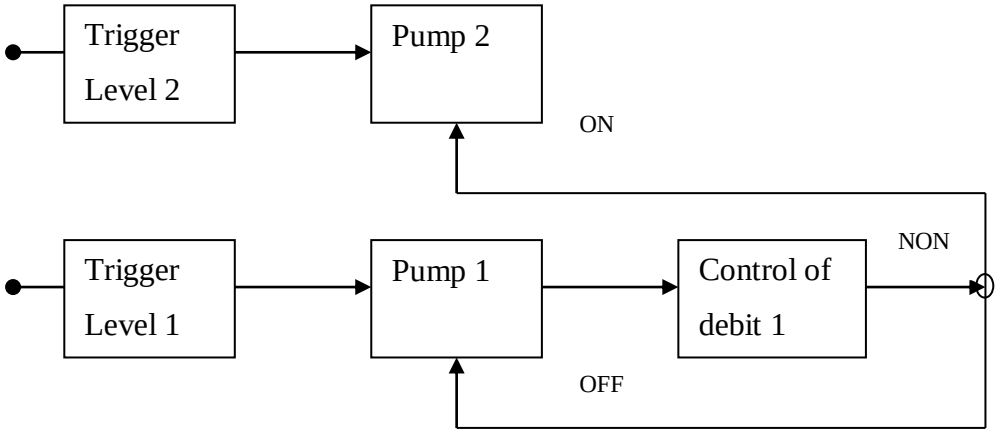

Figure 1.

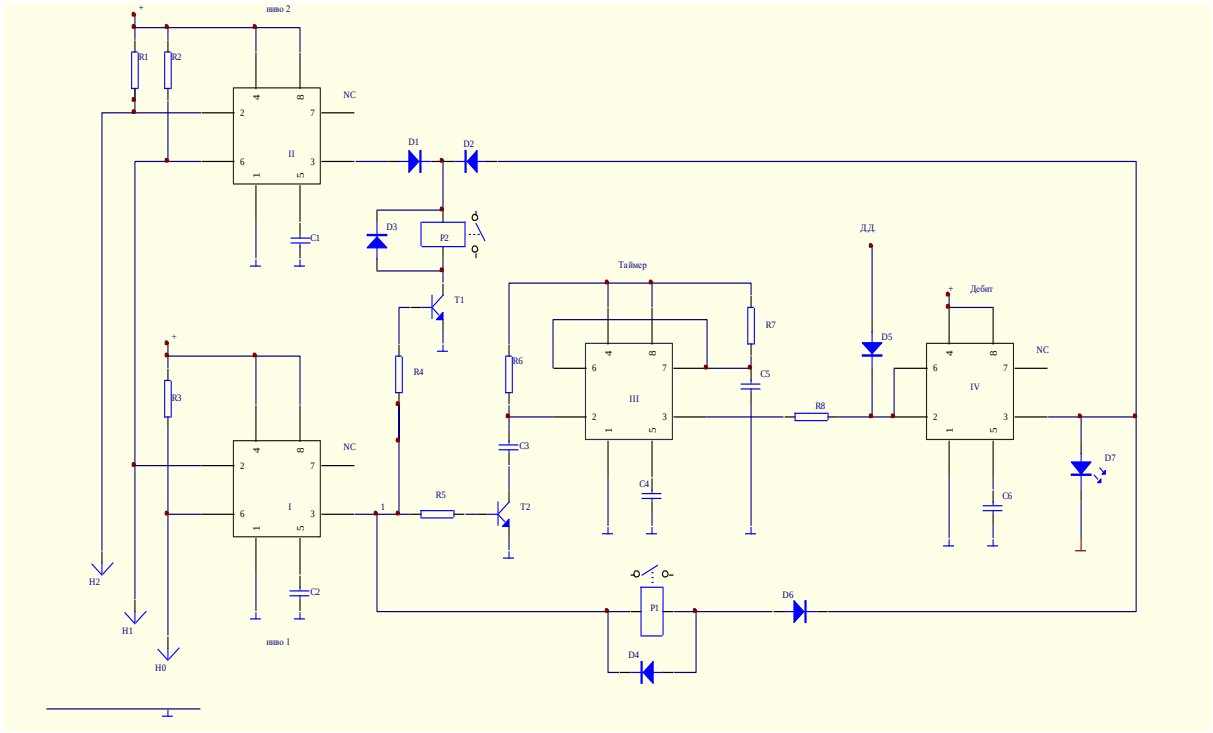

Figure 2.

In case water flow in water-collector is bigger than pump 1 debit, water reaches level H2 and by the trigger for level II voltage supply is provided for relay P2. Transistor T1 is opened at this moment, relay P2 goes into operation and switches on pump 2 starting to work together with pump 1.

Three operational regimes are possible:

1. Only one working pump;
2. Two pump working together at water level increase;
3. Only pump 2 working at pump 1 alarm regime.

Alarm regime of pump 1 is established by debit control device realized by timer (IC III) and trigger (IC IV). Timer keeps relay P1 switched on 10sek. In this interval the debit transducer D.T. should signalize for normal debit. If the debit is not normal low potential is supplied to the input of IC IV while the output (p.2) gets high potential. As relay P1 is between p.1 and p.2 they also have a hidh potential at alarm regime and the relay is switched off. At the same time IC IV output supplies relay P2 through diode D2. There is high potential on transistor T1 base and it

switches on relay P2 which gets into operation pump 2 as a reserve one.
In this way relay P2 is switched on in case at least one condition is being full filled:

- water level is above H1 and pump 1 has no normal debit
- water level is above H2

In the first case the second pump is switched on as a reserved and in the second case as an additional one at increased water flow in the water-collector.

CALCULATION AND REGULATION

Level triggers

Such volumes for resistances R1, R2 and R3 should be chosen that when electrode transducers H1,H2 and H0 are put into water their potential will be lower than 1/3 U_C .This is the real supporting level for input comparator to start working (leg 2 of IC) under which the trigger is switched on.

The resistances R1,R2 and R3 should be higher than 60k as water resistance between the submerged transducer and earth does not exceed 20kΩ. We have chosen the value 100kΩ. Each condensator C1 and C2 is 10nF. When water level exceeds H1, trigger I is switched on (high potential p.1) and when it falls under H0 the trigger is switched off. Respectively, when the water level is above H2 trigger II is switched on and when it is under H1 the trigger is switched off.

Timer

Timer III is being put into water together with trigger I through the group R5,R6,C3,T2. The volumes of the elements are: R5=10k Ω, R6=27kΩ,C3=100nF. The length of positive impulse is defined by the expression :T=1,1.R7.C5. At R7=100kΩ,C5=100 μF the impulse length is 10sek. It is enough to get into operation pump 1 and to reach its normal debit.

Debit trigger

At trigger IV input two signals reach - from the timer and from the debit transducer D.T. At normal work there should be low potential at the output(p.2) and high potential at the input in the first 10sek. The high input trigger potential is received from the timer and later from D.T. If the transducer does not give a high potential in the first10sek., the trigger is switched over (high potentialp.2) relay P1 is switched off, relay P2 is switched on and light diode D7 lights up. That is an indication for alarm in pump 1. Resistance R8 volume is 10kΩ. It limits the current from D.T. to timer output when it is switched off.

CONCLUSION

The suggested scheme for automatic regulation has been realized under laboratory conditions with two integral schemes LM556 (two timers 555 in one corp.) Voltage supply is +12V/-12V. Water resistance and transducer debit signal are simulated so that all states and scheme function could be checked up.

The main scheme advantages are:

1. Low price - The price of all elements with the supply does not exceed 20lv.
2. High reliability and maintenance ability- the number of electronic components is small. Integral schemes are assembled on sockets and can be changed rapidly and easily at any defect.
3. Possibility of widening - The scheme is constructed on a block principle and can be easily widened for regulation of a greater number of pumps. On these basis control and regulation schemes can be synthesized. Some other operational parameters can be also controlled by pressure, temperature etc. transducers.
4. Intrinsically safety - The scheme is intrinsically safe at using intrinsically safe supplying source and relays with hermetized contacts.

Due to these advantages the suggested scheme and other based on timer 555 can find an application for regulation of one or two pumps in cases where the use of specialized controllers is too expensive.

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