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A Program for Computing the Tax on Wages and Automatically Drawing Up the Pay-List on the N.C.R. 395 Electronic Accounting Machine

Computing the tax on wages and determining the net income is a current, particularly complex work, requiring a large volume of labour. Automatizing this on electric accounting machines provides a series of obvious advantages.

One of the most difficult problems encountered when mechanizing the operations for computing gross and net wages is the proper taxation of the wage-earners' income. This difficulty is mainly due to the particularly complex methodology in establishing the tax, requiring the existence of a memory having a minimum capacity of 6,000 addresses. Concomitantly, this implies loading and, respectively, blocking at least 5/6 of the respective memory with constant values.

The problem of the efficiency in using a medium capacity electronic accounting computer for operations of gross and net salaries also arises.

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As an introduction we first intend to present a few data about the N.C.R. 395 electronic accounting machine on which the respective routine was achieved. We consider that these data will contribute to a better understanding of the program elaborated.

The N.C.R. 395 electronic machine on which the work was programmed is a machine with external programming and automatic introduction of the initial data, the technical information carrier used being an 80-column punched card.

The memory of this machine is on a disk and its capacity is 120 addresses of 14 digits each. These addresses are numbered from 00—119. The machine is capable of effecting the four basic arithmetic operations, as well as a series of logical operations. Concomitantly, the machine has the possibility to automatically select the order number of an address together with its contents and to change by 10 the order number of a previously determined address (the latter also constitutes one of the forms of logical decisions).

The machine carries out the effective operation in various positions called stops which is one of the component elements of external programming. We point to the fact that the operations carried out at the respective stops may be accompanied by printing operations or not (the printing may be eliminated).

1. SPECIFIC PROBLEMS REGARDING THE COMPUTATION OF TAXES ON WAGE EARNER INCOMES

According to Romanian legislation, the computing methodology for the taxation on the monthly earnings of the wage earners comprises a number of 11 income brackets to which correspond different taxation quotas; these quotas, in turn, are made up of various fixed amounts summing up the taxation computed by percentages, likewise variable. This legislation was completed in December 1966, in order to mark a distinction in setting the income tax on the persons having children and on the childless persons. For instance, the tax due by persons having exceeded the age of 25 who have not or have not had children is, as a rule, 10 per cent higher than the tax on the persons having children; for earnings exceeding 2,000 lei this increase is no longer 10 per cent but 20 per cent. At the same time, it is provided that in the case of earnings smaller than 801 lei the tax should not be increased, even in the conditions shown above. In addition, there is a provision according to which when the earnings of the wage earner amount from 2,001 to 2,030 lei — although the 20 per cent increase is, theoretically, applied — this increase is practicaly so reduced as not to lead to a net earning smaller than those of persons having gross salaries up to 2,000 lei inclusive.

We will not insist here on the other details of this methodology, particularly intricate, but we will present the manner in which we have succeeded in solving the mechanization of the respective computations taking into account all the aspects mentioned, including the ones generated by a series of conditions regarding: tax reduction for decorated persons or for persons having in their keep more than 3 persons; worked days (hours); supplementary pension; various reductions in the form of deductions, instalments, etc. All these aspects had to be taken into consideration so that, concomitantly with the computation of the tax, we should automatically draw up the entire wage list, starting from the tariff rate and ending with the balance to be paid.

2. ALGORITHM PROPER AND FLOW CHART

The computing algorithm is based on the combined transposition in the program of the machine of the principles established by the present legal instructions concerning the tax on wage computation. This transposition demanded the elaboration of original solutions and the deducing of formulae not included in the instructions, care being taken not to trespass in any manner the framework established by the law.

The basis of the algorithm is formed by ascertaining the level of the gross earnings on the basis of the orders of hundreds and thousands, according to which a group of three constant values is selected for each one from the memory of the computer. One then proceeds to the detailed computation (down to the order of monetary subdivisions) by applying the taxation percentage on the part of the earnings on which taxation is computed by percentage and the addition of the fixed taxation amount. From this point of view the algorithm presents no particular involvements, since it practically amounts to one operation of subtraction, one of multiplication, one of addition and finally to one of rounding off in favour of the wage earner.

The difficulty consists in ascertaining the order of hundreds and thousands for which the memory of 120 addresses of the machine initially seem to be completely insufficient, particularly if we take into account the fact that the program requires an important number of operating addresses, of vertical totalling, of recording and depositing the various categories of reductions. A series of programming artifices has allowed to reduce the number of addresses — for ascertaining the wage level and the computation proper of the tax — to a number of 30 addresses.

In view of computing taxation on the gross salary a series of constant value addresses are required, which we shall note by X, and a series of operating addresses, which we shall note by A.

$X_{00} = 0000000.00$
$X_{01} = 0000000.00$
$X_{02} = 0000000.00$
$X_{03} = 0000000.00$
$X_{04} = 0000000.00$
$X_{05} = 0000500.10$
$X_{06} = 0000500.10$
$X_{07} = 0200700.12$
$X_{08} = 0320800.14$
$X_{09} = 0460900.17$
$X_{10} = 0631000.18$
$X_{11} = 0811100.19$
$X_{12} = 1001200.20$
$X_{13} = 1411400.22$
$X_{15} = 1411400.22$
$X_{16} = 1411400.22$
$X_{17} = 2071700.16$
$X_{18} = 2071700.16$
$X_{19} = 2071700.16$
$X_{20} = 2071700.16$
$X_{21} = +2000.00$
$X_{22} = -2031.00$
$X_{23} = 255.00$
$X_{24} = 100.00$
$X_{25} = -160.00$
$X_{26} = 1720.00$
$X_{27} = 20.00$
$X_{28} = 800.00$

A_1 = gross wage
A_2 = for tax computation when gross wage is over 2,001 lei

A_3 = for taking over constant from X_{22}
A_4 = computed taxation + eventual increase — eventual decrease
A_5 = 10 per cent taxation increase
$A_5 + 10 = 20$ per cent taxation increase
A_6 = for computation of taxation increase taken over from X_{24}
A_7 = for taking over increase percent of taxation with a minus
A_8 = per cent reduction of taxation as a difference from 100 per cent.

We mention that the addresses numbered $X_{00} — X_{20}$ will further be attributed the generic denomination of X_i addresses, since they are of a rather special character; this special character results from the fact that each of the respective addresses contains 3 constant values * and their calling up is made by a procedure of automatic selecting. We still mention that automatic selecting is carried out in agreement with the orders of hundreds and thousands of the resultant gross salary.

Flow chart



a — takes over contents of selected address:
b — extracts the following successively from the respective address:

1. standard from which taxation is computed by percentage
2. fixed amount of taxation;
3. percentage of taxation;

c — subtracts standard, from gross salary;
d — multiplies difference by taxation per cent;
e — adds taxation computed by per cent to the steady amount of taxation.

3. KINEMATIC SCHEME OF PROGRAM FOR DRAWING UP THE ENTIRE PAY-LIST

The working program of the machine starts on a stop which reads the identification code of the first punched card and prepares the machine for alpha writing. Concomitantly, on this stop, initializing the tests is carried out and the control is received for passing on to the stop of alpha writing. After the part of alpha writing has been carried out, the machine receives an order — from the card — to pass on to the following numerical stop on which the elimination of the alpha writing and the transfer of the 100 constant into an operating address are achieved.

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* E.g. the address X_{14} = 1 4 1 (fixed amount of taxation) 1 4 0 0 (Standard from which percentage taxation is applied) 2 2 (Taxation percentage)

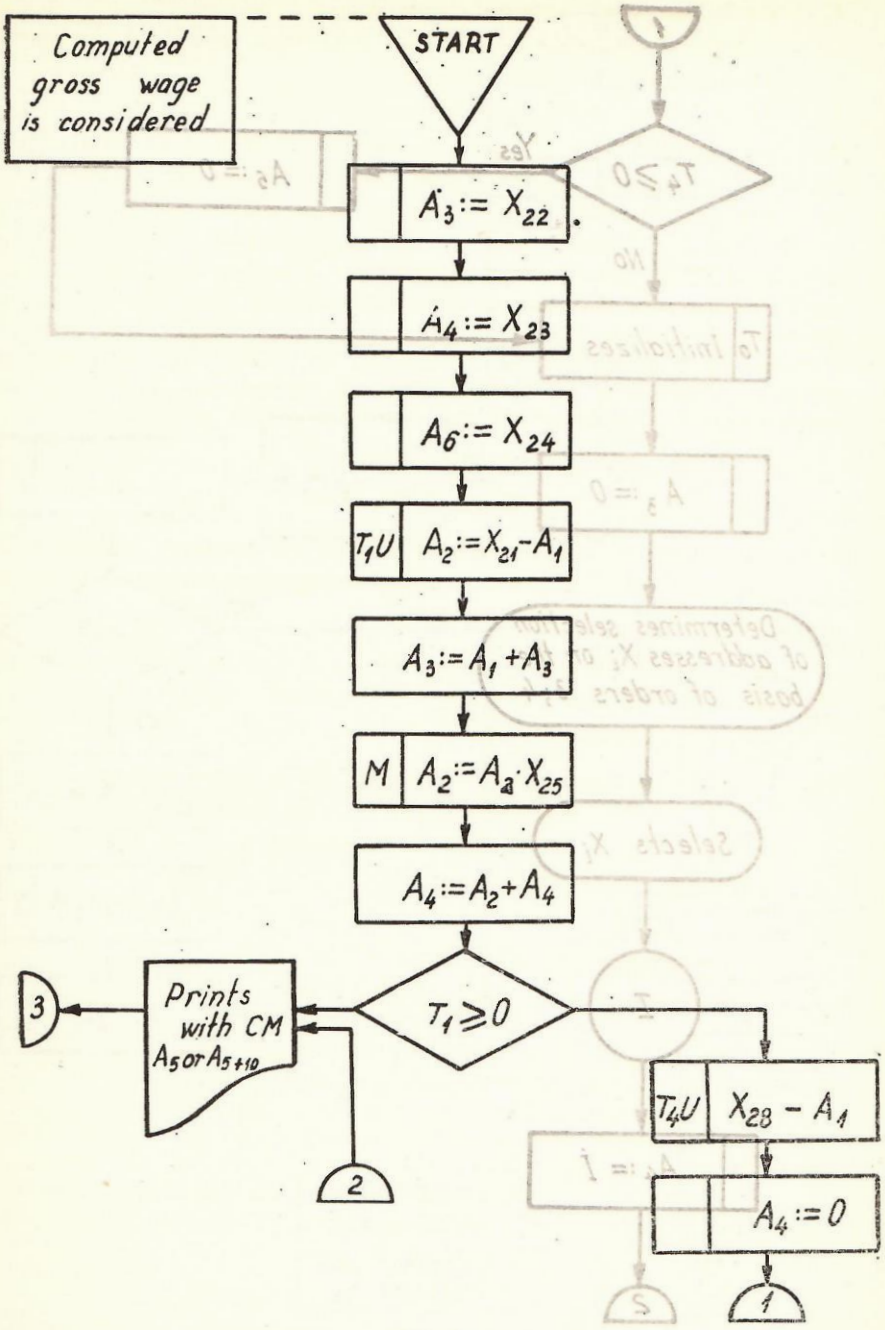
Computed gross wage is considered
START
$A_3 := X_{22}$
$A_4 := X_{23}$
$A_6 := X_{24}$
T_1U $A_2 := X_{21} - A_1$
$A_3 := A_1 + A_3$
M $A_2 := A_3 \cdot X_{25}$
$A_4 := A_2 + A_4$
$T_1 \geq 0$
Prints with CM A_5 or A_{5+10}
3
2
T_4U $X_{28} - A_1$
$A_4 := 0$
1

Fig. 1.

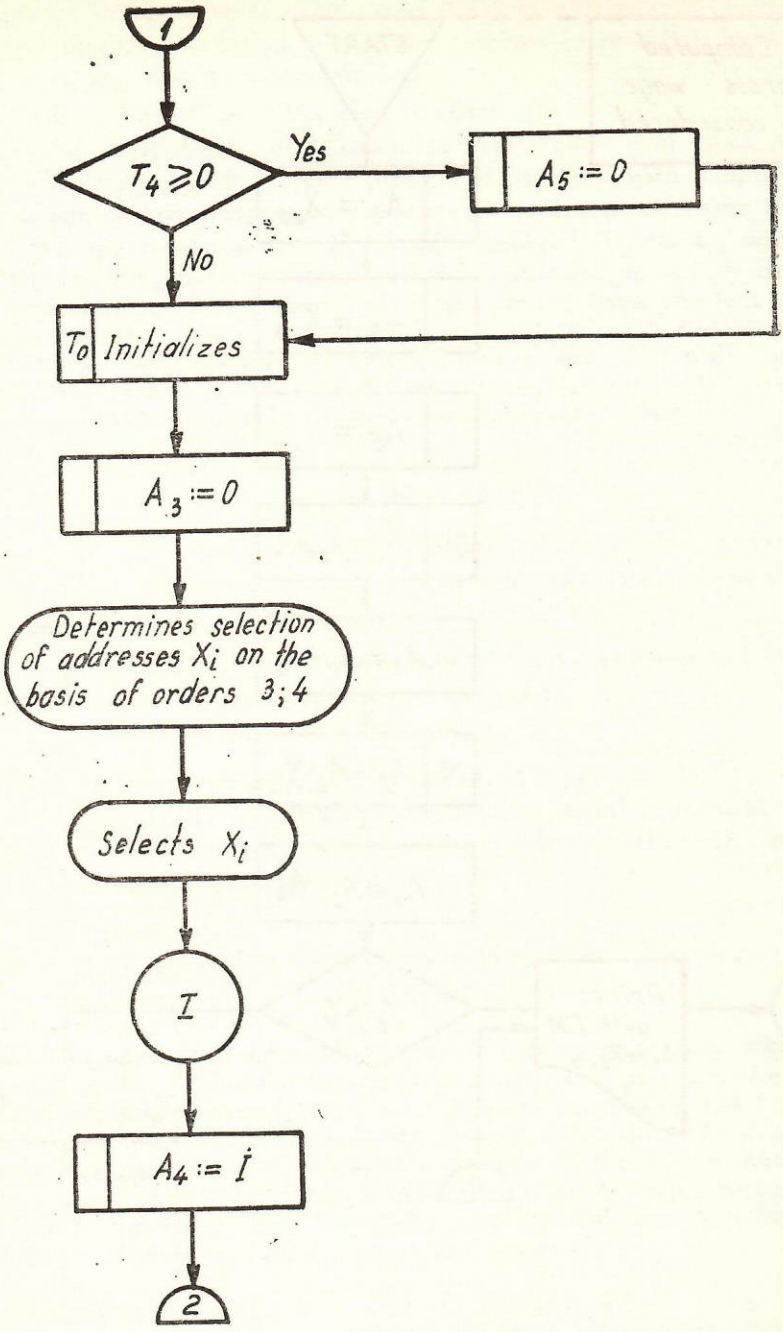
1
$T_4 \geqslant 0$
Yes
$A_5 := 0$
No
T_0 Initializes
$A_3 := 0$
Determines selection of addresses X_i on the basis of orders 3;4
Selects X_i
I
$A_4 := i$
2

Fig. 2.

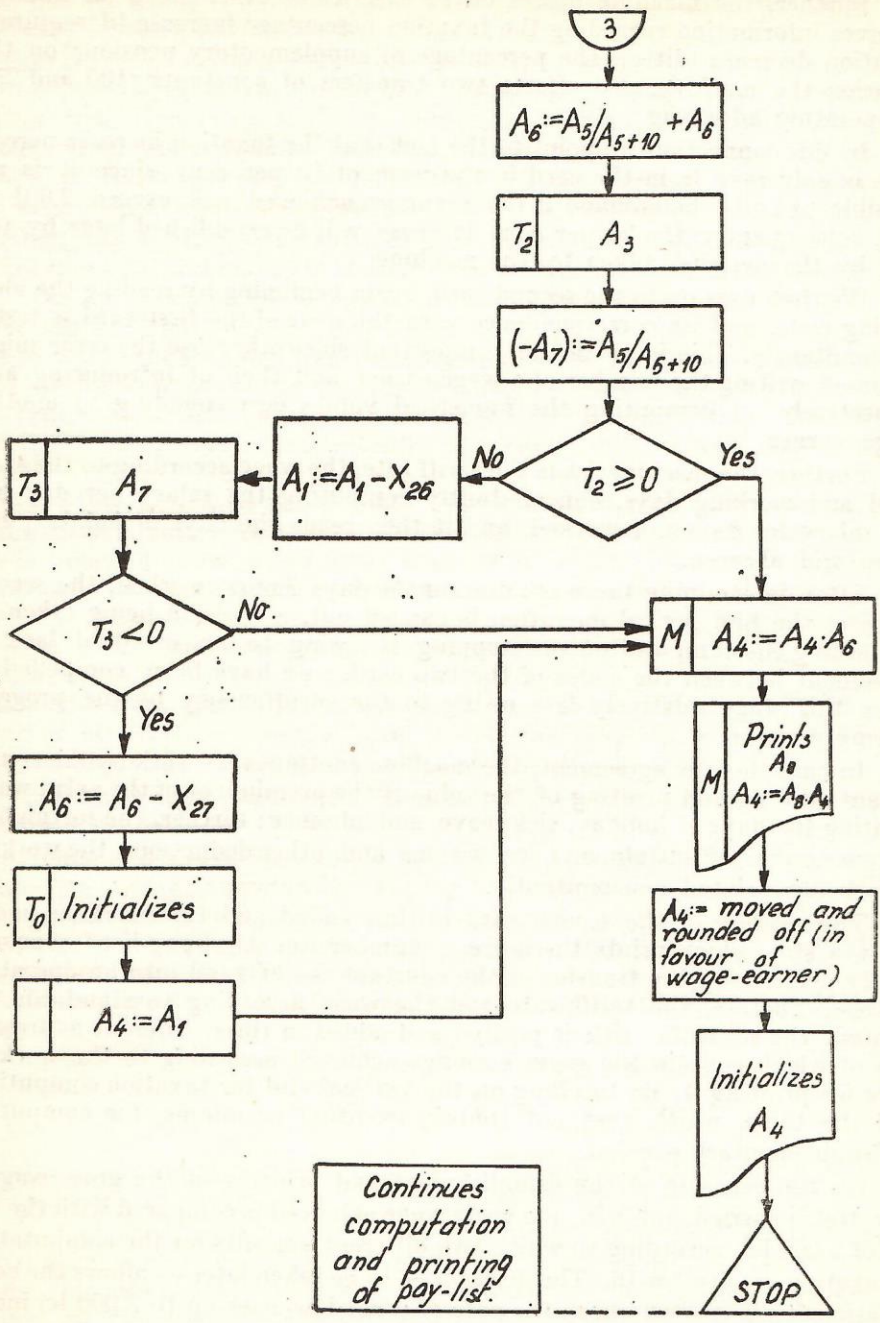
3
$A_6 := A_5/A_{5+10} + A_6$
T_2 A_3
$(-A_7) := A_5/A_{5+10}$
$T_2 \geq 0$
No
Yes
$A_1 := A_1 - X_{26}$
T_3 A_7
$T_3 < 0$
No
Yes
M $A_4 := A_4 \cdot A_6$
Prints A_8 $A_4 := A_8 \cdot A_4$
$A_6 := A_6 - X_{27}$
T_0 Initializes
$A_4 := A_1$
A_4 := moved and rounded off (in favour of wage-earner)
Initializes A_4
Continues computation and printing of pay-list.
STOP

Fig. 3.

Further, the machine passes on to a series of other stops on which it receives information regarding the taxation percentage increase (if required), taxation decrease (ditto), the percentage of supplementary pension; on this occasion the machine also effects two transfers of constants (100 and 255) in operating addresses.

In this connection we point to the fact that the taxation increase percentage is only read from the card in the form of 10 per cent, since it is not possible to know beforehand if the earnings achieved will exceed 2,001 lei and, consequently, the 20 per cent increase will be established later by test and by the decision taken by the machine.

We then pass on to the second card, again beginning by reading the identifying code, and its correspondence with the code of the first card is tested concomitantly. This is particularly important since otherwise the error might occur of writing the number of a wage earner and then of introducing and, respectively, of computing the numerical values corresponding to another wage earner.

Further, the machine reads the tariff rate, the wage according to the standard and working days, concomitantly computing the salary per day and the salary for days not worked, and it then reads the days of holiday, sick leave and absence.

After determining the wage due for the days (hours) worked, the second stage of the first logical operation is carried out, a decision being taken on continuing the computation or stopping it owing to an eventual lack of agreement between the codes of the two cards; we have been compelled to place this stage relatively late owing to the insufficiency of the program assembly parts.

In case there is agreement, the machine continues its work by the concomitant reading and printing of the value of the premium or of the extra wage, printing the days of holiday, sick leave and absence; further, the fortnightly advance,value of instalments, reductions and other deductions, the working days being printed concomitantly.

The reading of the second card is thus ended and the machine passes on to a stop which prints the correct number on the pay-list, concomitantly performing the transfer of the constant (—2031.00) into an operating address. Further, the tariff rate and the wage according to standards are printed, the scientific title is printed and added in three different addresses, two of which contain the gross earnings achieved according to the working days for printing it, its totalling on the vertical and for taxation computing, and the third, which does not contain eventual premiums, for computing the supplementary pension.

On the occasion of the establishment and printing of the gross wage a new test is carried out, viz., the gross wage achieved is compared with the value of 2,000 lei, according to which two different variants for the computation of taxation are dealt with. The decision — to be taken later — allows the computations to be passed on, in the case of earned salaries up to 2,000 lei inclusive, to the variant assuming at most a 10 per cent taxation increase (if this be the case).

This variant again includes a test, viz. whether the earning achieved is up to 800 lei inclusive; in this case when taking the decision, the taxation increase is cancelled if it exists.

In case the wage exceeds 800 lei, the eventual taxation increase is carried out in the framework of the subsequent operations; however, this takes place after again repeating the tests from the beginning. Concomitantly, one passes on to the automatic selection of the *X* addresses according to the orders of the hundreds and thoudands of the earned wage. These selected addresses contain the constants shown in chapter 2.

Further, the various constant values in the automatically selected addresses are extracted and moved to the left or to the right for correct positioning and the taxation is computed, ultimately reaching the stop which prints and computes the eventual taxation increase.

In the case of the second variant the pre-determined conditions of decision send the machine on to another branch of computation which — in the first place — prints the taxation increase and ascertains if the gross earning achieved exceeds 2,031 lei or not, concomitantly cancelling the eventual taxation increase.

The new decision then taken sends the computation process either towards the determination of taxation increase, or towards a new test, viz. if there is taxation increase and if the wage is from 2,001 to 2,030 lei. If both the latter conditions are true, then the taxation so far computed is cancelled and the net wage (which is constant between the respective limits) is deducted from the gross wage, the increased taxation being thus determined.

One passes from here — in all five variants — to the printing and to the computation of taxation decrease after which the taxation is rounded off in favour of the wage earner and the taxation proper is printed.

Concomitantly with printing the taxation, this is added up in an address for the total per column.

The remaining operations to be carried out are generally operations for computing and concomitantly printing the value of the net wage, of the amount due as an advance, of the various forms of deductions and reductions, finally reaching the balance to be paid, after which the current number of the wage earner is again printed so that the possibility of identifying the respective position of the wage earner should exist at both ends of the wage list.

4. INTRODUCING THE DATA IN THE MACHINE

In view of automatically introducing the data in the computer it was found convenient to use 2 cards for each wage earner, viz:

— the first card, called *master card*, containing a numerical identifying code, the alpha part (consisting of surname, name, function and plan structure) and the numerical part comprising percentage of taxation increase depending on the existence or non-existence of children, percentage of taxation decrease depending on the conditions established by law;

— the second card, called the *current card*, which again includes the identifying code, the tariff rate and standard wage, days worked, holidays, sick leave and absences, premium or extra wage granted to the wage earner, advance paid at the middle of the month, eventual instalments, reductions and other deductions; thus, the second card comprises only numerical data.

It should be noticed that the first card is used month after month and is only modified when changes occur in the data considered relatively constant. The second card is duplicated in a proportion of approximately 35 per cent, in the case of the wage earners who have not worked all the working hours or days in the respective month, and in a proportion of over 60 per cent in the case of the wage earners having had no absence of any kind in the month considered.

In other words, the part to be punched month after month is minimum 29 and maximum 44 columns.

This systematizing allowed to achieve an important decrease in the volume of work carried out by the operator.

5. EFFICIENCY OF THE AUTOMATIC DRAWING UP OF PAY-LIST ON THE N.C.R. 395 MACHINE

The computation and effective drawing up of the wage lists for 1,000 wage earners requires a total duration of 12—14 hours (including card punching and changing forms for writing pay-lists).

Of this duration, the actual work on the computer represents approximately 8—9 hours, hence 1.2—1.4 operator/day (one operator/day is considered, according to legal standards, as being 7 hours). If we consider that the average wage of a specialist operator is 1,300 lei, then for the average time of 1.3 operator/day there correspond 66.30 lei.

The time required to punch 1,000 current cards amounts to 7—8 operator/hours the punching being performed, as already shown, on 29—44 columns. This time should not astonish us, since after the first hundred cards have been punched they can be taken over for processing by the machine, the work thus being continued in parallel, not to mention the fact that several punchers may be used concomitantly.

Having in view the mean wage of 1,100 lei for a punching operator, labour cost amounts to 46.35 lei.

Thus, the direct costs for live labour amount to 112.65 lei.

Accurate data regarding the computation of machine writing off not being available, an approximate value was established which, it is pointed out, is only given as a guide; in accordance with the above times, this writing off represents approximately 450 lei.

It may thus be considered that the level of costs for automatically drawing up the pay-lists of 1000 wage earners amount to 562 lei, this being, in our opinion, a sufficiently low cost. Besides, the decrease in time required to perform the work, the elimination of rush work in the wage computation offices or departments as well as, particularly, the increase in the degree of accuracy of the whole operation, have not been taken into account.

PROGRAMME POUR LE CALCUL DE L'IMPOT SUR LES SALAIRES ET POUR LA REDACTION AUTOMATIQUE DES LISTES DE SALAIRES A L'AIDE D'UN ORDINATEUR N.C.R. 395

Le calcul exact de l'impôt sur les revenus des salariés a été l'un des problèmes les plus difficiles posés lors de la mécanisation du calcul des salaires bruts et nets. Cette difficulté est due principalement à la méthodologie particulièrement complexe du calcul de l'impôt, celle-ci réclamant une mémoire d'une capacité d'au moins 6.000 adresses. Elle demande en outre de charger et, respectivement, de bloquer par des valeurs constantes au moins 5/6 de cette mémoire.

Une autre question qui se pose est celle de l'efficience de l'utilisation d'un ordinateur de capacité moyenne pour le calcul des salaires bruts et nets.

Afin de liquider ces insuffisances et de pouvoir effectuer le calcul des salaires sur des ordinateurs petits et très petits, un algorithme spécial a été élaboré. Il s'agit de délimiter plusieurs échelons d'impôts sur les sommes brutes et, respectivement, d'encadrer le reste des valeurs constantes auxquelles on ne peut renoncer dans un nombre de dix adresses, comprenant chacune 3 constantes. Le calcul des impôts sur les salaires se trouve ainsi réduit, même pour les cas les plus compliqués, à un maximum de 20 adresses.

ПРОГРАММА ДЛЯ РАСЧЕТА НАЛОГА НА ЗАРАБОТНУЮ ПЛАТУ И АВТОМАТИЧЕСКОГО СОСТАВЛЕНИЯ ПЛАТНОЙ ВЕДОМОСТИ НА ЭЛЕКТРОННОЙ МАШИНЕ N.C.R. 395

Одной из труднейших проблем механизации работ по вычислению заработной платы брутто и нетто является правильное обложение доходов получаемых работниками.

Эта трудность в основном объясняется особенно сложной методикой определения налога, требующей наличия памяти машины, способной зарегистрировать по крайней мере 6 000 адресов. В то же время предполагается загрузка и, соответственно, блокировка самое меньшее 5/6 соответствующей памяти постоянными величинами. Также ставится вопрос эффективности использования электронно-вычислительной машины средней мощности для расчета заработной платы брутто и нетто.

Для избежания этих трудностей и получения возможности переноса работ по расчету заработной платы и на небольшие вычислительные машины, был разработан специальный алгоритм, который составляет разграничения нескольких налоговых порогов. Таким образом, расчет налога на заработную плату снижается, даже в самом сложном случае, максимум до 20 адресов, из которых каждый содержит по 3 постоянных.