REGNE CENTRALEN

DANISH INSTITUTE OF COMPUTING MACHINERY

AN INTRODUCTION

REGNECENTRALEN was established in 1955 as a self-owned institution, connected with the Academy of Technical Sciences (ATV), with the purpose of developing manufacturing end selling electronic computers and data processing systems, as well as performing various types of data processing at its own service-centres.

REGNECENTRALEN has, after starting modestly in 1955 – with less than 10 employees – developed into an organization with over 200 staff, the total of whose qualifications and experience are placed at the disposal of business and industry for the solution of data-processing problems, from calculations in the natural and mathematical sciences to office automation and the education and training of customers' staff.

REGNECENTRALEN has concentrated its resources, mainly into the development of electronic data-processing systems but has additionally, tackled many problems of a special nature. The first computer to be developed and built in Denmark was the DASK, introduced in 1958. DASK is well-known in Denmark in connection with a number of projects – for instance, DASK made prognoses for the last General Election, and the results were broadcast in Radio and T.V. Since DASK was introduced in 1958, it has been considerably improved by the addition of several external units, which have increased DASK's effectiveness as a commercial data-processing installation. Of this special equipment the following can be mentioned: Card Reader, Card Punch, Magnetic Tape and Line Printer. Late in 1961, the prototype of a new data-processing system named GIER was ready. GIER, which is a fast and fully-transistored machine, had been tested during 1960/61 and attracted so much attention that it was decided to make it in serial production and sell it to businesses and institutions. Since the autumn of 1961, 16 GIER systems have been installed in Denmark, Norway, Germany and France.

REGNECENTRALEN is expanding its production of GIER. The next series is being built in a newly-established factory in Præstø. Besides building GIER, this factory will produce the peripheral equipment that brought the GIER system into the limelight as a medium-sized, effective and economic data-processing system.

Especial mention must be given to the very effective Card Reader and the extremely fast Punched Tape Reader.

The Card Reader can sense 80 columns of punched information as well as 27 columns of pencil-marked information at the rate of 60.000 cards/hours.

The Punched Tape Reader which has been designed and built exclusively by REGNECENTRALEN's own technicians reads tape at 2000 char./sec.

REGNECENTRALEN has, so that full use can be made of Gier, made great efforts to establish a library of standard programs, which will be at the users's disposal. Likewise, programs of general interest, written by GIER users are systematically being collected for distribution to other GIER users.

REGNECENTRALEN has, furthermore, developed a programming language – SLIP – with mnemotechnical symbols for ease of programming.

Even greater efforts have been made in the preparation of GIER ALGOL 60 (a so-called problem-oriented programming language). The GIER version of ALGOL 60 is one of the fastest and most effective, to be found to-day, and has attracted attention from all over the world.

REGNECENTRALEN has periodic training-courses, both for its own personnel and for personnel from other concerns. These courses are co-ordinated with the training-programs held in Norway and Sweden by NORSK REGNESENTRAL and MASKIN-NÄMDEN, respectively. As backing for these training programs, a large number of articles and manuals have been published, and have been used by Polytechnics and Universities, among others.

REGNECENTRALEN's SERVICE CENTRES which at present are situated in Copenhagen, Århus and Aalborg, will shortly be extended with an additional 2 or 3 centres, forming a network covering the whole of Denmark and geographically situated so that there will always be a SERVICE CENTRE within reasonable distance.

All the SERVICE CENTRES will be equipped with identical EDP installations, so that jobs and training can be made at each and every centre. Hereby the following advantages:

A service customer will always be able to get his job made at another service centre if the one centre is overloaded.

The standard programs prepared by REGNECENTRALEN for special types of concerns, eg. payroll-programs, can be used by each and every service centre.

Large business with branch offices can get their data processed locally, and thus without communication problems.

REGNECENTRALEN's SERVICE CENTRES are fully supported by the CDC-1604 A installed in Copenhagen. The CDC installation is at the moment the largest in the land and in a position to process really large and complicated jobs.

REGNECENTRALEN's SERVICE CENTRES are already processing a large number of different types of jobs.

OFFICE-AUTOMATION

Sales statistics and calculation of gross-profits per customers or per item.

Commission Accounting.

Purchase Tax Accounting.

Tax Returns

Payroll including: Printing of Paypackets, Statistics, Income Tax Returns and Holiday Pay Accounts.

Debitor Accounting including Statements and Dunning letters.

Calculation of Interest, Cash Balances, Deposits and Withdrawls and Book-keeping for Banks and Savings Banks.

OPERATIONS RESEARCH

Stock Record, Stock Control, Stock-taking, Forecasting.

Production-planning including: man-power distribution, machine-loading and supplementary production.

Linear programming.

Pert-Network Analysis.

Simulation.

TECHNICAL CALCULATIONS

Road-building.

Chemical engineering.

Ship-construction.

GIER SYSTEM

SPECIFICATION

CENTRAL PROCESSING UNIT

GIER is a binary, parallel, single address electronic computer with built-in floating point arithmetic and powerful facilities for automatic address-modification and indexing.

The GIER central processing unit consists primarily of a number of control registers and an immediate-access ferrite-core store – the IAS – of 1024 words of 42 bits. (Each word is equivalent to 7 alpha-numerical characters or 12 digits). The cycle time is 10 μsec.

In addition to the IAS, there is a 2nd-level store – the DRUM – which has 320 tracks of 40 words each, giving a total capacity of 13,824 words. Drum transfers (in which information is copied from the IAS to the drum and vice-versa) are made simultaneously with other operations in GIER, at the rate of 20 ms per track. The capacity of the drum store may be extended by the addition of a further 2 drums, to a maximum of 38,400 words.

In order to cater for additional peripheral units and real-time phenomena, the central processor has been equipped with a general purpose 2-way DATA CHANNEL and an INTERRUPT unit. Information in the data channel can be transferred to and from the IAS at the rate of 5 μsec per word of 42 bits (in parallel). The interrupt unit comprises 12 interrupt channels and an associated masking register. Interrupts are signals which notify the computer of internal or external conditions that have arisen and require immediate action by the computer. An interrupt passing the mask will cause a program under execution to be interrupted, and a special subroutine dealing with the appropriate condition will be performed, after which control is returned to the original program.

The IAS may be supplemented by another 2nd level store – the BUFER – which is also a ferrite core store, with a capacity of 4096 words. One or two of these buffers may be connected to the IAS via the data channel, with a rate of transfer of 13 μsec/word. Up to 4 magnetic tape units may be connected to GIER via each buffer.

Operation times	addition	multiplication	division
fixed point	49 μsec.	180 μsec.	270 μsec.
floating point	100 μsec.	170 μsec.	220 μsec.

	weight	height	width	depth
Standard Processor	500 kg	193 cm	144.6 cm	54.2 cm
Buffer Store	400 kg	193 cm	144.6 cm	54.2 cm

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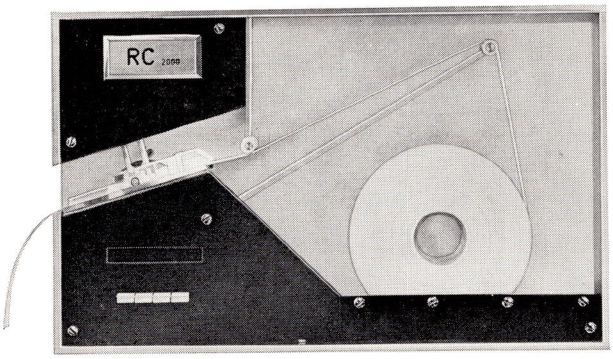
Correlation of Bits with Integers and Decimal Digits

Number of bits	Maximum unsigned integer	Maximum No of decimal digits
1	1	0
2	3	
3	7	
4	15	1
5	31	
6	63	
7	127	2
8	255	
9	511	
10	1 023	3
11	2 047	
12	4 095	
13	8 191	
14	16 383	4
15	32 767	
16	65 535	
17	131 071	5
18	262 143	
19	524 287	
20	1 048 575	6
21	2 097 151	
22	4 194 303	
23	8 388 608	
24	16 777 216	7
25	33 554 431	
26	67 108 863	
27	134 217 727	8
28	268 435 455	
29	536 870 911	
30	1 073 741 823	9
31	2 147 483 647	
32	4 294 967 295	
33	8 589 934 591	
34	17 179 869 183	10
35	34 359 738 367	
36	68 719 476 735	
37	137 438 953 471	11
38	274 877 906 943	
39	549 755 813 887	
40	1 099 511 627 775	12
41	2 199 023 255 551	
42	4 398 046 511 103	

GIER SYSTEM

SPECIFICATION

PUNCHED TAPE READER
RC 2000



For the input of programs, data, etc. to the GIER system REGNECENTRALEN's new, high-speed, photo-electric punched tape reader – RC 2000 – is used. In the construction of RC 2000 the emphasis has been placed on reducing the number of moving parts to an absolute minimum by the use of electronic functions. The construction of the reading-head allows spliced tape to be read; splicing is made by means of special adhesive tape.

The reader is furnished with an internal ferrite buffer of 256 8-bit words situated between the reading-head and the input to GIER. The state of this buffer is used to regulate the speed of the servo traction motor which feeds the tape.

By means of replaceable reading heads, the reader can be adjusted to read standard 5/6/7/8 channel paper tape, and also, for instance, Olivetti's 6 channel tape with rectangular holes. The maximum speed of the reader is 2000 char./sec. (5 m tape/sec.), the speed being otherwise dependent on the speed with which the buffer can be emptied.

Off-line converting, to GIER magnetic tape units, for instance, is posible.

weight	height	width	depth
30 kg	32 cm	52 cm	44 cm

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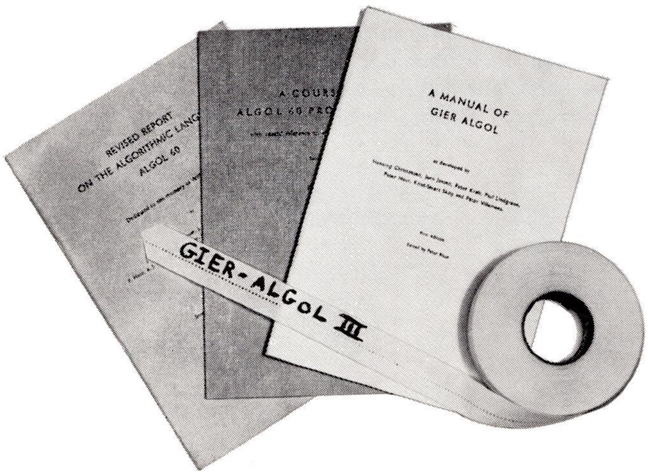
GIER SYSTEM

SPECIFICATION

ALGOL 60 COMPILER



ALGOL 60 (ALGOrithmic Language) is an international programming language, i.e. a language which can be translated, by means of an electronic computer, into the language of the computer itself: the so-called machine code.

The main advantages of programming in ALGOL over programming in machine code are:

1) ALGOL is problem oriented – therefor programming is easier and less time-consuming; this applies especially to the corrections that usually have to be made during the preparation and revision of programs.

2) An ALGOL program is an English language description as well as a program and can thus be directly understood by others (also non-programmers).

3) ALGOL 60 is independent of the computer – therefore ALGOL programs may be used in electronic computers of various type and manufacture.

ALGOL has been constructed with the description of numerical and logical processes in mind. Thus an ALGOL program consists of a number of statements and expressions which describe, on the one hand, the calculations and, on the other hand, the sequence in which they are to be executed. The basic symbols are: digits, letters, logical values and ALGOL delimeters. By means of a special grammar the basic symbols are grouped to represent various quantities: simple variables, arrays, labels, switches and procedures.
The procedures permit the user to introduce quite new elements into the language in which he is writing – elements that can be specially adjusted to the individual problem. This makes ALGOL extremely flexible.

ALGOL programs for GIER are punched in 8-channel tape which is then translated by means of the GIER ALGOL Compiler. During the translation, which is performed at a speed equivalent to the generation of about 2000 machine instructions/min., the program is tested for errors in grammar and relevant error message are output on the typewriter. The object programs generated by the compiler are almost as effective as "hand-made" programs – which is partly due to the compiler's fully automatic, dynamic administration of the immediate – acces and drum storages.
The compiler occupies 5,000 of the 12,800 words on the drum.
A new edition of the compiler is being prepared – an edition with which it will be possible to use magnetic tape as well as procedures in machine code.

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SELECTED EXECUTION TIMES IN
GIER ALGOL

The execution time of a program in GIER ALGOL depends not only on its individual algorithmic constituents, but also on the loop structure and the number of variables declared at the time when each part of the program is executed. The times given below are based on actual timings at the machine and include an average track administration time such as it may be expected in loops which may be accomodated completely in the IAS. Substantially longer execution times will result under the following circumstances: a) Frequent transfers of program tracks from drum are necessary. b) A major part of the execution time of the program is spent in a loop with a cycle time of the order of 2 milliseconds or less and this loop happens to have been placed across a program track transition by the compiler. A program suffering from the latter of these calamities may be cured by insertion of a suitable amount of neutral program (r := r or the like) before the final **end.**

ALGORITHMIC ENTITY	EXAMPLE	EXECUTION TIME, MILLI-SECONDS
Addition	a + b	0.12
Multiplication	a × b	0.18
Division	a / b	0.21
Square	a ↑ 2	0.18
Cube	a ↑ 3	0.4
Power, integer exponent	a ↑ i	
abs (exponent) = 1		3.8
10		5.5
100		8
1 000		10
10 000		12
100 000		14
1 000 000		16
Power, real exponent	a ↑ r	12
Subscripted variable		
1 subscript	A[i]	0.9
2 subscripts	B[i, j]	1.2
3 –	C[i, j, k]	1.5
Step-until element, constant step and simple upper limit, each loop	**step** 1 **until** n	0.6
Block with simple variables	**begin real** a; **end**	2.0
Block with array declaration	**begin array** a [1:10]; **end**	3.6
Reference to formal parameter called by name		
Actual parameter is		
simple		0.4
expression		3.2
array identifier		0.0
switch idetifier		0.0
procedure identifier		0.0
Call of declared procedure		
having an empty procedure body		
No parameter	P;	4.7
1 parameter	Q(a);	5.3
2 parameters	R(a, b);	5.7
3 –	S(a, b, c);	6.3
Call of standard procedure		
abs	abs(x)	0.17
arctan	arctan(x)	6.6
cos	cos(x)	6.0
exp	exp(x)	5.8
ln	ln(x)	5.6
sign	sign(x)	3.2
sin	sin(x)	5.8
sqrt	sqrt(x)	6.2

GIER SYSTEM

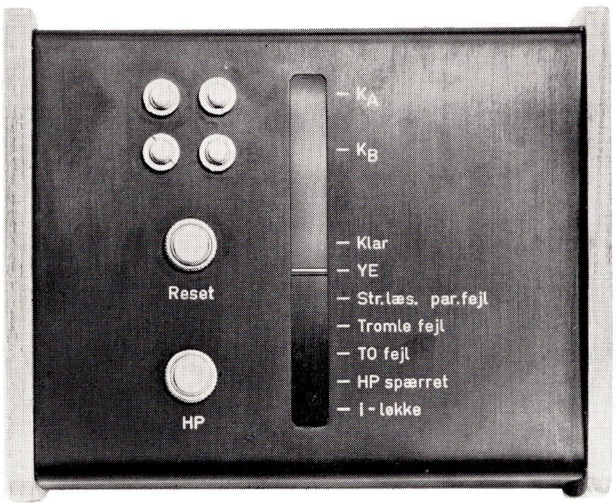
SPECIFICATION

THE ADMINISTRATIVE SYSTEM

HELP

GIER is equipped with an administrative system called HELP for facilitating testing and runnig programs. The systems comprises an interrupt mechanism, activated through the HP button, a central administration program monitored by typewriter input, and a number of subroutines among which the input program SLIP is the largest and most important. The others are subroutines for normal output, for storage dumps, for initializing, for comparison of sections of storage, and for tracing a program during the run.

The main features of the central administration and some of the utility subroutines are outlined here, while SLIP is treated in another specification.



HP button and the HELP administrator. Since the IAS is rather small the system is designed so that it occupies only 10 cells of the IAS during the run of a program. On the other hand it is obvious that, during an interrupt, the system must be able to use a much larger part of the IAS and yet be able for restore it's contents before running is continued.

This is achieved by reserving the last 26 tracks of the drum for an "image" of the IAS during the interrupt. Since the system itself occupies the first 58 tracks of the drum the total store available to the programmer consists of 1014 cells of the IAS and about three quarters of the 320 drum tracks.

In the first 32 of the 58 reserved tracks writing is inhibited, so that it is impossible during a normal run to destroy the fundamental part of the HELP system.

At any stage of a run can call for an interrupt by pressing the HP button with the following effect: The contents of the registers and the IAS are stored in the image on the last 26 drum tracks, and control is transferred to the HELP administrator which then waits for typewriter input describing what action is required. It is now possible to activate any of the HELP subroutines or to make corrections in the stored program.

When the desired interruption has been performed, an end signal must be typed. Then the IAS and the registers are restored from the image and control is transferred to that point of the program at which it was interrupted.

HELP utility subroutines. The subroutines may be roughly divided into three categories according to their use before, during, and after a run:

a) **Before a run** is commenced one may use a subroutine for initializing the whole computer. After input of the program this can be copied to an unused part of the drum for later comparisons or for restoring the initial situation if something goes wrong during the run.

b) **During the run** one may use tracer subroutines i.e. subroutines which trace a program's activities making reports, for instance, when each jump is performed or when the contents of a selected register or cell change value. One may, also, cause storage dumps to be made every time a selected instruction is executed.
HELP includes furthermore subroutines which can be used for the standard output of text and numbers.

c) **After the run** subroutines may be used for dumps of any part of the store, for comparison between the program before after the run, and for output of the corrected program in a condensed form suitable for fast input.

If a user wants additional facilities it is easy to extend the HELP system to include new subroutines either in addition to or instead of some of the standard routines. If, on the other hand, the maximum available storage is required it is possible to confine the HELP systeme to 26 + 39 drum tracks instead of 26 + 58 tracks, thus sacrificing some of the facilities. But the 26 + 39 tracks are necessary if the interrupt mechanism, the administrator and the input routine SLIP is to be kept intact.

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GIER SYSTEM

SPECIFICATION

THE INPUT PROGRAM SLIP

The basic programming language used with GIER is called the SLIP language, i.e. the language accepted by the input routine SLIP (which means Symbolic Language Input Program). SLIP reads instructions, strings of text, and three types of numbers namely fixed-point and floating-point numbers and integers which may be packed with a maximum of four integers in each cell. The input may include comments (in square brackets, for instance) which are ignored by SLIP.

SLIP is a subroutine in HELP and is always called via the HELP administrator.

An important feature is that symbolic addressing is allowed in instructions. This means that the address constant and the increment of an instruction may be symbolic names whose values are defined through the use of the names as labels elsewhere in the program; the class of names available is, however, rather restricted. With respect to the use and scope of such names the SLIP language has a block structure very much like that of ALGOL:

a) Names must be declared in a block head before use and can be used within the block whose head contains the declaration, i.e. they are local to that block.

b) If a name is declared in each of several blocks inside each other, the name may have different values on each block level.

In the design of SLIP, special consideration has been made for ease in the use of symbolic names coupled with relative addressing.

During input an extensive syntactical check is performed and whenever an error is found an appropriate message is typed out. After this, SLIP continues to read in the program, skipping the remainder of the erroneous instruction or number. This implies that all the syntactical errors are often found in one sweep, and it also implies that if there is only one or two mild errors in a program, these may be corrected on the spot by means of HELP, and a test run can be carried through in spite of these errors.

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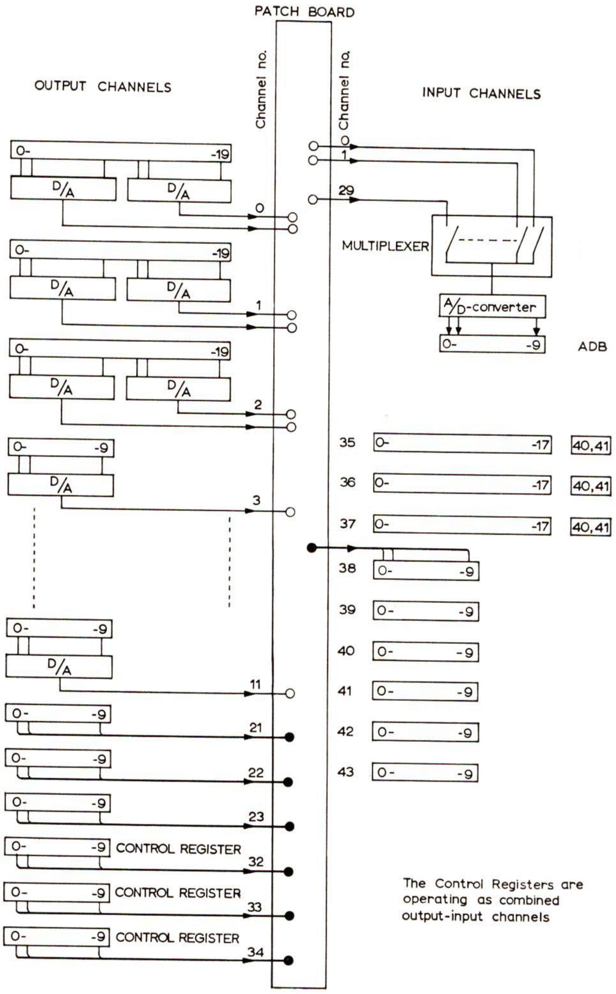
GIER SYSTEM

SPECIFICATION

PROCESS CONTROL UNIT



To provide a means of communication between GIER and real-time physical processes such as analogue computers and industrial implementation systems, the GIER system can be extended by the addition of a Process Control Unit. This unit is connected to GIER via the data channel in the central processor and consists of a number of channels capable of receiving and sending information in the form of digital and analogue signals with appropriate A/D–D/A conversion.

Datatransfers are completely controlled by the computer program. However, in order to make effective use of the process control unit it will often be necessary to operate it in connection with the interrupt unit. It may be necessary to attach DC amplifiers for signal-matching purposes.

The number of inputs and outputs currently available are as follows:

30 inputs for analogue signals including electronic multiplex and common A/D converter with buffer register.

12 inputs for digital information (9 10-bit registers and 3 20-bit registers).

15 outputs for analogue signals with individual buffer registers and D/A converters.

6 outputs for digit information (6 10-bit registers).

The above constellation has been designed and is being used for a linkage between GIER and an analogue computer and, incidentally, for several other research activities in the field of real-time computer control. The requirements for each user of the process control unit, will naturally be individual but the unit can however be adapted to almost every conceivable application.

1000-11-63

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GIER SYSTEM SPECIFICATIONS-ERRATA

REGNECENTRALEN — JANUARY 1964

CENTRAL PROCESSING UNIT
Lines 4–7 should read:

The GIER central processing unit consists primarily of a number of control registers and an immediate-access ferrite-core store – the IAS – of 1024 words of 42 bits. (Each word is equivalent to 7 alphanumerical characters or 12 digits). The cycle time is 10 μsec.

The last 7 lines should read:

routine dealing with the appropriate condition will be performed, after which control is returned to the original program.

The IAS may be supplemented by another 2nd level store – the BUFFER – which is also a ferrite core store, with a capacity of 4096 words. One or two of these buffers may be connected to the IAS via the data channel, with a rate of transfer of 13 μsec/word. Up to 4 magnetic tape units may be connected to GIER via each buffer.

PUNCHED TAPE READER RC 2000
The last two lines should read:

Off-line converting, to GIER magnetic tape units, for instance, is possible.

CAROUSEL
The first 4 lines should read:

The Carousel ECM 64 from Facit is a magnetic tape store consisting of 64 replaceable spools located on the periphery of a rotary platter (the Carousel) which can be rotated in either direction. The Carousel may be connected to GIER via a buffer of 4,096 words.

Lines 12–14 should read:

on the tape, a "read-after-write-check" is performed. Tape can be rewound under program-control and in the new model, ECM 64-A, it is also possible to pre-select a block before information is to be transferred.

PROCESS CONTROL UNIT
The 7th line from the foot of the page should read:

6 outputs for digital information (6 10-bit registers).

THE ADMINISTRATIVE SYSTEM HELP
The first 6 lines should read:

GIER is equipped with an administrative system called HELP for facilitating testing and running programs. The system comprises an interrupt mechanism, activated through the HP button, a central administration program monitored by typewriter input, and a number of subroutines among which the input program SLIP is

HP button and the HELP administrator. Since the IAS is rather small the system is designed to that it occupies only 10 cells of the IAS during the run of a program. On the other hand it is obvious that, during an interrupt, the system must be able to use a much larger part of the IAS and yet be able to restore its contents before running is continued.

Lines 15–21 should read:

At any stage of a run one can call for an interrupt by pressing the HP button, with the following effect: The contents of the registers and the IAS are stored in the image on the last 26 drum tracks, and control is transferred to the HELP administrator which then waits for typewriter input describing what action is required. It is now possible to activate any of the HELP subroutines or to make corrections in the stored program.

Lines 38–44 should read:

HELP includes, furthermore, subroutines which can be used for the standard output of text and numbers.

c) **After the run** subroutines may be used for dumps of any part of the store, for comparison between the program before and after the run, and for output of the corrected program in a condensed form suitable for fast input.

ALGOL 60 COMPILER
The 5th and 6th lines from the foot of the page should read:

the compiler's fully automatic, dynamic administration of the immediate–access and drum storages.

LIBRARY SERVICE
Class 3, 4 and 5 of the classification system (on the LH side of the page) should read:

3. **Mathematics**
3.3 Approximation and Interpolation

4. **Mathematical Statistics**
4.0 General
4.1 Data Description
4.2 Correlation and Regression Analysis
4.3 Analysis of Variance
4.4 Multivariate Analysis
4.5 Time Series

5. **Operational Research**
5.2 Scheduling

TABLE OF CODES
The codes for the ON-LINE TYPEWRITER which can be punched using the AUX code should be:

RR	aux + <
BR	aux + B

GIER SYSTEM

SPECIFICATION

INSTALLATION LIST

APRIL 1964

NAME	LOCATION	COUNTRY	BUSINESS	DATE INSTALLED
1. Royal Danish Geodetic Institute	N. Farimagsgade 3 Copenhagen K	Denmark	Geodetics	Dec. 1960
2. Haldor Topsøe	Baunegaardsvej 73 Hellerup	Denmark	Chemical Engineering	Dec. 1961
3. Danish Atomic Energy Research Establishment	Risø	Denmark	Research and Development	Febr. 1962
4. A/S Regnecentralen	Guldsmedegade 3 Århus C	Denmark	Service Centre and Development	April 1962
5. A/S Regnecentralen	Smallegade 2 Copenhagen F	Denmark	Research and Education	May 1962
6. Hydro- og Aerodynamic Laboratory	Hjortekærsvej 99 Kgs. Lyngby	Denmark	Engineering and Development	June 1962
7. University of Copenhagen The Observatory	Østervoldgade 3 Copenhagen K	Denmark	Research	Aug. 1962
8. Bassin d'ESSAIS des Carenes	Boulevard Victor 6 Paris 15	France	Research	Oct. 1962
9. Technical University of Norway Division of Automatic Control	Trondheim	Norway	Research	Dec. 1962
10. Technical University of Norway SINTEF	Trondheim	Norway	Education	Febr. 1963
11. University of Copenhagen H. C. Ørsteds Institute (Mathematical Institute)	Universitetsparken 5 Copenhagen Ø	Denmark	Education Research	May 1963
12. OECD Halden Reactor Project	Halden	Norway	Research and Development	April 1963
13. A/S Regnecentralen	Falkonerallé 1 Copenhagen F	Denmark	Service Centre	July 1963
14. Max-Planck-Institut für Kernphysik	Saupfercheckswe g (69) Heidelberg	W. Germany	Research and Development	Oct. 1963