Reasoning vs. Orthodoxy, or, The Lesson from the Fate of Russian "Reasoning Machine"

Valery Shilov, Sergey Silantiev

Reasoning vs. Orthodoxy, or, The Lesson from the Fate of Russian "Reasoning Machine"

Valery V. Shilov, Sergey A. Silantiev

MATI – Russian State Technological University, Moscow, Russia
{shilov, intdep}@mati.ru

Abstract. This paper devoted to Russian scientist Alexander Schukarev and his work on logical machine. Historically, this work may be divided on two periods – before and after Russian October revolution. We try to understand and explain why Schukarev′s activity in this field was ceased and his logical machine was forgotten for the long time.

Keywords: Stanley Jevons, Pavel Khrushchev, Alexander Schukarev, logical machine, reasoning, ideology.

1 Introduction

On 25 May 1865 the great English logician Stanley Jevons wrote to his brother Gerbert: "My newest job on hand is a reasoning machine, or logical abacus, adapted to show the working of Boole′s Logic in a half mechanical manner. I got a rough model to work excellently the other night, and I think I can easily get it finished during the summer" [1, p. 205]. This "reasoning machine" was in fact the first version of the first in history mechanical engine which really may be called reasoning (or logical) machine – Jevons′ famous "logical piano". At the beginning of XX century famous American philosopher and psychologist James Mark Baldwin in his Dictionary gave such definition: "Logical Machine: Ger. *logische Machina;* Fr. *machine logique;* Ital. *macchine logistiche*. An instrument devised to facilitate by mechanical means the handling of logical symbols or diagrams" [2, p. 28]. Baldwin added that "There are three such instruments which merit attention" [ibid.]; these "instruments" were constructed by Jevons (1869), John Venn (1881) and Allan Marquand (1881, 1883).

Martin Gardner gave remarkable review of the history of logical machines in his classic work [3]. However, he did not describe some of them because of various reasons. In particular, he did not know very interesting Jevons type logical machines invented in Russia by professor Pavel Khrushchev (1849-1909) and then improved by professor Alexander Schukarev (1864-1936) (Fig. 1).

Professor Khrushchev was prominent chemist. Circa 1900 he built his machine – but this is the only established fact. The further fate of machine is related with the name of Schukarev. That is why this paper devoted to this scientist and his work on logical machine. Historically, this work may be divided on two periods – before and

after Russian October revolution. We try to understand the reasons why Schukarev′s activity in the field of logic and theory of cognition was ceased and his logical machine was forgotten for a long time. Exactly these reasons explain why until recently only few and rather brief publications about this machine are known [4-6].

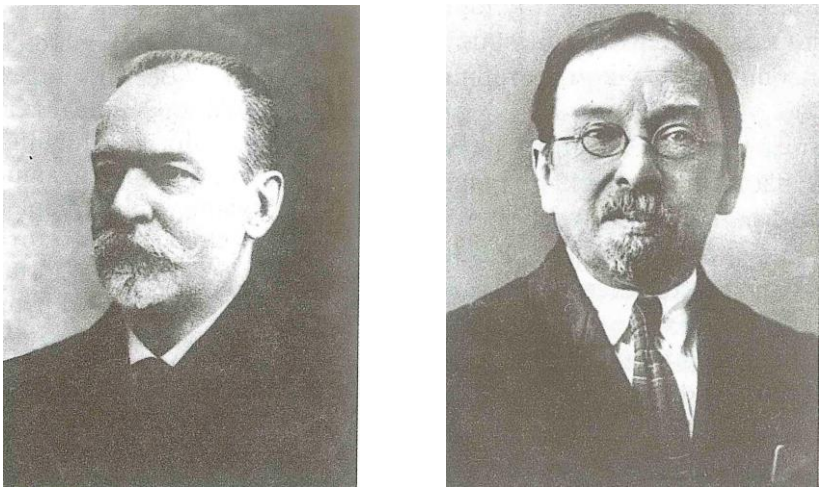

Fig. 1. Pavel Khrushchev and Alexander Schukarev

2 Professor Alexander Schukarev: his way in the science

Alexander Schukarev was born on 2 November 1864 in Moscow in the family of petty officer. In 1889 he graduated from Moscow University, Faculty of Physics and Mathematics. Then he was a lecturer in several colleges. His scientific interests were formed under the influence of joint work with outstanding Russian thermo-chemist Vladimir Louginine. In 1890 Louginine established the first Russian thermo-chemical laboratory in Moscow University and Schukarev worked there as a laboratory assistant. In 1906 Schukarev received M. Sc. degree and in 1909 Doctor of Science degree. Then he was elected as a professor of general chemistry of Ekaterinoslav High Mining School. After two years of work there he became the professor of Kharkov Technological University. Almost all his further scientific activity spent in this University.

Significant part of Schukarev scientific publications was devoted to his main specialty – physical chemistry but he also was interested in the problems of logic, methodology of science and philosophy. From the beginning of 1900′s Schukarev regularly published articles with philosophical analysis of natural science. In 1913 he published monograph under the title “Problems of theory of cognition and its applications to the natural science” [7].

3 First acquaintance with logical machine

During his work in Kharkov University, Alexander Schukarev saw Khrushchev logical machine in one of physical-chemical laboratory storerooms. It was very interesting for Schukarev who investigated the problems of logic and theory of cognition. He recalled that he in fact had "inherited" the logic machine from Khrushchev. Probably it means that this machine was simply handed to the scientist.

Khrushchev machine as it prototype – Jevons logical piano – was constructed as a high drawer with keyboard on which separate messages were set. It had also indicator board with the openings where the possible term combinations were formed (Fig. 2). Unfortunately, the description of Khrushchev machine made by Schukarev contains a brief statement that its construction and principles of work are the same as Jevons one.

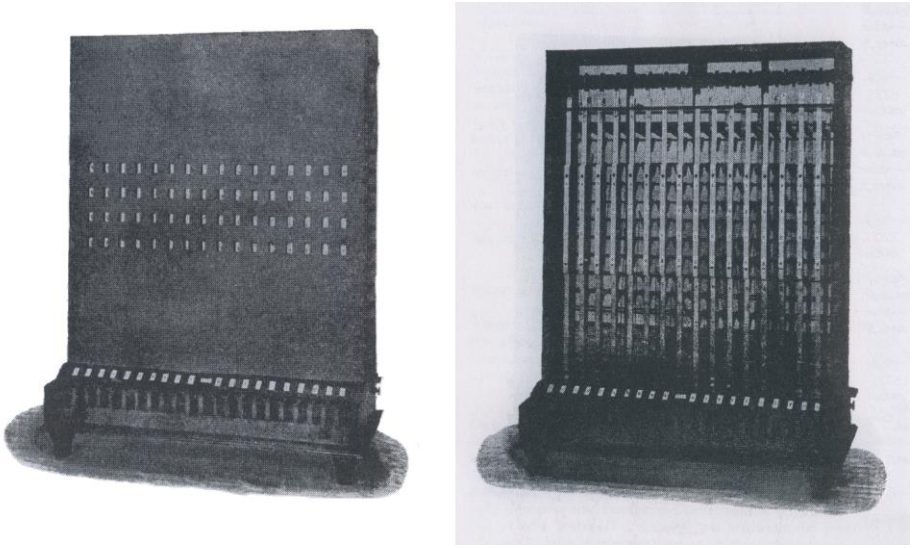

Fig. 2. Khrushchev logical machine (Source: [7, p. 52, 53])

Circa 1913 Schukarev made the improved variant of Jevons logic machine and described it (unfortunately also very laconically) in the article "Mechanization of thinking (Jevons logical machine)" published in 1925:

I simply gave the instrument the smaller dimensions, made it from metal and eliminated some constructional defects. The further step forward was the connecting the special illuminated screen to the instrument. The work of machine is transmitted to this screen and results of "thinking" appear not in symbolic form as on Jevons machine but in ordinary verbal form [8].

Schukarev so ended his description:

> "In my device, the rear rods connect electrically with special screen consisting of 16 horizontal racks, each bearing two ordinary electrical lamps.

List of transparent paper with ordinary words written by drawing ink is hanged before these racks. These words coordinate with the combinations on rods. For example, let A designates "silver", B – "metal", C – "current conductor", O – "possess free electrons". Than the words "Silver – metal, current conductor, possess free electrons" will be written on the first upper line of illuminated screen against the first rack with the lamps.

In null machine position, all screen lamps are lit and all combinations could be seen very clear by audience. After installing definite sentences, some rods are lifted up and appropriate racks are deactivated. Only those combinations of concepts which compatible with given settings remain illuminated" [8].

4 New life of logical machine

Logical machine regained the new life due to Schukarev. In 1912 he demonstrated it on the conference of Society of physical-chemical science at Kharkov University. This demonstration was repeated "almost 10 times" (apparently before various audiences) by "public insistence".

Undoubtedly, the character of modifications made by Schukarev (though he specified that they "were not of principle character") allows us to conclude that he built just new machine. It was not simple improvement of Khrushchev machine (Fig. 3). He wrote that machine "at present time [in 1912-1913 – *Auth*.] is the property of Kharkov University" [7, p. 49]. That is why we may suppose that after building of his own machine the inventor returned its prototype back to the University. Unfortunately, the fate of original Khrushchev machine is unknown.

During his public lectures Schukarev used the logic machine for supporting his opinions and theoretical statements. It is worth to mention that unlike Stanley Jevons who considered his machine useful only for the purposes of learning, Schukarev thought that "it may be used not only for that":

"In 1916 after several demonstrations of my device, which now is well known on the South Russia, I received the following letter from one of my students:

…"Local magistrate acquittal one of the accused person, which was motivated by the following justification: during the investigation there were no information excluded the absence of ill-will from the accused. Local jurists stated that this formula did not correspond to the acquittal verdict and they asked me to write you in order to check it with the help of logic machine".

I executed this request and set on machine:

A – "case", B – "contain information excluded the absence of ill-will", C – "charge". In result, I got the following combinations:

AbC Abc aBC abC abc

Thus, the given case A as it doesn′t contain information excluding the absence of ill-will b allows the charge C and discharge c as well.

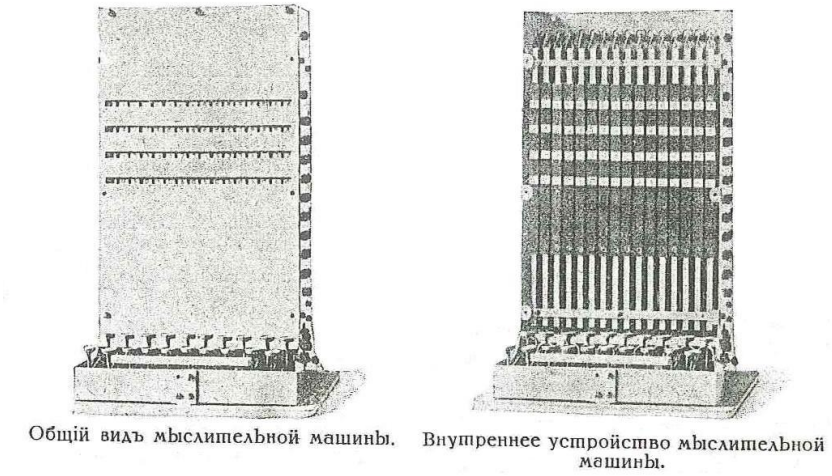

Fig. 3. Schukarev logical machine (Source: [9])

> Any other case a which contains information excluding the absence of ill-will B demands indisputable charge C.
>
> Any other case a which also doesn't contain information excluding the absence of ill-will b allows the charge C and discharge c as well.
>
> Thus, magistrate from Rostov was absolutely right in his acquittal verdict (because discharge is preferred to charge)" [8].

"It is possible that in other same lawsuits logical machine could find practical application" – so Schukarev completed his article. In Appendix to his monograph [7] and in the article [8] he also gave the example from the field of chemistry when logic machine helped to get "absolutely true" conclusions.

Until 1917 Schukarev demonstrated his machine not only in Kharkov but in other cities of South Russia. In April 1914 he gave some lectures in Moscow. It is known several newspaper advertisements about these lectures. For example, in the newspaper "Russkie Vedomosti" from 16 April 1914 we may read:

> **Thinking machine**
>
> Public lecture of Professor A. N. Schukarev "Cognition and thinking" will be presented on Saturday, 19 April, in large auditorium of Polytechnic museum. Thinking machine will be demonstrated during the lecture. This apparatus allows to reconstruct mechanically the process of human thinking − to draw conclusions from determined statements. Initially, machine was built by mathematician Jevons and improved by the author of the lecture. Results of it operations display on the screen in verbal form.

One of spectators of this lecture gives additional information about Schukarev logic machine:

"Professor of Kharkov Technological Institute A. N. Schukarev presented in large auditorium of Polytechnic museum the lecture under the title "Cognition and thinking". He demonstrated "logic thinking machine", invented by Englishman Jevons and improved by the author.

<…> A. N. Schukarev reconstructed and modified it. This machine performed mechanical process of thinking more perfectly without human mistakes.

Machine consists of vertical box of 40 sm height, 25 sm width and 25 sm length. It has keyboard: its rear row designates subjects and front row designates verbs.

There are lines of rods (sticks) inside the box moving by keys pressing. Four letters A, B, C and D are printed on each rod. There are 16 rods at all. They can present all possible combinations of letters <…>

After pressing the appropriate keys the combinations of terms inconsistent with given premises are eliminated. Thus, only combinations consistent with premises are remained – that is logical conclusion <…>.

Machine mechanically and without mistakes draws the conclusion and works more perfectly than human brain.

<…> Professor A. N. Schukarev has long worked on the improvement of Jevons machine. He made the special modification – every rod connects with electrical contact. This contact closes the chain of lamps on illuminated screen with some sentences written on it. Every sentence corresponds to one of letter combinations. Some contacts are broken when the rods are moving and sentences incompatible with given premise become invisible.

Thinking machine draws the conclusions better than the man does because all the conclusions are derived from our experience. In this sense machines are more useful than human brain.

We have arithmometers which can add, subtract and multiple great numbers by simple turn of the handle. It is obvious that time demands to have logic machine capable for unmistakable conclusions when you only press the appropriate keys. It will keep for a man a lot of time for creative work, hypothesis, fantasy and inspiration" [9].

5 Scientist and ideology: the fate of the doomed

Schukarev was continuing public presentations and further improvement of his machine until the 1925. It is known that besides regular demonstrations of logic machine in Kharkov, Schukarev showed it in Moscow and Leningrad. Logic machine caused the great interest of spectators as was earlier. However, after 1917 the situation in Russia was changing. To the mid of 1920′s part of leading philosophers were expatriated and many others were prohibited to work and publish. All editions propagated "idealism and clericalism" were suppressed. Marxist monopoly was established in philosophy. Many traditional philosophical doctrines including formal logic were radically revised. In 1925 Soviet philosopher Ivan Orlov published the article "About the rationalization of brainwork" [10] in ideological journal "Pod

znamenem marksizma (Under the banner of Marxism)". He criticized the scientific activity of Schukarev from the standpoint of Marxist dialectics.

The main Orlov thesis was – "he [Schukarev – *Auth*.] wants to convince us in the formal character of thinking and possibility of its mechanization by logical machine". Orlov declared that conception of formal character of thinking "drastically contradicts to the dialectic materialism". Orlov ascribes to Schukarev the statement that "machine will think instead of man". But Schukarev says only about possible mechanization of some thinking functions! First part of Orlov′s article is completely based on falsifications of Schukarev ideas.

However, in post-revolutionary Russia not only Schukarev ideas were unclaimed but he himself was non grata person. If we get to know Schukarev better not only as a scientist but also as a man it would be more clear the fate of his logic machine. Unfortunately almost all known publications do not describe him particular as a man. That is why the unique document discovered by authors – memories of his Kharkov′s colleague professor A. Filippov published in 1950 in Paris [11] – obtains specific value.

Memoirist describes Schukarev as a typical Russian pre-revolutionary professor who lived only for science and who "did not note surrounding reality". Schukarev of course saw and understood Soviet reality but it seems he principally ignored it. According to Filippov, Alexander Schukarev lived well enough as many other academicians worked in field of natural and technical science. Meantime many humanitarians "lived in poor hovels, languished from enforced idleness and wandered ragged along the streets". For example, professor of philosophy Vladimir Karinsky "did not differ in appearance from the ordinary beggar". However, Schukarev continued to live in the flat he occupied from Tsar Times. He dressed "decently and even smartly" and "came always dressed in frock-coat" on his public lectures.

But it is obvious that life position and behavior of such men as Alexander Schukarev were determined not only by the degree of material wellbeing. That is why his administrative superiors were in constant strain that Schukarev "will do some politically unacceptable thing". For example, memoirist writes that the so called "Circle ("Kruzhok") for studying of dialectic materialism" was organized in Kharkov soon after withdrawal of White Army at the end of 1919. Attendance of the Circle meetings was obligatory for all professors. On the very first meeting Schukarev made serious scientific report and at the end "he scratched forehead and said: oh yes, I forgot that the goal of our Kruzhok is the study of dialectic materialism. Well, what may I said about the learning of dialectic materialism? One can do everything, it doesn′t matter, for example you may collect the white mice". Professor calmly went out but scandal erupted was hardly extinguished. Memoirist also provides interesting information about Alexander Schukarev logic machine:

> "Especially famous was A. N. with his logic machine. In fact, it was machine of English logic Jevons and he only attached the large screen to it. All machine operations immediately displayed on the screen. On this screen, he demonstrated the specific examples of abstract character combinations. In whole, A. N. was wonderful constructor. For example, according to the opinion of specialists, the "calorimetric bomb" constructed by him was much better than that of famous French chemist Berthelot. Even before the

> revolution well-known journalist Alexander Yablonsky described in jocular form the misadventures of logic machine. Once during it demonstration one of the spectators (young girl student) was indignant – "this machine as any other machine is the instrument of people exploitation". Next time on the question: "do we have Constitution" machine answered: "not we, not have, not Constitution". Finally, police superintendent stopped the political dispute. These misadventures continued in Soviet period but now not as a joke. One time a year A. N. dressed in frock-coat visited "House of Scientists" (Club of scientists) and demonstrated operation of his logic machine. He illustrated its work by such very "suitable" for Bolshevik examples as "the evidence of God existence". Needless to say, how violently the Marxists presented on the lecture attacked A. N. and his machine. However, these attacks did not produce any effect on A. N. He only laughed merrily and good-naturedly as a child" [11].

One more episode described by memoirist shows how much logic machine impressed spectators. Once after the usual antireligious lecture the propagandist who just "had proved the nonexistence of God" suggested the listeners to say their opinion. "To his surprise one of elderly University janitors stood up and began to speak. "You say – started this janitor – that God does not exist". Lecturer compassionately nodded. "But machine of professor Schukarev, – continued janitor, – had proved clearly that God exists". Surprised lecturer did not find what to answer (all Bolsheviks deeply believed in power of technology). Lecturer had just considered and disproved all known proofs of God′s existence but overlooked the "machine proof". Probably, Alexander Schukarev himself would be surprised by such effect of his demonstrations!

The range of Schukarev scientific interests was always very wide. It was mentioned above that he did not limit himself by investigations in the field of special problems of physical chemistry. Beside the theory of cognition, he examined the problems of social life, human talent etc. He always sought the possibility to use mathematical methods in his researches. For example, he derived some empirical relations and then gathered statistical data with the help of volunteers. Professor Filippov recalled that "his *a priori* graphical curve was generally confirmed on practice".

Alexander Schukarev wrote: "regarding the politics, I never before the revolution nor after it wanted to participate in this kind of activity because I early admitted the thesis – "where the struggle begins there the creative work ends". I mainly was interested in the latter". To the end of 1920′s such accentuated political indifference was interpreted as especially hostile to the Soviet power. Punishment must be expected earlier or later. Moreover, the scientist who "did not notice … Soviet reality" obviously gave reasons for repressions.

When in 1929 Bolsheviks decided to establish Ukraine Academy of Science they really did this with great pompousness. Meetings and sessions were organized, articles in newspapers were published, pompous speeches were delivered etc. Professor Schukarev was also invited at one of such ceremonial meetings. He came and said that it was no need absolutely to establish Ukraine Academy of Science

because there were no worthy candidates to the members of this Academy. After the speech, he gathered his papers and went out not hear abuses to his address [11].

Immediately after this statement, the communist press began campaign of harassment. Newspapers wrote that though Schukarev was eminent scientist it is impossible to elect him to the members of Academy. Professor replied by sending the letter to the newspaper "Kharkov Proletarian" (of course it was not published). With old-fashioned courtesy ("Dear editor! Please do not refuse to take in consideration…") he fully agreed with the opinion not to be elected to the Academy. Firstly, there was no need in this Academy at all. Secondly, if there is a need to elect somebody, he must be devoted Marxist obligatorily, – "than we might finally find out what Marxism is."

All in all, "cup of patience" was overfilled. In the middle of 1920′s the "Explorating Chair of European Culture History" was founded in Kharkov. Its members were mainly non-Marxists humanitarians who were prohibited to teach at the universities. Alexander Schukarev was a member of this Chair as well. In 1929 Chair issued the volume of Works which very angered the Bolshevik ideologists. The newspaper "Communist" wrote: "Hostile elements oppose their own culture to the growth of socialist culture … Spongers got rich on the Soviet bread begin propagate bourgeois ideology and philosophy to the youth". Accusations were dreadful – denial of Party character of science, "clear idealism, clericalism, … reactionary, double-faced philosophy" etc. Schukarev article under the defiant to that period of time title "Alchemist-gnostic philosophy of play cards" caused especially violent attacks. Schukarev and his colleagues were named "the open agents of bourgeois philosophy, who … spit on our reality". Communists demanded to summon the Worker-Peasant Inspection and CheKa ("punishing sword of Revolution") for the struggle with "the demonstration of ideology which is alien to the proletariat". In result, the Chair was closed in 1930.

At first Schukarev did not suffer but situation around him became more and more threatening. Just that time the forty-year jubilee of Shukarev′s scientific activity was approaching. A. Filippov recalls:

> "Surely, I began thinking how to organize the celebration. Main specialty of A. N. was chemistry. That is why I decided to ask physicochemical society to arrange this celebration. The secretary of the society professor Mukhin agreed enthusiastically. After that, I several times met Mukhin but he did nothing. When I directly asked him – why? – the answer was – "I am afraid that A. N. could say something politically dangerous". <…> Finally, the celebration of A. N. science activity was not arranged at all" [11].

In result, Schukarev was forced to retire in 1931, but as far as we know he stopped the public demonstrations of his logical machine several years before. Soviet historians did not connect these two events. They did not even explain the reasons of Schukarev retirement. They also wrote that the only reason for canceling logical machine demonstrations was the sharply rejection of the idea of thinking mechanization by orthodox Marxist philosophers. They considered the logical machine as "fruitless and absurd venture" [5]. However, this point of view seems too simple. It is also doubtful that the single publication of his violent critic Ivan Orlov (by the way, the only one we know by name) could impress Schukarev so strong. We

think that the reason not in this. Not only Schukarev′s scientific and philosophical views but he as an individual was not acceptable for the Soviet power. The ideological campaign against him described above is evidently proved it.

Many of his colleagues were arrested or dismissed. But Schukarev was permitted to consult several research institutions. In particular, he cooperated with the Institute of Experimental Medicine studying living cell thermodynamics. He also continued to work on the large paper in the field of logic and philosophy entitled "Experience of substantiation of structural realism system". In 1934 scientist sent his manuscript to Moscow to the Lenin Library and to Leningrad to the Academy of Science Library. Shukarev was in poor health in last years and died in spring 1938. A. Filippov recalls:

> "Funeral was ceremonial. His colleagues and pupils pronounced heartfelt speeches. The only communist who delivered a speech was director of Institute of Experimental Medicine <…>. However, even he did not say anything about the "Party and Government" and "building the socialism in our country". All orators remembered Schukarev as a wonderful man and scientist" [11].

After the Schukarev′s death his logical machine was forgotten as well as the Khrushchev′s one. They were remembered in the USSR only at the beginning of 1960′s. It was time of common enthusiasm by cybernetic ideas and active discussion of the problem – "Could machine think?" In 1963 academician Axel Berg who was the chairman of the Council on cybernetics saw by chance the half-century old advertisement about the demonstration of "thinking machine" in Polytechnic Museum. Berg was very interested and asked the staff of Polytechnic Museum to give him more detailed information.

23 March 1964 well-known Soviet historian of technology A. Yarotsky sent a letter to Axel Berg with the results of his search. Photocopy of the chapter about the logic machine from Schukarev book and English article about Jevons machine were attached to the letter. Yarotsky wrote: "Instinct did not deceive you – the problem is really interesting. I will be glad to continue my search and present you more information". At the same time, he hinted at ideological ambiguity of Schukarev person. ("Philosophical aspect of the problem is of acute interest", – Yarotsky wrote to Berg whom he notified that "Jevons was founder of so-called school of vulgar political economy" criticized by Marx [12]). Probably, particular for the reason of political ambiguity it took more than seven years when the first publication [4] about Khrushchev and Schukarev machines got published. For example, these machines just were not mentioned in detailed article "Logic machines" containing the historical review of logical machines from Lull till Marquand [13]. In general, the works [4-6] in fact are the only ones which describe the logical machines constructed by Khrushchev and Schukarev.

Only in last years several papers were published where an attempt was made to evaluate newly the life and works of Alexander Schukarev [14-17]. Today, A. N. Schukarev and P. D. Khrushchev finally gained deserved recognition and got the worthy place in the pantheon of Russian science. Schukarev memorial plaque was erected on the wall of Kharkov Polytechnic Institute on 21 October 2011 since of 75 years of his death (Fig. 4).

Fig. 4. Schukarev memorial plaque (Source: [16, p. 186])

6 Conclusion

Authors of this paper hope that it is clear now why the logical ("reasoning") machine of Alexander Schukarev was so rarely mentioned in Soviet scientific literature. Never in conditions of totalitarian political regimes talented but dissent persons can create and live in full mere. Creative scientific work and life of professor Alexander Nikolaevich Schukarev was uneasy beginning from 1917. He could not did what he wanted to do in the field of philosophy and logic. But he never agreed to make ideological compromises and keep a virtue of the real Scientist and Man.

References

1. Letters & Journal of W. Stanley Jevons. Edited by his wife. Macmillan and Co, London (1886)
2. Baldwin, James Mark: Logical Machine. In: Dictionary of Philosophy and Psychology. Vol. II, pp. 28-30. MacMillan and Co, New-York (1902)
3. Gardner, M.: Logic Machines and Diagrams. McGraw Hill Book Co, New-York, Toronto, London (1958)
4. Veligzhanin, V. A., Povarov, G. N.: K istorii sozdaniya logicheskikh mashin v Rossii (К истории создания логических машин в России). Voprosy filosofii, 3, pp. 156-158 (1971)

5. Povarov, G. N., Petrov, A. E.: Russkie logicheskie mashiny (Русские логические машины). In: Kibernetika i logika, pp. 137-152. Nauka, Moskva (1978)
6. Povarov, G. N.: The First Russian Logic Machines. In: Computing in Russia. The History of Computer Devices and Information Technology revealed. G. Trogemann, A. Y. Nitussov, W. Ernst (Eds.), pp. 51-62. VIEWEG, Wiesbaden (2001)
7. Schukarev, A. N.: Problemy teorii poznaniya: v ikh prilozhenii k voprosam estestvoznaniya i v razrabotke ego metodami (Проблемы теории познания: в их приложении к вопросам естествознания и в разработке его методами). Mathesis, Odessa (1913)
8. Schukarev, A. N.: Mekhanizatsiya myshleniya: Logicheskaya mashina Dzhivonsa. (Механизация мышления: Логическая машина Дживонса). Vestnik znaniya, 12, pp. 825-830 (1925)
9. Sokov, A. N.: Myslitel′naya mashina (Мыслительная машина). Vokrug sveta, 18, p. 287 (1914).
10. Orlov, I. E.: O ratsionalizatsii umstvennogo truda (О рационализации умственного труда). Pod znamenem marksizma, 12, pp. 72-93 (1926)
11. Filippov, A.: Dva sovetskikh professora: Dva portreta. I. A. N. Schukarev (Два советских профессора: Два портрета. И. А. Н. Щукарев). Vozrozhdenie, 7, pp. 101-104 (1950)
12. Fet, Ya. I.: Kibernetika v Politekhnicheskom muzee (Кибернетика в Политехническом музее). In: Rasskazy o kibernetike, pp. 154-159. Novosibirsk (2007)
13. Biryukov, B. V., Shestakov, V. I., Kaluzhnin, L. A.: Logicheskie mashiny (Логические машины). In: Filosofskaya entciklopediya. T. 3, pp. 232-234. Sovetskaya entsiklopediya, Moskva (1964)
14. Shilov, V. V.: Logicheskie mashiny P. D. Khruscheva i A. N. Schukareva (Логические машины П. Д. Хрущова и А. Н. Щукарёва). Kibertoniya, 1, pp. 17-27 (2012)
15. Shilov, V. V.: K istorii russkikh logicheskikh mashin (К истории русских логических машин). Informatsionnye tekhnologii (Prilozhenie), 8, pp. 20-21 (2012)
16. Shilov, V. V.: Istoriya logicheskikh mashin (История логических машин). LIBROKOM, Moskva (2014)
17. Koshkin, V. M., Dulfan, A. Ya.: Professor Aleksandr Nikolaevich Schukarev. Trudno byt′ geniem. Fakt, Kharkov (2011)