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SYNCHRONIZING THE START OF 400-KV VOLTAGE PULSE GENERATOR (GIN-400) AND MEASURING CIRCUIT DURING OSCILLOGRAPHING OF SHORT-TERM PROCESSES

by

M. I. Barash, I. S. Lavover, G. I. Chumakov

EDITED TRANSLATION

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Block	Italic	Transliteration	Block	Italic	Transliteration
А а	*А а*	A, a	Р р	*Р р*	R, r
Б б	*Б б*	B, b	С с	*С с*	S, s
В в	*В в*	V, v	Т т	*Т т*	T, t
Г г	*Г г*	G, g	У у	*У у*	U, u
Д д	*Д д*	D, d	Ф ф	*Ф ф*	F, f
Е е	*Е е*	Ye, ye; E, e*	Х х	*Х х*	Kh, kh
Ж ж	*Ж ж*	Zh, zh	Ц ц	*Ц ц*	Ts, ts
З з	*З з*	Z, z	Ч ч	*Ч ч*	Ch, ch
И и	*И и*	I, i	Ш ш	*Ш ш*	Sh, sh
Й й	*Й й*	Y, y	Щ щ	*Щ щ*	Shch, shch
К к	*К к*	K, k	Ъ ъ	*Ъ ъ*	"
Л л	*Л л*	L, l	Ы ы	*Ы ы*	Y, y
М м	*М м*	M, m	Ь ь	*Ь ь*	'
Н н	*Н н*	N, n	Э э	*Э э*	E, e
О о	*О о*	O, o	Ю ю	*Ю ю*	Yu, yu
П п	*П п*	P, p	Я я	*Я я*	Ya, ya

*ye initially, after vowels, and after ъ, ь; e elsewhere.
When written as ё in Russian, transliterate as yё or ё.

RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

Russian	English	Russian	English	Russian	English
sin	sin	sh	sinh	arc sh	$\sinh^{-1}$
cos	cos	ch	cosh	arc ch	$\cosh^{-1}$
tg	tan	th	tanh	arc th	$\tanh^{-1}$
ctg	cot	cth	coth	arc cth	$\coth^{-1}$
sec	sec	sch	sech	arc sch	sech^{-1}
cosec	csc	csch	csch	arc csch	csch^{-1}

Russian	English
rot	curl
lg	log

SYNCHRONIZING THE START OF 400-KV VOLTAGE PULSE GENERATOR (GIN-400) AND MEASURING CIRCUIT DURING OSCILLOGRAPHING OF SHORT-TERM PROCESSES

M.I. Barash, I.S. Lavover, G.I. Chumakov.

Study of thunderstorm effects on electrical power supply circuits of mining enterprises and the pulse characteristics of rock and ground conductors requires oscillographing of short-term processes which last 0.5 μs or more.

The dual-beam cathode oscillographs OK-17 used in the GIN-400 make it possible to register single signals with fronts lasting 0.05-0.07 μs. Their start systems, however, require improvement.

As we know, the starting of an oscillograph (triggering of beam and beginning of scanning) can be done from either the studied signal, which is transmitted to the input of the amplifier (autostart), or from a special start signal (independent start). In autostart the begining of beam scanning is determined by the amplitude, polarity, and transconductance of the arriving voltage, and triggering of the circuit occurs only when the amplitude of the voltage reaches a certain value.

In autostart registration of the front of a short-term process calls for the introduction of a special input signal converter, even though in this case the initial portion of the studied process is not registered. This cannot be permitted, for example, when studying the electrical strength of rock at the pulse front. The defect can be eliminated by introducing a delay element into the studied voltage circuit. In this case, however, distortion of the pulse is unavoidable.

In independent start (such start systems given rather detailed discussion in [1]) the oscillographing of the signal which is shaped at the input of the high-volt pulse generator involves a number of difficulties. First of all, it is impossible to use a time-rigid driven sweep. This is because of the probability-statistical time characteristics in the triggering of the air spark dischargers which commutate the high-volt capacitors [2].

The total time of commutation is equal to the sum of the triggering times of each of its stages. Moreover, at optimal values of the air spark gaps the breakdown time of the first gap significantly exceeds the sum of breakdown times of the subsequent gaps.

The need for a special system for synchronizing the starting of oscillograph scannning is determined by the fact that the internal delay system in the OK-17m oscillograph does not permit a delay of more than 45-60 μs in the beginning of the beam scan. Simultaneously, to reduce the scatter in breakdown time of the ignition gap in the case of a charge voltage which changes under experiment conditions, provison should be made in the sychronization block for shaping of an ignition pulse with a steep front.

From the structural scheme of the syncrhonization block (Fi.g 1) we learn that when the "start" command is given from the command signal block (BKS) triggering of start pulse generator 1Г occurs. Its output pulse simultaneously starts the ignition control trigger 1T and delay device 1Cx 3. Trigger 1TГ through amplifier Y1 and electronic switch K triggers ignition generator 2Г . This results in the appearance of a single discharge at the output of voltage pulse genrator GIN-400. The studied signal, taken from the low-voltage arm of voltage dividerДH is transmitted to the vertical deflecting plates of one of the channels of pulse oscillograph OK-17

m. Since the studied signal is delayed in relation to the signal at the output of generator 1Г it becomes necessary to delay the tirggering signal of the oscillograph by a time which is slightly less that the time required to trigger the spark discharge gaps. The 1Cx3 device is used as the preliminary scanning delay element in the studied block. A square pulse of positive polarity from the output of trigger 2TГ is supplied through the internal delay circuit 2Cx3 to the input of the light pulse generator 3Г, which opens the tube for the time of the forward stroke of the beam and triggers sweep generator 4Г, which develops a voltage proportional to the time. The external standard-signal generator 5Г is connected to the vertical deflecting plates of the second beam of the oscillograph, thus providing a reference for time intervals on the oscillogram. The basic diagram of the main elements of the synchronization block of the GIN-400 is shown in Fig. 2. Starting pulse generator 1Г and delay device 1Cx3 take the form of driven collector-base coupled multivibrators.

The work of the driven multivibrator can be examined with delay device 1Cx3 serving as an example.

In the original state of the diagram transistor T_3 is opened and works in the saturation mode. Transistor T_4 is closed and the voltage on its collector is constant. The circuit is triggerd by a pulse of negative polarity supplied to the base circuit of transistor T_4. The tripping of the circuit causes T_4 to open, while T_3 closes and remains in that state as a result of the drop in voltage on resistor R_8, caused by the overcharge current of capacitor C_4. The duration of the pulse shaping is determined by formula (1)

$$t_u = 0,7 \cdot R_8 \cdot C_4, \quad (1)$$

where R_8 is the resistance of the transistor base, kohm; C_4 - capacitance of capacitor, μF.

By changing the value of R_8 and C_4 it is possible to regulate the duration of pulse shaping within certain limits.

Symmetrical saturated triggers with individual starts 1TΓ and 2TΓ are used as the control elements in the circuit. When the "ignition" button in the BKS is released the triggers return to their original state. The ignition pulse is formed by electronic switch KЛ to whose emitter circuit the primary winding of the ignition transformer is connected.

Before the arrival of the signal from the output of amplifier Y1 transistor T11 is opened and a direct current flows through the winding of ingnition transformer TП . When transistor T11 is closed, the current in the winding disappears. This leads to the development of a voltage surge of positive polarity in the secondary winding of the ingition transformer. This pulse is supplied to the first discharge gap and assures a single shock capacitance discharge of the GIN-400 onto the studied object. The shapes of the output signals of the inndividual cells of the circuit and the time shifts between signals are shown in Fig. 3.

The block designed to synchronize the starting of the GIN-400 and the measuring circuit is used in the laboratory of electrical explosion and lightning protection of the Department of Electrical Mining Engineering of the Irkustsk Polytechnical Institute to study inductions in electrical explosion circuits and the electrical strength of rock.

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Fig. 1. Structural diagram of start synchronization block of GIN-400.

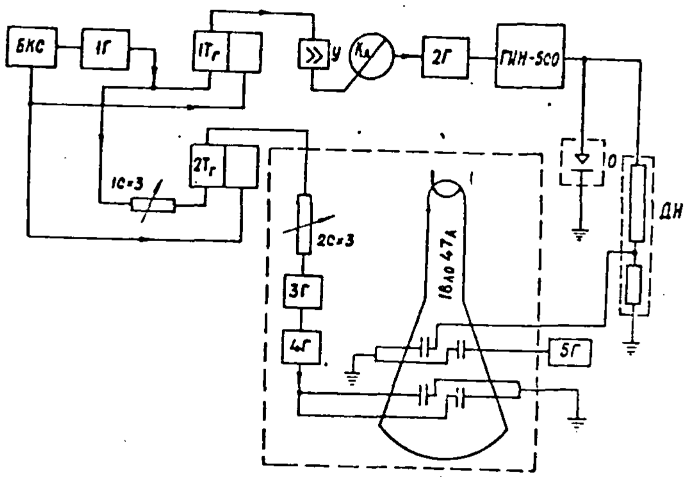


Fig. 2. Basic diagram of main elements in synchronization block. Key: to

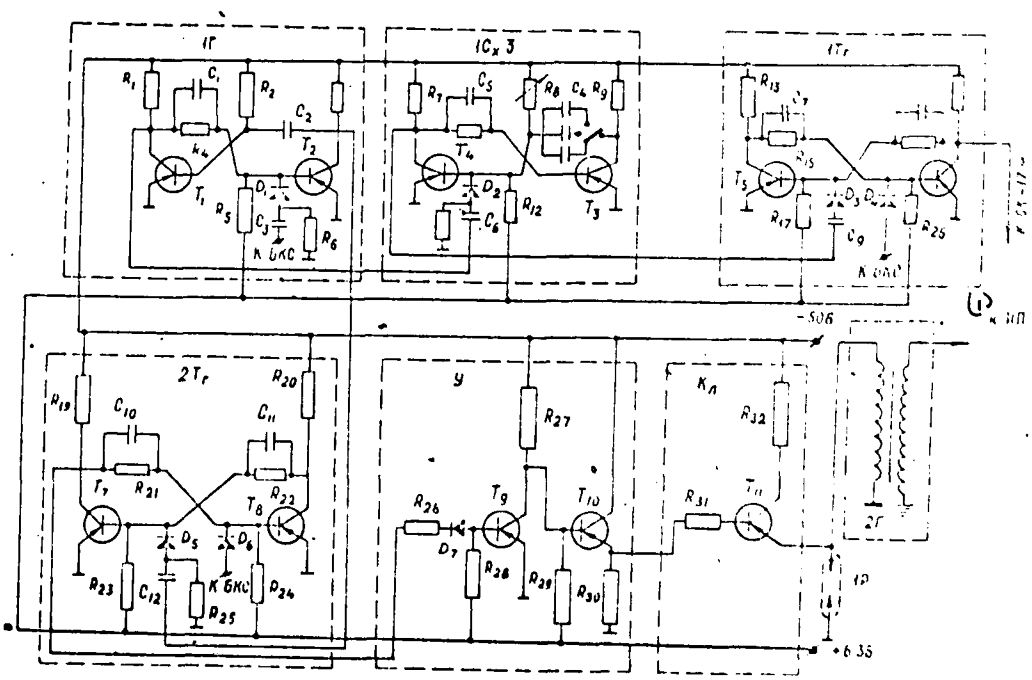
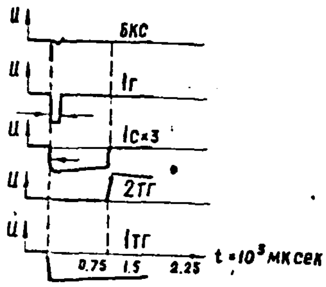


Fig. 3. Shapes of output pulses and time shifts. Key: μs.



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