

# EXPERIMENTAL MACHINE TRANSLATION

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This paper falls into two parts :

PART I: The presentation of examples demonstrating the validity of the cyclic procedure of output improvement,

PART II : The presentation of an example of linguistic formulations based on output investigation and aimed at output improvement.

All of the research leading to the present paper is based on the author's nine months of work at the EURATOM Research Center in Ispra, Italy (November 1963-July 1964)

## PART I: INTRODUCTION

Fifteen years ago the words "machine translation" would have been "grammatically correct", but as nonsensical as anything that is not within the sphere of human perception. Ten years ago, they would have already referred to an actual occurrence (highly advertised at the time), but would have to be meant largely in terms of the future. Today, they refer to a complex past, to a definite present, and to a promising future.

Those who have had an interest in MT the past several years have the historical facts well in their minds ; and those who at this time may be developing an interest in the field may find them in numerous publications put out by research centers which have been mushrooming all over this country as well as abroad in the past few years.

One of the procedures followed by MT researchers has been that of gradual, "cyclic" improvement, based on repeated attempts at formulating the linguistic data in the most rigorous way possible, and on testing them in repeated machine translation runs.

One of the early, and consistent, advocates of this procedure was Dr. Léon Dostert. (See "The Georgetown-I.B.M. Experiment", Locke, W. N. and A. D. Booth, *Eds.*, *Machine Translation of Languages* (M.I.T. and Wiley, 1955), pp. 124-135, "Machine

Translation and Information Retrieval", *Vistas in Information Handling* (Spartan Books, Washington, 1963), Chapter 5, and *General Report* (Georgetown University Machine Translation Research Project, Washington, 1963), Preface).

Some of the results of many years spent by numerous researchers in the application of this procedure are presented here on the basis of examples coming from cyclic translation runs.

Three outputs have been examined from the point of view of this study: those of October, 1963, February, 1964 and June 1964. The examples quoted are consequently marked as "Oct. 63", "Feb. 64" and "June 64".

In general, the linguistic formulations resulting in the improved versions are not discussed. In some cases, some of the linguistic formulations are quoted.

Naturally, the outputs quoted above, as any previous ones, have been studied in detail by the investigators whose linguistic and programming formulations led to them. But as an innovation in evaluation a procedure was launched in December 1963 which was aimed at obtaining the comments of the users of the translations. A questionnaire was devised to facilitate for the scientists the task of output evaluation. The results obtained by the distribution of this questionnaire, and their analysis by one of the members of the EURATOM staff are presented in APPENDIX II<sup>1</sup>.

The examples which are given below are actual representations of machine-produced output. No pre-editing or post-editing was involved in the process. The examples come from texts in physics, chemistry, mathematics, and cybernetics. All the translations were made with the SLC Programming System developed by Dr. A. F. R. Brown. They were made on the 7090 computer at the EURATOM Research Center in Ispira, Italy.

The examples quoted below represent different areas of linguistic research. Consequently, they are marked according to the sub-divisions.

### 1) *Article Handling*

Experiments with scientific texts from which the articles were eliminated, and which were distributed to native speakers of English specializing in the given scientific disciplines, showed that the elimination of articles did not hinder the readability of the texts. Subsequently the indefinite article was suppressed in the outputs. The definite article was maintained mainly for the purpose of the delimitation of syntagmatic constructions.

The suppression of the indefinite article resulted in numerous improvements. Due to the limitations of space only a few examples are quoted.

<sup>1</sup> It should be mentioned that mechanical translations have been made over the past three years at the request of scientists in the EURATOM Research Center. The average rate has been one article a week.

a) *The indefinite article*

. . . . ISSLEDOVANI4 3NERGETICESKO1 ZAVISIMOSTI SECENI4 ZAXVATA  
NEITRONOV . . .

Oct. 63 ... the investigations of *an* energy relation of cross-sections of *a* capture of neutrons ...

Feb. 64 ... the investigations of energy relation of cross-sections of capture of neutrons ...

ZNANIE XIMICESKIX SVO1STV INDIVIDUAL6NYX SVOBODNYX RADIKALOV  
CREZVYCA1NO VAJNO . . .

Oct. 63 *A* knowledge of chemical properties of individual free radicals is extremely important ...

Feb. 64 Knowledge of chemical properties of individual free radicals is extremely important ...

OB5A4 TEORI4, KOTORA4 RAZVIVAETS4 V GLAVE 5\$, VKLHCAET V  
SEB4 V PERERABOTANNOM VIDE OSNOVNIIE REZUL6TATY RABOT . . .

Oct. 63 *A* general theory, which develops in *a* chapter 5, includes in *a* processed form the main results of works ...

Feb. 64 General theory, which is developed in chapter 5, includes in processed form the main results of works ...

ALGORITM PEREVODA S FRANQUZSKOGO 4ZYKA NA RUSSKII,

Oct. 63 The algorithm of *a* translation from *a* French tongue on Russian,

Feb. 64 The algorithm of translation from French language on Russian,

b) *The definite article*

The insertion of the definite article has been somewhat improved in the February run and more substantially so in the June run.

TRUDY VTORO1 MEJDUNARODNO1 KONFERENQII ...

Oct.63 Labors second an international conference ...

Feb. 64 *The* labors of *the* second international conference ...

... ZNACENI4 A\$ U PERVYX V P4T6 RAZ MEN6WE, CEM U VTORYX.

Oct. 63 ... values *A* at first in five times less, than at second.

Feb. 64 ... values (algebraic formula) *at the* first in five times less, than at *the* second.

PRI INIQIROVANNOM RASPADE PROPRIONATA RTUTI . . .

Feb. 64 Upon initiated the decay of propionate of mercury ...

June 64 Upon the initiated decomposition of *the* propionate of mercury ...

ANALOGICNO I PRI REAKQII S SERO1 FENIL-RADIKALY PEREXODILI  
NA SERU,

Feb. 64 Analogously and also upon reaction with gray phenyl-radicals went over on sulphur,

June 64 Analogously and upon reaction with gray *the* phenyl-radicals went over on sulphur,

## 2) *The Genitive Case*

Frequently, the genitive case was either not recognized or incorrectly interpreted (as for example plural, see example 4).

3TO VLI4NIE SKAZYVAETS4 NA UVELICENII 3LEKTRONNOI PLOTNOSTI

...

Oct. 63 This influence affects an increase the electronic density ...

Feb. 64 This influence affects increase *of* electronic density ...

, V SLUCAE TAKO1 OWIBKI ...

Feb. 64 , in a case such an errors ...

June 64 , in the case *of* such an error ...

IZUCENIE FOTOREAKQII DIFENILRTUTI . . .

Feb. 64 The study of the photoreactions diphenylmercuries ...

June 64 The study *of* the photoreactions *of* diphenylmercury ...

... LIW6 ODIN PRIMER TAKO1 REAKQII ...

Oct. 63 ... only one example such reactions ...

Feb. 64 ... only one example *of* such a reaction ...

IZ-ZA SVOE1 OTNOSITEL6NO BOL6WE1 STABIL6NOSTI ...

Feb. 64 Because of its/their relatively greater *to* stability ...

June 64 Because of its/their relatively greater stability ...

## 3) *The Dative Case*

Earlier outputs showed either the lack of the recognition of the forms in the dative case, and consequently no insertions, or wrong insertions.

... I PODOBNYX EMU RADIKALOV ...

Oct. 63 ... and similar it radicals

Feb. 64 ... and similar *to* it radicals ...

. . . IPOUROVN4MSEREBRA.

Oct. 63 ... and according to *to* the levels of silver.

Feb. 64 ... and according to the levels of silver.

OTNOSITEL6NO REAKQI1 RAZLOJENI4 ...

Oct. 63 The relatively reactions of decomposition ...

Feb. 64 Relatively *to* the reactions of decomposition ...

#### 4) *The Instrumental Case*

Earlier outputs showed indiscriminate insertion of 'by' whenever a word or a string of words in the instrumental case occurred in Russian.

, SOVPADAET S REZUL6TATAMI RABOT ...

Oct. 63 , coincides with *by* the results of works ...

Feb. 64 , coincides with the results of works ...

3TO POSLUJILO OSNOVANIEM ...

Oct. 63 This served *by* a basis ...

Feb. 64 This served *as* a basis ...

... 3NERGI4 SV4ZI MEJDU VODORODOM I UGLERODOM ...

Oct. 63 ... the energy of bond between *by* hydrogen and *by* carbon ...

Feb. 64 ... the energy of the bond between hydrogen and carbon...

... OBLADAHT RAZNO1 3NERGIE1 ...

Oct. 63 ... possess different *by* energy ...

Feb. 64 ... possess different energy ...

#### 5) *Reflexive Verbs*

Considerable improvement was achieved in the translation of reflexive verbs which were usually translated before as the corresponding non-reflexive verbs. The most recent translations made in Oak Ridge, Tenn. in August 1964 showed the general character of this improvement, since reflexive verbs were correctly transferred also in these random translation runs. (See APPENDIX III).

3TA RAZNIQA VVODILAS6 KAK POPRAVKA V NORMIROVKE ...

Oct. 63 This difference *introduced* as correction to a normalization.

Feb. 64 This difference *was introduced* as correction to normalization. ...

, NE DISPROPORTIONIZUETS4 I NE DIMERIZUETS4 ...

Oct. 63 , does not disproportionate and does not it *dimerize*.

Feb. 64 , *is not disproportionated* and *is not dimerized*.

V 3TOM PARAGRAFE IZLAGAHTS4 REZUL6TATY,

Oct. 63 In this paragraph there *present* results,

Feb. 64 In this paragraph there *are presented* results,

... MATERIAL VVODITS4 V MAWINU NA PERFOKARTAX,

Oct. 63 ... material it *introduces* into a machine on punched cards,

Feb. 64 ... material *is introduced* into machine on punched cards,

### 6) Impersonal Structures

Definite progress is evident particularly in a) the treatment of structures with such predicate words as MOJNO, NEOBXODIMO, VOZMOJNO, IZVESTNO, and other "O-forms" (short neuter predicates), and b) structures following ESLI.

It was decided with regard to a) that the insertion of 'it is' will suit most transfer situations for the present time, although some of the translations may be awkward. However, only rearrangement routines are necessary to obtain correct output sequences. For this reason it was considered preferable to have all the "building blocks" in correct form even if the ordering is not correct as yet, rather than to write rules which would be applicable only to very specific situations, and would be rather complicated. Thus, example a) 2 could be translated as 'The same can be observed...', but since the future general arrangement routine is going to call for any predicate to be followed by its object, it is preferable to maintain the present translation.

a)

TEOREMU 6.2 MOJNO RASSMATRIVAT6 KAK NEKOTOROE OBOBSEENIE

TEOREMY 2.1 . . .

Oct. 63 The theorem 6.2 is possible to consider as a certain generalization of the theorem 2.1...

Feb. 64 The theorem 6.2 *it is* possible to consider as certain generalization of theorem 2.1...

3TO JE MOJNO NABLHDAT6 . . .

Oct. 63 This however is possible to observe ...

Feb. 64 The same *it is* possible to observe ...

PRINIMA4 VO VNIMANIE 3TO POLOJENIE, NEOBXODIMO DOPUSTIT6 ...

Oct. 63 Assuming into attention this position, necessary to permit ...

Feb. 64 Assuming into attention this position *is* necessary to permit ...

... NEOBXODIMO ZNAT6 SECENI4 ...

Feb. 64 ... necessary to know the cross-sections ...

June 64 ... *it is* necessary to know the cross-sections ...

V DAL6NEIWEM VOZMOJNO DISPROPORQIONIROVANIE ...

Feb. 64 Into subsequently possible disproportionation ...

June 64 Subsequently *is* possible disproportionation ...

KAK IZVESTNO IZ LITERATURNYX DANNYX,

Feb. 64 As known from the literature given,

June 64 As *is* known from the literature data,

, KOTORUH LEGKO PODSCITAT6,

Feb. 64 , which easily to calculate,

June 64 , which *it is* easy to calculate,

... INTERESNO IZMERIT6 ...

Feb. 64 ... interesting to measure ...

June 64 ... *it is* interesting to measure ...

IZ RIS 4. VIDNO, CTO ...

Feb. 64 From Fig. 4. apparent, that ...

June 64 From Fig. 4. it is apparent, that ...

b)

ESLI DOBAVL4T6 K REAKQIONNOI MASSE ...

Oct. 63 If it is added to the reaction mass ...

Feb. 64 If *one adds* to the reaction mass ...

, ESLIPONIMAT6 STROGUH MARKOVOST6 V BOLEE JESTKOM SMYSLE

RABOTY ...

Oct. 63 , if it is understood strict MARKOVOST6 in the more stiff sense of work ...

Feb. 64 , if *one understands* strict MARKOVOST6 in the more stiff sense of work ...

### 7) Copula Insertion

This improvement is particularly noticeable in connection with predicates in the short neuter form (sometimes referred to as "O-forms"), and other short form predicates.

, TO ZNANIE IX SV01STV I REAKQII OSOBENNO VAJNO .

Oct. 63 , this knowledge of their properties and also reactions especially important.

Feb. 64 , this knowledge of their properties and also reactions *is* especially important.

... I OQENENY IX PARAMETRY.

Feb. 64 ... and evaluated their parameters.

June 64 ... and *were* evaluated their parameters.

AVTORY PRIZNATEL6NY ...

Feb. 64 The authors grateful ...

June 64 The authors *are* grateful ...

, KOTOROE NE POME5ENO V SLOVAR ...

Oct. 63 , which not placed into a dictionary ...

Feb. 64 , which *was* not placed into dictionary ...

POSLE TOGO KAK VSE SLOVA PRAZY OBRABOTANY OPISANNOM SPOSOBOM,

Oct. 63 After this as all of the words of the phrase treated with described method,

Feb. 64 After this as all of the words of the phrase *were* treated with described method,

OSOBEENNO OPASNY V 3TOM OTNOWENII KOROTKIE OSNOVY ...

Oct. 63 Especially dangerous in this relation short bases ...

Feb. 64 *Are* especially dangerous in this relation short bases ...

### 8) *The Lexical Area*

Improvements in this area fall into two groups : a) filling in lexical gaps, i.e. words which were not in the dictionary and consequently were not translated but just printed out the way they are in Russian, and b) semantic substitutions aiming at a more accurate or generally applicable equivalent.

a)

VSLEDSTVIE 3TOGO ...

Feb. 64 VSLEDSTVIE this ...

June 64 *As a result* of this ...

VO VSEX BEZ ISKLHCENI4 ...

Feb. 64 In VSEX without exception ...

June 64 In *all* without exception ...

b)

NE VSE REAKQII, IMEHSIE MESTO S DRUGIMI ALKIL6NYMI RADIKALAMI,

Feb. 64 Not all of the reactions, which *have place* with other alkyl radicals,

June 64 Not all of the reactions, which *occur* with other alkyl radicals,

3TOT RADIKAL XOROWO IZUCEN ...

Feb. 64 This radical was *readily* studied ...

June 64 This radical was *well* studied ...

### 9) *Prepositions*

Various changes were made in the translation of prepositions based on the study of their contextual distribution.

V TO JE VREM4 ...

Oct. 63 *In* the same time ...

Feb. 64 *At* the same time ...



... V 1959 G.

Oct. 63 ... *into* 1959 G.

Feb. 64 ... *in* 1959.

POSTUPILA V REDAKQIH . . .

Feb. 64 Was received *into* editorial office ...

June 64 Was received *in* editorial office ...

, I POME5AHTS4 V SPECIAL6NO OTVEDENNOE MESTO PAM4TI.

Oct. 63 , and are placed *in* special the assigned place of memory.

Feb. 64 , and are placed *into* the specially assigned place of memory.

IZ-ZA MALOGO TEPLOVOGO SECENI4 ...

Oct. 63 *From-for* a small thermal cross-section ...

Feb. 64 *Because of* small thermal cross-section ...

### 10) Homographs

The following example shows partial improvement: the formulations worked for one context in which the homographie form was found, and did not work for the other.

. . . NAWI DANNYE XOROWO SOGLASOVALIS6 S DANNIMI RABOT ...

Oct. 63 ... our *given* good conformed from *given* works ...

Feb. 64 ... our *given* readily conformed with the *data* of works ...

### 11) Syntagmatic Strings

Strings of words which are in morphosyntactic agreement were in some cases not recognized as such, and consequently erroneously translated, especially with regard to prepositions and articles preceding them.

, PRINADLEJASIE DRUGIM IZOTOPAM.

Oct. 63, which belong *the other to isotopes*.

Feb. 64 , which belong *to the other isotopes*.

... SOOTVETSTVUET PROQENTNYM SODERJANI4M ...

Oct. 63 corresponds *the percentage to contents* ...

Feb. 64 correspond *to the percentage contents* ...

, NAXOD45IES4 V ORTO-POLOJENII K TREXVALENTNOMU ATOMU UGLERODA.

Oct. 63 , which are found in an ortho-position *K a trivalent to atom* of carbon.

Feb. 64 , which are found in ortho-position *to trivalent atom* of carbon.

- , SOOTVETSTVUH5EM ALFAVITNOMU POR4DKU SLOV,  
 Oct. 63 , corresponding *the alphabetic to order* of words,  
 Feb. 64 , corresponding *to the alphabetic order* of words,  
 OBRAZOVANIE OTNOSITEL6NO NEBOL6WIX KOLICESTV RTUTI ...  
 Feb. 64 Formation *relatively to small amounts* of mercury ...  
 June 64 The formation *of relatively small quantities* of mercury ...  
 , OBRAZUH5EGOS4 PRI TERMICESKOM RASPADE PEREKISI ...  
 Feb. 64 , formed upon *thermal the decay* of peroxide ...  
 June 64 , formed upon *the thermal decomposition* of peroxide ...

### 12) *The Subject Routine*

The most noticeable improvement is the elimination of 'it' and 'they' which used to be inserted if the subject was not recognized. This improvement was achieved fully in the February runs and there are no such errors in the June translations.

... NESKOL6KO POSLEDNIX STROK MOGUT BYT6 PUSTYMI.

Oct. 63 ... somewhat of the last lines *they* can be empty.

Feb. 64 ... several last lines can be empty.

... I POKAZAT6, CTO 3TOT 3FEKT OTSUTSTVUET ...

Oct. 63 ... and to show, that this effect *it* is absent ...

Feb. 64 ... and to show, that this affect is absent ...

CA5E VSEGO OWIBKI SV4ZANI S ABSOLHTNO1 NORMIROVKO1 ...

Oct. 63 Mostly in all errors *they* are connected with the absolute normalization ...

Feb. 64 Mostly in all errors are connected with the absolute normalization ...

V R4DU SOEDINENII, SODERJA5IX GALOID CETYREXLORISTY1 UGLEROD ZANIMAET OSOBOE MESTO,

Oct. 63 In the series of compounds, which contain a haloid, tetrachloride carbon *it* occupies a special place ,

Feb. 64 In series of compounds, which contain haloid, carbon tetrachloride occupies special place,

### 13) *Sentences with the Subject Following the Predicate*

The problem here is the insertion or non-insertion of 'there'. Some progress has been achieved in this area, especially in the June runs.

V KAJDO1 STROKE ZAPISYVAHTS4 7 BUKV,

Feb. 64 In each line *there* are recorded 7 letters,

June 64 In each line are recorded 7 letters,

, PROVER4HT, NAXODIT6S4 LI V NE1 PERVOE SLOVO,

Feb. 64 ,test, whether is in it the first word,

June 64 ,test, whether *there* is in it the first word,

3TOT RADIKAL XOROWO IZUCEN, I, KAK POKAZANO V LITERATURE,  
RASPADAETS4 NA AQETON ...

Feb. 64 This radical was readily studied , and, as was showed in the literature, *there*  
decomposes on acetone ...

June 64 This radical was well studied, and , as was showed in the literature, decom-  
poses on acetone ...

... U NIX EST6 RASXOJDIE ...

Feb. 64 at them is derivation ...

June 64 at them *there* is derivation ...

#### 14) *The LI Routine*

An example is given here of linguistic formulations which resulted in output im-  
provement.

First, some examples of incorrect transfer are quoted from earlier outputs. The  
errors were due to the indiscriminate translation of LI as 'whether'.

Next, some of the formulations are quoted.

Finally, examples of improved output are given.

The formulations referred to have been published as *The Transfer of Russian LI into  
English* by Bozena Henisz, Georgetown University Machine Translation Research  
Project, Paper No. 32, June 1963.

OZNACAET LI 3TO, CTO MAWINA MYSLIT?

Signifies whether this, that a machine thinks?

NE MOGUT LI MAWINY OBLEGCIT6 ... ?

Cannot whether automatic devices facilitate ...?

Formulations

B. *LI : Direct Question Particle*

1. Transfer i as zero.

2. Mark the sentence for interrogative rearrangements and  
insertions.

Signifies this, that a machine thinks?

Cannot automatic devices facilitate ...?

ODIN CELOVEK VR4D LI MOG BY UPRAVL4T DVIJENIEM ...

One man it is doubtful whether whether could manage by the movement. ...

	Y	N	A
1. Transfer i as zero.	—	—	2
2. Mark the sentence for interrogative rearrangements and insertions.	—	—	99

## Formulations

C. *LI: Emphatic Particle*

	Y	N	A
1. Is i-1 VR4D or EDVA?	2	D	—
2. Transfer i as zero.	—	—	99

One man hardly could control the movement ...

BUDUT LI 3TO KVADRATICNYE FORMY, VODA, JURAVLI ILI ...  
will be whether this quadratic forms, water, cranes or ...

## Formulations

D. *LI: Conjunction for Indirect Questions*

	Y	N	A
1. Is there a word LI i + n?	2	6	—
2. Does i + n begin with a capital letter?	6	3	—
3. Is there a comma i + m between i and i + n?	4	Ø	—
4. Transfer i + n as 'or whether'.	—	—	5
5. Place 'or whether' immediately after i + m.	—	—	6
6. Transfer i as 'whether'.			
7. Is there a comma or a conjunction, or such a clause introducer as T.E. ('that is') i - n?	8	9	—
8. Place 'whether' immediately after the comma, conjunction, or T.E.. If a conjunction or T.E. follows the comma, place 'whether' after the conjunction or T.E. .	—	—	9
9. Place 'whether' as the first word in the sentence.			99

The desirable translation of the example preceding these formulations has not been obtained due to the partial rerun of the text. It is :  
whether this will be quadratic forms, water, cranes or. ...

The above examples are from the translation of a book on cybernetics : MAWINA I MYSL6 by Z. Rovenski, A. Uemov, E. Uemov. The following examples are from the translations made in Ispra which were mentioned above.

PRI IZUCENII POVEDENI4 3TOGO RADIKALA NAS INTERESOVAL  
VOPROS, BUDET LI IMET MESTO REAKQI4. . .

Oct. 63 Whether upon the study of behavior of this radical us interested a question,  
is take the reaction ...

Feb. 64 Upon the study of this radical us interested the question, *whether* will occur  
the reaction ...

PO OKONCANII POISKA PERVOGO SLOVA PROVERAHT, NE SODERJITS4  
3TO SLOVO . . .

Oct. 63 Whether according to the completion of the search of the first word test, is not  
contained this word ...

Feb. 64 According to the completion of the search of the first word test, *whether* is not  
contained this word ...

PROVERAHT, 4VL4ETS4 LI OBOROT QELYM ...

Oct. 63 Whether they test, is the revolution whole.

Feb. 64 Test, whether is the revolution whole.

### 15) Multiple Negatives

The presentation here is very much the same as for the LI routine.

The errors in the former outputs were due to the fact that whenever the Russian text contained more than one negative word, all of them were translated as negative, while English (at least standard English) tolerates only single negatives for the negative value. Double negatives result in a positive in modern Standard English.

Russian negative forms were grouped into Class I negatives and Class II negatives.

Class I negatives are always logically negative :

NE : 'not'  
 NET : 'there is not'  
 NEL6Z4 : 'it is not possible'

Class II negatives are either logically negative or insignificant with respect to logical negation. Class II negatives were supplied with two translations. Some Class II negatives are:

	First Translation	Second Translation
NIKTO	no one	anyone
NICTO	nothing	anything
NIKOGDA	never	ever
NIGDE	nowhere	anywhere
NIKAKO1	no	any

The first five examples that follow of incorrect and improved translation are from the book on cybernetics mentioned above (MAWINA I MYSL6).

ON NIKOGDA NE DUMAL ...

It *never did not* think ...

It *never* thought ...

... IX NIKTO NE NAZOVET AVTOMATICESKIMI.

... them *anybody does not* call automatic.

... them *nobody* calls automatic.

... NE IME4 OBYCNO NICEGO OB5EGO S NIM ...

... *not* having usual *nothing* general S it ...

... having usual *nothing* general with it ...

. . . XOT4 SOZNANI4 V PRIRODE NET . . .  
 ... although consciousness in nature *not* ...  
 ... although *there is no* consciousness in nature ...

NEL6Z4 LI AVTOMATIZIROVAT6 ... ?  
 Is *impossible* whether to automatize ...  
 It is *not possible* to automatize ...?

#### Formulations

It is impossible to quote all the formulations pertinent to the improvements shown by the examples because of the comprehensiveness of the formulations. The formulations were published as *The Transfer of Multiple Negatives in Russian into English* by R. Ross Macdonald with Bozena Henisz, Georgetown University Machine Translation Research Project, Paper No. 33, June 1963.

The following formulations are intended as an illustration.

#### D. Class II negatives, conjunct and disjunct

	Y	N	A
1. Is there a Class II negative i-n?	3	2	—
2. Translate i by means of the first meaning.	—	—	Z
3. Translate i by means of the second meaning.	—	—	Z
F. NE			
d.			
1. Does NE modify the predicate?	2	4	—
Is there a Class II negative in the segment?	3	5	—
2. Translate NE : Ø.	—	—	99
3. Translate NE : 'not' .	—	—	99
4. Use the existing routines for NE.	—	—	99

The following examples come from the translations runs made in Ispra.

V TERMICESKIX REAKQI4X NIKOGDA NE NABLHDALOS6 DIMERIZAQII  
 . . .

Feb. 64 In thermal reactions *never* was *not* observed the dimerization. ...

June 64 In thermal reactions *never* was observed the dimerizations. ...

, MY NICEGO NE TER4EM ...

Feb. 64 , we *nothing do not* lose ...

June 64 , we *nothing lose* ...

P03TOMU NIKAKIX POPRAVOK NE VVODILOS6.

Feb. 64 Therefore *no* corrections was *not* introduced.

June 64 Therefore *no* corrections was introduced,

, CTO NIKOGDA NE OTMECALOS6 V LITERATURE I NE NABLHDALOS6 V NAWIX OPYTAX .

Feb. 64 , that *never* was *not* noted in the literature and was not observed in our experiments.

June 64 , that *never* was noted in the literature and was not observed in our experiments,

, CTO ONI NE IZVESTNY DL4 METIL-RADIKALA.

Oct. 63 , that they *not are known* for a methyl-radical.

Feb. 64 , that they *are not known* for methyl-radical.

## PART II

The following is a presentation of linguistic formulations aimed at output improvement, which, however, have not been programmed yet, and consequently have not been tested in translation runs.

These formulations are the result of the present author's examination of translation outputs and concordances. The results of the investigation were written as a complete paper and are presented in their entirety.

### *The Transfer of Russian I into English*

The research which led to this paper was made possible by grants from The Atomic Energy Commission and from EURATOM, which are gratefully acknowledged.

#### 0. *Abstract*

This paper is concerned with the transfer of the Russian item *I* into English for machine translation purposes.

The problems connected with the existing rules are briefly discussed and are exemplified by some unacceptable translations.

A new set of transfer formulations is established.

#### 1. *Objective*

The objective of this study was the establishment of a linguistic program for a more acceptable transfer of the Russian item *I* into English. The formulations were intended for inclusion in the Russian-to-English machine translation program.

## 2. The Problem

The transfer of homographie "isolated letters", of which *I* is one, is among the most complicated problems in MT on account of the multiple structural and semantic functions of these items and the lack, on the whole, of simple environmental clues for the resolution of the ambiguities. The procedure of Lexical Choice has been used until now for the resolution of the ambiguities and for the choice of English equivalents. (See the *General Report*, Georgetown University Machine Translation Research Project, Paper No. 30; and *Lexical Choice*, Occasional Paper No. 15). It has been effective to a certain extent, but in many cases the rules were based on broad environmental criteria such as subjects and predicates, or agreement and government strings. These criteria are perfectly valid, and often the only ones that can be employed, but solutions based on them obviously assume the correct identification of what is usually most difficult to identify and thus they are open to the risk of a high percentage of failures.

The research leading to this paper flowed out of the work on clause separators undertaken as part of a new correction and improvement procedure aiming at the simplification and condensation of the existing routines. The procedure was applied to two areas : to nouns exhibiting morphological ambiguities, especially in connection with subject recognition (nouns which have the same morphological form in the genitive singular and in the nominative and accusative plural), and to clause separators. The new aspect of the procedure consisted in providing a model of correct solutions and including it in the material to be run. As a result, machine-produced sentence diagrams were obtained which showed both the correct solutions and the analysis performed by the machine on the basis of the programmed formulations. This facilitated very considerably the identification of errors and, consequently, the correction and improvement work. One of the problems connected with clause separators is the transfer of *I* and, in particular, the determination of its function as a clause separator as against its other functions. This naturally necessitated the examination of all the functions of *I*, and the research led to the formulation of the linguistic transfer rules which are presented below.

A few examples will illustrate some incorrect transfers of *I*. These examples are from the translations made with the program as it was in February 1964. The desirable translation is indicated in parentheses.

G\$A- I G\$B-NAFTIL-RADIKALY, ..., IMELI I SXODSTVO I RAZLICIE SPENIL-RADIKALOM.

*Ai* beta-naphthyl-radicals, ..., had *and* congruity and difference with phenyl-radical. ('and', 'both')

ANALOGICNO PROXODIL I OTRYV VODORODA OT XLOROPORMA.

Analogously passed *and* the breaking away of hydrogen from chloroform. ('also')



OBRAZOVANIE DIBENZILA IZ BENZIL-RADIKALOV OPISANO TAKJE I  
DLA GAZOVOI FAZY.

The formation of benzyl from benzyl-radicals was described *and also* for gaseous phase. ('also')

KROME METIL- I ETIL-RADIKALOV NAMI ISSLEDOVALIS I NEKOTORYE  
DRUGIE ALKILNYE RADIKALY,

Besides methyl- and ethyl-radicals by us there were studied *and* other alkyl radicals, ('also')

REAKCII PREDPOCTITELNOGO OTRYVA VODORODA PERED KHLOROM  
OTMECALIS NAMI NEODNOKRATNO I RANEE.

The reactions of preferable breaking away of hydrogen before chlorine were noted by us repeatedly *and* previously. ('also')

TO JE SAMOE NABLHDALOS I V NAWIX OPYTAX ...

The same was observed *and* in our experiments ... ('also')

3TO JE MOJNO NABLHDAT I PRI REAKCII ...

The same it is possible to observe *and* by the reaction ... ('also')

ANALOGICNO I PRI REAKCII S SEROJ PENIL-RADIKALY PEREXODILI  
NA SERU,

Analogously *and also* upon reaction with gray phenyl-radicals went over on sulphur, ('also')

RAZLOJENIE METIL-RADIKALA NA (FBHF) 5 ESJI I MOJET IMET  
MESTO,

The decomposition of the methyl-radical on (long formula) if *also* can occur, (zero)

DAJE I PRI KOMBINATNOJ TEMPERATURE IMEET MESTO REAKCII ...

Even *also* at room temperature occurs the reaction ... (zero)

### 3. Corpus

The material used for this study consisted of:

- a. A concordance in physics based on a text of 83,000 running words,
- b. A concordance in cybernetics based on a text of 45,000 running words,
- c. Texts in physics, chemistry, mathematics and cybernetics of approximately 14,000 running words.

### 4. Procedure

The research was focused on the establishment of rules of transfer for those occurrences of *I* which call for a translation other than 'and'. Special attention was paid

to the cases calling for the English equivalent 'also' and for zeroing *I* in translation. It was found most effective to base a few of the solutions on lists of items occurring in the environment of *I*, although it is fully realized that they may not be exhaustive. Exhaustiveness was not attempted, and in some cases even deliberately avoided, since some infrequent and untypical occurrences of *I* would have called for numerous formulations based on very broad and unspecific environmental clues.

### 5. *Structural Analysis*

Among the most frequent functions of *I* are those of :

- a. inter-clause coordinating conjunction,
- b. coordinating conjunction between single or modified items (strings) showing structural concordance,
- c. clause introducer,
- d. a non-linguistic symbol (e.g. a mathematical one),
- e. an enumerative conjunction,
- f. an "additive" particle (this term is used here to refer to some occurrences of / which call for the translation 'also'),
- g. an "emphatic" particle. (The term "emphatic" is placed in quotation marks, since a detailed analysis of the style of the writer would often be required to determine whether he uses the item *I* with the intention or emphasis of not. In any case, zero transfer is required in the cases to which the above term refers. One frequent occurrence of this type is between the subject and the predicate).

### 6. *The Linguistic Statement*

The following rules have been formulated for the transfer of *I*. They are presented in the form of a "verbalized flow chart", a description of which may be found in the *General Report*, Georgetown University Machine Translation Research Project, Paper No. 30, p. 68.

$i = I$

<i>A</i>	Y	N	A
1. Is <i>i</i> between quotation marks?	5	2	—
2. Is <i>i</i> + 1 an equals sign, or a closing parenthesis?	5	3	—
3. Is there a \$ keypunched immediately to the left of <i>i</i> as a prefix to <i>i</i> ?	4	6	—
4. Is C keypunched immediately to the left of \$?	6	5	—

	Y	N	A
5. Exclude i .	--	—	99
6. Do not exclude i .	—	—	B
<i>B</i>			
1. Is there an i + n which is also I ?	2	C	—
2. Is there an item between i and i + n which shows morpho-syntactic coordination with an item after i + n ?	3	C	—
3. Is there an item to the left of i which shows morphosyntactic coordination with an item to the right of i ?	C	4	—
4. Translate i as 'both'.	—	—	5
5. Is i + n + m also I ?	6	C	—
6. Is there an item between i and i + n which shows morpho-syntactic coordination with an item between i + n and i + n + m and with an item after i + n + m ?	7	C	—
7. Is there an item to the left of i which shows morphosyntactic coordination with an item to the right of i ?	C	8	—
8. Zero i .	—	—	99
<i>C</i>			
1. Is i - n (mostly i - 1) a subject, or an adverb, or a noun in the instrumental case?	2	4	—
2. Is there a predicate to the left of i - n or between i - n and i ?	4	3	—
3. Is there a predicate to the right of i ?	7	4	—
4. Is i - n XOT4, or TAKJE, or DAJE?	7	5	—
5. Is i-1 E5E, or UJE?	7	6	—
6. Is i - 1 BYL and is i +1 a short form adjective or participle?	7	D	—
7. Zero i .	—	—	99
<i>D</i>			
1. Is there a predicate in i - n (mostly i - 1) ?	2	4	—
2. Is there a subject to the left of the predicate (or between the predicate and i) ?	4	3	—
3. Is there a subject (a noun, or an adjective acting as a noun, or a pronoun) in i + n (n usually = 1, may ≤ 5) ?	13	4	—
4. Is i -1 an item from list 1 (see below) ?	13	5	—
5. Are i - 1 and i - 2			
V CASTNOSTI, or			
A ZATEM, or			
PRI 3TOM, or			
ESLI JE, or			
TAK JE?	13	6	—

	Y	N	A
6. Are I – 2 and i-3 A ZNACIT?	13	7	—
7. Are i – 1 and i – 2 and i – 3 V TOM CISLE ?	13	8	—
8. Is i –n SLEDOVATEL6NO, or NO, or KROME, or PRICEM?	13	9	—
9. Are i – n and i–n–1 NE TOL6KO?	13	10	—
10. Are there a subject and a predicate to the right of i ?	E	11	—
11. Is i + 1 BEZ ?	13	12	—
12. Is i–1 or i-2 PRI or DL4	13	E	—
13. Translate i as 'also'.			99

*List 1*

CTO, KAK, TO, OTSHDA, VPROCEN, DA, ODNAKO, ESLI, PO3TOMU,  
T.E., VED6, TAK.

*E*

1. Is i between two clauses?	4	2	—
2. Is there any item to the left of i showing morphosyntactic coordination with an item to the right of i within a clause ?	4	3	—
3. Is i+1 T.D. or DR. ?	4	A	
4. Translate i as 'and' .			99

*7. Conclusion*

The formulations presented above are an attempt at a more systematic procedure for the transfer of single letters with multiple structural functions and with more than one English equivalent.

Further research on single letters is much needed. The problem, in addition to being of general linguistic interest, is one of particular importance for language mechanical data processing.

## APPENDIX I: TRANSLITERATION OF RUSSIAN (CYRILLIC) CHARACTERS

Group 1	Group 2	Group 3
A A O O	B V C S	Б В Ц Q
E E T T	H N Y U	Г G Ч C
K K X X	P R	Д D Ш W
M M		Ж J Щ 5
		З Z Ъ 7
		И I Ь 6
		И 1 Ы Y
		Л L 3 3
		П P Ю H
		Ф F Я 4

## APPENDIX II: THE QUESTIONNAIRE

The following questionnaire, mentioned before, was distributed to scientists in the EURATOM Research Center in Ispra, Italy in the spring of 1964. Its purpose was to obtain an evaluation of machine translations from actual or potential users of machine translated texts.

This questionnaire was devised by Dr. Dostert.

An analysis of the results of the questionnaire was made by Mr. J. Rousseau of the group of Automatic Linguistics in the EURATOM Center. The statistical analysis given below is quoted after the one made by Mr. Rousseau.

I am grateful to Mr. J. Rousseau for making his analysis available to me.

An asterisk following the figures denoting the number of answers means that either the question was considered not clear, or the answers were hesitant or divided.

Text	Physics	Chemistry	Mathematics and Cybernetics
Number of questionnaires distributed	23	20	9
Number of questionnaires with answers received	5	9	6

QUESTIONS	ANSWERS		
	Physics	Chemistry	Mathematics and Cybernetics
1. Is your knowledge of English fluent fair	5 0	8 1	5 1
2. Do you have competence in reading Russian? yes no	2 5	2 7	0 6
3. Are the difficulties presented by the translation such as to preclude the gen- eral understanding of the article? yes no	1* 4	1* 8	2 4
4. In what degree of accuracy is the <i>in-</i> <i>formation</i> transferred? adequate sufficient inadequate	3 0 2	7 0 2*	0 2, 1* 2
5. To make the translation available, do you consider that revision is : superfluous desirable indispensable	1,1* 7 0	1,1* 1 2	2 4
6. The ameliorations that you principally wish the translation would aim at: General vocabulary Technical vocabulary Grammar Style General presentation Other	1 5 3 0 1 titles	1 9 1 1 0 titles	3 5 3 3

QUESTIONS	ANSWERS		
	Physics	Chemistry	Mathematics and Cybernetics
7. Does the reading of the translation require an excessive amount of time, bearing in mind its length? yes no If yes, is this attributable a) to the subject matter b) to the form of the translation	3 5 0 3	2,2* 2 4* both 1	4 2 2* both 2
8. Are the last pages of any of the articles more easily and rapidly read than the first? yes no To what extent?	1 3	4, 1* 4 30% 50%	2 4 substantial
9. Have you had occasion to use texts translated on this system before? yes no If yes, do you consider the quality of the translations submitted for this evaluation really higher than those you have read before? yes no	1 4 1 0	4 5 3 1	0 6 0 0
10. Could the speed of access to information compensate, in your judgement, for possible inadequacies of the mechanical translation? yes no	3,2* 0	7, 1* 1	4,2* 0

QUESTIONS	ANSWERS		
What is the maximum lapse of time in machine translation processing which you consider acceptable?	Physics	Chemistry	Mathematics and Cybernetics
	1 week — 3 persons 2 weeks — 2 persons 1 month — 3 persons		
11. Have you any suggestion or comment which could assist in evaluation of MT output?	0	0	0

### *Summation*

Question 1 : generally good

Question 2: generally no

Questions 3 ; 4, 5 — see following detailed analysis

Question 3 : usually understandable

Question 4: generally satisfactory

Question 5 : the answers differ according to the text, in the order from better to worse :  
chemistry, physics, mathematics and cybernetics.

Question 6 : technical vocabulary

Question 7 : mixed

Question 8 : mixed

Question 9 : generally no

### *Analysis of answers to questions 3, 4, 5\**

#### *Liste des réponses aux questions 3, 4, 5*

Question 3 : sens général de l'article (general meaning of the article)

Question 4: précision de l'information transmise (accuracy of the transmitted information)

Question 5 : nécessité d'une révision (need for revision)

\* This table is an exact reproduction of Mr. Rousseau's analysis.



La réponse est symbolisée par " + " si c'est la plus favorable, par " — " si c'est la plus défavorable, par "." si c'est la moyenne. " +. " vent dire intermédiaire entre meilleure et moyenne, etc. (An answer is marked " + " if it is very favorable, as " — " if it is very unfavorable, as "." if it is average. " +. " indicates intermediate between very good and average, etc.)

		QUESTIONS		
		3	4	5
ARTICLE	Chimie	+	+	.
		—	+	.
		+	+	.
		+	.	.
		+	+	+
		+	+	.
		+	+	.
		+	+	+. .
		+	.	.
Physique	.	—	—	
	+	+	+	
	+	+	. —	
	+	+. .	.	
	+	—	—	
Math. — Cyb.	+	—	—	
	—	.	—	
	+	.	—	
	+	—	—	
	+	.	.	
	—	.	.	

## APPENDIX III

This appendix contains exact reproductions of machine-translated texts. Samples of four translations are presented here.

All of the translations were made on the 7090 computer with the SLC Programming System.

First, the first four paragraphs of the article on cybernetics, from which examples were quoted in this paper, are presented. The article is : CONCERNING MACHINE TRANSLATION FROM FRENCH LANGUAGE ON RUSSIAN (this title is machine-translated) by G. V. VAKULOVSKAYA and O. S. KULAGINA.

There are five parts in this presentation:

- 1) The Russian text
- 2) The translation of October 1963
- 3) The translation of February 1964
- 4) The translation of June 1964

Second, a sample of a text in physics is presented. This text was chosen by scientists in Union Carbide Nuclear, Oak Ridge, Tenn. The translation was a random run (i.e. the text had never been seen or examined by MT researchers).

One page of this translation is presented, preceded by the Russian text.

The translation was made in Union Carbide Nuclear at Oak Ridge, Tenn. in August 1964.

### 1. *The Russian Text*

(The transliteration System is given in APPENDIX I).

```

$P 1$ *
P* ALGORITM PEREVODA S FRANQUZSKOGO 4ZYKA NA RUSSKIL ,
PRIVEDENNYI V (/ 2$/), REALIZOVAN NA MAWINE (( C$STRELA
)) PRI POMOCI 17$ PROGRAMM , OB5IL OB7EM KOTORYX OKOLO
8500$ PRIKAZOV , I OKOLO 2000$ 4CEEK ZANIMAET TABLIQY I
KONSTANTY *
$P 2$ *
P* OPIWEM POR4DOK RABOTY 3TIX PROGRAMM I KAJDUH IZ NIX *
$P 3$
P* PERVA4 PROGRAMMA - PROGRAMMA POISKA SLOV V SLOVARE *
3TA PROGRAMMA VVODIT V MAWINU OCEREDNUH FRAZU , PRICEM V
NASTO45EE VREM4 , POKA NET AVTOMATICESKOGO CTENI4 S KNIGI
I MATERIAL VVODITS4 V MAWINU NA PERFOKARTAX ,
PREDPOLAGAETS4 , CTO KAJDA4 FRAZA NACINAETS4 S NOVOI
PERFOKARTY I ZANIMAET QELOE CISLO PERFOKART ( NESKOL6KO
POSLEDNIX STROK MOGUT BYT6 PUSTYMI ) *
POSLE POSLEDNEGO SLOVA FRAZY STAVITS4 TOCKA ,
ZAKODIROVANNA4 V VIDE DVUX STROK .. (FBHF) 10 *
KAJDOE SLOVO NACINAETS4 S NOVOI STROKI PERFOKARTY *
V KAJDOL STROKE ZAPISYVAHTS4 7$ BUKV , PRIVEM 6$ BUKV
PIWUTS4 V RAZR4DAX ADRESOV ( PO DVE BUKVY V KAJDOM ADRESE
) , A 7$ - 4 - V RAZR4DAX KODA OPERAQII *
ESLI SLOVO ZANIMAET NESKOL6KO STROK , TO VO VSEX STROKAX ,

```

KROME POSLEDNEL , STAVITS4 ZNAK PERENOSA ( 1\$ V KONTROL6NOM SIGNALE ) \*

TAKOE RAZME5ENIE BUKV OKAZYVAETS4 UDOBNYM PRI KODIROVKE FRAZY , NO ONO NE SOVPADAET S TEM , KOTOROE PRIN4TO V SLOVARE , GDE VSE BUKVY STO4T PODR4D , A ZNAK PERENOSA STAVITS4 V POSLEDNEM RAZR4DE 4CEIKI ( ZNAK PERENOSA V KONTROL6NOM SIGNALE MEVAL BY SRAVNENIH SLOV ) \*

PO3TOMU PERVA4 PROGRAMMA NACINAET SVOH RABOTU S TOGO , CTO IZMEN4ET KODIROVKU FRAZY , ZAPISYVA4 SLOVO TAK , KAK 3TO SDELANO V SLOVARE \*

ZATEM MAWINA OBRABATYVAET SLITNYE ARTIKLI , RAZBIVA4 KAJDYI IZ NIX NA DVA SLOVA , TAK , NAPRIMER , L\$AU PREVRA5AETS4 V L\$A L\$LE , L\$DUQUEL V L\$DE L\$LEQUEL I T. D. \*

3TO IZBAVL4ET OT NEOBXODIMOSTI OBRABATYVAT6 3TI SLOVA SPEQIAL6NYM OBRAZOM ( KAK ARTIKL6 - PREDLOG ) \*

\$P 4\$ \*

P\* POSLE 3TOGO NACINAETS4 PERESTANOVKA SLOV FRAZY V ALFAVITNOM POR4DKE , T. E. UPOR4DOCENIE SLOV PO VOZRASTANIH VELICIN IX KODOV , PRICEM V MOMENT SRAVNI4 KODOV DVUX SLOV K KAJDOMU IZ NIX POSLE KODA POSLEDNEL BUKVY PRIPISANO CISLO 77\$ ( VOS6MERICNA4 SISTEMA ) DL4 TOGO , CTOBY KOROTKA4 OSNOVA OKAZALAS6 POZADI DLINNOI , V KOTORUH ONA VXDIT , KAK 3TO IMEET MESTO V SLOVARE (SM. (/ 1\$ /) ) \*

PRI PERESTANOVKE SLOV DL4 ZAPOMINANI4 IX PERVONACAL6NOGO POR4DKA VO FRAZE STROITS4 TABLIQA SOOTVETSTVII ( T. C. ) , KOTORA4 IMEET SLEDUH5IL VID \*

KAJDOMU SLOVU FRAZY SOOTVETSTVUET ODNA STROKA T. S. \* STROKI RASPOLOJENY V TOM POR4DKE , V KAKOM IDUT SLOVA VO FRAZE ( T. E. 1\$ - 4 STROKA T. S. SOOTVETSTVUET PERVOMU SLOVU FRAZY , 2\$ - 4 - VTOROMU , I T. D. ) \*

(PAGE) AD246\$ \*

V STROKE ZAPOMINAETS4 ADRES 3TOGO SLOVA V ZAPISI V ALFAVITNOM POR4DKE \*

ESLI KAKOE-TO SLOVO PRISUTSTVUET VO FRAZE NESKOL6KO RAZ ( IMEHTS4 V VIDU SLOVA , SOVPADAH5IE QELIKOM , VKLHCA4 OKONCANI4 ) , TO V ALFAVITNOI RASSTANOVKE SLOV ONO FIGURIRUET ODIN RAZ \*

V T. S. DL4 NEGO OTVEDENO STOL6KO STROK , SKOL6KO RAZ ONO PRISUTSTVUET VO FRAZE , I VO VSEX 3TIX STROKAX STOIT ODIN I TOT JE ADRES \*

## 2. The October 1963 Translation

PGPH. 1 .

THE ALGORITHM OF A TRANSLATION FROM A FRENCH TONGUE ON RUSSIAN , GIVEN IN (/ 2 /) , REALIZED ON A MAW

INE (( A //ARROW )) WITH 17 THE PROGRAMS, THE GENERAL VOLUME OF WHICH ABOUT 8500 ORDERS , AND ABOUT 2000 CELLS OCCUPY TABLES AND CONSTANTS .

PGPH. 2 .

WE DESCRIBE THE ORDER OF WORK OF THESE PROGRAMS AND EACH FROM THEM .

PGPH. 3 .

THE FIRST PROGRAM - THE PROGRAM OF A SEARCH OF WORDS IN A DICTIONARY .

THIS PROGRAM INTRODUCES INTO A MACHINE THE NEXT PHRASE , YET AT PRESENT , MEANWHILE NOT OF AUTOMATIC READING FROM A BOOK AND MATERIAL IT INTRODUCES INTO A MACHINE ON PUNCHED CARDS , SUPPOSES , THAT EACH PHRASE BEGINS FROM THE NEW PUNCHED CARD AND OCCUPIES THE WHOLE NUMBER OF THE PUNCHED CARDS ( SOMEWHAT OF THE LAST LINES THEY CAN BE EMPTY ) .

AFTER THE LAST WORD OF THE PHRASE PUTS A POINT , ZAKODIROVANNA4 IN THE FORM OF TWO LINES .. (FBHF) 10 .

EACH WORD BEGINS FROM THE NEW LINE OF A PUNCHED CARD . IN EACH LINE RECORD 7 LETTERS , YET 6 LETTERS ARE WRITTEN IN THE DISCHARGES OF THE ADDRESSES (ACCORDING TO TWO LETTERS IN EACH ADDRESS ) , AND 7 - 4 - IN THE DISCHARGES OF A CODE OF THE OPERATION .

IF A WORD OCCUPIES SOMEWHAT LINES , THEN IN ALL LINES , BESIDES THE LATTER , PUTS THE SYMBOL OF CARRYING OVER ( 1 IN A CONTROL SIGNAL ) .

SUCH A DISPOSITION OF LETTERS TURNS OUT TO BE CONVENIENT UPON KODIROVKE THE PHRASE , BUT IT DOES NOT COINCIDE S BY THIS , WHICH TAKEN IN A DICTIONARY , WHERE ALL OF THE LETTERS THEY ARE IN SUCCESSION , AND THE SYMBOL OF CARRYING OVER IT PUTS IN THE LAST DISCHARGE OF THE CELL ( THE SYMBOL OF CARRYING OVER IN A CONTROL SIGNAL IT WOULD MIX TO THE COMPARISON OF WORDS ) .

THEREFORE THE FIRST PROGRAM BEGINS ITS WORK S THAT CHANGES KODIROVKU THE PHRASES , RECORDING A WORD AS THIS MADE IN A DICTIONARY .

A THEN MACHINE TREATS SLITNYE ARTICLES , BREAKING EACH FROM THEM ON TWO WORDS , SO , FOR EXAMPLE , AV IT IS TRANSFORMED IN A LE , DUQUEL IN DE LEQUEL ETC. .

THIS FREES FROM THE NECESSITY TO TREAT THESE WORDS WITH A SPECIAL WAY ( AS AN ARTICLE - THE PRETEXT ) .

PGPH. 4 .

AFTER THIS BEGINS THE REARRANGEMENT OF WORDS OF THE PHRASE IN AN ALPHABETIC ORDER, I.E. REGULATING OF WORDS ACCORDING TO TO AN INCREASE OF MAGNITUDES OF THEIR CODES , YET IN THE MOMENT OF COMPARISON OF CODES OF TWO WORDS K EACH FROM THEM AFTER THE CODE OF THE LATTER LETTER ASSIGNED A NUMBER 77 ( A VOS6MERICNA4 SYSTEM ) FOR THIS , A SHORT BASIS TURNED OUT TO BE BEHIND LONG , IN WHICH IT ENTERS , AS THIS TAKE IN A DICTIONA

RY ( CF. (/ 1 /) .  
 UPON THE REARRANGEMENT OF WORDS FOR THE MEMORIZING OF  
 THEIR INITIAL ORDER IN THE PHRASE BUILDS THE TABLE OF  
 AGREEMENTS ( T. CH. ) , WHICH IT HAS A FOLLOWING FORM  
 .  
 TO EACH WORD OF THE PHRASE CORRESPONDS AN ONE LINE T.  
 S. .  
 LINES LOCATED IN THIS ORDER , IN WHICH GO WORDS IN THE  
 PHRASE ( I.E. 1 - 4 A LINE T. S. CORRESPONDS THE FIR  
 ST TO WORD OF THE PHRASE , 2 - 4 - SECOND , ETC. ) .  
 (O)-(O)-(O)-PAGE AD246 (O)-(O)-(O)-(O) .  
 IN A LINE MEMORIZES THE ADDRESS OF THIS WORD IN A RECO  
 RDING IN AN ALPHABETIC ORDER .  
 IF WHICH - THIS WORD IS PRESENT IN THE PHRASE SOMEWHAT  
 OF TIMES ( THEY THERE IS IN TO THE FORM OF A WORD , A  
 GREEING WHOLLY , INCLUDING COMPLETIONS ) , THEN IN ALP  
 HABETIC DISPOSITION OF WORDS IT FIGURES ONE TIME .  
 IN T. S. FOR IT ASSIGNED SO MANY LINES , HOW MANY A TI  
 ME IT IS PRESENT IN THE PHRASE , AND IN ALL THESE LINE  
 S IS ONE AND THE SAME ADDRESS.

### 3. The Translation of February 1964

```
// . $ //PGPH. 1 .
.$ //THE ALGORITHM OF TRANSLATION FROM FRENCH LANGUAGE
ON RUSSIAN , GIVEN IN (/ 2 /) , REALIZED ON MACHINE ((//ARROW
)) WITH 17 THE PROGRAMS , THE GENERAL VOLUME OF WHICH ABOUT
8500 ORDERS , AND ALSO ABOUT 2000 CELLS OCCUPY TABLES AND
CONSTANTS .
//.$ //PGPH. 2 .
.$ //WE DESCRIBE THE ORDER OF WORK OF THESE PROGRAMS AND
EACH OF THEM .
//.$ //PGPH. 3 .
//THE FIRST PROGRAM - THE PROGRAM OF SEARCH OF WORDS
IN DICTIONARY .
//THIS PROGRAM INTRODUCES INTO MACHINE THE NEXT PHRASE , YET
AT PRESENT , MEANWHILE NOT AUTOMATIC READING FROM BOOK AND
MATERIAL IS INTRODUCED INTO MACHINE ON PUNCHED CARDS , IS
SUPPOSED , THAT EACH PHRASE IS BEGUN FROM THE NEW PUNCHED CARD
AND OCCUPIES THE WHOLE NUMBER OF THE PUNCHED CARDS ( SEVERAL
LAST LINES CAN BE EMPTY ) .
//AFTER THE LAST WORD OF THE PHRASE THERE IS PUT POINT ,
$ZAKODIROVANNA4 $ IN THE FORM OF TWO LINES .. (LONG FORMULA) .
//EACH WORD IS BEGUN FROM THE NEW LINE OF PUNCHED CARD .
// IN EACH LINE THERE ARE RECORDED 7 LETTERS , YET 6 LETTERS
ARE WRITTEN IN THE DISCHARGES OF THE ADDRESSES ( ACCORDING TO
TWO LETTERS IN EACH ADDRESS ) , AND 7 - $4 $ - IN THE
DISCHARGES OF CODE OF THE OPERATION .
//IF WORD OCCUPIES SEVERAL LINES , THEN IN ALL LINES , BESIDES
```

THE LATTER , THERE IS PUT THE SYMBOL OF CARRYING OVER ( 1 IN CONTROL SIGNAL ) .  
 //SUCH A DISPOSITION OF LETTERS TURNS OUT TO BE CONVENIENT UPON \$KODIROVKE \$ THE PHRASE , BUT IT DOES NOT COINCIDE WITH THIS , WHICH WAS TAKEN IN DICTIONARY , WHERE ALL OF THE LETTERS ARE IN SUCCESSION , BUT THE SYMBOL OF CARRYING OVER IS PUT IN THE LAST DISCHARGE OF THE CELL ( THE SYMBOL OF CARRYING OVER IN CONTROL SIGNAL WOULD MIX TO THE COMPARISON OF WORDS ) .

//THEREFORE THE FIRST PROGRAM BEGINS ITS/THEIR WORK FROM THE FACT THAT CHANGES \$KODIROVKU \$ THE PHRASES , RECORDING WORD AS THIS WAS MADE IN DICTIONARY .  
 //THEN MACHINE TREATS \$SLITNYE \$ ARTICLES , BREAKING EACH OF THEM ON TWO WORDS , SO , FOR EXAMPLE , AV IS TRANSFORMED IN A LE , DUQUEL IN DE LEQUEL ETC. .  
 //THIS FREES FROM THE NECESSITY TO TREAT THESE WORDS WITH SPECIAL WAY ( AS ARTICLE - THE PRETEXT ) .  
 //.\$ //PGPH. 4 .  
 .\$ //AFTER THIS THERE IS BEGUN THE REARRANGEMENT OF WORDS OF THE PHRASE IN ALPHABETIC ORDER , I.E. REGULATING OF WORDS ACCORDING TO INCREASE OF MAGNITUDES OF THEIR CODES , YET AT THE MOMENT OF COMPARISON OF CODES OF TWO WORDS TO EACH OF THEM AFTER THE CODE OF OF THE LATTER LETTER ASSIGNED NUMBER 77 ( \$VOS6MERICNA4 \$ SYSTEM ) FOR THIS , THAT SHORT BASIS TURNED OUT TO BE BEHIND LONG , INTO WHICH IT ENTERS , AS THIS OCCURS IN DICTIONARY ( CF. ( / 1 / ) ) .  
 //UPON THE REARRANGEMENT OF WORDS FOR THE MEMORIZING OF THEIR INITIAL ORDER IN THE PHRASE THERE IS BUILT THE TABLE OF AGREEMENTS ( T. CH. ) , WHICH HAS FOLLOWING FORM .  
 //TO EACH WORD OF THE PHRASE CORRESPONDS ONE LINE T. S. .  
 //LINES LOCATED IN THIS ORDER , IN WHICH GO WORDS IN THE PHRASE ( I.E. 1 - \$4 \$ LINE T. S. CORRESPONDS TO THE FIRST WORD OF THE PHRASE , 2 - \$4 \$ - TO THE SECOND , ETC. ) .  
 //(0)-(0)-(0)- //PAGE AD246 (0)-(0)-(0)-(0) .  
 //IN LINE THERE IS MEMORIZED THE ADDRESS OF THIS WORD IN RECORDING IN ALPHABETIC ORDER .  
 //IF SOME WORD IS PRESENT IN THE PHRASE SEVERAL TIMES ( THERE ARE IN THE FORM OF WORD , AGREEING WHOLLY , INCLUDING COMPLETIONS ) , THEN IN ALPHABETIC DISPOSITION OF WORDS IT FIGURES ONE TIME .  
 //IN T. S. FOR IT ASSIGNED AS MANY LINES , AS TIMES IT IS PRESENT IN THE PHRASE , AND IN ALL THESE LINES IS THE SAME ADDRESS .

#### 4. The Translation of June 1964

PGPH. 1 .

THE ALGORITHM OF TRANSLATION FROM //FRENCH LANGUAGE ON RUSSIAN , GIVEN IN ( / 2 / ), REALIZED ON MACHINE ( ( //ARROW ) )

WITH 17 THE PROGRAMS , THE GENERAL VOLUME OF WHICH ABOUT 8500 ORDERS , AND ABOUT 2000 CELLS OCCUPY TABLES AND ALSO CONSTANTS

PGPH. 2 .

WE DESCRIBE THE ORDER OF WORK OF THESE PROGRAMS AND EACH OF THEM .

PGPH. 3 .

THE FIRST PROGRAM - THE PROGRAM OF SEARCH OF WORDS IN DICTIONARY .

THIS PROGRAM INTRODUCES IN MACHINE THE NEXT PHRASE , YET AT PRESENT , MEANWHILE NOT AUTOMATIC READING FROM BOOK AND MATERIAL IS INTRODUCED IN MACHINE ON PUNCHED CARDS , IS SUPPOSED , THAT EACH PHRASE IS BEGUN FROM THE NEW PUNCHED CARD AND OCCUPIES THE WHOLE NUMBER OF THE PUNCHED CARDS ( SEVERAL LAST LINES CAN BE EMPTY ) .

AFTER THE LAST WORD OF THE PHRASE THERE IS PUT POINT , ZAKODIROVANNA4 IN THE FORM OF TWO LINES .. (LONG FORMULA ) . IN EACH LINE ARE RECORDED 7 LETTERS , YET 6 LETTERS ARE WRITTEN IN THE DISCHARGES OF THE ADDRESSES ( AS FAR AS TWO LETTERS IN EACH ADDRESS ) , AND 7 - 4 - IN THE DISCHARGES OF CODE OF THE OPERATION .

IF WORD OCCUPIES SEVERAL LINES , THEN IN ALL LINES , BESIDES THE LATTER , THERE IS PUT THE SYMBOL OF CARRYING OVER ( 1 IN CONTROL SIGNAL ) .

SUCH A DISPOSITION OF LETTERS TURNS OUT TO BE CONVENIENT UPON KODIROVKE THE PHRASES , BUT IT DOES NOT COINCIDE WITH THIS , WHICH WAS TAKEN IN DICTIONARY , WHERE ALL OF THE LETTERS ARE IN SUCCESSION , BUT THE SYMBOL OF CARRYING OVER IS PUT IN THE LAST DISCHARGE OF THE CELL ( THE SYMBOL OF CARRYING OVER IN CONTROL SIGNAL WOULD MIX TO THE COMPARISON OF WORDS ) .

THEREFORE THE FIRST PROGRAM BEGINS ITS/THEIR WORK FROM THE FACT THAT CHANGES KODIROVKU THE PHRASES , RECORDING WORD AS THIS WAS MADE IN DICTIONARY .

THEN MACHINE TREATS SLITNYE ARTICLES , BREAKING EACH OF THEM ON TWO WORDS , SO , FOR EXAMPLE , AV IS TRANSFORMED IN A LE , DUQUEL IN DE LEQUEL ETC . .

THIS FREES FROM THE NECESSITY TO TREAT THESE WORD WITH SPECIAL WAY ( AS ARTICLE - THE PRETEXT ) .

PGPH. 4 .

AFTER THIS THERE IS BEGUN THE REARRANGEMENT OF WORDS OF THE PHRASE IN ALPHABETIC ORDER , I.E. REGULATING OF WORDS ACCORDING TO INCREASE OF MAGNITUDES OF THEIR CODES , YET IN THE COURSE OF THE MOMENT OF COMPARISON OF CODES OF TWO WORDS TO EACH OF THEM AFTER THE CODE OF THE LAST LETTER ASSIGNED NUMBER 77 (VOS6MERICNA4 SYSTEM ) , THAT SHORT BASIS TURNED OUT TO BE BEHIND LONG , IN WHICH IT ENTERS , AS THIS OCCURS IN DICTIONARY ( CF. ( / 1 / ) ) .

UPON THE REARRANGEMENT OF WORDS FOR THE MEMORIZING OF THEIR INITIAL ORDER IN THE PHRASE THERE IS BUILT THE TABLE OF AGREEMENTS ( T. CH. ) , WHICH HAS FOLLOWING FORM .

TO EACH WORD OF THE PHRASE CORRESPONDS ONE LINE T. S. .  
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 OF THE PHRASE , 2 - 4 - TO THE SECOND , ETC. ) .  
 (0)--(0)--(0)-- PAGE AD246 (0)--(0)--(0)--(0) .  
 IN LINE THERE IS MEMORIZED THE ADDRESS OF THIS WORD IN  
 RECORDING IN ALPHABETIC ORDER .  
 IF SOME WORD IS PRESENT IN THE PHRASE SEVERAL TIMES ( THERE  
 ARE IN THE FORM OF WORD , WHICH COINCIDE WHOLLY , INCLUDING  
 COMPLETIONS ) , THEN IN ALPHABETIC DISPOSITION OF WORDS IT  
 FIGURES ONE TIME .  
 IN T. S. FOR IT ASSIGNED AS MANY LINES , AS TIMES IT IS  
 PRESENT IN THE PHRASE , AND IN ALL THESE LINES IS THE SAME  
 ADDRESS .

*5. A Random Translation Run of a Text in Physics  
 Made in Oak Ridge, Tenn. in August 1964*

*a) The Russian Text*

(PAGE) 92 C\$3KSPERIMENTAL6NYE C\$REZUL6TATY C\$I C\$IX  
 C\$OBSUJDENIE \*  
 P\* C\$KONDENSIROVANNYE NA XOLODNUH PODLOJKU SLOI TELLURA  
 OBLADALI SOPROTIVLENIEM , LEJA5IM V PREDELAX NESKOL6KIX  
 SOT KILOOM \*  
 P\* C\$IZMERENIE SOPROTIVLENI4 V BOL6WINSTVE SLUCAEV  
 PROIZVODILO6 V VOZDUXE \*  
 C\$PR4MOI I OBRATNYI XODY TEMPERATURNOI ZAVISIMOSTI  
 SOPROTIVLENI4 PRI NAGREVANII I OXLAJDENII NE SOVPADAHT ,  
 PRICEM POSLE KAJDOGO QIKLA NAGREVANIE - OXLAJDENIE  
 SOPROTIVLENIE OBRAZQA PRI DANNOI TEMPERATURE VOZRASTAET (  
 SM. RIS. 1 ) \*  
 P\* C\$DLITEL6NOE NABLHDENIE ZA POVEDENIEM OBRAZQOV TELLURA  
 , NE PODVERGNUTYX TERMICESKOL OBRABOTKE I NAXOD45IXS4 PRI  
 KOMNATNOI TEMPERATURE , POKAZALO NEOBRATIMOE VOZRASTANIE  
 SOPROTIVLENI4 SO VREMENEM \*  
 P\* C\$ZAVISIMOSTI SOPROTIVLENI4 OT TEMPERATURY OBRAZQOV  
 TELLURA , SKONDENSIROVANNYX NA PODOGRETUH PODLOJKU ( 150 -  
 160 DEG. CL\$C ) , PRIVEDENY NA RIS 2 \*  
 C\$I V TOM SLUCAE IMEET MESTO REZKOE VOZRASTANIE  
 SOPROTIVLENI4 OBRAZQA POSLE PЕРVOGO QIKLA NAGREVANI4 \*  
 VOSPROIZVODIMOST6 KRIVOL LOG R # F ( 1/T ) USTANAVLIVAETS4  
 POSLE 4 - 5 QIKLOV NAGREV - OXLAJDENIE \*  
 RIS. 1 C\$ZAVISIMOST6 LOG CL\$R # F ( 1/T ) DL4 OBRAZQA  
 TELLURA , KONDENSIROVANNOGO NA XOLODNUH PODLOJKU \*  
 C\$VERXNA4 PR4MA4 OTVECAET USTANOVIVWEMUS4 REJIMU \*  
 RIS. 2 C\$ZAVISIMOST6 LOG CL\$R # F ( 1/T ) DL4 OBRAZQA  
 TELLURA , KONDENSIROVANNOGO NA GOR4CUH PODLOJKU \*



C\$VERXNA4 KRIVA4 OTVECAET USTANOVIVWEMUS4 REJIMU \*  
 P\* C\$OBRAZQY GERMANI4 , KONDENSIROVANNYE NA XOLODNUH  
 PODLOJKU , OBLADALI SOPROTIVLЕНИЕM V DES4TKI MEGOM \*  
 C\$KONDENSIROVANNYE NA PODLOJKI , NAGRETYE DO 500 - 550  
 DEG. CL\$C , PLENKI GERMANI4 IMELI SOPROTIVLENIE , LEJA5EE  
 V PREDELAX OT 7 DO 30 KOM, ( BOL\$WINSTVO 10 - 16 KOM, ) \*  
 C\$V 3TOM SLUCAE MOJNO UTVERJDAT6 , CTO SLOI POLUCALIS6  
 KRISTALLICESKIE (/1 , 2 /) \*  
 P\* C\$SLOI , ODNOVREMENNO SKONDENSIROVANNYE NA PODLOJKI IZ  
 STEKLA , SLHDY I PLAVLENNOGO KVARQA , IMELI PRAKTICESKI  
 ODINAKOVOE SOPROTIVLENIE POR4DKA 12 \*  
 C\$PRI DLITEL6NOM XRANENII V VOZDUXE SOPROTIVLENIE  
 VOZRASTAET NEZNACITEL6NO ( ZA 40 SUTOK NA 1 , 8 PCT. ) \*  
 C\$ZAVISIMOST6 SOPROTIVLENIA4 OT TEMPERATURY V INTERVALE OT  
 KOMNATNOI DO 130 DEG CL\$C BLIZKA K 3KSPONENQIAL6NOI \*  
 C\$PRI MNOGOKRATNYX QIKLAX NAGREVANIE - OXLAJDENIE TOCKI NA  
 GRAFIKE LOG R  $\neq$  F ( 1/T ) DOSTATOCNO TOCNO LOJATS4 NA ODNU  
 I TU JE KRIVUH \*  
 P\* C\$DL4 VY4SNENI4 VLIANI4 VOZDUXA BYLI VYPOLNENY  
 IZMENENI4 ZAVISIMOSTI SOPROTIVLENIA4 OT TEMPERATURY  
 OBRAZQOV TELLURA V VAKUUME \*  
 C\$REZUL6TATY IZMERENII V OS4X LOG C\$R I 1/T MOGUT BYT6  
 PREDSTAVLENY DVUM4 OTREZKAMI PR4MYX S IZLOMOM PRI  
 TEMPERATURE OKOLO 90 DEG. LC\$C ( RIS. 3. ) \*  
 RIS. 3, C\$ZAVISIMOST6 LOG CL\$R  $\neq$  F ( 1/T ) DL4 OBRAZQA  
 TELLURA , KONDENSIROVANNOGO NA GOR4CUH PODLOJKU \*  
 C\$RESTNIKOM NA VERXNEI KRIVOI OTMECENO NACALO IZMENENI4  
 ZAVISIMOSTI V VAKUUME ( SRAZU JE POSLE IZGOVTOLENI4  
 OBRAZQA ) \*  
 C\$JIRNA4 LINI4 OTVECAET KODU ZAVISIMOSTI , SN4TOI V  
 VOZDUXE \*  
 C\$NIJNIE QIKLY OTVECAHT IZMERENI4M V VOZDUXE SPUST4 DES4T6  
 DNEI POSLE IZGOTOVLENI4 OBRAZQA \*  
 P\* C\$POSLE KAJDOGO QIKLA NAGREVANIE - OXLAJDENIE  
 SOPROTIVLENIE OBRAZQA PADALO \*  
 C\$POSLE POLUCASOVOI VYDERJKI V VAKUUME PRI TEMPERATURE 130  
 DEG LC\$C SOPROTIVLENIE NESKOL6KO UVELICIOS6 , OSTAVA4S6  
 VSE JE MEN6WE PERVONACAL6NOGO \*  
 P\* C\$PRI ZAPOLNENII VAKUUMNOI SISTEMY VOZDUXOM  
 SOPROTIVLENIE OBRAZQOV UMEN6WALOS6 \*  
 C\$POSLEDNIE NAGREVANI4 OBRAZQA V VOZDUXE IZMEN4LI XARAKTER  
 ZAVISIMOSTI SOPROTIVLENIA4 OT TEMPERATURY V STORONU  
 SPR4MLENI4 KRIVOI LOG R  $\neq$  F ( 1/T ) UMEN6WENI4 EE NAKLONA \*

b) The Translation

(0)--(0)--(0)-- PAGE 92 (0)--(0)--(0)--(0) //EXPERIMENTAL  
 //RESULTS //AND THEIR //DISCUSSION .  
 CONDENSED ON COLD SUPPORT THE LAYERS OF TELLURIUM

POSSESSED RESISTANCE , WHICH LIE WITHIN THE LIMITS SEVERAL HUNDREDTH KILOOM .

THE MEASUREMENT OF RESISTANCE IN THE MAJORITY OF CASES WAS CARRIED OUT IN AIR .

THE STRAIGHT AND BACK COURSES OF TEMPERATURE RELATION OF RESISTANCE UPON HEATING AND COOLING DO NOT COINCIDE , YET AFTER EACH RING HEATING - COOLING THE RESISTANCE OF FORM AT THE GIVEN TEMPERATURE INCREASES ( CF. FIG. 1 ) .

PROLONGED OBSERVATION FOR THE BEHAVIOR OF THE FORMS OF TELLURIUM , NOT SUBJECTED TO THERMAL TREATMENT AND BEELING AT ROOM TEMPERATURE , SHOWED IRREVERSIBLE INCREASE OF RESISTANCE WITH TIME .

THE REALTIONS OF RESISTANCE FROM THE TEMPERATURE OF THE FORMS OF TELLURIUM , CONDENSED ON WARMED UP SUPPORT ( 150 - 160 DEG. //C ) , WERE GIVEN ON FIG. 2 .

AND IN THIS CASE OCCURS SHARP INCREASE OF RESISTANCE OF FORM AFTER THE FIRST RING OF HEATING .

REPRODUCTION CURVE  $\log R \neq F ( 1/T )$  INSTALLS AFTER 4 - 5 RINGS HEATING - COOLING .

FIG. 1 //RELATION  $\log //R \neq F ( 1/T )$  FOR THE FORM OF TELLURIUM , WHICH WAS CONDENSED ON COLD SUPPORT .

THE UPPER STRAIGHT LINE RESPONDS TO INSTALLING REGIME .

FIG. 2 //RELATION  $\log //R \neq F ( 1/T )$  FOR THE FORM OF TELLURIUM , WHICH WAS CONDENSED ON HOT SUPPORT .

UPPER CURVE RESPONDS TO INSTALLING REGIME .

THE FORMS OF GERMANIUM , CONDENSED ON COLD SUPPORT , POSSESSED RESISTANCE IN DOZENS MEGOM .

CONDENSED ON SUPPORTS , WHICH WERE HEATED UP TO 500 - 550 DEG. //C , FILMS OF GERMANIUM HAD RESISTANCE , WHICH LIES WITHIN

THE LIMITS FROM 7 UP TO 30 KOM, (MAJORITY 10 - 16 KOM, ) .

IN THIS CASE IT IS POSSIBLE TO AFFIRM , THAT LAYERS WERE OBTAINED CRYSTALLINE ( /1 , 2 / ) .

LAYERS , SIMULANEOUSLY WHICH WERE CONDENSED ON SUPPORTS OF GLASS , MICAS AND MELTED QUARTZ , HAD PRACTICALLY THE EQUAL RESISTANCE OF ORDER 12 .

UPON PROLONGED STORAGE IN AIR RESISTANCE INCREASES

INSIGNIFICANTLY ( FOR 40 DAYS ON 1 , 8 PERCENT ) .

THE RELATION OF RESISTANCE FROM TEMPERATURE IN RANGE FROM ROOM UP TO 130 DEG //C IS CLOSE TO EXPONENTIAL .

UPON REPEATED RINGS HEATING - THE COOLING OF THE POINT ON DIAGRAM  $\log R \neq F ( 1/T )$  SUFFICIENTLY ACCURATELY ARE PLACED ON THE SAME CURVE .

FOR THE EXPLANATION OF INFLUENCE OF AIR WERE ACCOMPLISHED CHANGES OF RELATION OF RESISTANCE FROM THE TEMPERATURE OF THE FORMS OF TELLURIUM IN VACUUM .

THE RESULTS OF MEASUREMENTS IN AXES  $\log //R$  AND  $1/T$  CAN BE REPRESENTED BY TWO SEGMENTS OF STRAIGHT LINES WITH BREAK AT TEMPERATURE ABOUT 90 DEG. LC\$ C ( FIG. 3. ) .

FIG. 3, //RELATION  $\log //R \neq F ( 1/T )$  FOR THE FORM OF TELLURIUM , WHICH WAS CONDENSED ON HOT SUPPORT .

BY THE CROSS ON UPPER CURVE WAS NOTED THE BEGINNING OF CHANGE OF RELATION IN VACUUM ( AT ONCE HOWEVER AFTER THE PRODUCTION OF FORM ) .

THE ALIPHATIC LINE RESPONDS TO THE COURSE OF RELATION , WHICH WAS RECORDED AIR .

THE LOWER RINGS RESPOND TO MEASUREMENTS IN AIR AFTER TEN DAYS AFTER THE PRODUCTION OF FORM .

AFTER EACH RING HEATING - COOLING THE RESISTANCE OF FORM FELL .

AFTER A HALF HOUR,S EXTRACTION IN VACUUM AT TEMPERATURE 130 DEG LC\$ C RESISTANCE SLIGHTLY WAS INCREASED , REMAINING HOWEVER LESS INITIAL .

UPON THE FILLING OF VACUUM SYSTEM BY AIR THE RESISTANCE OF FORMS WAS DECREASED .

THE LAST HEATINGS OF FORM IN AIR CHANGED THE CHARACTER OF RELATION OF RESISTANCE FROM THE TEMPERATURE ASIDE OF THE RECTIFICATION CURVE  $\log R \neq F(1/T)$  THE DECREASES OF ITS SLOPE .

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