March 13, 1962 M. PAPO ET AL 3,024,989

TABULATING AND COMPUTING MACHINE

Filed April 25, 1960

32 Sheets-Sheet 1

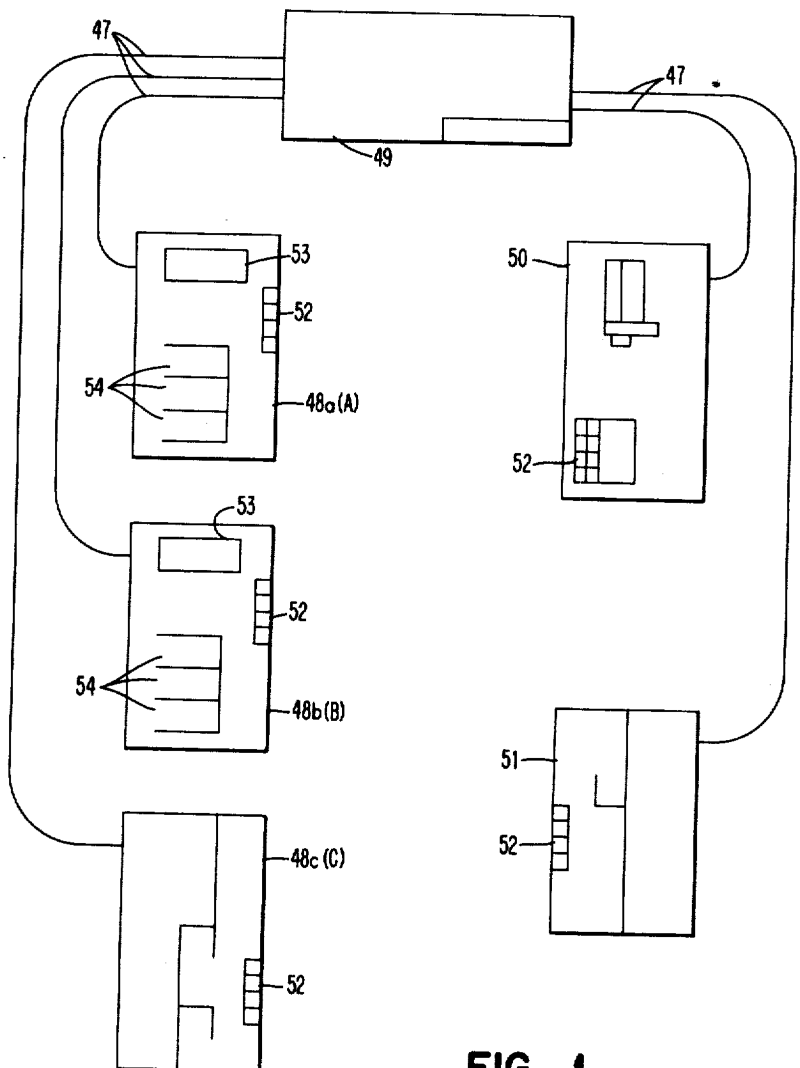


FIG. 1

INVENTORS
MAURICE PAPO
EUGENE KOUZMINE
BY John P. Dority
ATTORNEY

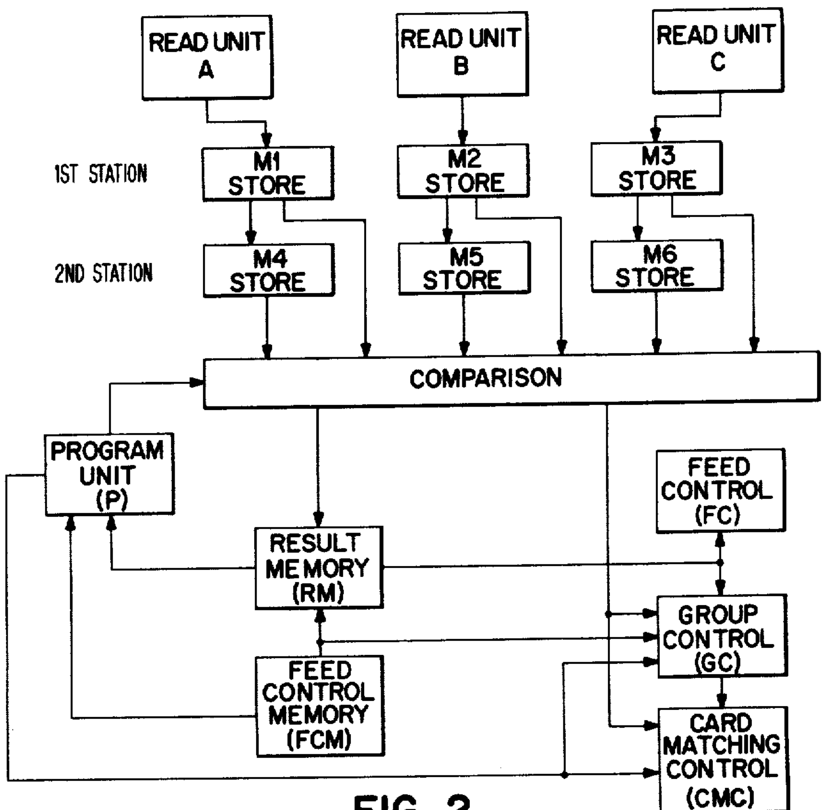


FIG. 2

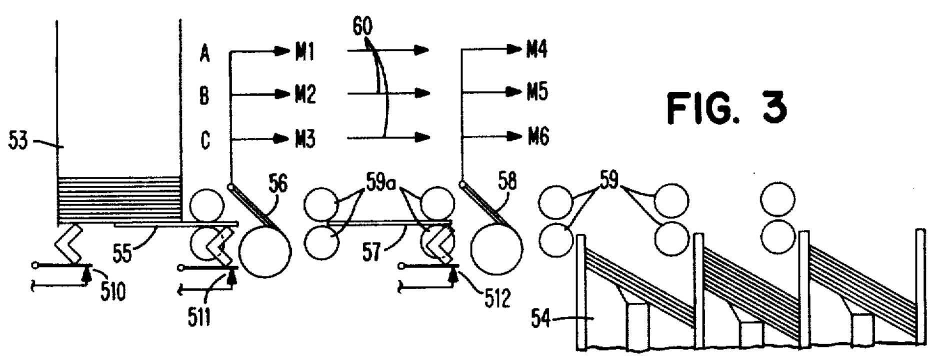


FIG. 3

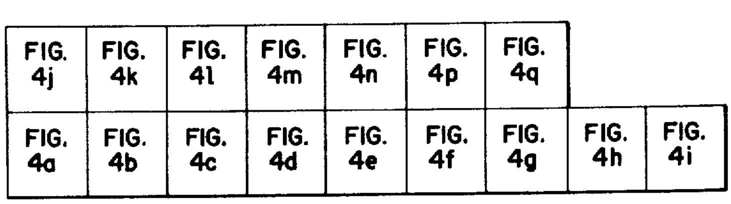


FIG. 5

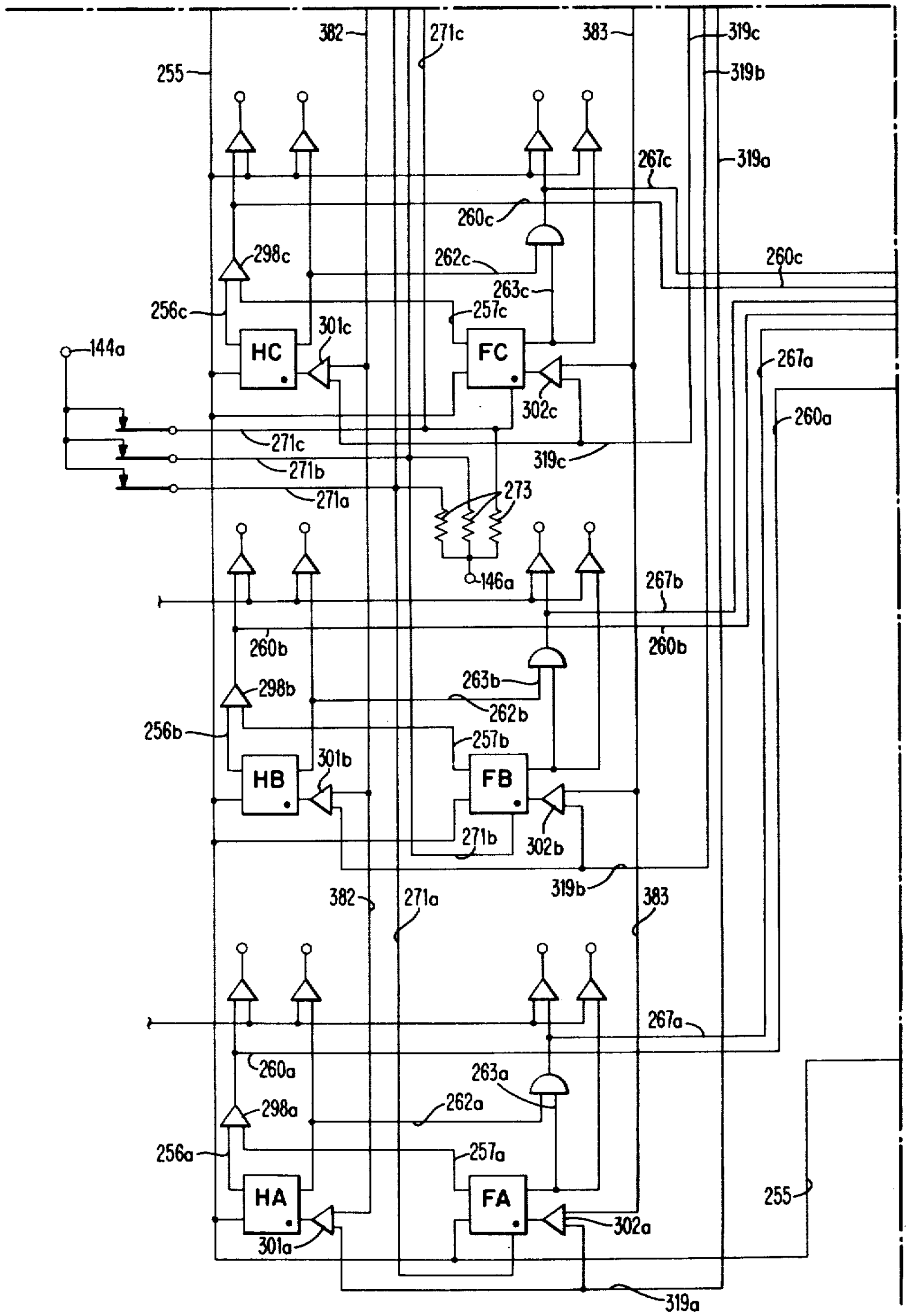

382
271c
383
319c
319b
255
319a
267c
260c
260c
298c
262c
263c
256c
257c
301c
HC
FC
144a
267a
302c
260a
271c
271b
319c
271a
273
146a
267b
260b
260b
263b
298b
262b
256b
257b
301b
HB
FB
271b
302b
319b
382
271a
383
267a
260a
263a
262a
298a
256a
257a
HA
FA
255
301a
302a
319a

FIG. 4a

TABULATING AND COMPUTING MACHINE

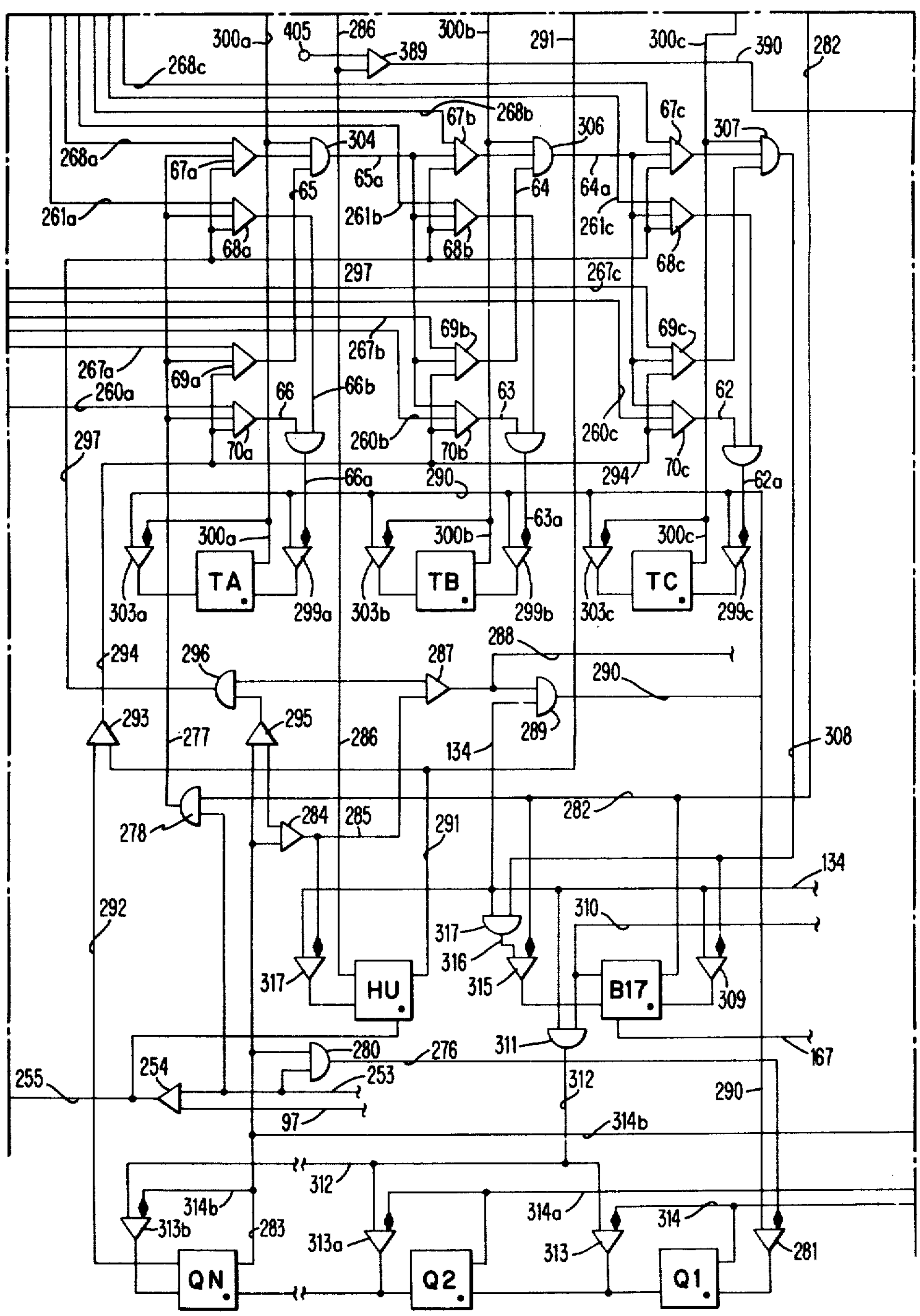


FIG. 4b

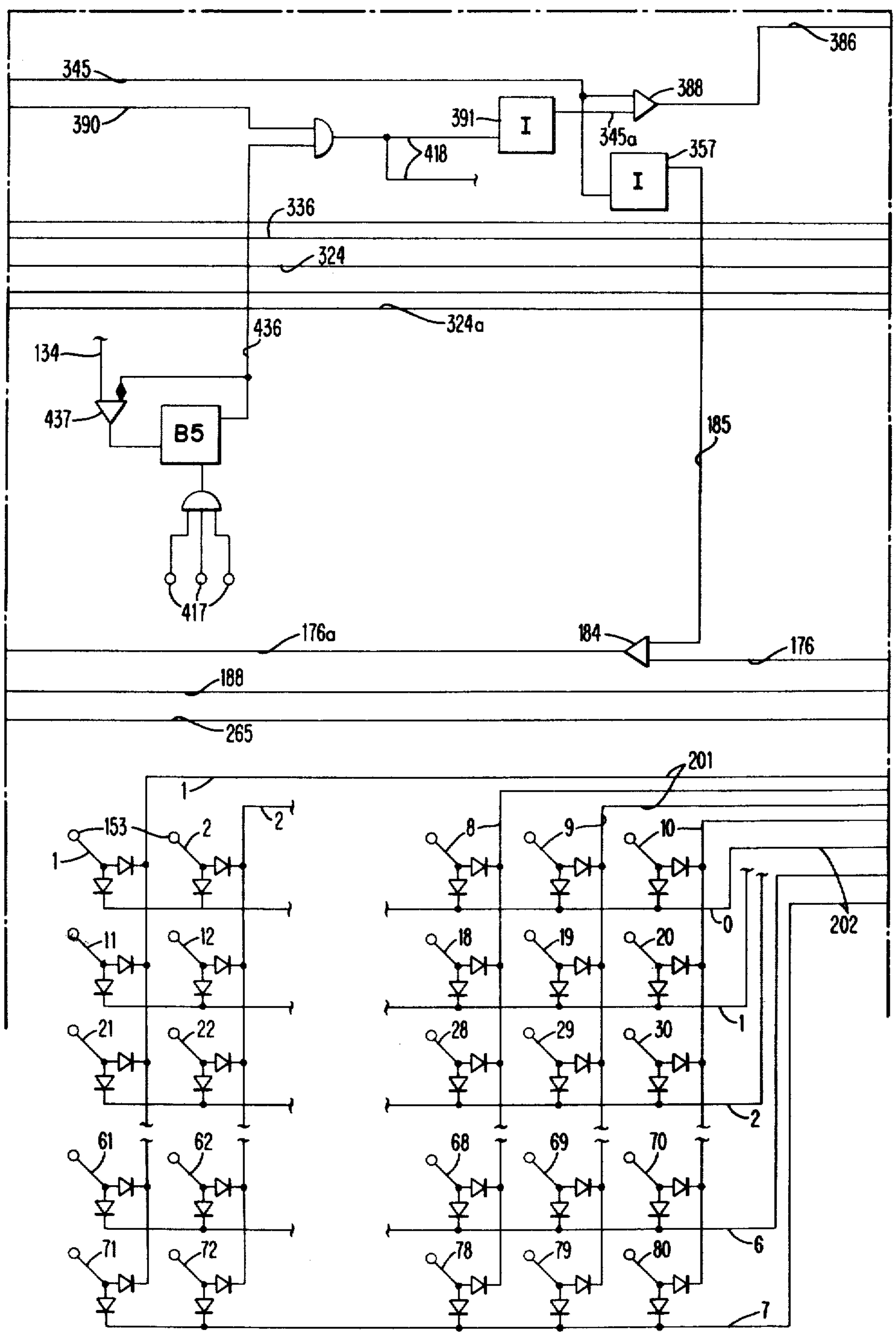

345
390
391
I
388
386
345a
357
I
418
336
324
324a
436
134
437
B5
185
417
176a
184
176
188
265
201
1
2
153
1
2
8
9
10
0
202
11
12
18
19
20
1
21
22
28
29
30
2
61
62
68
69
70
6
71
72
78
79
80
7

FIG. 4d

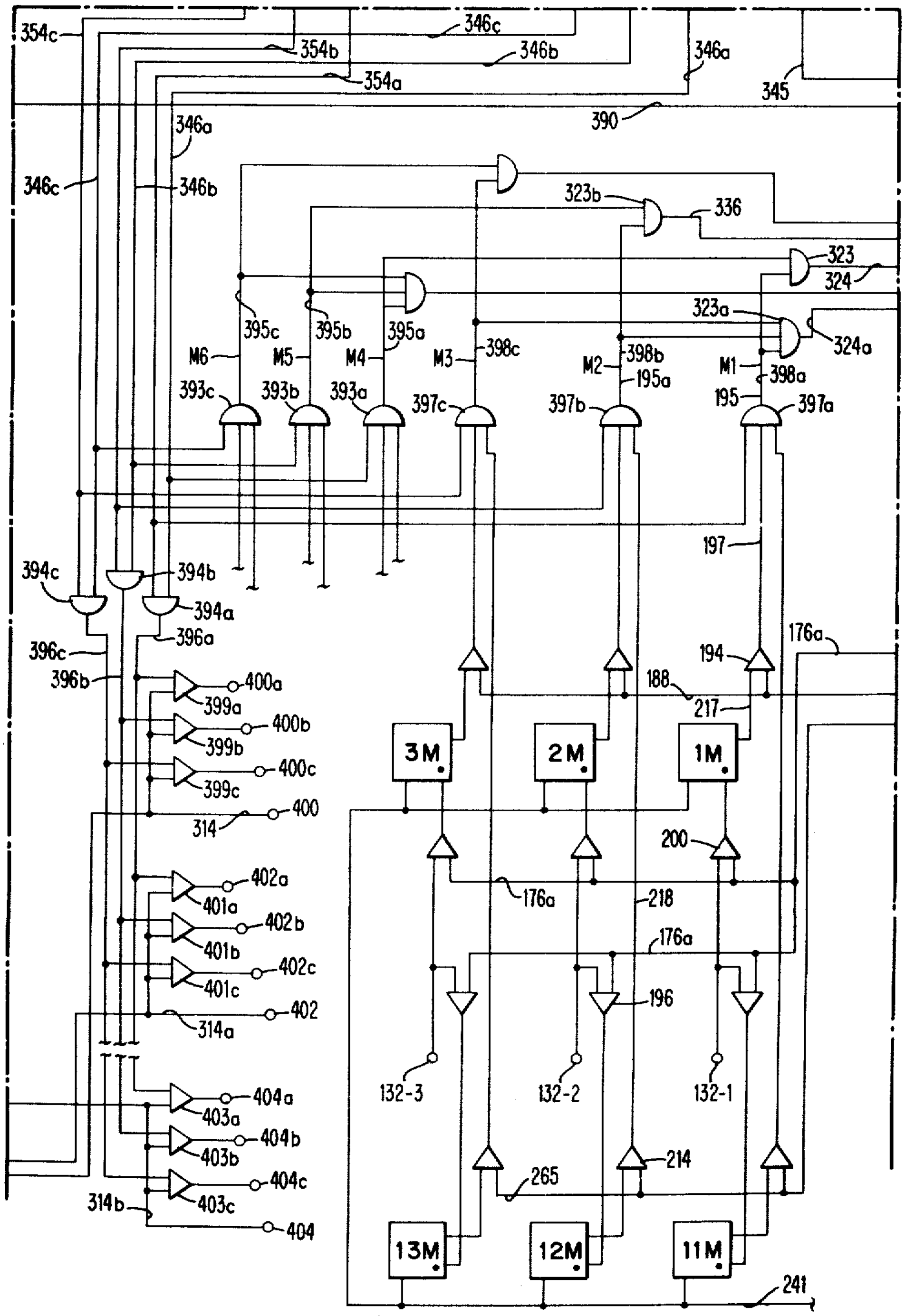

354c
346c
354b
346b
354a
346a
345
390
346a
346c
346b
323b
336
323
324
323a
324a
395c
395b
395a
M6
M5
M4
M3
398c
M2
398b
195a
M1
398a
195
393c
393b
393a
397c
397b
397a
197
394c
394b
394a
396c
396a
396b
176a
194
188
217
400a
399a
400b
399b
400c
399c
400
314
3M
2M
1M
200
176a
218
402a
401a
402b
401b
402c
401c
402
314a
196
132-3
132-2
132-1
404a
403a
404b
403b
404c
403c
314b
404
265
214
13M
12M
11M
241

FIG. 4c

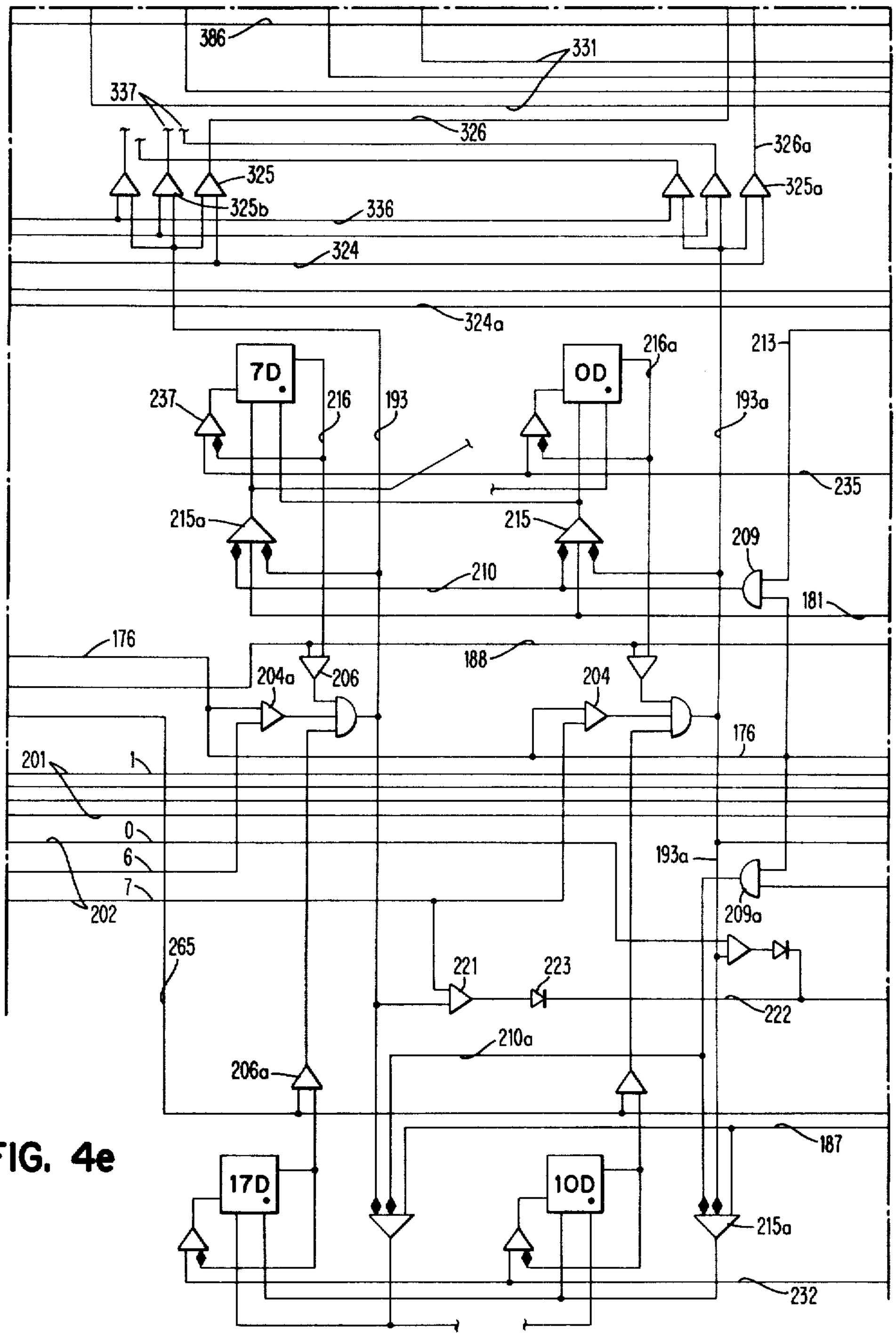

386
331
337
326
326a
325
325a
325b
336
324
324a
7D
0D
216a
213
237
216
193
193a
235
215a
215
209
210
181
176
188
204a
206
204
176
201
1
0
6
7
202
193a
209a
265
221
223
222
210a
206a
187
17D
10D
215a
232

FIG. 4e

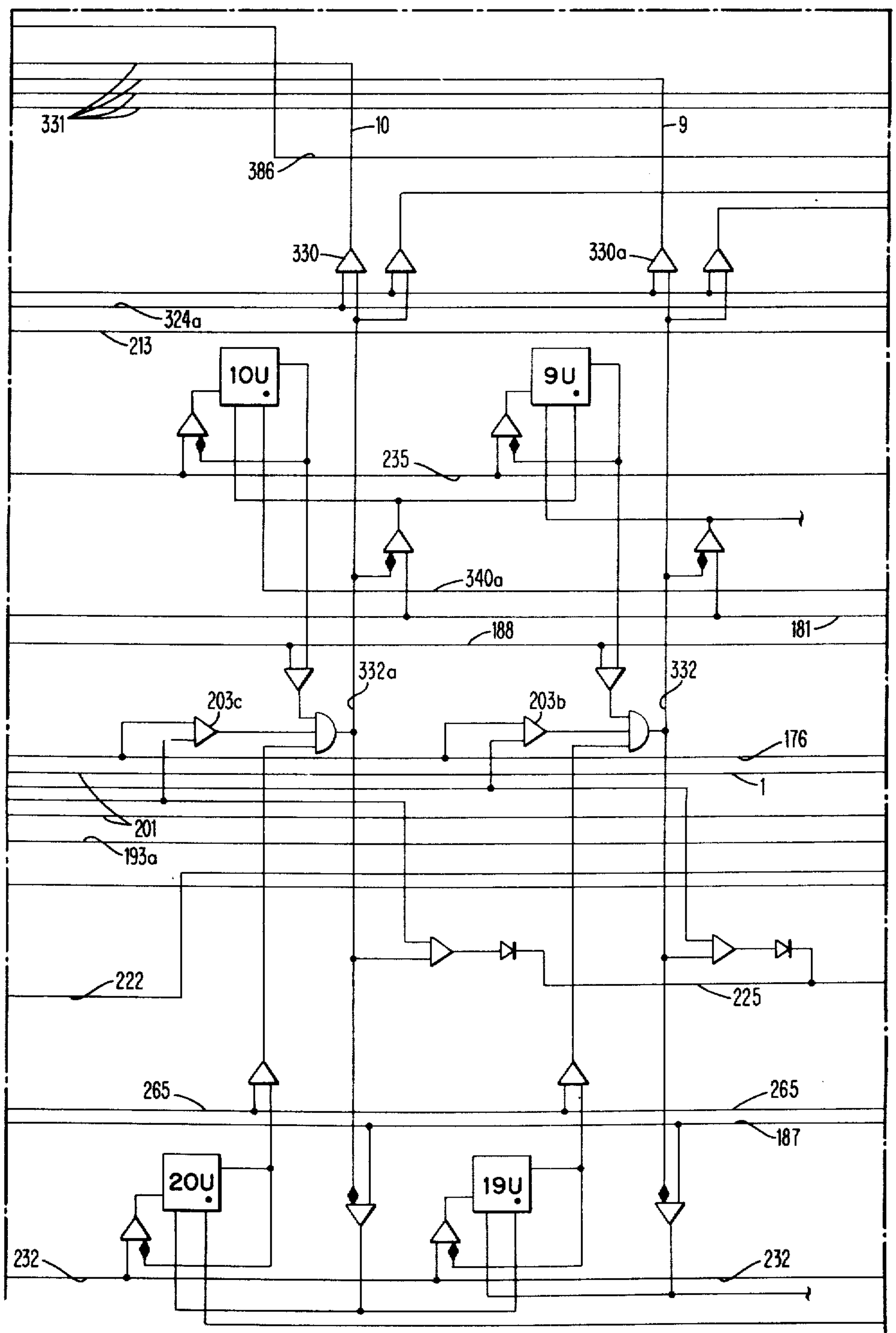

331
10
9
386
330
330a
324a
213
10U
9U
235
340a
188
181
332a
332
203c
203b
176
1
201
193a
222
225
265
265
187
20U
19U
232
232

FIG. 4f

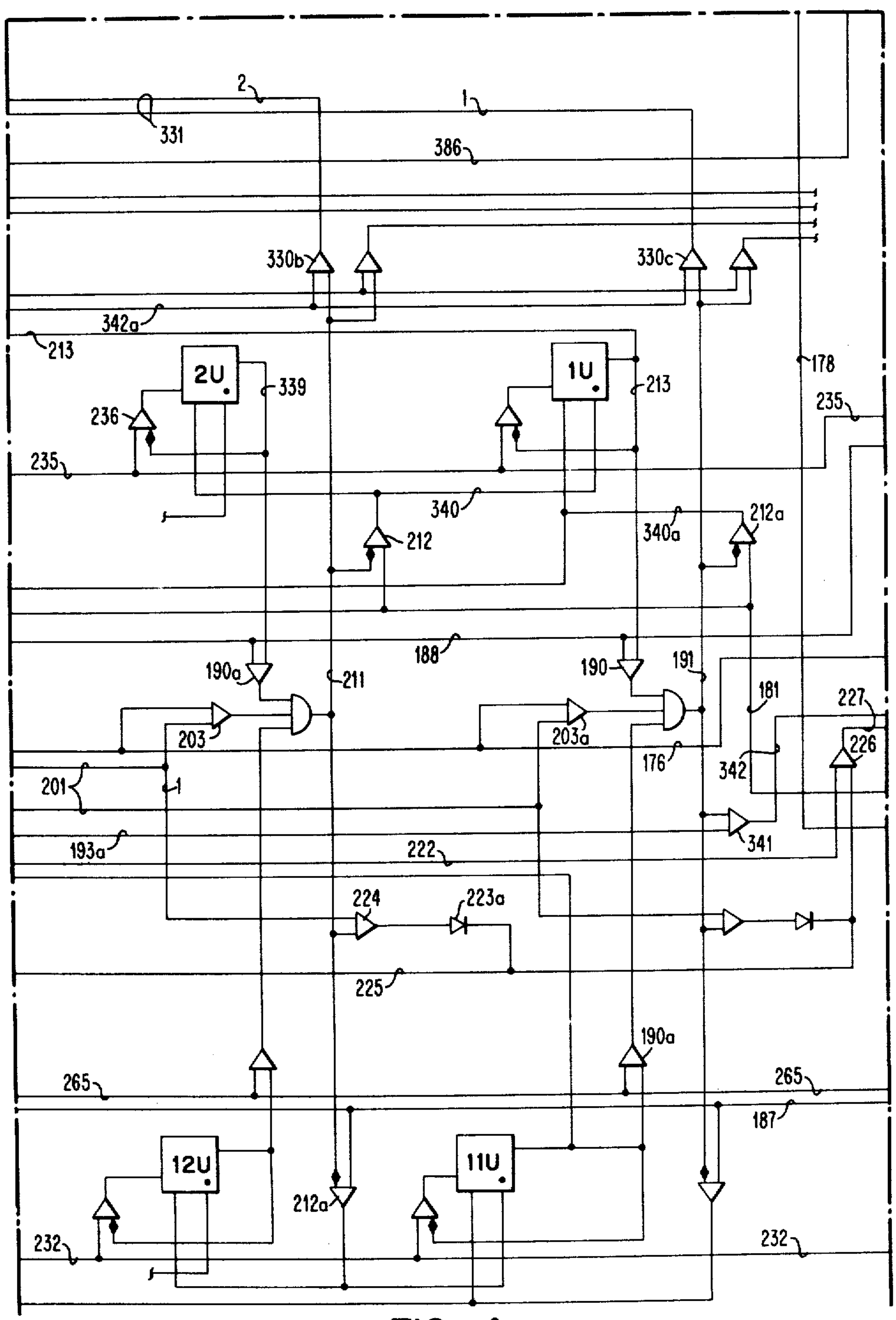
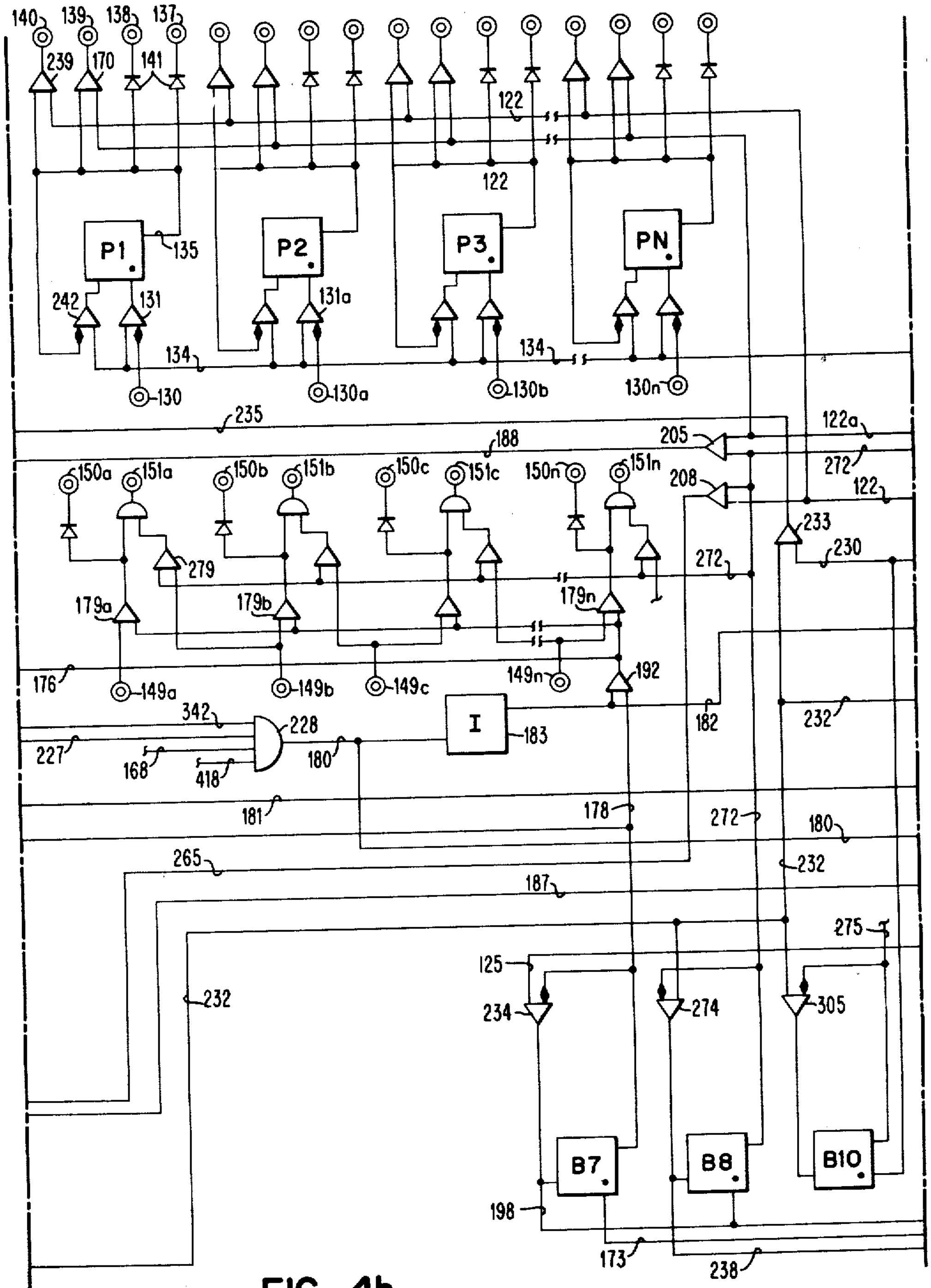

2
1
331
386
330b
330c
342a
213
2U
339
1U
213
178
235
236
235
340
212a
340a
212
188
190a
211
190
191
181
227
203
203a
176
342
226
201
1
193a
341
222
224
223a
225
190a
265
265
187
12U
11U
212a
232
232

FIG. 4g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139
138
137
239
170
141
122
122
P1
P2
P3
PN
135
242
131
131a
134
134
130
130a
130b
130n
235
188
205
122a
272
208
122
233
230
150a
151a
150b
151b
150c
151c
150n
151n
279
272
179a
179b
179n
176
149a
149b
149c
149n
192
342
228
227
168
418
180
I
183
182
232
181
178
272
180
265
232
187
275
125
234
274
305
232
B7
B8
B10
198
173
238

FIG. 4h

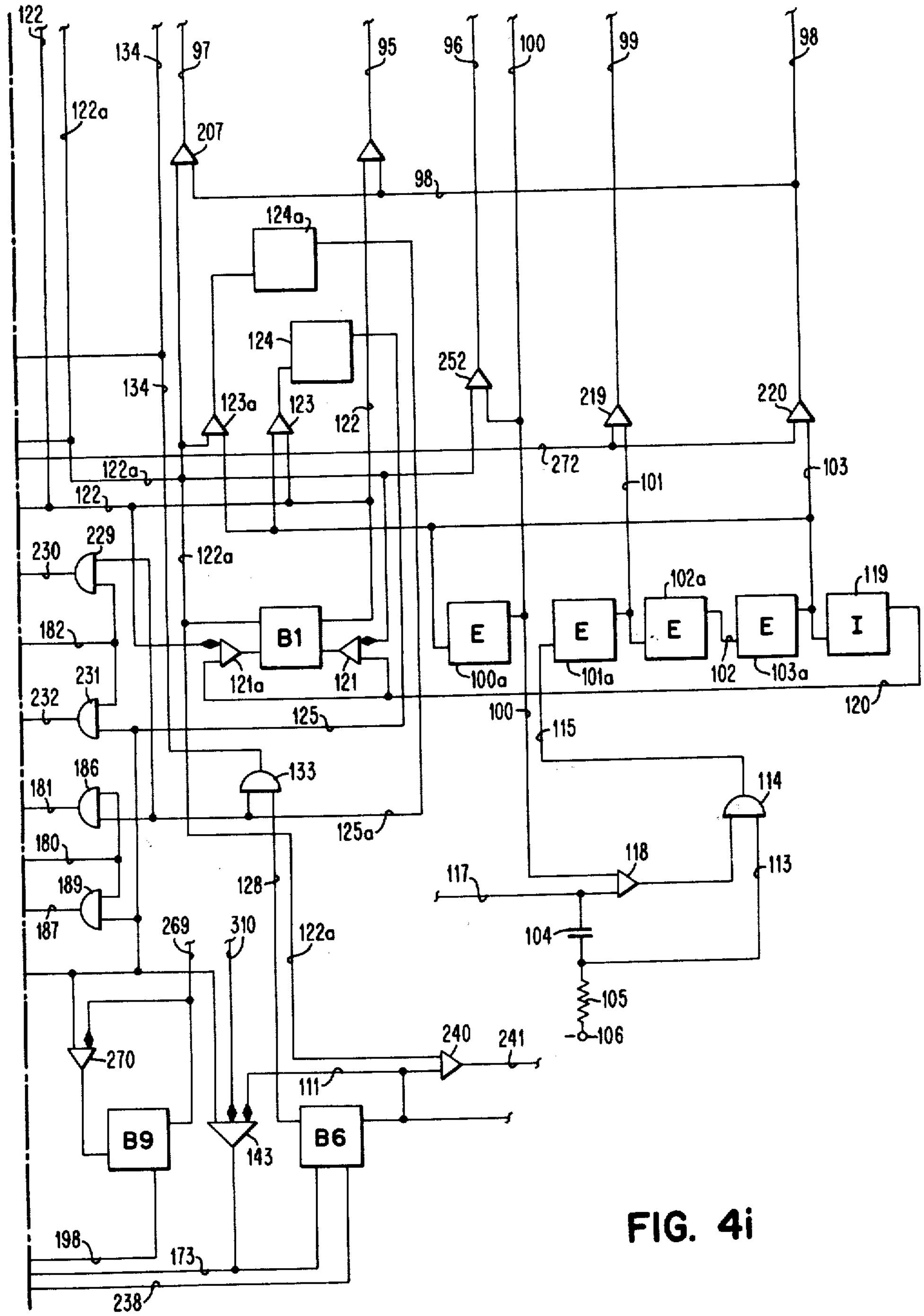
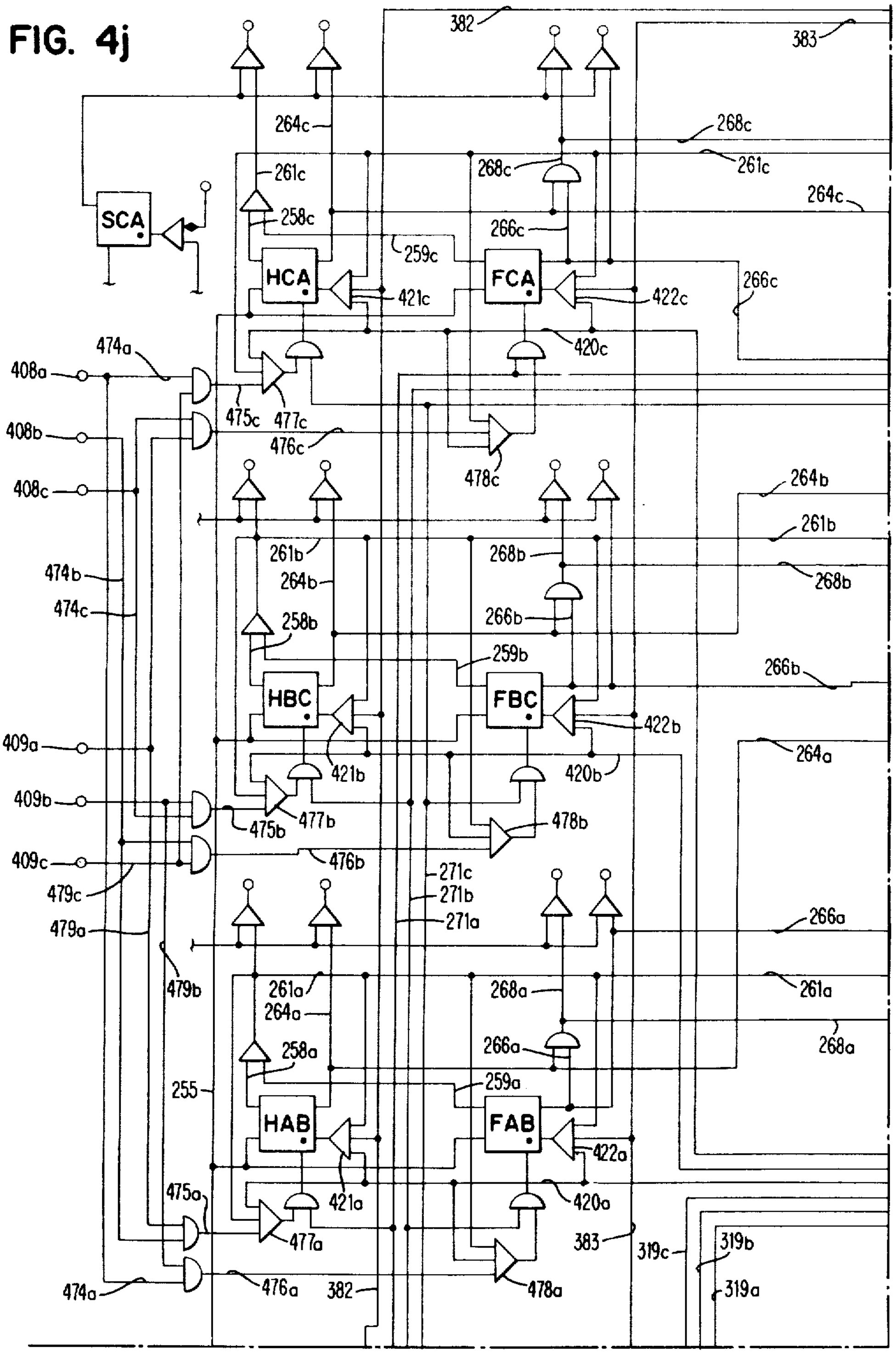

122
122a
134
97
95
96
100
99
98
207
98
124a
124
252
219
220
134
123a
123
122
272
103
122a
122
101
230
229
122a
102a
119
182
B1
E
E
E
E
I
121a
121
100a
101a
102
103a
232
231
125
100
120
115
133
186
181
114
125a
180
118
189
128
117
113
187
269
310
122a
104
105
106
270
240
241
111
B9
143
B6
198
173
238

FIG. 4i

FIG. 4j


382
383
264c
261c
268c
258c
266c
259c
SCA
HCA
FCA
421c
422c
420c
474a
408a
408b
408c
475c
477c
476c
478c
264b
261b
268b
266b
258b
259b
HBC
FBC
421b
422b
420b
264a
409a
409b
409c
475b
477b
476b
478b
474b
474c
479c
479a
479b
271c
271b
271a
266a
261a
268a
264a
258a
259a
255
HAB
FAB
421a
422a
420a
475a
477a
476a
478a
474a
382
383
319c
319b
319a

TABULATING AND COMPUTING MACHINE

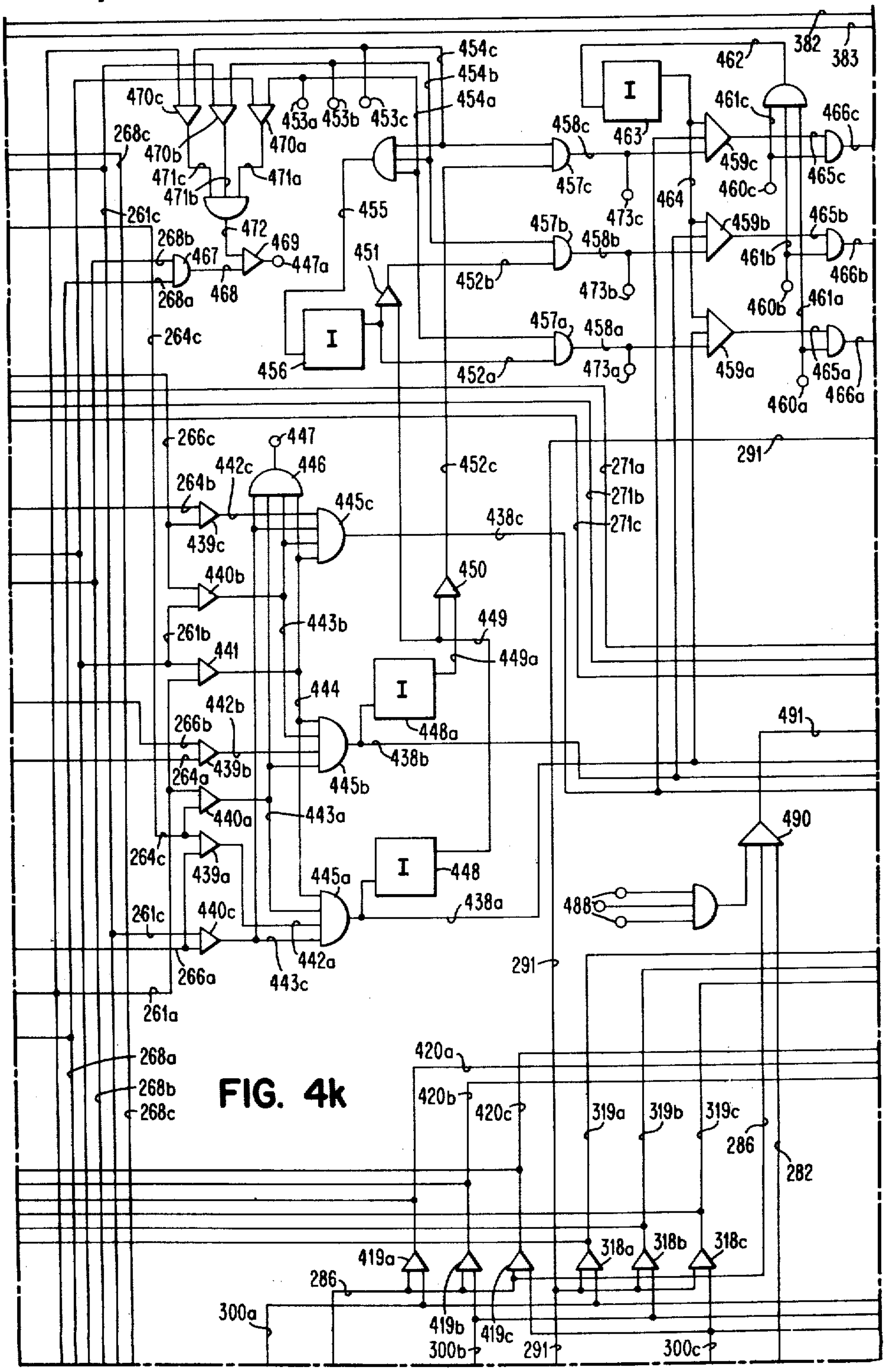
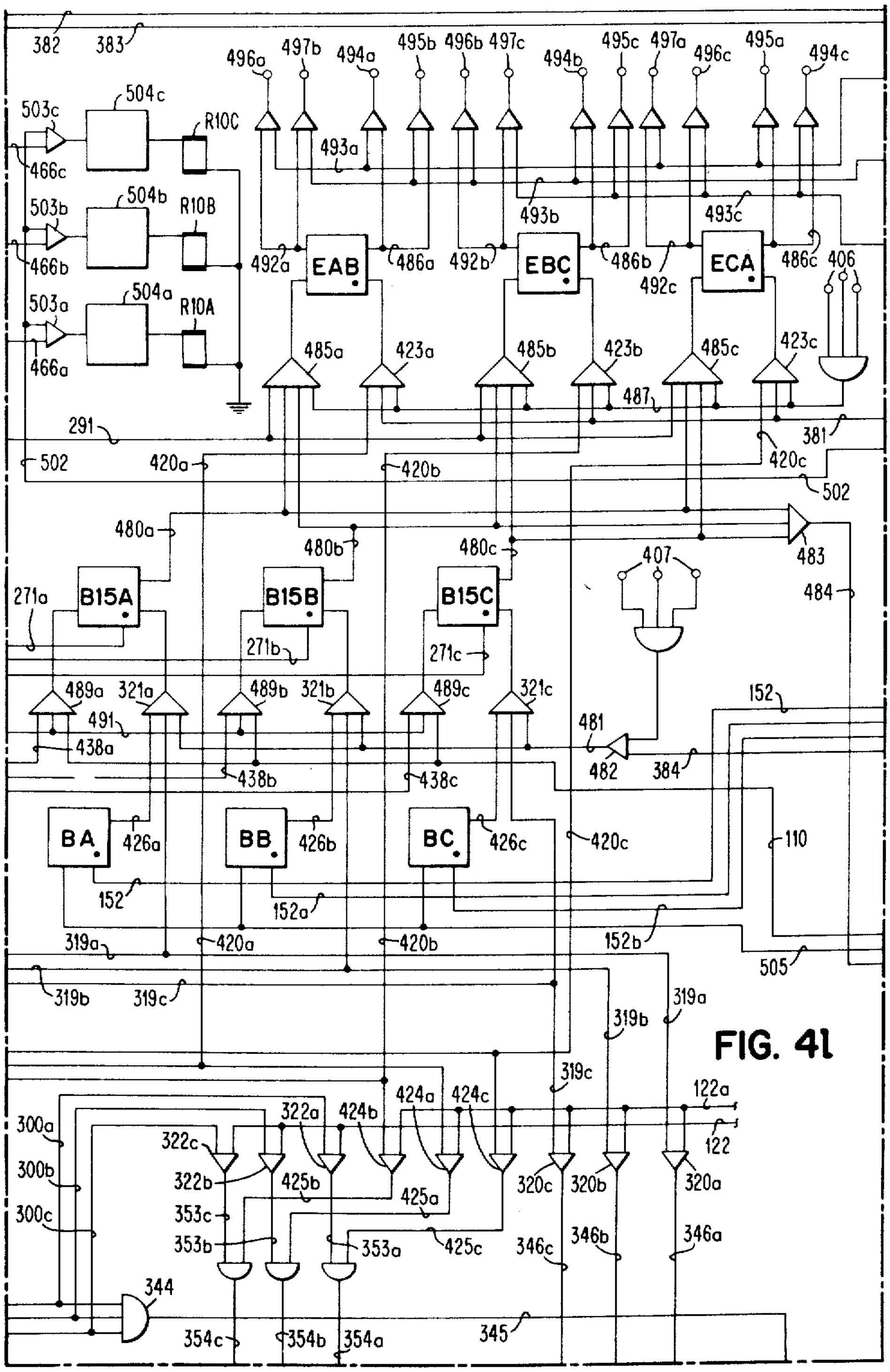


FIG. 4k



382
383
496a
497b
494a
495b
496b
497c
494b
495c
497a
496c
495a
494c
504c
503c
R10C
466c
493a
504b
503b
R10B
493b
493c
466b
492a
EAB
486a
492b
EBC
486b
ECA
486c
406
492c
503a
504a
R10A
466a
485a
423a
485b
423b
485c
423c
487
291
381
502
420a
420b
420c
480a
480b
480c
483
407
484
271a
B15A
B15B
B15C
271b
271c
489a
321a
489b
321b
489c
321c
152
491
438a
438b
438c
481
482
384
BA
426a
BB
426b
BC
426c
110
152a
152b
319a
505
319b
319c
300a
300b
300c
322a
322b
322c
424a
424b
424c
425a
425b
425c
122a
122
320a
320b
320c
353a
353b
353c
346a
346b
346c
344
345
354a
354b
354c

FIG. 41

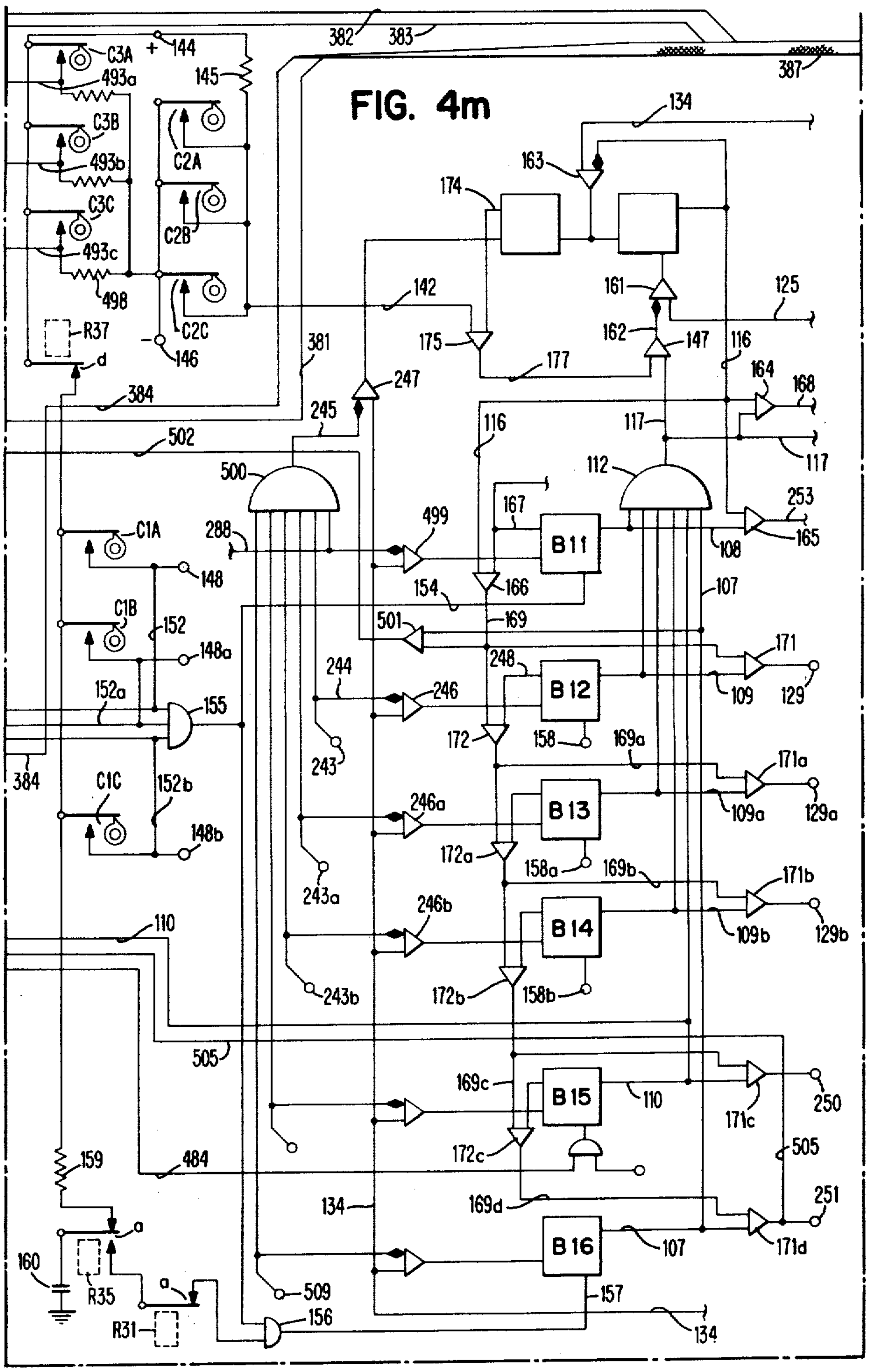
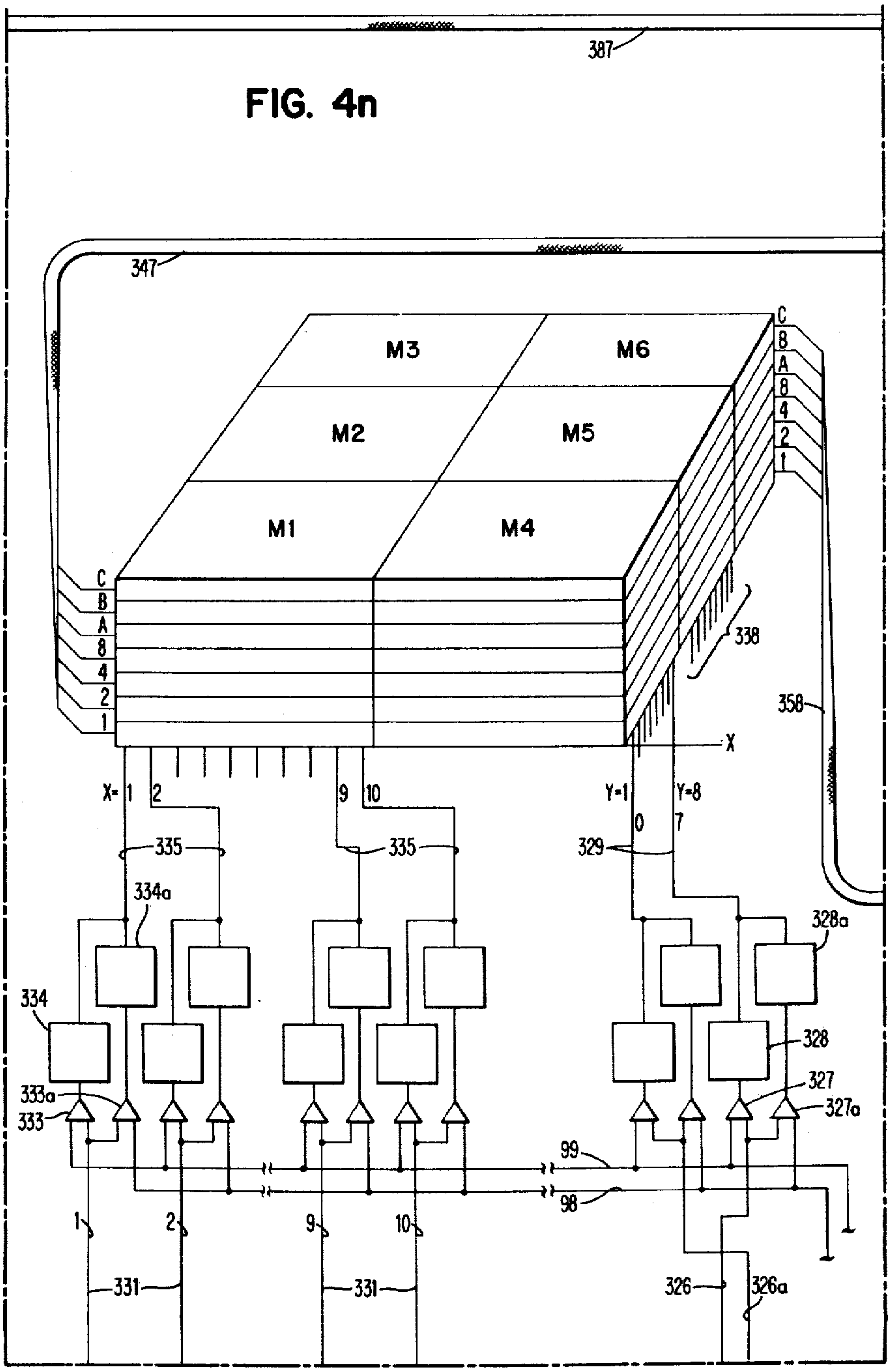

382
383
387
C3A
+ 144
145
493a
C3B
493b
C3C
493c
498
C2A
C2B
C2C
R37
d
146
384
381
134
163
174
142
161
125
175
177
162
147
116
164
168
247
245
502
116
117
117
112
500
499
167
B11
253
165
108
C1A
288
148
154
166
107
C1B
152
148a
169
501
171
244
248
B12
246
152a
155
109
129
243
172
158
169a
171a
384
C1C
152b
148b
246a
B13
109a
129a
172a
243a
158a
169b
171b
246b
B14
109b
129b
110
243b
172b
158b
505
169c
B15
110
250
171c
172c
159
484
505
251
134
169d
a
B16
107
171d
160
R35
a
509
157
R31
156
134

FIG. 4m

FIG. 4n


387
347
M3
M6
M2
M5
M1
M4
C
B
A
8
4
2
1
338
358
X
X=1
2
9
10
Y=1
Y=8
0
7
335
329
334a
328a
334
328
333a
333
327
327a
99
98
331
326
326a

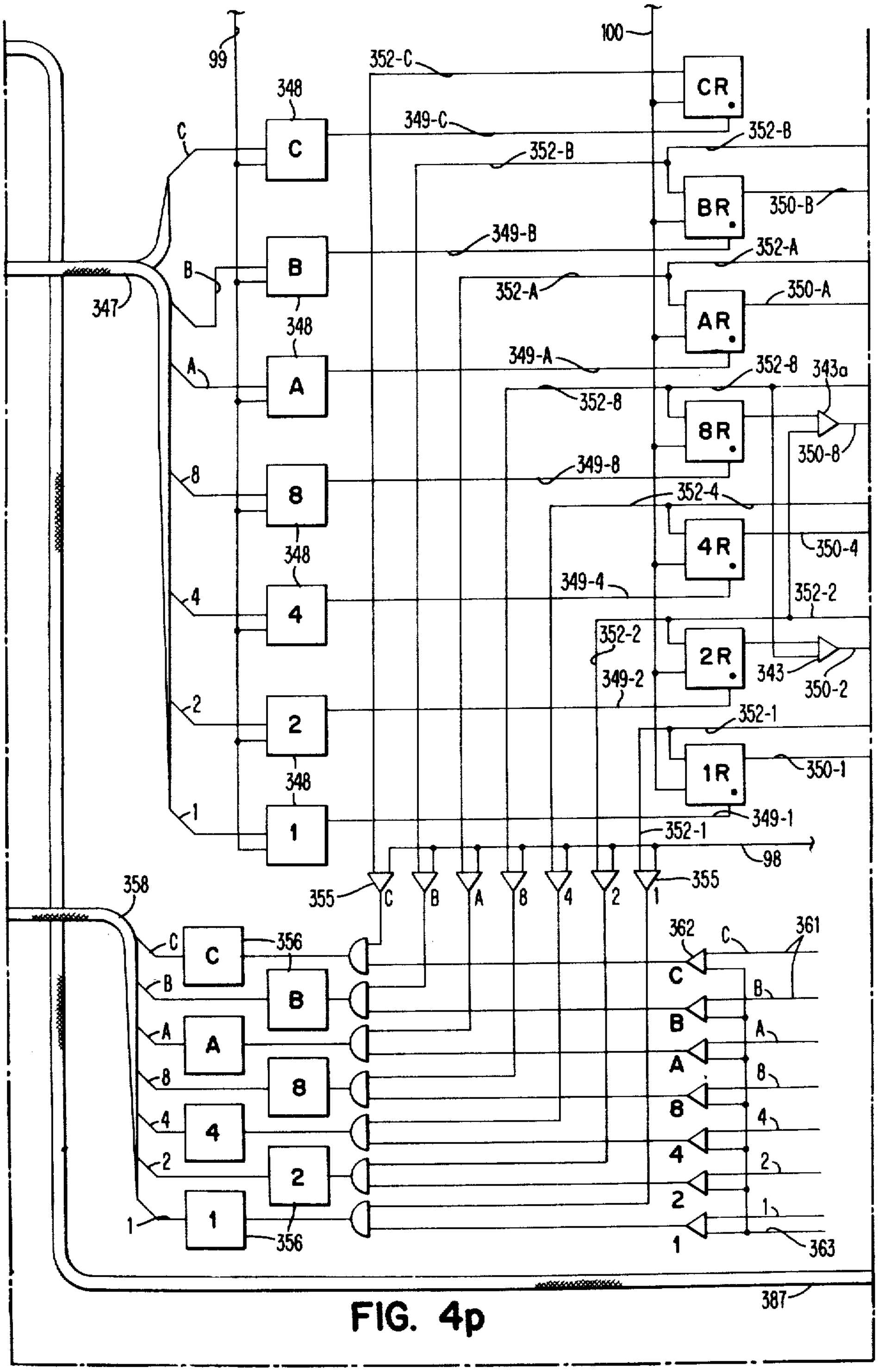

99
100
CR
BR
AR
8R
4R
2R
1R
352-C
349-C
352-B
349-B
352-A
349-A
352-8
349-8
352-4
349-4
352-2
349-2
352-1
349-1
350-B
350-A
350-8
350-4
350-2
350-1
343a
343
347
348
355
356
358
361
362
363
387
98

FIG. 4p

TABULATING AND COMPUTING MACHINE

Filed April 25, 1960 32 Sheets-Sheet 18

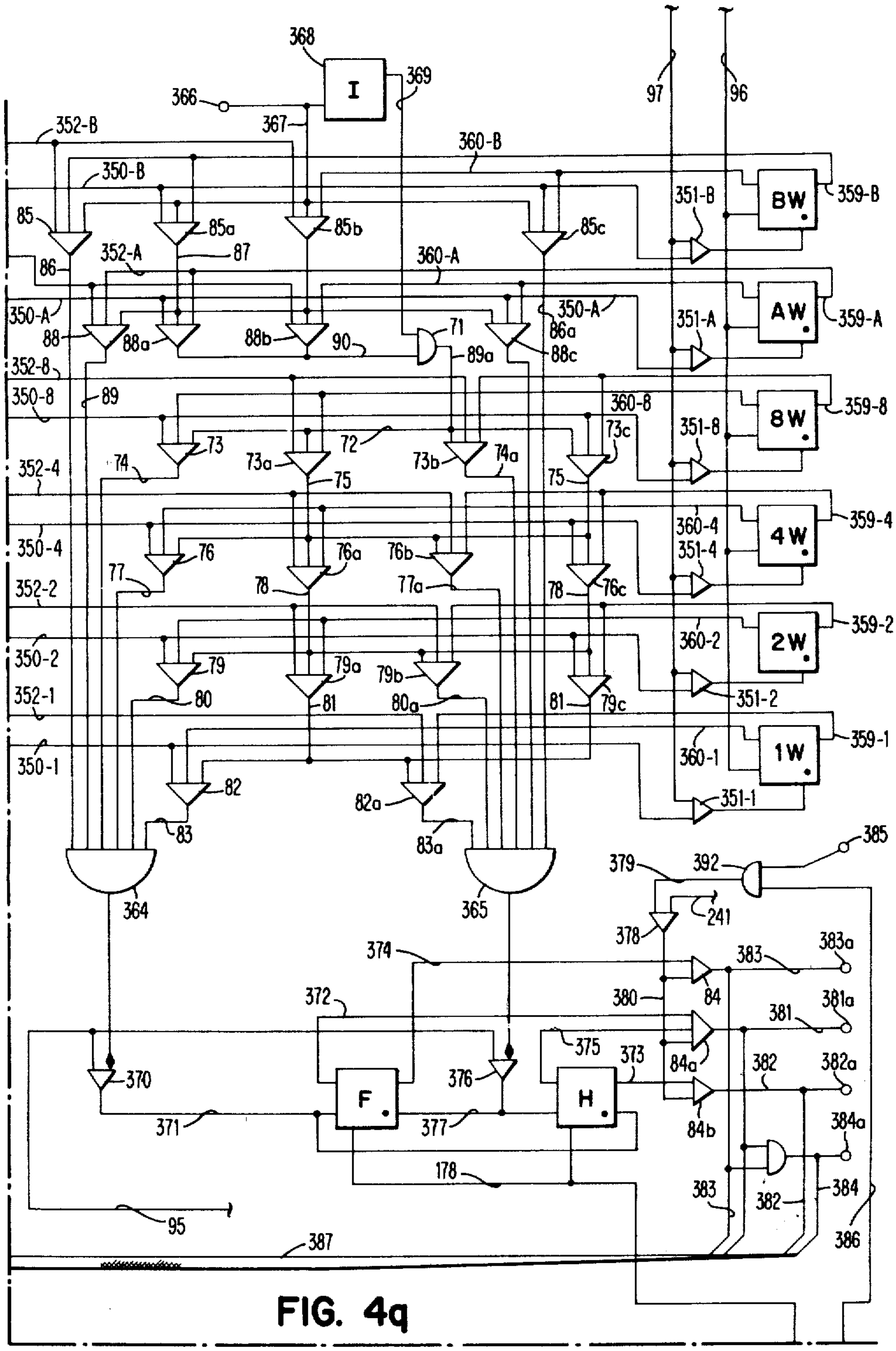


FIG. 4q

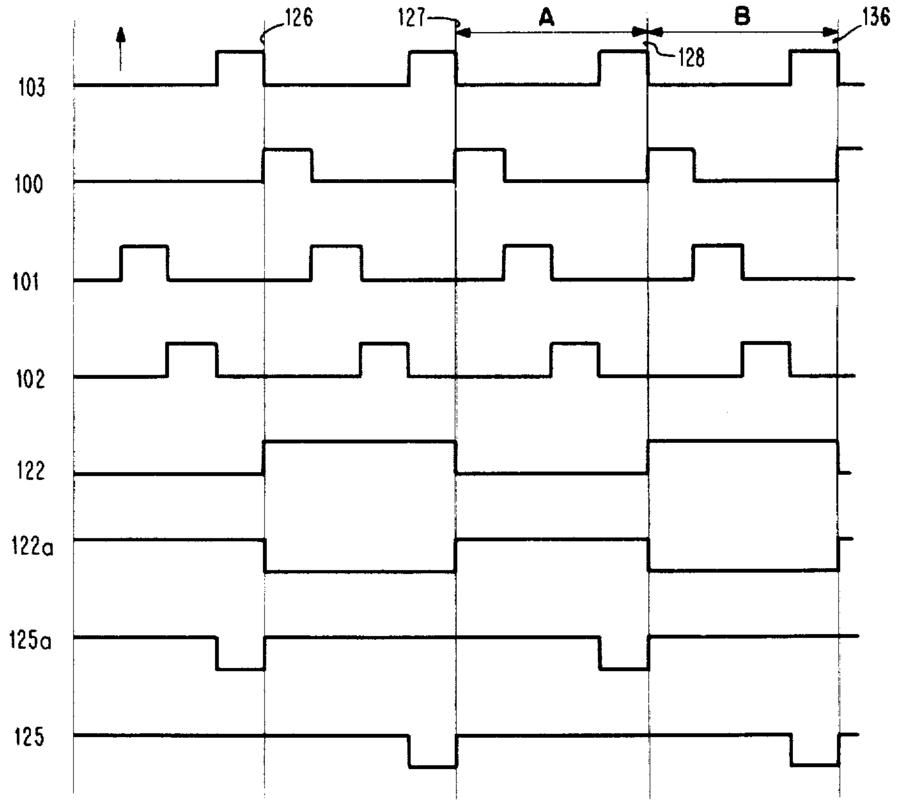

126
127
A
B
136
128
103
100
101
102
122
122a
125a
125

FIG. 16

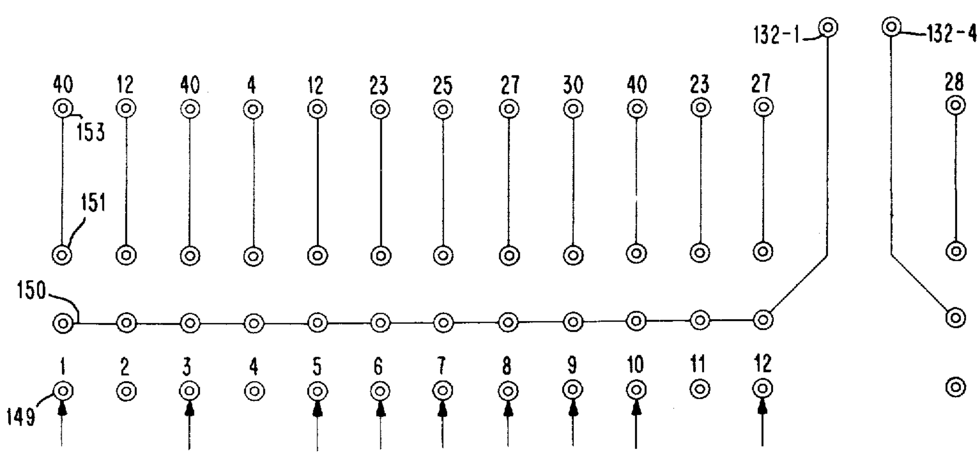

132-1
132-4
40 12 40 4 12 23 25 27 30 40 23 27
28
153
151
150
1 2 3 4 5 6 7 8 9 10 11 12
149

FIG. 6

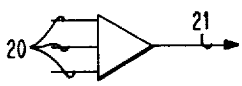


FIG. 7

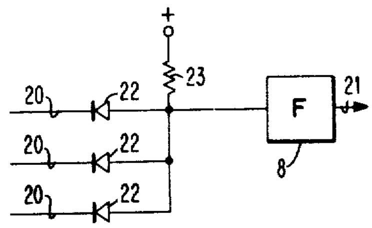


FIG. 7a

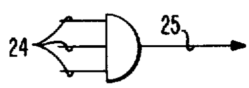


FIG. 8

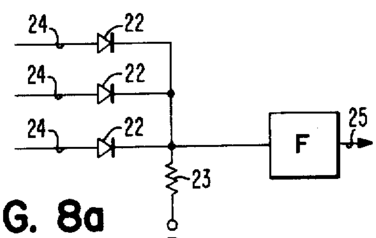


FIG. 8a

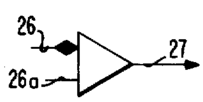


FIG. 9

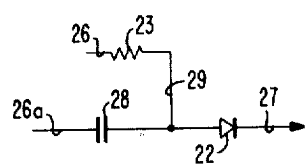


FIG. 9a

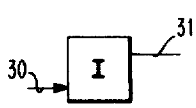


FIG. 10

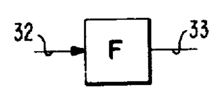


FIG. 11

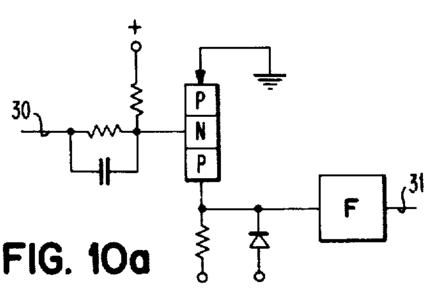


FIG. 10a

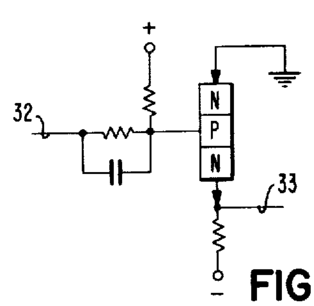


FIG. 11a

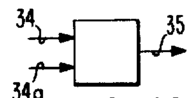


FIG. 12

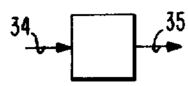


FIG. 12b

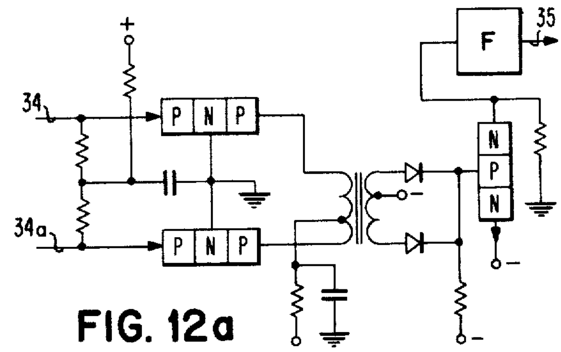


FIG. 12a

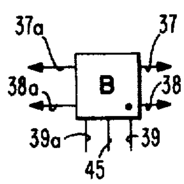


FIG. 13

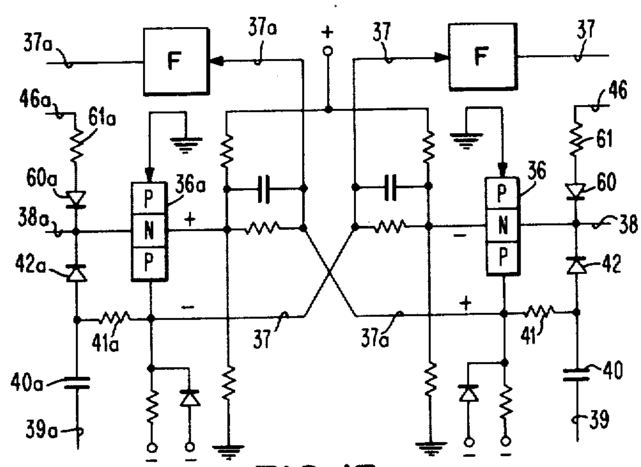


FIG. 13a

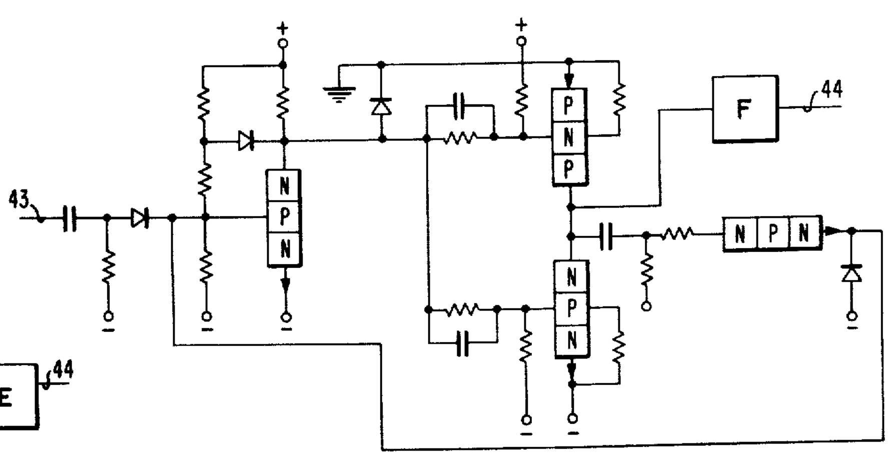


FIG. 14

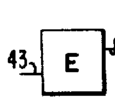


FIG. 14a

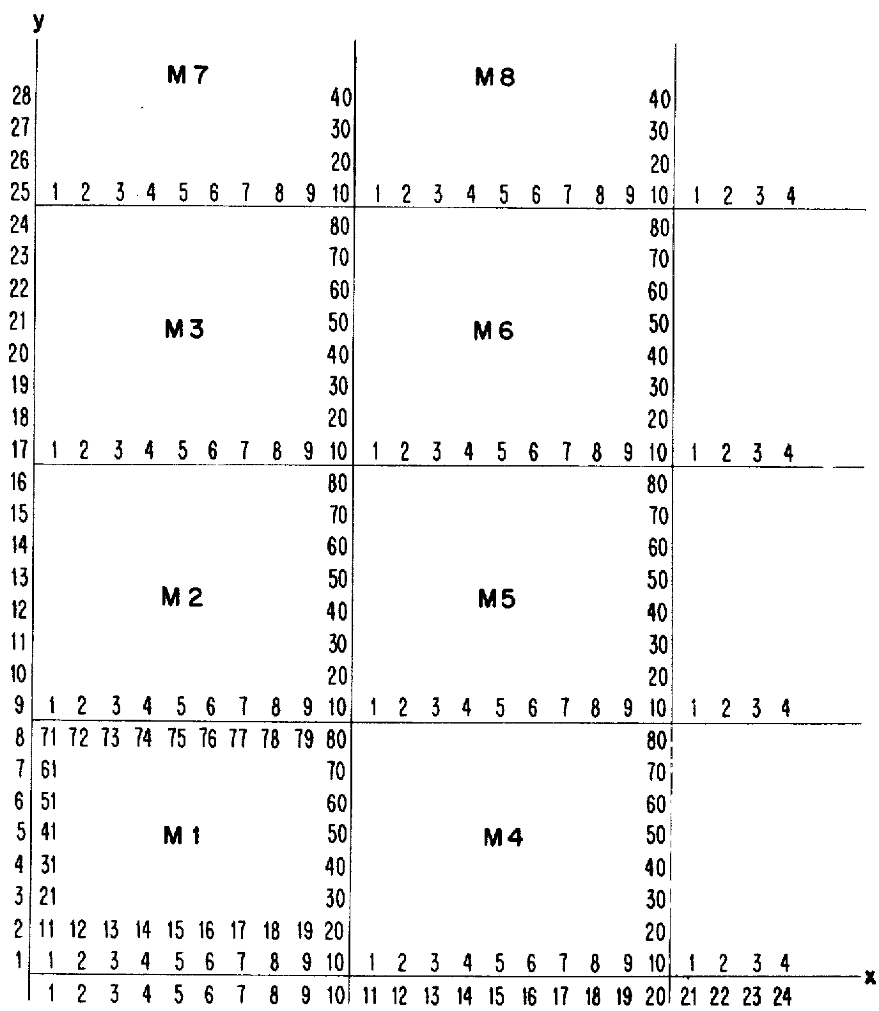


FIG. 15

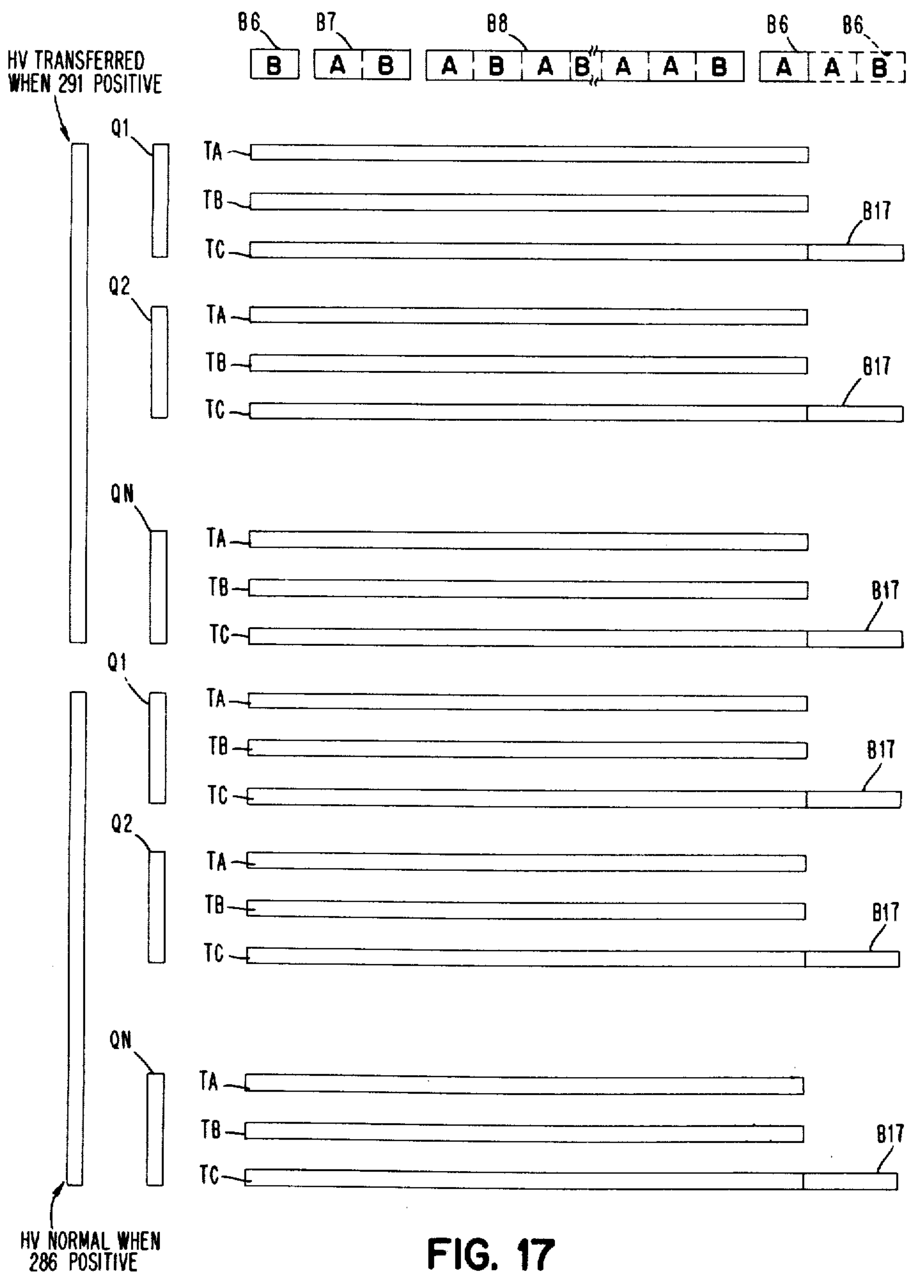

B6
B7
B8
B6
B6
B
A
B
A
B
A
B
A
A
B
A
A
B
HV TRANSFERRED WHEN 291 POSITIVE
Q1
TA
TB
TC
B17
Q2
TA
TB
TC
B17
QN
TA
TB
TC
B17
Q1
TA
TB
TC
B17
Q2
TA
TB
TC
B17
QN
TA
TB
TC
B17
HV NORMAL WHEN 286 POSITIVE

FIG. 17

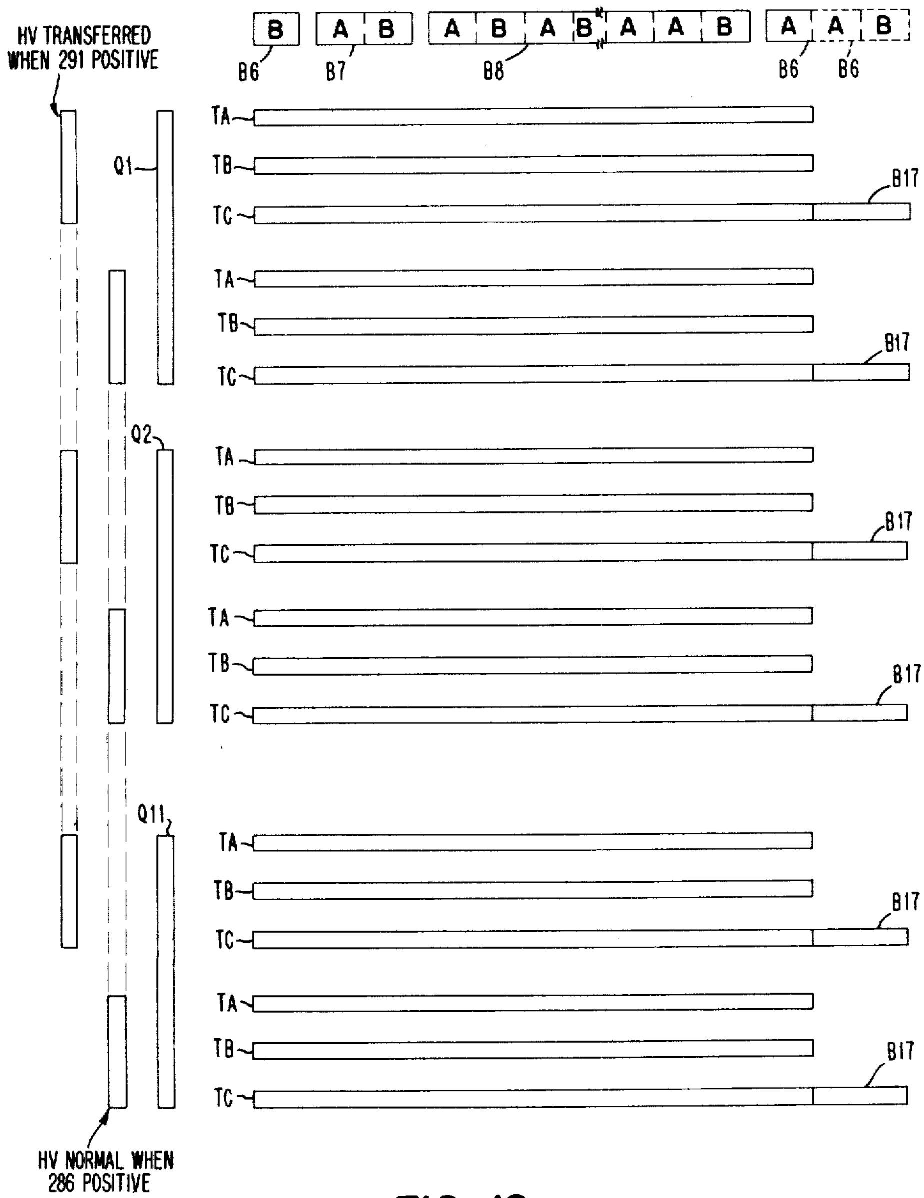

HV TRANSFERRED
WHEN 291 POSITIVE
B
A
B
A
B
A
B
A
A
B
A
A
B
B6
B7
B8
B6
B6
TA
TB
TC
Q1
B17
Q2
Q11
HV NORMAL WHEN
286 POSITIVE

FIG. 18

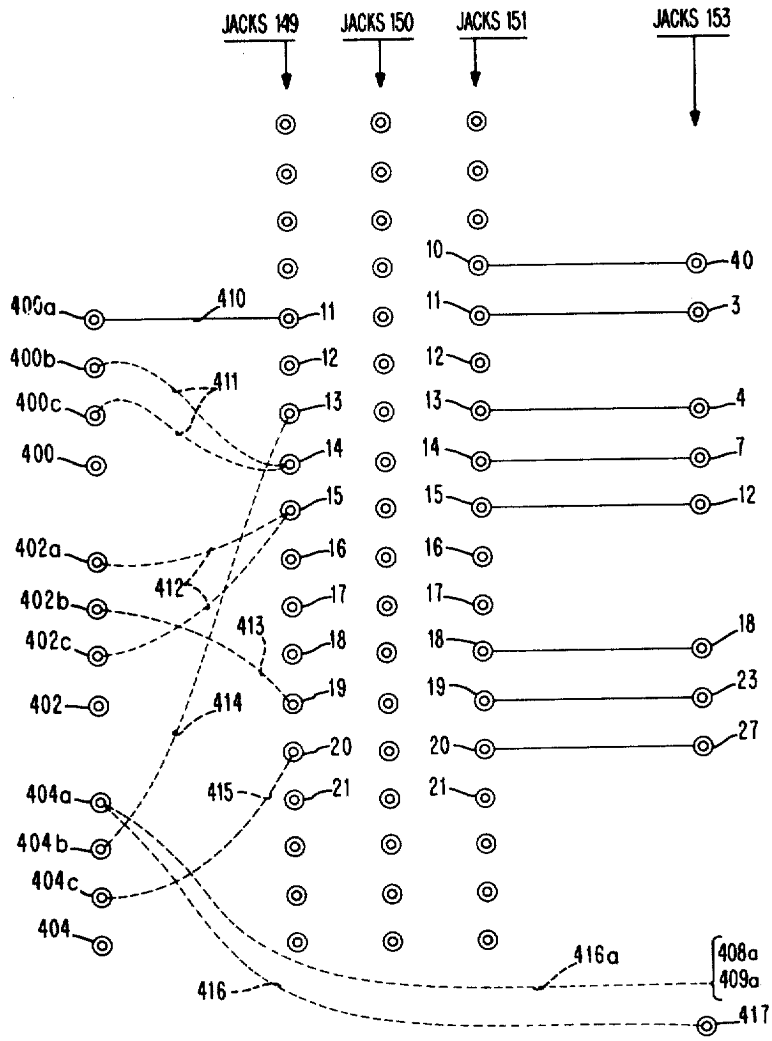

JACKS 149
JACKS 150
JACKS 151
JACKS 153
400a
410
400b
411
400c
400
402a
412
402b
413
402c
402
414
404a
415
404b
404c
404
416
416a
408a
409a
417

FIG. 19

TABULATING AND COMPUTING MACHINE

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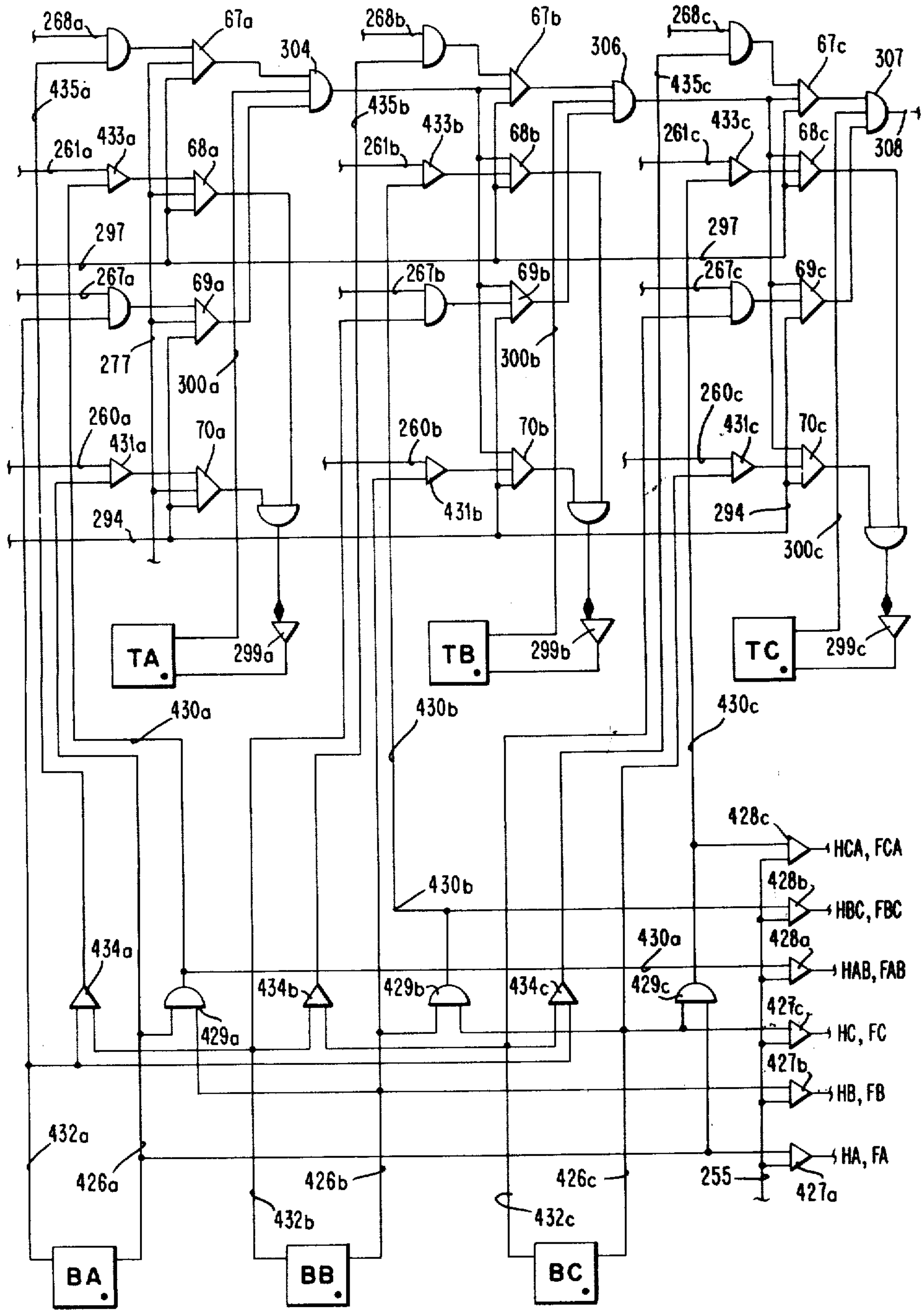

FIG. 20

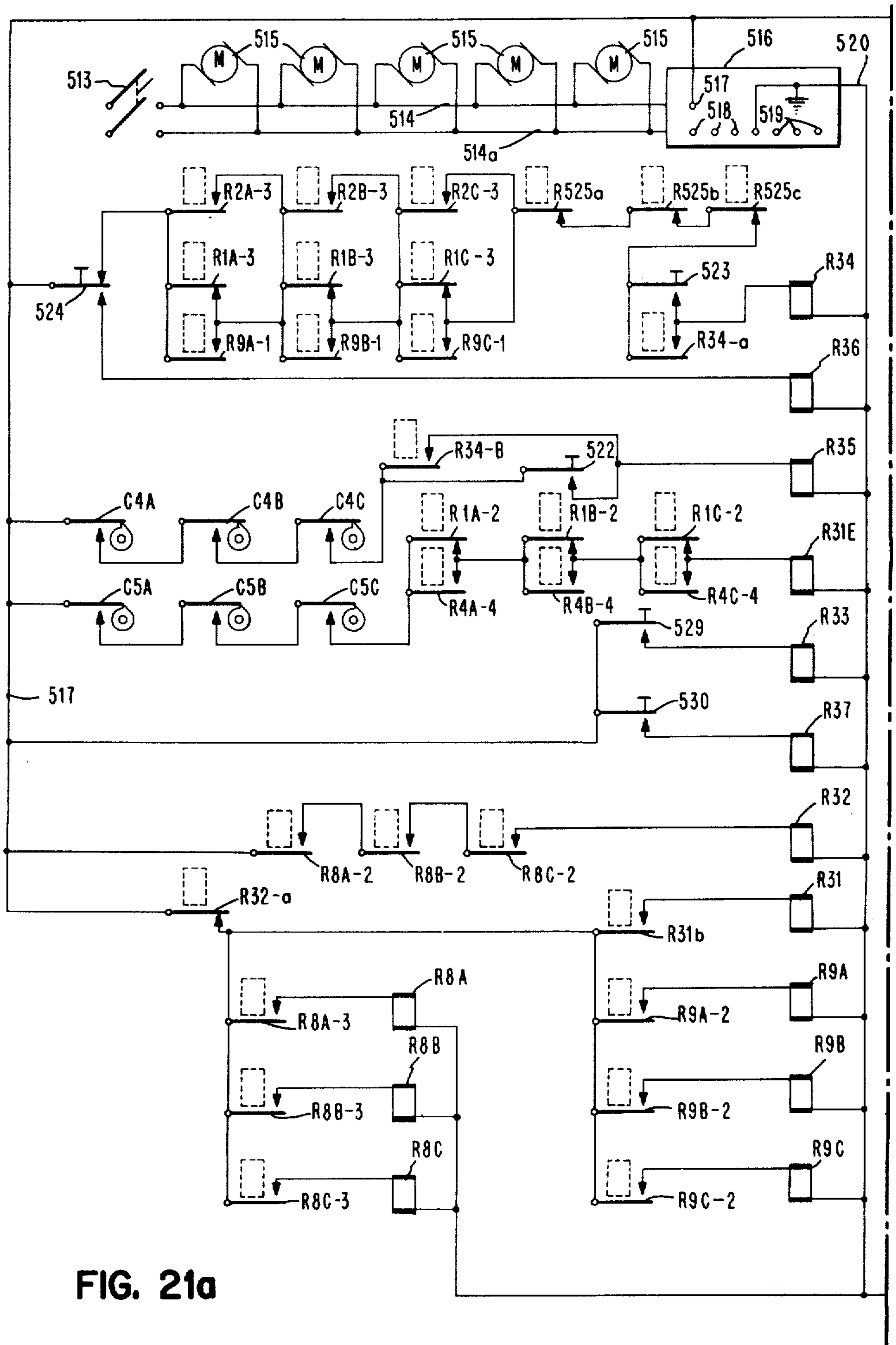
513
515
515
515
516
520
517
518
519
514
514a
R2A-3
R2B-3
R2C-3
R525a
R525b
R525c
R1A-3
R1B-3
R1C-3
523
R34
524
R9A-1
R9B-1
R9C-1
R34-a
R36
R34-B
522
R35
C4A
C4B
C4C
R1A-2
R1B-2
R1C-2
R31E
R4C-4
C5A
C5B
C5C
R4A-4
R4B-4
529
R33
517
530
R37
R32
R8A-2
R8B-2
R8C-2
R31
R32-a
R31b
R8A
R9A
R8A-3
R9A-2
R8B
R9B
R8B-3
R9B-2
R8C
R9C
R8C-3
R9C-2

FIG. 21a

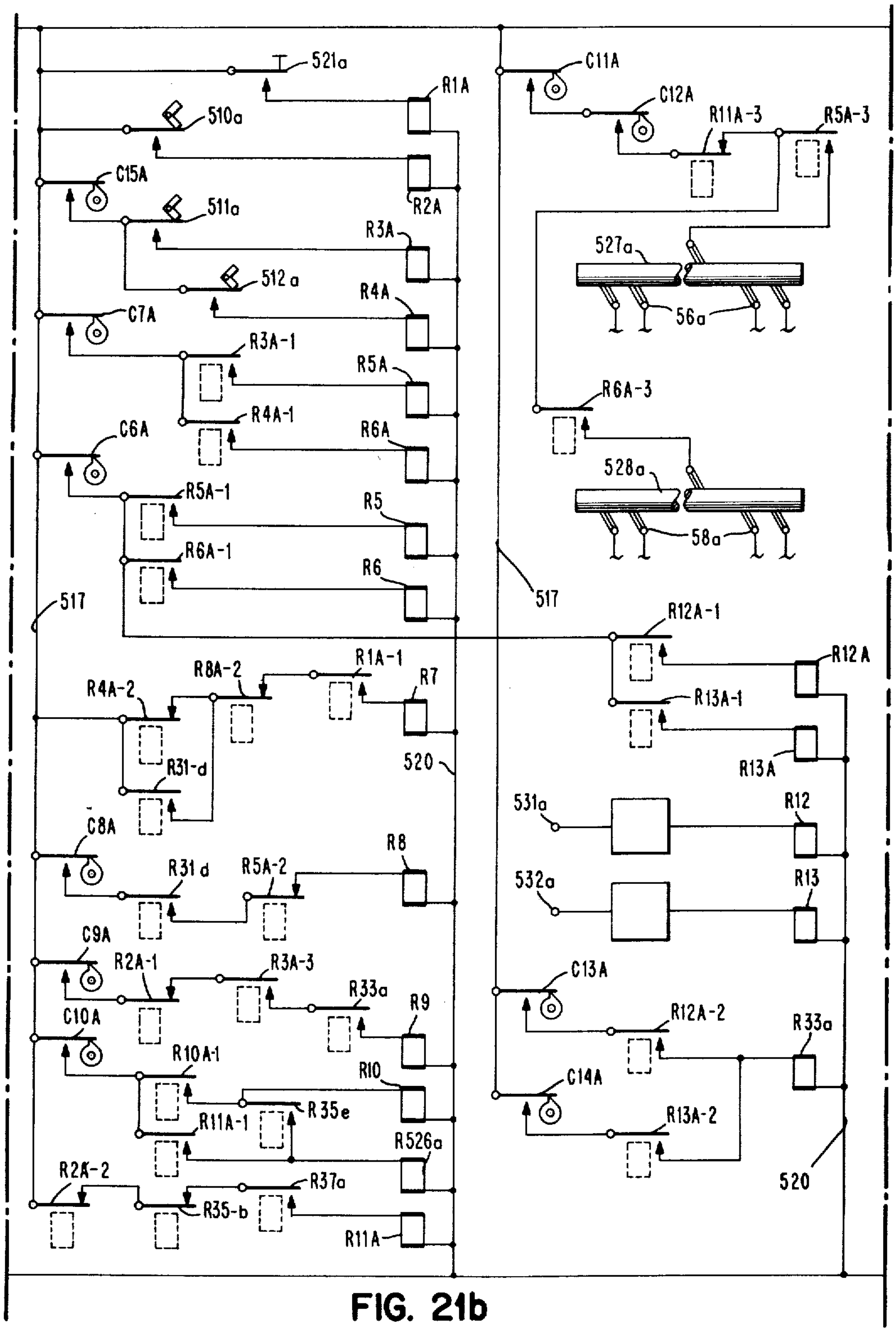
521a
R1A
510a
C15A
R2A
511a
R3A
512 a
R4A
C7A
R3A-1
R5A
R4A-1
C6A
R6A
R5A-1
R5
R6A-1
R6
517
R4A-2
R8A-2
R1A-1
R7
R31-d
520
C8A
R31 d
R5A-2
R8
C9A
R2A-1
R3A-3
R33a
R9
C10A
R10A-1
R10
R11A-1
R35e
R526a
R2A-2
R37a
R35-b
R11A
C11A
C12A
R11A-3
R5A-3
527a
56a
R6A-3
528a
58a
517
R12A-1
R12 A
R13A-1
R13A
531a
R12
532a
R13
C13A
R12A-2
R33a
C14A
R13A-2
520

FIG. 21b

March 13, 1962 M. PAPO ET AL 3,024,989

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Filed April 25, 1960 32 Sheets-Sheet 29

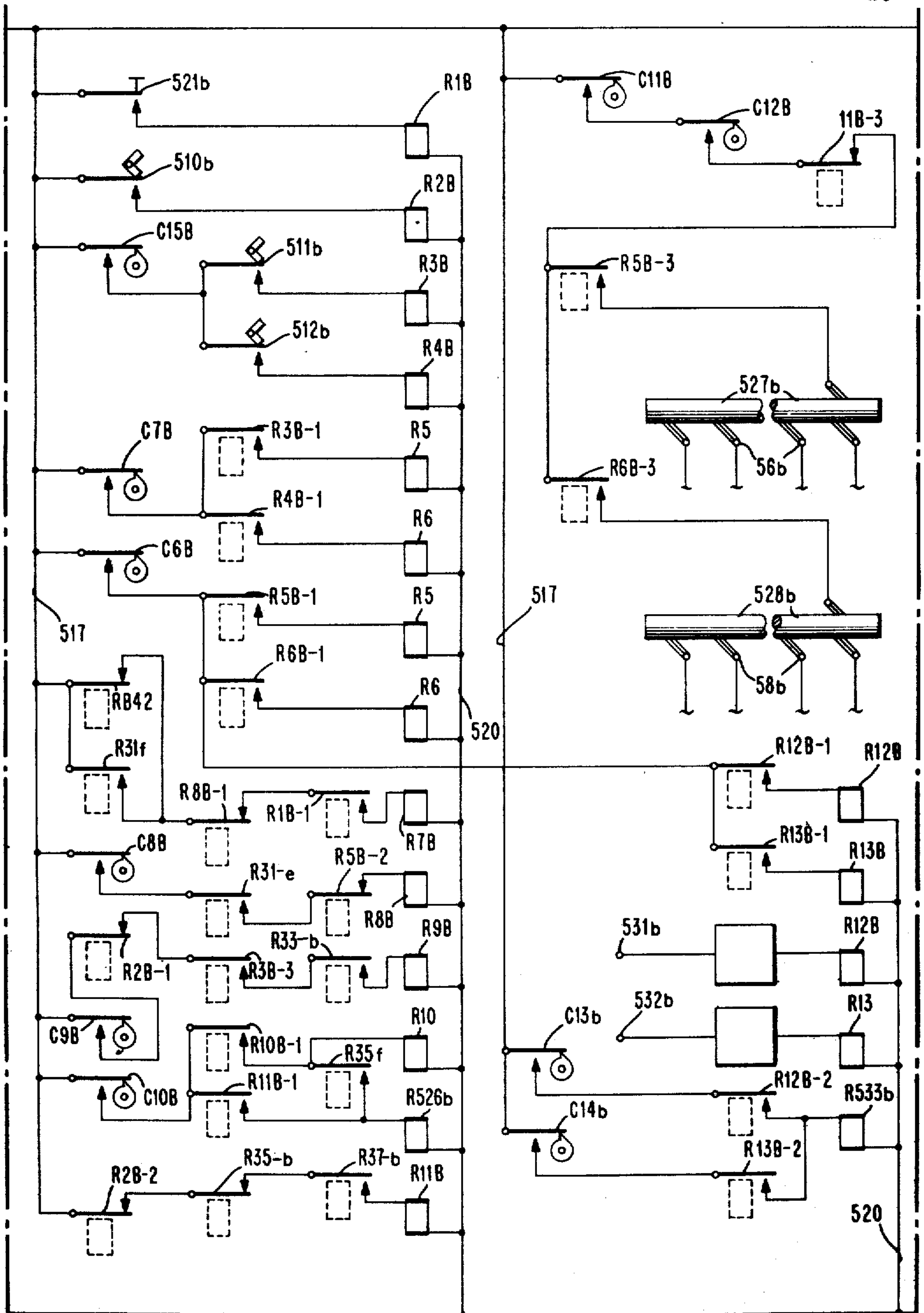

FIG. 21c

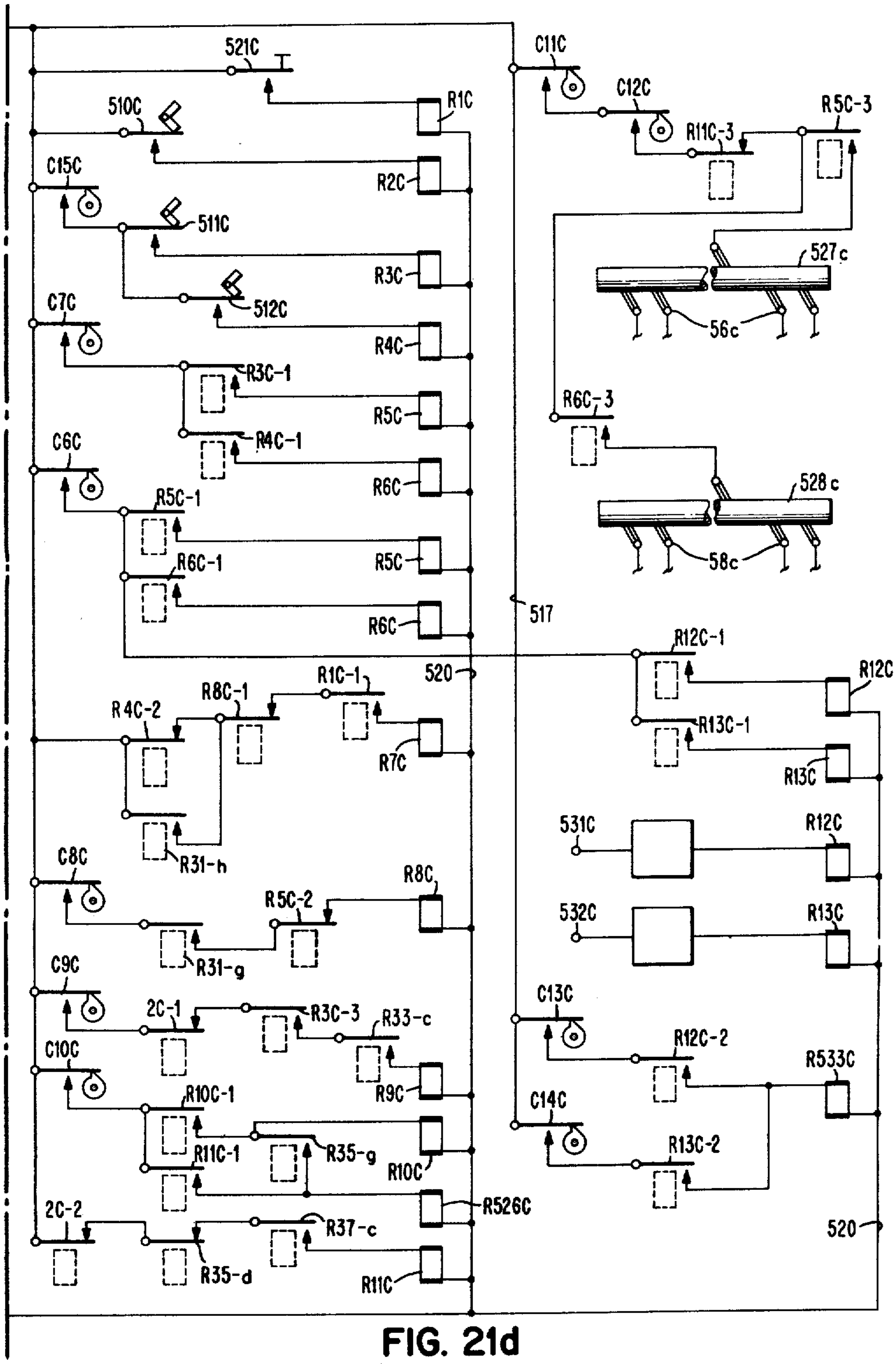
521C
R1C
510C
R2C
C15C
511C
R3C
512C
R4C
C7C
R3C-1
R5C
R4C-1
R6C
C6C
R5C-1
R5C
R6C-1
R6C
C11C
C12C
R11C-3
R5C-3
527c
56c
R6C-3
528c
58c
517
520
R12C-1
R12C
R13C-1
R13C
R4C-2
R8C-1
R1C-1
R7C
R31-h
531C
532C
C8C
R8C
R5C-2
R31-g
C9C
2C-1
R3C-3
R33-c
R9C
C10C
R10C-1
R11C-1
R35-g
R10C
R526C
2C-2
R37-c
R35-d
R11C
C13C
R12C-2
R533C
C14C
R13C-2

FIG. 21d

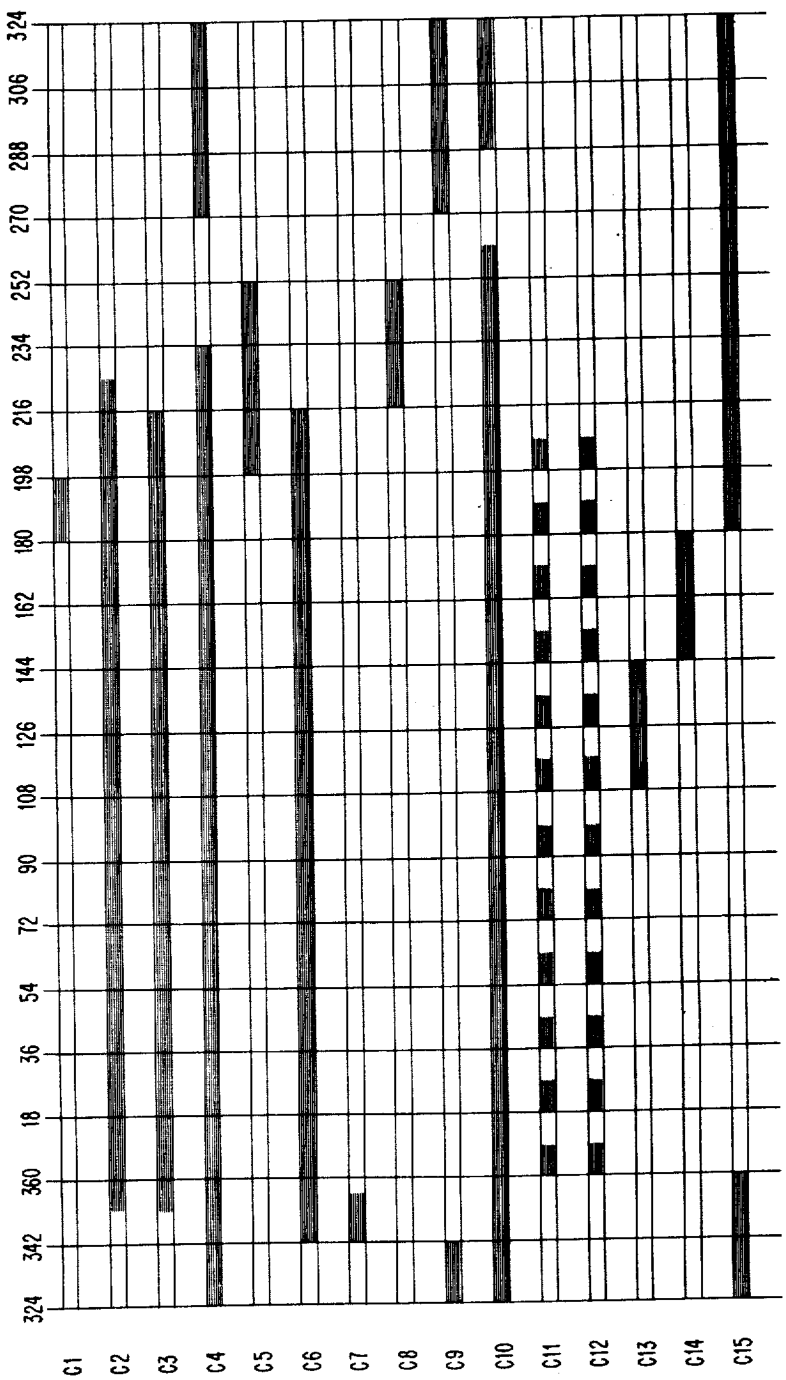
324
306
288
270
252
234
216
198
180
162
144
126
108
90
72
54
36
18
360
342
324
C1
C2
C3
C4
C5
C6
C7
C8
C9
C10
C11
C12
C13
C14
C15

FIG. 22

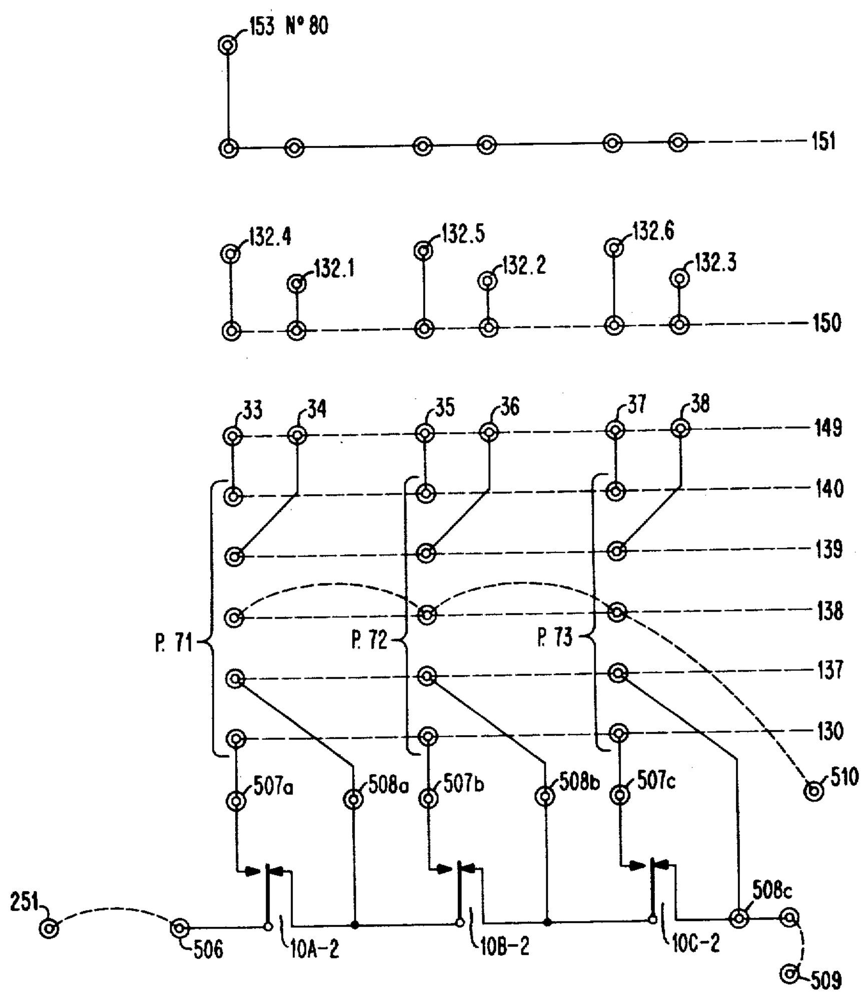
153 N° 80
151
132.4
132.1
132.5
132.2
132.6
132.3
150
33
34
35
36
37
38
149
140
139
138
137
130
P. 71
P. 72
P. 73
507a
508a
507b
508b
507c
510
251
506
10A-2
10B-2
10C-2
508c
509

FIG. 23

United States Patent Office

3,024,989
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3,024,989

TABULATING AND COMPUTING MACHINE

Maurice Papo and Eugene Kouzmine, Paris, France, assignors to International Business Machines Corporation, New York, N.Y., a corporation of New York

Filed Apr. 25, 1960, Ser. No. 24,595
Claims priority, application France Apr. 23, 1959
8 Claims. (Cl. 235—151)

This invention relates to improvements in tabulating and computing machines operated with recording cards. The invention is particularly applicable to machines supplied simultaneously with two or more different card series, and primarily relates to the controls for such machine.

In the preparation of some invoices and account statements from recording cards various preliminary operations are required such as grouping and filing of the cards. Then the latter are often sorted into classes so that some of them may be used again. For various reasons of cost and convenience card files are often created. Such is the case for example for cards from which the name and address of a customer or of the owner of a current account are printed; cards having special importance or the likelihood of being used frequently; cards summing up the state of a stock or of a current account; cards determining special invoicing conditions, etc.

With the usual operating methods, i.e. with machines which may receive only one series of recording cards, it is necessary to merge the files and the detail cards, putting momentarily aside, if needed, the file cards for which there is no detail card, as well as all the detail cards for which no file cards have been drawn up. Later on, various other sorting and filing operations are necessary to separate the file cards from the detail cards and to remake the original files.

All these operations are relatively time-consuming and become more so as they affect a greater number of cards. They require multiple card handling which increases various risks of errors.

When it is desired to operate a machine, or a group of machines, by feeding it with two or more distinct series of record cards, it has been found that many intricate problems are raised, and which moreover are disadvantageous in that they may subdivide into a fairly great number of specific cases.

For example, in a machine or a group of machines comprising three card readers, one may be led to use only some of the card readers (one or two) the third one (or the other two) being left constantly unused. Such a case may be found in any operation wherein the three card readers are used, whenever one approaches the end of the work there always occurs a moment when the cards stored in any one of the card readers run out so that the operation must go on with only two card readers. Further, the cards stored in a second card reader will also run out, so that the work will be completed with only one card reader.

Similar problems are raised when it is desired to perform operations wherein one or two of the card readers must be used, and when it is desired to choose quite freely any of the card readers. Generally, the number and variety of the problems which may arise therefrom are such that in the past the problem has not been approached in the whole. For example, in a machine comprising three card readers A, B and C, it has been specified that an operation requiring one card reader will have to be performed with card reader A, and not with card readers B and C. Similarly, for an operation requiring two card readers, it has been specified that this operation will be performed compulsorily by means of card readers A and B and not by means of card readers

A and C or B and C. Thus, and because of other similar rules, the number and variety of the problems that can be solved are reduced. Such a result is obtained to the detriment of the flexibility of the device, since the freedom in the selection is completely eliminated.

It may be useful, for a good understanding of the following description to examine some of the problems raised by the operation of a machine or of a group of machines fed with two or more distinct series of record cards.

Let it be considered first that the machine is provided with three card readers.

Let it be supposed that the cards are grouped into three series, A, B and C, having for index numbers respectively:

Series A	Series B	Series C
07	05	03
12-1	12-5	12-4
12-2	12-6	15
12-3	16	17-2
17-1	19	

Let it be supposed first that these cards must be fed according to increasing index numbers, and, when their numbers are identical, in the following successive order: series A, series C, series B.

In the described example, it is seen that the feeding order must be successively 03, 05, 07, then cards 12–1 to 12–3 of the A series (since these cards must be fed first) then card 12–4 of the C series, and cards 12–5, 12–6 of the B series, etc. (Suffixes 1 to 6 of the cards bearing index number 12 being mentioned only to differentiate the various cards from one another, and to designate their feeding order.)

The problem of the well ordered advance of three card series raises various difficulties when the advance is desired to be entirely automatic. It is obvious that one does not know at first how the series are composed nor how the various cards are filed within the series with respect to one another, so that it is necessary to perform a preliminary scanning of each incoming new card and to compare systematically its index numbers with those of the already fed cards. Thus it may be known how the various cards are classified with respect to one another, and it will suffice to feed systematically the card corresponding to the lower index number for the whole card feed problem to be properly solved. If there are two or more cards having the same index number, it will suffice to use the priority rules, i.e. to feed first the cards of the A series, then the cards of the C series, the cards of the B series being fed last.

To solve the whole of these problems, there has been provided first, and according to the invention, three prescanning memories, which will be designated respectively by reference letters A, B and C for registering any newly fed card, the recording being obviously made according to the series and being erased only when another card of the same series is to be fed and recorded.

Let it be supposed that cards A07, B05, C03 are fed and recorded into the prescanning memories. It is possible to know which of the card readers will feed first only by systematically comparing two by two the index numbers of the various cards, i.e. by performing the following comparisons AB, BC and CA (index number A with index number B, etc.).

When the individual result of each comparison is known, it is possible to deduce the final result therefrom. The latter is always one of the three following cases:

(1) A card lower than the two others (which may be indifferently any one of cards A, B or C);

(2) Two equal cards, lower than the third one (this would be the case of three cards having index numbers 07—07—12);

(3) Three equal cards.

In the case of the illustrative example (analysis of cards A07, B05, C03), card C03 is the lower, so that it is necessary to cause a feeding operation in card reader C. Card C12–4 is thus advanced and recorded into the corresponding prescanning memory, instead of card C03. In these conditions, the following comparison will concern cards A07, B05, C12–4.

Prefixes A, B, C are no part of the index numbers; they are added to the index number only to designate to which series the various considered cards belong. On the other hand, index numbers having only two digits have been selected, while in the practice, the number of digits of the index numbers may be much higher. Moreover, these index numbers may be recorded originally in various card areas which are not adjacent; the areas possibly varying from one card to the next.

The tabulating and computing machines with which the invention is primarily useful normally comprise various organs such as program unit, arithmetical unit, selectors, etc. The comparisons between index numbers which have just been mentioned may be made by utilizing the program unit and the arithmetical unit of these machines, the selectors being used to store the results of the comparisons. Such arrangements require complicated connections and are costly. An object of the invention is to provide program and storage units permitting the execution and storage of various comparisons.

In addition to the systematic comparison of the index numbers of the various series of cards, it may be useful to perform a comparison within each series. It should be mentioned that such a comparison is systematically carried out in some accounting machines whenever the card sequence must be checked and when the sequence breaks are to be detected.

Such comparisons are necessary in the case of machines simultaneously fed with several distinct series of cards. Various types of sequence controls are required depending on whether one single series of cards or simultaneously all the series are involved. Sequence breaks of the first type occur when cards A12, B12 or C12 have run out. A sequence break of the second type occurs when all the cards bearing index number 12 have run out.

It is to be pointed out that the accounting applications are quite varied, and index numbers may preferably be punched in different locations to suit a particular application. The index numbers may be punched for example in columns 11 and 12 for series A, and in columns 25 and 26 for series B and C. It is obvious that the cards punched in that way cannot be grouped in one single series. Such cards, on the other hand are usable in a machine comprising several card readers, when the comparison fields may be chosen freely.

Similarly various types of cards may be encountered where index numbers are contained in but some of them for example in series B and C. In such a case, comparisons AB, and AC do not mean anything (since to index numbers B and C there corresponds no equivalent in series A) so that they must be eliminated as required.

On the other hand, it is obvious that if in a card reader a master card file is advanced and in another a series of detail cards, it is not certain at first that to each master card there corresponds a detail card (or a series of detail cards) and conversely. If the master cards represent the state of a stock and the detail cards the movements concerning that stock (entries and withdrawals) there may exist untouched lots or new lots. As the case may be, it may be desirable to perform a sorting between the master cards and the detail card in order to determine which are the untouched lots and the detail cards having no corresponding master card.

What has been mainly considered above by way of example is a machine, or a group of machines, comprising three card readers, and applications in which the three card readers are used simultaneously. For each element of the index numbers, and apart from the case when some elements of the index numbers are found only in some series of cards and not in all series, the comparisons which are to be effected are of the following type:

AA′ BB′ CC′

within a same series of cards (systematic comparison of the index numbers of a card with those of the immediately following card); and on the other hand of the following type:

AB BC CA

between cards of two different series. It may be remarked that, for each element of the index numbers, the comparisons of each type are three in number.

For an operation in which two card readers only are necessary, the comparisons of the first type are reduced to two (for example AA′ and BB′), whereas those of the second type are reduced to a single operation (comparison AB in the considered case).

It is to be noted that an operation wherein only two card readers are used may be performed in three different ways, namely: card readers A and B; card readers A and C; or card readers B and C. The comparisons will be: either AA′, BB′, AB; AA′, CC′, AC; or BB′, CC′, BC.

As already mentioned, one of the preceding cases occurs automatically at the end of any work wherein normally the three card readers are used. Without going into the details it may be further mentioned that the interseries comparisons (i.e. types AB, BC or CA) are to be eliminated integrally at the end of the operation or in the case of an operation wherein one card reader is used.

Similarly, in the case of a machine using four card readers, it may be determined that the comparisons within a same series of cards are four in number (whereas the interseries comparisons are six, AB, AC, AD, BC, BD, CD).

This invention relates to tabulating and computing machines of the general type wherein there is effected an integral and preliminary recording of the information contained in the recording cards. As is known, such machines comprise in particular an arithmetical and logical unit enabling the handling of information contained in said cards. The operations to be performed may include transfer of all or part of the information from one memory to another, arithmetical operations (addition, subtraction, multiplication, division), comparisons between the various pieces of information, etc.

More particularly, the invention relates to a machine or a group of machines fed directly with two or more distinct series of recording cards, and contemplates as many different card reading devices and such a number of memory organs as to store the information contained in at least two adjacent cards in each series. This implies the presence of at least six memories of, for example, at least 80 locations in case it is desired to feed the machine with three distinct series of cards, and where each card comprises 80 recording positions.

A primary object of the invention is to provide improved means for determining the card feed order as well as the program operation which is to be effected according to the advance condition of the cards and according to the way the cards are matched.

Another object of the invention is to provide an improved arrangement of the functions performed between two consecutive card feeding operations.

According to the invention a card of one of the series is read out and integrally recorded into the memory provided therefor. The index numbers of this newly fed card are compared with those of the cards previously fed, said index numbers being directly taken from the various memories which are provided to record them. Then the computation programs and associated operations concerning said programs are performed. Finally, another card is advanced, account being taken, when the cards are fed, of all the results provided by the comparison operations performed on the various index numbers.

Another object of the invention is to provide an improved comparing device cooperating with above mentioned memories and with an arithmetical unit.

The comparing device reads out directly from these memories the information to be compared and delivers through the arithmetical unit various pulses eventually indicating the equality, the unequality and the direction of the unequality, the comparing device retaining none of the original information stored.

Another object of the invention is to provide improved means enabling a comparing device to operate either within a single series of cards or between two different series. In each case, the comparing device may be made to accommodate a number of fields of a variable size and may be modified at will by a system of removable connections. It is then possible to associate at will with each field various special related functions (sequence control, numerical or alphabetical comparisons, control of a given program step, matching check, etc.) and in some cases some comparisons or the scanning of some fields may be dropped at will.

Another object of the invention is to provide an improved program unit for a machine employing multiple card feeds.

Another object of the invention is to provide an improved memory unit adapted to operate with a program unit for recording and preserving the result of comparisons controlled from the program unit, and which may further interact with the program unit.

According to the invention the memory unit may act to modify the development of the programs controlled from the memory unit or to drop the comparisons of the lower order whenever a comparison of the same type, but of a higher order has caused an unequality to be detected.

Another object of the invention is to provide improved means for exercising special controls associated with a program unit.

Another object of the invention is to provide a comprehensive device requiring no specialized memories for the comparison operations and lending itself to the use of common devices for multiple purposes.

Another object of the invention is to provide various accessory arrangements for automatically feeding cards at the beginning of the work, for systematically turning off the card readers and for automatically suppressing the corresponding comparison operations either when a card reader is unused or at the end of an operation.

Another object of the invention is to provide special controls for the program unit so as to limit in all cases the comparison operations to only the operations which are concerned with the index numbers of the newly fed card.

Another object of the invention is to provide an improved mechanism wherein subsequent card feed operations are dependent on the contents of prior fed cards.

The foregoing and other objects, features and advantages of the invention will be apparent from the following more particular description of preferred embodiments of the invention, as illustrated in the accompanying drawings.

In the drawings:

FIGURE 1 is a diagram of a physical layout of a machine constructed in accordance with the present invention.

FIGURE 2 is a schematic diagram showing the relationship of the functional units of the machine of FIGURE 1.

FIGURE 3 is a schematic view showing the card advance within the reading units of the machine of FIGURES 1 and 2.

FIGURES 4*a* to 4*q* represent the general arrangement of the electronic circuits.

FIGURE 5 shows how FIGURES 4*a* through 4*q* fit together.

FIGURE 6 shows an example of a set of control hubs.

FIGURES 7 through 14 represent various component circuits and the symbols representing them in FIGURES 4*a* to 4*q*.

FIGURE 15 is an illustrative memory arrangement.

FIGURE 16 is the timing diagram of some pulses occurring in the machine of FIGURES 4*a* through 4*q*.

FIGURE 17 shows the time relations between the control times of some of the triggers of FIGURES 4*a* through 4*q*.

FIGURE 18 shows, for a second embodiment, the time relations between the control times of the same triggers.

FIGURE 19 is another illustrative example of a set of control hubs.

FIGURE 20 shows another embodiment of some of the circuits of FIGURES 4*a* to 4*q*.

FIGURES 21*a* through 21*d* are a schematic diagram of the relay circuits for a machine constructed in accordance with the present invention.

FIGURE 22 is a diagram showing the closing times of some of the mechanically controlled contacts of FIGURES 21*a* through 21*d*.

FIGURE 23 shows another illustrative set of control hubs.

Referring to FIGURE 1 a preferred embodiment of a machine constructed according to the invention is shown comprised of a series of distinct units, interconnected by means of wires **47** and particularly comprising: reading units **48*a*, 48*b*, 48*c***; computing unit **49**; printing unit **50**; and punching unit **51**. Hereinafter, the card readers will be more simply designated by letters A, B and C. Control button and light indicator units **52** are used to control or to stop each one of the units or all of them. In case of an automatic stop, for example when the hopper of one of the card readers is empty, light indicators indicate which of the card readers has caused the machine to stop. It will be further remarked that there are provided, for each one of card readers **48*a*** and **48*b***, a hopper **53** and stackers **54**, very schematically represented here. With the purpose of simplification, it will be assumed, hereinafter that all card readers are identical.

Referring to FIGURE 3, the cards in the hopper close a contact **510**. During successive cycles, the cards are first advanced to position **55**, in front of so called "prescanning" brushes **56**. They are then advanced past these brushes to be scanned, then they are advanced to position **57** in front of the "operation" brushes. They are then advanced past the latter brushes to be scanned again and then are directed towards one of the stackers **54**. Rollers **59, 59*a*** cause the cards to advance. They may all be depending upon one another, or some of them, namely rollers **59** may be assigned a continuous rotation. The cards are advanced as required, as is usual, and an Off time of variable length may occur between two consecutive moves. Contacts **511** and **512** are closed whenever a card is in position **55** or **57**. Contact **510** opens when the last card in the hopper **53** is brought to position **55**. Generally, contacts **510, 511, 512** indicate the advance state of the cards and also indicate whether the advance is correct.

Thus each card is advanced under brushes **56**, then, during the following cycle, past brushes **58** at the time the following card is scanned by brushes **56**. On its passage under brushes **56** each card is recorded in its whole in one of memories M1, M2, M3 (FIGURE 2) according to the correspondence of the row of brushes to one of card readers A, B or C. Similarly, each card advanced past brushes **58** may be entirely recorded in one of memories M4, M5, M6, according to the brush row corresponding to one of card readers A, B or C.

According to a preferred embodiment of the invention, the second recording may be replaced by a direct transfer from one of memories M1, M2 or M3 to the corresponding memory M4, M5 or M6, said transfer being performed immediately before the cards are advanced past brushes 56. The memory from which the transfer has been made is thus cleared and available for a new recording.

Before explaining how the card feed is automatically controlled by the recordings made in memories M1, M2, M3 some special circuits as well as various circuits relating to the operation of the computing unit will be described (FIGURES 4*a* to 24).

FIGURE 11*a* is a power circuit. FIGURE 11 is a symbolic representation of that same circuit. Input leads 32 and output leads 33 are always at the same potential. The circuit represented in FIGURE 11*a* is only needed for the simultaneous supply of several shunted circuits, or the feeding of a common output terminal with pulses from a number of different sources. As a general rule, the circuit will not be represented, but will usually be considered as included in the circuits of FIGURES 7, 8, 10, 12, 13 and 14.

FIGURE 7*a* represents a coincidence circuit. The input leads 20 are supplied a voltage which is normally negative, but which, under some conditions, may turn positive. In the first case, the output lead 21 is subjected to a negative voltage since diodes 22 transmit the current and a significant voltage drop occurs in resistance 23. This happens particularly when one only of leads 20 is negative. On the contrary, if all leads 20 are simultaneously supplied a positive voltage, no current traverses diodes 22 so that resistance 23 is traversed only by the current flowing through lead 21. The corresponding voltage drop being relatively low, the potential of lead 21 is set to a positive value. The positive value of the potential indicates a coincidence between the input positive pulses. Any number of inputs may be provided (two, three . . . as the case may be).

The circuit of FIGURE 7*a* is symbolically represented as shown in FIGURE 7. As the case may be the output is effected directly or through a circuit similar to that represented in FIGURE 11.

FIGURE 8 shows the symbol representing the "Or" circuit of FIGURE 8*a*. Output lead 25 is at a normally negative voltage, which turns immediately positive when one only of input leads 24 is itself positive. The circuit of FIGURE 8*a* will be seen in FIGURES 4*a* to 4*q* under its symbolic form. Reference to it will be generally omitted. The output may be delivered directly or through a circuit similar to that represented in FIGURE 11.

Similarly, FIGURE 9 represents the symbolic form of the circuit shown in FIGURE 9*a*. The latter is a coincidence circuit for transmitting very short positive pulses for controlling the triggers such as that represented in FIGURE 13. Inputs 26 and 26*a* (FIGURE 9*a*) are normally negative and positive respectively: the first one is to receive positive pulses, the second one negative pulses. So long as input 26 is negative, the pulses applied to input 26*a* are inoperative because lead 29 is then at a negative potential and because diode 22 prevents the pulses from being transmitted. On the contrary, when input 26 is at a positive voltage, the potential of lead 29 sets itself to a positive value, thus permitting all positive pulses from input 26*a* to be transmitted. This occurs whenever the potential of input 26*a* returns to a positive value. Condenser 28 then transmits a positive pulse of a short duration, which momentarily increases the potential of lead 29. The circuits are arranged so that diode 22 allows the current to flow therethrough.

FIGURE 10 is the symbol representing the circuit of FIGURE 10*a*. The latter is an inverter. Output 31 is negative whenever the input is positive and conversely. A circuit similar to that represented in FIGURE 11 may possibly be inserted at the output thereof.

FIGURE 12*a* represents one of the amplifying circuits used in conjunction with magnetic core memories. The electromotive force, induced on the inversion of the magnetic force, is applied across input 34 and 34*a*. A positive pulse is collected on output 35. The circuit is shown in FIGURES 4*a* to 4*q* under the symbolic forms represented in FIGURES 12 and 12*b*. In FIGURE 12*b*, the inputs have been merged with the purpose of simplification. A circuit similar to that represented in FIGURE 11 may be incorporated in the output circuit.

FIGURE 13*a* represents a transistor trigger. A first stable state of the circuit corresponds to transistor 36, for example, being conductive. In such a case, output 37 is set at a negative voltage, whereas output 37*a* is at a positive voltage. The trigger may be switched by a positive pulse applied to input 38. A positive pulse applied to input 38*a* is inoperative. In most cases this positive pulse must be applied through a circuit of the type represented in FIGURES 9 and 9*a*.

This same trigger (FIGURE 13*a*) may be switched by a positive voltage applied to lead 39. Said voltage acts upon the circuit composed of condenser 40, resistance 41 and diode 42, which is nothing but the assembly of the component circuits of FIGURE 9*a*. It will be particularly noted that one end of resistance 41 depends upon output 37*a*, which is now assumed to be positive. A positive voltage applied to lead 39*a* is inoperative because the end of resistance 41*a* depends upon lead 37 which is assumed to be at a negative voltage. Generally, it is possible, if required, to apply several different pulses to one of leads 38 or 38*a*, or to provide the application to leads 39 and 39*a* of positive voltages from various sources.

A second stable state of the trigger corresponds to transistor 36*a* being conductive. In such a case, output 37*a* is set at a negative voltage, whereas output 37 is then at a positive voltage. The trigger may be switched either by a positive pulse applied to lead 38*a*, or by a positive voltage applied to lead 39*a*. It is obvious that this switching causes the potentials of leads 37 and 37*a*, respectively, to be inverted.

The trigger of FIGURE 13*a* will be represented in leads 4*a* to 4*q* by the symbol shown in FIGURE 13, the reference letters being any one desired. The determination of the lead type will be made without any ambiquity according to their origin and according to whether they are applied to the right, or left portion of the square, or to the upper or lower portion theerof. A control signal 45 may also be applied in the midpoint of the lower part. Such a control signal indicates that a positive pulse simultaneously is applied to both inputs 38 and 38*a*. It was seen that only the pulse applied to the conducting side is operative, the time constants of the circuits are determined so that there occurs then but one switching. A point placed inside the square, on the right or on the left, indicates the normally conducting side. It was seen that in this case, the corresponding output is a negative voltage; on the other hand, circuits similar to that represented in FIGURE 11 may be inserted in the output circuits 37 and 37*a*.

In case it is desired to maintain a given trigger in a given state, there will be applied a permanent positive voltage to one of inputs 38 and 38*a*. A positive voltage applied for example to input 46 turns lead 38 positive, thus locking transistors 36. The result is a negative voltage in lead 37*a*, which turns transistor 36*a* conductive and causes a positive voltage to be applied to lead 37. In such a case, the pulses applied to input 38*a* are inoperative so to speak, because these pulses have a short duration and they may cause but a temporary modification of the conductive or nonconductive state of transistors 36 and 36*a*.

Positive voltages will not be differentiated by the inputs such as 39 and 40. The preferred input type will result from the logic of the circuits, according to whether any further switching is desired or not.

FIGURE 14 shows a pulse emitter. A positive voltage applied to lead **43** causes a positive pulse of a relatively short duration to be delivered on the output. The circuit of FIGURE 14 schematically represented under the form of the rectangle of FIGURE 11*a* with reference letter E will provide basic pulses which will condition the whole of the circuits, as will be explained now.

PULSE GENERATORS

The pulse generator is composed of four emitters **100*a***, **101*a***, **102*a***, **103*a*** (FIGURE 4*i*) operating as a closed circuit. These emitters have been described more in detail in FIGURE 14. When applied positive pulses on their input terminal **43**, they deliver a positive pulse of a very short duration to leads **100**, **101**, **102**, **103** (FIGURE 4*i*) respectively, and are timed as indicated in FIGURE 16.

Said pulse generator is automatically turned on as soon as one of triggers **B11** to **B16** (FIGURE 4*m*) is switched; it then remains on so long as the triggers have not all been reset.

Triggers **B11** to **B16** are normally conducting through their right side, as is indicated by the points placed inside the various blocks. In such a case, and as mentioned above with reference to the circuits of FIGURE 13, the output leads, such as **108**, **109**, **110** or **107**, are at a negative voltage, and so is lead **117** from mixing circuit **112**. The voltage of that lead is applied in particular to coincidence circuit **118** (FIGURE 4*i*) which is locked thereby. In parallel, lead **113** which is connected to negative terminal **106**, through resistance **105**, is also negative.

For any one of triggers **B11** to **B16** (FIGURE 4*m*) happening to be switched (it will be seen later how this is done) one of leads **108**, **109**, **110**, or **107**, is set to a positive voltage, which causes a positive voltage to appear in lead **117** and to keep the same value so long as those among triggers **B11** to **B16** which have been switched are not all reset. This voltage is particularly applied to condenser **104** (FIGURE 4*i*), to lead **113** and through mixing circuit **114**, to lead **115**, and finally to emitter **101*a***. The latter thus delivers a first pulse, which causes, a little later and successively, units **102*a***, **103*a*** and **100*a*** to emit pulses. The voltage of lead **117** is applied to coincidence circuit **118**, thus favoring the transmission of pulses from lead **100**.

When emitter **100*a*** begins operating, the pulse on lead **100** is transmitted by coincidence circuit **118** and applied again to emitter **101*a***, through mixing circuit **114**.

Emitter **101*a*** also provides a second pulse, which in turn starts emitters **102*a***, **103*a***, **100*a***, then again **101*a***.

To sum up, the chain constituted by emitters **101*a***, **102*a***, **103*a***, **100*a***, provides a series of successive pulses, which is indefinitely repeated so long as the voltage applied to lead **117** is unchanged.

Lead **103** particularly feeds to inverter **119** which feeds to lead **120** and coincidence circuits **121** and **121*a***. Trigger **B1** being initially restored as indicated by the dot placed within the square, output lead **122*a*** is at a negative voltage, thus favoring coincidence circuit **121**. The latter which is of the type described in FIGURE 9 thus transmits a first pulse which switches trigger **B1**. It is to be remarked that lead **120** is originally positive. It turns negative when emitter **103*a*** is started, and it was seen that the coincidence circuit of FIGURE 9 transmits no pulse. When pulse **103** is interrupted, that is when lead **103** turns negative again, lead **120** turns positive and it was seen that the coincidence circuit of FIGURE 9 can transmit a pulse only then. The first switching of trigger **B1** coincides with the end of first pulse **103** that is with vertical **126** in FIGURE 16.

Trigger **B1** being switched as seen above, lead **122*a*** is reset to a negative voltage, thus locking coincidence circuit **121*a***. Consequently, a switching pulse may be applied to the left side of trigger **B1** at the end of the next pulse **103**. The switching time corresponds in FIGURE 16 to vertical **127**.

Therefore lead **122*a*** is reset to a positive voltage, thus favoring again coincidence circuit **121** and preparing a new switching of trigger **B1**, etc.

Generally, trigger **B1** is switched whenever lead **103** returns to a negative voltage. Leads **122** and **122*a*** are subjected to alternate voltages, alternatively positive and negative, as may be seen from FIGURE 16.

ADVANCE PULSES

A branch line of lead **103** connects to coincidence circuits **123** and **123*a***, which have for their other inputs leads **122** and **122*a*** respectively. The output leads therefore are always negative, except when the positive voltages are applied simultaneously to both inputs of coincidence circuits **123** and **123*a***. These leads connect to inverters **124** and **124*a*** respectively, which feed to leads **125** and **125*a***. These leads are always at a positive voltage, except when positive voltages are simultaneously applied to coincidence circuits **123** or **123*a***. The function of leads **125** and **125*a*** is to switch the various triggers, as will be seen in detail later on. The circuits controlled from these leads are generally arranged so that the switching occur when leads **125** or **125*a*** turn back to a positive voltage and therefore this switching coincides with the end of pulse **103**.

Memories and scanning chains.—In the embodiment being described the memories have been assumed to be magnetic core memories. It is known that the magnetic state of some substances, under some conditions, assumes two readily defined saturation states and that it is possible, by differentiating said states, to characterize the presence or the absence of a bit of information. It is understood that the use of such a memory is but illustrative of the invention. The adopted recording mode is a composite mode resulting from the association of binary elements 1, 2, 4, 8, and of auxiliary arguments A, B, C. Such a code requires seven magnetic cores per position. It lends itself to the numerical and alphabetical recordings, as well as to the recording of some special signs. Argument C may be an even or odd parity checking code, as desired. It will be inserted systematically in some cases, so that the number of arguments used for the recording of a digit or of a letter is for example always even. Thus digit 1 will be for example recorded as 1—C. Digit 6 will be recorded as 2—4 without C, whereas digit 7 will be recorded 1—2—4—C. It is well understood that the adopted recording code is not necessary for the invention, and is but illustrative.

The cores corresponding to a same position and the circuits interconnecting them will be conventionally referenced by digits or letters **1**, **2**, **4**, **8**, A, B, C, according to corresponding code argument. It is obvious that in that case, letters A and B have a quite different meaning from that they will be assigned in expressions such as time A, time B, scanning chain A, scanning chain B. This will cause no confusion since these letters will never be used singly.

As concerns the sign for the numerical factors, it will be recorded as an argument A if it is a minus sign. The absence of said argument will automatically indicate a positive sign. As a rule, for each memory area, the sign will be recorded in the less significant position. In some cases, the sign may assume any position (in the case for example of a factor directly recorded from a punched card, or when the perforation characterizing the sign of that factor is in some column of said card).

The memory locations may be as numerous as desired, ranging conveniently from a few units to a few tens. It is to be noted, though, that the invention has been specially conceived so as to lend itself to the adoption of high capacity memories.

Similarly, the memories may also be in any number.

For obvious reasons and to avoid indefinitely reproducing identical circuits, on the accompanying drawings, there have been represented but 6 memories (FIGURE 4*n*) referenced M1 to M6. Each memory has been symbolically represented by seven superposed blocks seen in perspective, each one corresponding to an argument of the code used.

By way of example each memory presents 80 distinct locations thus permitting the recording of 80 digits, alphabet letters or special characters. It will be noted that each memory is able, if required, to record all the information data stored in a punched card comprising eighty columns.

In each memory, the locations are grouped according to a coordinate system such as that represented in FIGURE 15. Location **1** to **10** of memory M1 for example are defined by coordinates:

$y=1$, $x=1, 2 \ldots 8, 9, 10$.

Similarly locations **11** to **20** are defined by coordinates:

$y=2 \quad x=1, 2 \ldots 8, 9, 10,$

whereas locations **71** to **80** are defined by coordinates:

$y=8 \quad x=1, 2 \ldots 8, 9, 10.$

This mode of definition is but illustrative and it would be possible to adopt, for example, any one of the following coordinate systems:

$x=1$ to 9	$y=1$ to 9
$x=1$ to 12	$y=1$ to 7
$x=1$ to 16	$y=1$ to 5
$x=1$ to 80	$y=1$

with, if desired, some blank locations if the coordinate system allows definition, in the whole, a number of memory locations higher than the effective location number.

The various locations of one memory will be numbered conventionally in the increasing order according to a continuous numeration system ranging for example between **1** and **80**. The numeration mode corresponds to the present custom consisting in referencing the columns of a card by a continuous system of numbers increasing from left to right. It is to be noted that this numeration mode is exactly the reverse of that generally adopted to designate the various consecutive digits of a number. Thus number 248 will be recorded for example:

2 in location **14**
4 in location **15**
8 in location **16**

When it will be desired to analyze and read out that number (for example, in order to add it to another number) it will be done digit by digit, beginning by the less significant ones.

Therefore, we shall study successively the scanning and read out of the digit stored in location **16**, then that of the digit stored in position **15**, etc. In other words, the various positions in one memory will be scanned in the order reverse to that of their numbers.

To allow free access to any position of any one of the memories, scanning chains are associated with these memories, the number of the scanning chains corresponding to the numbers of the addresses of the chosen operation type. A simple address operation would consist in performing the elementary adding operation $a+b=c$, by means of three distinct program steps, the first one controlling the transfer of factor A to an adding organ, the second one controlling the transfer of factor B, whereas the third one controls the storage of the addition result, the latter operation being indispensable to clear the adding organ and to allow it to be used again in another series of operations. Such an operating mode requires but one scanning chain since each program step controls but one factor.

A three address operation would allow the elementary addition operation $a+b=c$ in one single program step. It requires three scanning chains. For it is necessary to control simultaneously the extraction of factors A and B and the storage of the result of the addition.

In many cases, it is not advantageous to proceed in such a way, and in particular when said factor is immediately useless as soon as it has realized its function. In such a case, the result of the operation may be substituted. Thus one gets a double address operation type and the standard elementary operation: $A+B=B'$.

Factor B is an intermediate computation result which is determined only to facilitate the computation of B′ and which is erased as soon as it has fulfilled its function, i.e. precisely as soon as it has allowed the computation of B′. Two scanning chains are enough, in such a case, and it will be remarked further that these chains have perfectly differentiated functions: one chain controls the readout of factor A and its regeneration, and the second one controls the readout and erasing of factor B and its substitution by the result of operation, B′.

It is this double-address operation type which has been adopted in the embodiment which is being described: The scanning chains will be generally designated: chain A or chain B, according to whether they control the read out and regeneration of factor A or the read out of factor B and its replacement by the result of operation, B′.

The scanning chains are arranged in a way similar to that in which the various locations of one memory have been grouped, in rows and columns (refer to FIGURE 15). Chain A for example is subdivided into a unit chain allowing the memory to be scanned according to abscissa x and in a tens chain performing the same scanning according to ordinate y.

The unit chain is formed of triggers **1U** to **10U** (FIGURES 4*g* and 4*f*) out of which but the first two and the last two have been represented. To these triggers, there are associated memory locations **1** to **10** and those deriving therefrom by adding integer multiples of 10. The various memory locations being scanned in the order opposite to that of their numbers, such will be the advance of the unit chain, as will be seen later.

The tens chain is composed of triggers **0D** to **7D** (FIGURE 4*e*), out of which only the triggers quoted have been represented. To these triggers, there are associated respectively the first ten locations of a memory, then the ten next, and so on. As will be seen, the advance of the tens chain is also performed in the order opposite to that of their numbers, so that there are scanned first the memory locations bearing numbers **80** to **71**, then locations bearing numbers **70** to **61**, etc. Generally, the index number of the triggers controlling the scanning of a given location in the memories is immediately obtained by separating the two digits of that number from each other. Thus location **27** is controlled respectively by trigger **2D** and **7U**. One exception for the locations bearing a number multiple of 10, location **30** for instance is controlled by triggers **2D** and **10U** and not by triggers **3D** and **0U**.

To scanning chain A, there are associated further triggers **1M**, **2M**, **3M** . . . (FIGURE 4*c*) permitting the characterization of the memory according to its number. Trigger **1M** for example being switched, lead **217** is at a positive voltage, and such are leads **197** and **195** when coincidence circuit **194** allows the voltage to be equalized. Lead **195** connects to mixing circuits **323** and **323*a***, which respectively feed to leads **324** and **324*a***. Therefore, the latter will be positive, whenever coincidence circuit **194** allows the voltage to be equalized, i.e. whenever lead **188** is itself positive.

Lead **324** controls coincidence circuits **325** and **325*a***. Thus the latter may turn positive if anyone of leads **193** or **193*a*** is positive, i.e. if any one of triggers **0D** to

7D is switched (the circuits corresponding to triggers 1D to 6D). If trigger 7D for example is switched, lead 216 is positive, thus switching lead 193 to a positive voltage when lead 188 is itself positive. It has been seen that the voltage of lead 195 (FIGURE 4c) and leads 324 and 324a depended upon the voltage of that same lead 188. Leads 326 and 326a (FIGURE 4e) may be found again in FIGURE 4n. Lead 326 for example controls coincidence circuits 327 and 327a, units 328 and 328a and that among the leads of group 329 further referenced 7 or $Y=8$. Under the same conditions, lead 326a controls that among the leads of the same group which is further referenced 0 or $y=1$.

Similarly lead 324 (FIGURE 4e) controls coincidence circuits 330 (FIGURE 4f) 330a, 330b, (FIGURE 4g) 330c and the leads generally indexed 331. Thus the latter may turn also positive if any one of leads 191, 211, 332 (FIGURE 4f) or 332a is itself positive, i.e. if any one of triggers 1U to 10U is switched. Lead 213 (FIGURE 4g), for example, is positive if trigger 1U is switched, and so are lead 191, when lead 188 is itself positive, and that among leads 331 which is further referenced 1 (see also FIGURE 4n) which controls coincidence circuits 333, 333a, units 334 and 334a, as well as that among the leads of group 335 which is further referenced $x=1$.

Finally, the simultaneous switching of triggers 1M (FIGURE 4c), 7D (FIGURE 4e) and 1U (FIGURE 4g), for example, results in respectively controlling those among the leads of groups 335 and 328 which are further indexed $x=1$ and $y=8$ in further controlling the memory location where these leads intersect, i.e. location 71 in memory M1.

Similarly, it will be seen that, under some conditions, the switching of trigger 2M (FIGURE 4c) results (lead 188 positive) in turning lead 195a positive. A branch line of that lead connects to mixing circuit 323a and lead 324a, i.e. to the same lead as previously, which finally controls lead group 335 (FIGURE 4n). On the ohter hand, a second branch of lead 195a connects to mixing circuit 323b which in turn controls lead 336 (see also FIGURE 4e), lead group 337 as well as lead group 338 (FIGURE 4n). The circuits connecting the two latter lead groups have not been represented, but may appear after those connecting lead groups 326 (FIGURE 4e) and 329 (FIGURE 4n). Lead groups 335 and 338 intersect again in a memory area corresponding to the 80 locations of memory M2.

Similarly, it will be seen that the switching of trigger 3M (FIGURE 4c) generally controls memory M3 (FIGURE 4n), the connecting circuits having been but partially represented. Similarly an unshown trigger (FIGURE 4c) controls a fourth memory, etc.

Scanning chain B is arranged exactly as chain A. It comprises:

A units chain composed of triggers 11U to 20U (FIGURES 4g and 4f);

A tens chain composed of triggers 10D to 17D (FIGURE 2e).

Triggers 11M, 12M, 13M . . . (FIGURE 4c) are associated therewith.

It will be noted that all the references are the same as those used for chain A, systematically increased by 10. Trigger 12M for instance, causes a voltage to be applied to lead 195a, i.e. to the lead which is applied a voltage on the switching of trigger 2M, with the only difference that this voltage application coincides now with a positive voltage of lead 265. Under the same conditions, trigger 17D (FIGURE 4e) for example, causes the application of a voltage to lead 193, which is also controlled by trigger 7D, whereas trigger 11U (FIGURE 4g) causes the application of a voltage to lead 191. Generally speaking, chain B permits memories M1, M2, M3 . . . (FIGURE 4n) to be controlled in the same manner as did chain A, with the difference that this control now coincides with a positive voltage of lead 265.

GENERAL OPERATION PRINCIPLE

To make it easier to understand what follows, it is of interest to note the objectives, as well as the approach used to reach the objectives.

The main objective is to accommodate transfer operations, arithmetical operations, or else in comparing operations, said operations being effected between quantities stored in memories.

Let it be assumed, for example, that it is desired to add two factors. These factors, *a* and *b*, will be supposed stored respectively in areas A and B of some memories, and let us suppose that *b'* is their sum, and is to replace *b* at the end or in the course of the operation.

To simplify, it will be supposed that *a* and *b* are of the same scale (i.e. that they express a sum of units of the same range) and that they are respectively 321 and 8765.

In a first operation time, the first digit of *a*, namely 1, is read out.

During the second operation time, the first digit of *b*, that is 5, is read out, added to 1, which makes 6; then 5 is replaced by 6. At that moment, memory area *b* is storing quantity 8766 instead of 8765 as previously.

During a third operation time, the second digit of *a*, i.e. 2, is read out, then during a fourth operation time, the second digit of *b*, i.e. 6 is read out, added to 2, which gives 8, and 6 is replaced by 8. At that moment, memory area B contains quantity 8786 instead of 8766 previously, and 8765 originally.

During a fifth operation time, the third digit of *a*, namely 3, is extracted, then, during a sixth operation time, there occurs: the read out of the third digit of *b*, namely 7; the addition of 3 to 7, i.e. 10; the replacement of 7 by 0.

Memory area B contains at that moment 8086. The carry 1 is stored apart so as to be possibly recycled should the occasion arise.

During a seventh operation time, the fourth digit of *a*, namely 0, is read out. Particularly, area A is fictitiously completed by a series of zeros when the scanning of the corresponding area is completed.

During a second operation time, there ocurs: the read out of the fourth digit of *b*, i.e. 8; the addition of that digit to the corresponding digit extracted from area A or replacing a preceding one therein, i.e. in the illustrative example $8+1=9$; the replacement of 8 by 9.

Memory area B, at that moment, stores 9086 which is the result of adding 321 to 8765.

From above, it is seen that the result of the addition is elaborated progressively, digit by digit, and that the operation method used is primarily characterized by the alternance of two operation times: First time—read out of a well determined digit of area A; Sectond time—read out of the correspondingly significant digit of area B. Addition of the digit with that previously read out from area A. Possible addition of a carry from the immediately lower order. Replacement by the result of the whole of these operations of the digit previously read out from area B.

The first operation time will be designated conventionally as time A, and the second one as time B.

As will be seen, the first operation time will be primarily characterized by a positive voltage applied to lead 122a (FIGURE 4i), as well as by various pulses controlled from that lead. Time A will extensively define any time corresponding to a positive voltage across lead 122a. The end of that time is indicated by leads 120 and 125a turning back positive, by the switching of trigger B1 caused by a pulse from coincidence circuit 121a, and by other switchings which will be discussed later and which are for preparing the following operations.

The second operation time is substantially characterized by a positive voltage across lead 122 as well as by various pulses controlled from that lead. Similarly and extensively, the name of time B will be given to any time corresponding to a positive voltage of leads **122**. At the end of that time, leads **120** and **125** turn back positive, trigger B1 is switched by a pulse from coincidence circuit **121** and there occur additive switchings which will be discussed later, and which are primarily for preparing the following operations.

It is to be pointed out that the latter pulses indicate the end of the operations relating to digits of a well determined order.

POSITIONMENT AND ADVANCEMENT OF THE SCANNING CHAINS

Chain A and chain B are positioned in a way which will be described later. It has been explained how the various memory locations are made to correspond and which are the various combinations possibly provided by the tens and units chains. For memory location **72**, for example, triggers **7D** (FIGURE 4*e*) and **2U** (FIGURE 4*g*) are switched in chain A, or **17D** and **12U** in Chain B. Generally, there may be established a correspondence table indicating for each of the 80 memory positions the corresponding trigger combinations. Under these conditions, the scanning chains are positioned in a location of the memories when the combination of the corresponding triggers are switched. The circuits connecting the 80 hubs **153** (FIGURE 4*d*) and the coincidence circuits generally referenced **203** and **204** (FIGURES 4*g* and 4*e*) meet that positioning requirement. This will be seen hereinafter.

Chain A being positioned, for example in location **72** (triggers switched: **7D** and **2U**), it will be advanced, as will be seen later, at the end of each time A whenever the voltage of lead **181** (FIGURES 4*e* to 4*i*) is positive anew. The lead **103** reverts to its negative state at the same time. A first switching pulse is provided on the switching of trigger B7 (FIGURE 4*h*), and it will be assumed that this pulse has switched specifically triggers **7D** and **2U** (see above).

Therefore, leads **216** (FIGURE 4*e*) and **339** (FIGURE 4*g*) are positive. Lead **188** being itself positive (the reason why will be seen later), coincidence circuit **190***a* is favored on its two inputs, thus causing lead **190***a* to become positive and still favoring coincidence circuit **212**. The latter, when receiving a pulse from a branch line of lead **181** delivers a switching pulse from lead **340** to the left side of trigger **2U**, thus restoring it to its initial state, and to the right side of trigger **1U**, thus switching it. The switched triggers are then **7D** and **1U**, which correspond to memory location bearing number **71**.

During the following time A, leads **213** and **191** are positive. Consequently, at the end of that time, an advance pulse is transmitted by coincidence circuit **212***a* and lead **340***a*, and applied to the left side of trigger **1U** and to the right side of trigger **10U** (FIGURE 4*f*). Trigger **1U** is thus restored, whereas trigger **10U** is switched. In parallel with this positive voltage of lead **213** (FIGURE 4*g*) is applied to mixing circuit **209** (FIGURE 4*e*) to lead **210** and to coincidence circuit **215***a*.

Lead **188** is always positive during time A, trigger **7D** is switched, and leads **216** and **193** are also positive. This positive voltage is applied to another input of coincidence circuit **215***a*. Generally the latter voltage is inoperative, except when trigger **1U** (FIGURE 4*g*) is itself switched. The voltage of lead **213** is applied to coincidence circuit **215***a* (FIGURE 4*e*), as has just been explained. In such a case, the latter also transmits an advance pulse, which results in restoring trigger **7D** to its initial state, and in switching trigger **6D** (not shown). Under these conditions, the triggers switched at the end of the given time are respectively triggers **6D** and **10U** (FIGURE 4*f*) which correspond to the memory location bearing number **70**.

At the end of the succeeding times A, triggers **9U**, **8U**, **7U** . . . **2U**, **1U**, are successively switched, whereas triggers **10U**, **9U** . . . are successively restored to their initial state. The result is the successive control of trigger combinations **6D—9U**, **6D—8U** . . . **6D—2U**, **6D—1U**, respectively corresponding to the memory locations bearing numbers **69**, **68** . . . **62**, **61**. The trigger combinations controlled are **5D—10U**, **5D—9U** . . . corresponding to the memory locations bearing numbers **60**, **59**. Generally all the trigger combinations corresponding to a systematic scanning of the various locations of one memory are controlled successively, the scanning being effected in an order reserve to that of their numbers.

The scanning chains are generally disposed in a ring. Therefore it is necessary to interrupt the scanning operations when location **1** is reached in order to avoid the operations being resumed in location **80**. The trigger combination corresponding to that position is **0D 1U**. These triggers are assumed switched, leads **213** and **216***a* (FIGURES 4*g* and 4*f*) are positive as are leads **191** and **193***a* during the following time A. A branch line of these leads connects to coincidence circuit **341** (FIGURE 4*g*) which is thus simultaneously favored on both inputs, thus turning lead **342** positive. The result thereof will be described hereafter; it locks the scanning chain advance, and simultaneously causes it to be de-energized.

The operation of chain B is quite similar to that of chain A, except that it is effected during times B under the control of the voltage of lead **265** (FIGURES 4*c* to 4*h*).

GENERAL PROGRAMS

The main programs are developed under conditions which will be specified later on, under the control of triggers B11 to B16 (FIGURE 4*m*). These programs define a group of functions or a series of function groups which must necessarily occur according to a predetermined order. Some of the above mentioned triggers may be simultaneously controlled. They are then operated successively, in the order according to which they have been mentioned. Triggers B2 and B3 are associated with the preceding ones; they assume operations which will be specified later.

As will be seen later, trigger B11 is systematically controlled on each card feed, independently from the head to which the card is fed. It is provided to control the whole of the operations relating to the comparison of the indices of the newly fed card and those of the previously fed cards.

Triggers B12, B13, B14, are selectively controlled on the card feeding whenever the feed is made to a specific head. They control the whole of the operations relating to the feeding of a new card (computation or related operations).

Trigger B15 is picked up on sequence breaks; it controls the whole of the operations which are to be effected at that moment. As will be seen, the circuits are arranged so as to control trigger B15 either when there is a sequence break in any one of the heads, or when the sequence break occurs simultaneously in two or more heads or in all of them. It is known that usually a number of sequence break types are contemplated and each of these types is materialized in a series of special circuits. In the here described embodiment, there has been provided but one type of sequence break, for simplification, and to avoid indefinitely reproducing identical circuits. Several types of sequence breaks are contemplated; a corresponding series of triggers are provided and arranged as are B12, B13, B14 with corresponding controls.

The chosen embodiment further comprises a trigger B16 systematically controlled on each card feed, as trigger B11. This trigger is used to control the memory-to-memory transfers which must necessarily occur before any new card feed.

As will be seen, the operation of the machine which is now to be described implies a series of operations bearing, for each card reader, all the information stored in two adjacent cards. These operations suppose that the information stored in the cards have been recorded previously, and the recording may be effected in two quite distinct ways.

A card newly fed in reader A may be recorded into memory M1 for example, and the card previously fed may be rerecorded into another memory, for instance memory M4. This mode requires that two cards should be recorded simultaneously. It is disadvantageous in that it requires relatively elaborated circuits and in that the operation is relatively slow. The recording of a card requires in particular, 12 consecutive memory scannings; it is necessary to perform 24 scannings as a whole if it is desired to record two cards directly and simultaneously.

Another process consists, before feeding a new card, in extracting all the information data contained in the previously fed card (which are still stored in the memory where they have been recorded, M1 for example), and in transferring them to another memory, for example M4. The latter operation is advantageous in that it requires but one memory scanning instead of 12, when a direct recording is desired.

To make it easier to understand what follows, it will be assumed that the cards are recorded in the following way:

(1) From reader A to memory M1, then to memory M4;

(2) From reader B to memory M2, then to memory M5;

(3) From reader C to memory M3, then to memory M6.

These assignments are shown in FIGURE 3. The cards going through reader A, for example, are recorded in memory M1 when they pass in front of brushes 58. Similarly, the cards going through reader B are recorded in memory M2 then in memory M5, the cards going through reader C are recorded in memory M3, then in memory M6. The direct recording into memories M4, M5, M6, may be replaced by a direct recording from the corresponding memory M1, M2, M3. This is indicated by arrows 60.

As concerns the way in which the programs controlled from triggers B11 to B16 are started, let it be remembered first that any card feed control results in starting some mechanisms and particularly in operating the various cam-controlled contacts. FIGURE 22 indicates how the closing times of these contacts are timed. These times are sampled according to a degree graduation. There has been arbitrarily chosen, for the beginning of the index graduation, the moment when the card reading starts. Moreover, it was assumed that, on each stoppage, the feeding unit mechanisms are locked in location 324 of the index. This results in the cam contacts, the closing times of which are adjacent to this index position, closing during the stop time of the feeding unit.

The cam contacts have been referenced (FIGURE 22) from C1 to C15. The same symbols may be found again in FIGURES 21*a* and 21*d*, as well as in FIGURE 4*m*; however, they will be followed with letters A, B or C, in order to differentiate the various reading heads. This corresponds to an embodiment of the invention comprising three identical card reading devices, generally referenced A, B and C.

Let it be supposed that one card only is fed, said feeding being performed in any one of heads A, B or C, for example to head A. All the cams of the corresponding series will be operated for a cycle, and will cause the following results (see FIGURE 4*m*).

Lead **142** is normally at a positive voltage. It is connected to positive terminal **144** through resistance **145**. The operation of cam contact C2A results in connecting this lead to negative terminal **146**, thus bringing that lead to a negative voltage and therefore locking coincidence circuits **175** and **147**. Said locking lasts during all the time when contact C2A is closed, i.e. in fact during all the card reading time. The development of the programs controlled from triggers B11 and B16 is thus delayed up to the time when the cards have been completely and integrally read.

Whereas contact C2A is still closed, cam C14 closes its contact, thus applying a positive voltage to hub **148**, lead **152** and lead **154**. Similarly, the card feed in heads B and C operates cams C1B and C1C respectively, thus causing positive voltages to be applied to one of leads **152*a*** or **152*b***, to one of hubs **148*a***, and to lead **154**.

The positive voltage of lead **154** is applied on to the left side of trigger B11, and to mixing circuit **156**, lead **157** and the right side of trigger B16. Is causes these two triggers to switch immediately in the already described way (refer to FIGURE 13*a* and to the corresponding part of the description).

Hubs **148**, **148*a***, **148*b*** must be selectively connected to hubs **158**, **158*a***, **158*b***, in the order, according to which of the various card programs are developed in the case when it is contemplated to feed simultaneously 2 or 3 cards (or several cards if the card readers are more than 3). For example, for the development of the programs, it may be contemplated, to adopt the following order:

(1) Program corresponding to the card fed in reader C;

(2) Program coresponding to the card fed in reader B;

(3) Program corresponding to the card fed in reader A.

In such a case, the connections should be the following:

(1) Hub **148*b*** to hub **158**;
(2) Hub **148*a*** to hub **158*a***;
(3) Hub **148** to hub **158*b***.

Let it be mentioned that it is possible, if required, to connect two of hubs **148**, **148*a***, **148*b*** to the same hub **158**, **158*a***, **158*b***, or still to connect all three of them to the same hub.

Let it be supposed that the connections are:

(1) Hub **148** to hub **158**;
(2) Hub **148*a*** to hub **158*a***;
(3) Hub **148*b*** to hub **158*b***.

The positive voltage of hub **148** is thus applied to the right side of trigger B12, thus causing the switching of that trigger.

Trigger B16 may be switched on the transfer of contact R35–*a*. Condenser **160** is normally connected to the positive terminal **144**, through resistance **159** and contact R35–*a*. The latter being transferred, a positive pulse is applied to contact R31–*a*, then to lead **157** and to the right side of trigger B16 switching it thereby.

Contact R32–*d* (normally closed) opens, as will be seen, only in the exceptional case when cards advancing within the card readers are to be removed and when it is desired that this removal should eliminate all the controls effected from contacts C1A, C1B, C1C and hubs **148**, **148*a***, **148*b***.

GENERAL CONTROL CIRCUITS

With some of triggers B11 to B16 switched, it is necessary to cause the pulse generator to start; to cause the starting of each program step (and, at the same time, the just completed program to be cut off); to position the scanning chains; and to excute actually said program, etc.

The first operation is effected through the application of a positive voltage to lead **117** (FIGURE 4*i*). The following operations are made under the control of triggers B6 to B10 (FIGURES 4*h* and 4*i*), the specific functions of which are respectively:

B6—starting of each program step and switching off of the previously operated step;

B7—positionment of the scanning chains controlling memory areas A and B in the locations of said areas corresponding to the less significant order;

B8—checking of the arithmetical operation;

B9—various checkings relating to the less significant digits;

B10—checking of the running out of the digits of memory area A.

As will be seen, triggers B6 to B9 are switched because of pulses controlled from lead **125** and which are coincident with the switching pulse provided by coincidence circuit **121**, i.e. with the end of a time B. It will be the same for the restoration of trigger B10.

These triggers (B6 to B10) control one another and as a rule, constitute a ring; however, there exist cases when one or more of these triggers may be switched simultaneously. To understand the circuits, it is advantageous to know these cases from now and to know how the various operations are related to one another.

Trigger B6 is always switched at the beginning of an operation or at the beginning of a program and restored at the end of each program.

As concerns triggers B7 to B10, the sequence order of the switchings and the time during which these triggers remain switched are variable according to the amplitude of the scanning areas A and B. This order as well as the switching time in the cases for which the scanning of areas A and B correspond to 4 and 6 digits respectively is as follows:

B7
B8—B9
B8 only, during three consecutive periods
B8—B10 during two consecutive periods
B6

STARTING A PROGRAM STEP

Let it be assumed that trigger **B12** is switched (FIGURE 4*m*) trigger B11 is Off, and triggers B13 to B16 being in any state (switched or not). Lead **109** is then positive, as is lead **117** from mixing circuit **112**. The latter lead runs particularly to FIGURE 4*i*, where it operates the pulse generator (assembly composed of emitters **100***a*, **101***a*, **102***a*, **103***a*) in the already described way. It has been seen that there occurred successive switchings of trigger B1, which resulted in positive voltages being applied to leads **122** and **122***a* alternately. It has been seen also that leads **125** and **125***a* delivered parallelly and alternately a series of advance pulses. A branch line of lead **125** connects to coincidence circuit **161** (FIGURE 4*m*).

It has been seen further that the potential of lead **142** was initially negative. The potential returns to a positive value on the opening of cam contact C2A. Trigger B3 being restored as mentioned, lead **174** is also positive. Coincidence circuit **175** thus applies a positive voltage to lead **177** and to one of the inputs of coincidence circuit **147**. Lead **117** being itself positive, coincidence circuit **147** is favored at its two inputs thus causing a positive voltage across lead **162**, which connects to coincidence circuit **161**. On the application of the advance pulse (from lead **125**), trigger B2 is switched, thus bringing the voltage of lead **116** to a positive value.

It is obvious that there elapses more or less time between the starting of the pulse distributor (by the positive voltage of lead **109**), and the switching of trigger B2. Lead **125** may thus distribute a great number of advance pulses which will be operative to switch trigger B2 only when the voltage of lead **142** is positive. Lead **116** connects coincidence circuits **163**, **164**, **165** and **166**. The first one is used to restore trigger B2 and to cause trigger B3 to be switched. The second one, **164**, has for its second input a branch line of lead **117** which is now positive. Therefore the voltage of lead **168** connected therewith is also positive. The result of it will be discussed later. The third one, **165**, has for its second input lead **108** which is now negative; therefore it remains locked. The fourth one, **166**, has for its second input lead **167** which is positive. The result is a positive voltage across output lead **169**, which is applied respectively to coincidence circuits **171** and **172**. The latter is locked, because of the present state of trigger B12, whereas the first one is already favored on its second input because lead **109** is positive. Therefore the hub **129** will also be positive.

Trigger B6 (FIGURE 4*i*) being originally restored, as has been explained, output lead **111** is at a positive voltage. This lead connects to coincidence circuit **143** which has for its second input a branch of lead **125**. Lead **310** is now positive because of the present state of trigger B17 (FIGURE 4*b*). A switching pulse results therefrom and is applied to lead **173** (FIGURE 4*i*) and transmitted to the left side of trigger B6 and to the right side of trigger B7 (FIGURE 4*b*). The result is that both triggers are switched, which happens as soon as lead **125** delivers its first advance pulse, i.e. sensibly before trigger B2 is switched (FIGURE 4*m*).

The voltage of lead **11** (FIGURE 4*i*) thus goes negative. The voltage of lead **128** is positive, as well as that of lead **134**, because of the existence of mixing circuit **133**.

Later there occurs:

(1) The switching of triggers B8 and B9 (FIGURE 4*h* and 4*i*) and the restoration of trigger B7, as will be explained later;

(2) The restoration of B9;

(3) The switching of B2 (FIGURE 4*m*) as has been seen.

Lead **168** thus goes positive, causing, as will be explained later:

(1) The switching of trigger B10 (FIGURE 4*h*);

(2) The switching of trigger B6 (FIGURE 4*i*) and the restoration of all the triggers.

Trigger B6, therefore is switched, the voltage of lead **128** becomes negative, thus making the voltage of lead **134** dependent upon that of lead **125***a*.

It is to be pointed out that trigger B6 is switched when the voltage of lead **125** is positive again, i.e. at the end of time B. This trigger will remain switched until the end of the following time B. During that time interval, lead **125***a* will transmit an advance pulse.

Let it be supposed that there is a connection between hub **129** (FIGURE 4*m*) and hub **130** (FIGURE 4*h*) for controlling the program step from trigger P1. The first one is positive, as has been seen, as is the second one, because of the just mentioned connection. Coincidence circuit **131** is thus favored. Lead **134** has the same voltage as lead **125***a* (FIGURE 4*i*), thus an advance pulse is transmitted at the end of time A, which results in switching trigger P1 (FIGURE 4*h*). The voltage of lead **135** thus goes positive, making hubs **137** and **138** positive through diodes **141**. Hubs **139** and **140** will also go positive alternately as leads **122** and **122***a* are themselves positive.

The advance pulse transmitted by lead **134** is also applied to coincidence circuit **163** (FIGURE 4*m*) which, as seen above, is already favored on its second input. This causes triggers B2 and B3 to be switched which controls lead **168**, and hub **129** so that a new control signal cannot momentarily be applied to trigger P1 (FIGURE 4*h*). At the same time, the voltage of lead **174** (FIGURE 4*m*) has become also negative, thus making leads **177** and **162** negative, and inhibiting momentarily any new control signal to trigger B2.

This being performed, trigger B6 (FIGURE 4*i*) is restored to its original state at the end of time B through a switching pulse from lead **125** transmitted through coincidence circuit **143** and lead **173**. The same pulse also causes trigger B7 to be switched (FIGURE 4*h*) and and the voltage of lead **111** (FIGURE 4*i*) to go negative. The voltage of lead **128** goes positive, as well as that of lead **134**, which cannot any longer transmit the advance pulses from lead **125***a*. At the same time lead **178** (FIG-

URE 4*h*) goes positive because of the switching of trigger B7, thus providing the results which will now be analyzed.

SWITCHING TIME OF TRIGGER B7, POSITIONING OF THE SCANNING CHAINS

Trigger B7 is switched under the action of a pulse from lead **125** (FIGURE 4*i*), i.e. at the end of time B. This trigger remains switched during the following A and B times to be restored at the end of the latter time.

Lead **178** (FIGURE 4*h*) is positive, thus favoring coincidence circuits **192** and **234**. At the same time, lead **180** is negative (the reason of it will be seen later on). Inverter **183** delivers a positive voltage on lead **182** to coincidence circuit **192**. Lead **176** which is the output therefrom is therefore at a positive voltage also.

It has been seen that trigger P1 had been switched, making hubs **137** to **140** positive under certain conditions. Hubs **137** and **138** will be used respectively to control the operation type and to control the following program step. It will be supposed that the operation which is to be effected is an addition. Hub **139** is used to control the memory area, when the latter is controlled to subtract, whereas hub **140** acts in a similar way for the memory controlled to extract and replace. Connections must be made as follows:

(1) Hub **139** to one of hubs **149**, for example hub **149*b***;

(2) Hub **150*b*** to one of hubs **132** (FIGURE 4*c*); for example hub **132–1**, of the memory area controlled to extract, corresponding to memory **1**;

(3) Hub **151*b*** (FIGURE 4*h*) to one of hubs **153** (FIGURE 4*d*), for example, to that of these hubs further referenced **71**, if the less significant digit of the quantity to be read out is in location **71**;

(4) Hub **140** (FIGURE 4*h*) to one of hubs **149**, for example, hub **149*b*** (not shown);

(5) Hub **150*p*** to one of hubs (FIGURE 4*c*), for example, hub **132–2** if the memory area controlled to extract and replace corresponds to memory **2**;

(6) Hub **151*p*** (FIGURE 4*h*) to one of hubs **153** (FIGURE 4*d*) for example, to that further referenced **71**, if the less significant digit to be extracted is in location **71** (the same digit as above has been used in order to simplify the disclosure and to avoid integrally describing a multitude of similar circuits);

(7) Hub **137** (FIGURE 4*h*) to one of the hubs for defining the nature of the operation, in particular to the hub provided to define a control to add, if the operation is to be an addition (this hub has not been represented);

(8) Hub **138** to one of the hubs for controlling triggers P2 to P*n*, hub **130*a*** for example, if the following program step is to be that controlled from trigger P2.

It will be noted that the outputs from hubs **139** and **140** are dependent upon coincidence circuits **170** and **239**, which have for their inputs respectively, lead **135** which is now positive, and a branch line of leads **122*a*** and **122**. Hub **139**, therefore, is positive whenever lead **122*a*** is positive, whereas hub **140** conforms to the potential of lead **122**. The results are the following:

(1) *Time A*.—Lead **122*a*** (FIGURES 4*i* and 4*h*) is positive, as are hub **139**, hub **149*b*** (because of one of the above mentioned connections), hubs **150*b*** and **151*b*** by way of coincidence circuit **179*b***, and because lead **176** is itself positive), hub **132–1** (FIGURE 4*c*) and the hub **153** (FIGURE 4*d*) bearing number **71**.

The positive voltage of hub **132–1** favors in particular coincidence circuit **200** which has for its second input a branch line of lead **176*a***. The latter is now positive; it is connected from coincidence circuit **184** (FIGURE 4*d*) which has for one input a branch line of lead **176**, which is positive and for a second input lead **185** which is also positive (it will be explained why later). This results in a positive voltage being applied to the right side of trigger **1M** (FIGURE 4*c*) which is switched thereby, as has been explained (refer to the description of FIGURES 13 and 13*a*).

At the same time, the positive voltage of the jack **153** bearing number **71** causes a positive voltage to be applied to the leads of groups **201** and **202** which are further referenced **1** and **7** respectively. Lead **201–1** goes through FIGURES 4*e* and 4*f* and reaches in particular coincidence circuit **203** (FIGURE 4*g*). Lead **202–7** (FIGURE 4*d*) particularly connects to coincidence circuit **204** (FIGURE 4*e*). It has been seen that lead **176** (FIGURE 4*h*) was positive. This lead particularly connects to:

(1) Coincidence circuit **203** (FIGURE 4*g*) which will permit the control of trigger **1U**;

(2) Coincidence circuit **204** (FIGURE 4*e*) which will permit trigger **7D** to be controlled.

Lead **125*a*** (FIGURE 4*i*) particularly connects to mixing circuit **186** which has for its second input a branch line of lead **180** (see also FIGURE 4*h*). The latter being negative, as seen above, lead **181** which connects to mixing circuit **186** will conform to the voltage of lead **125*a***. As has been seen, the latter is provided to transmit switching pulses occurring at the end of time A.

It has been seen that coincidence circuit **203** (FIGURE 4*g*) was favored on both its inputs. The output lead is thus at a positive voltage, as is lead **211** which connects to coincidence circuit **212**. The latter, since supplied on its second input with the voltage of lead **181**, will transmit a first switching pulse which is applied to the left side of trigger **2U** and to the right side of trigger **1U**. It does not operate trigger **2U**, since this trigger is already conducting through its right side. On the contrary, trigger **1U** is switched, thus rendering lead **213** positive.

It may be seen that the voltage of lead **193*a*** (FIGURE 4*e*) is also positive, and consequently, a second switching pulse is emitted, transmitted by coincidence circuit **215** which results in switching trigger **7D**. Lead **210** is then positive since lead **176** is positive.

As will be seen, triggers **1U** and **7D** control the memory location bearing number **71**. Triggers **IU** and **7D** have been switched at the end of a time A. The corresponding memory location will be scanned during the following time A under the control of trigger **B8** (FIGURE 4*h*).

(2) *Time B*:—Lead **122** (FIGURE 4*i*) is positive as are hub **140** (FIGURE 4*h*), hub **149*p*** (not shown) (because of one of the above mentioned connections), hub **150*p***, not shown, hub **151*p*** also not shown (because of the presence of coincidence circuit **179*p***, not shown, and since lead **176** is positive) hub **132–2** (FIGURE 4*c*) and that of hubs **153** (FIGURE 4*d*) bearing number **71** (also because of above mentioned connections).

One lead of each group **201** and **202** is thus made positive, namely lead **7** of group **202** and lead **1** of group **201**. These leads are the same as those which were supplied a voltage at time A; however, the results are not similar, because it is now a time B. Coincidence circuits **204** (FIGURE 4*e*) and **203** (FIGURE 4*g*) are favored and leads **193*a*** (FIGURE 4*e*) and **211** (FIGURE 4*g*) are supplied a voltage because lead **176** is still positive. The switching pulse is no longer provided by lead **181**, but by lead **187**, as will be seen. The voltage of lead **125*a*** is unchanged during a time B so that only the circuits controlled from lead **125** may provide switching pulses. The latter lead connects particularly to mixing circuit **189** which receives on its second input the voltage of lead **180** (which is now negative). Lead **187** thus conforms to the voltage of lead **125**. Lead **187** connects in particular to coincidence circuit **212*a*** (FIGURE 4*g*), which is already favored on its second input, since lead **211** is positive. The result is, at the end of the considered time, a pulse causing trigger **11U** to be switched. Lead **187** also connects to coincidence circuit **215*a*** (FIGURE 4*e*), the second input of which is also favored, since leads **193*a*** and **210**a are positive. The result is a second pulse causing trigger **17D** to be switched. The scanning chain formed by triggers **11U** to **20U** (FIGURES 4*g* to 4*f*) and **10D** to **17D** (FIGURE 4*e*) is thus started so that a second memory location bearing number **71** may be scanned.

It has been seen that hub **132–2** (FIGURE 4*c*) has been applied a positive voltage. Coincidence circuit **196** is thus favored. Lead **176***a* being itself positive, the result is the application of a positive voltage to the right side of trigger **12M**, which is thereby switched.

At the end of time B, trigger B7 is restored to its initial state (FIGURE 4*h*) and triggers B8 and B9 are supplied with a control signal (see also FIGURE 4*i*). This is obtained through coincidence circuit **234** which receives on its second input the voltage of lead **125**. It then delivers a switching pulse at the end of time B which is transmitted to lead **198** and applied to the left side of trigger B7, and to the right side of triggers B8 and B9. Trigger B7 is then restored to its initial state, whereas triggers B8 and B9 are switched.

SWITCHING OF TRIGGERS B8 AND B9

Trigger **B8** (FIGURE 4*h*) controls the arithmetical operations. It also controls various related operations as will be seen later. It remains switched up to the running out of the factors. Trigger B9 (FIGURE 4*i*) more particularly controls the operations relating to the digit of the units in the case when this digit should comprise an element characterizing the sign of the factors. Lead **269** is then positive (when trigger B9 is switched); however, the circuits connected therewith have not been represented.

Let us examine again the already given example $a+b=b'$, with $a=321$, and $b=8765$, where the result of the operation replacing *b*.

Hereinbefore, it was assumed that the unit digit of factors *a* and *b* was in location **71** of memories **1** and **2** respectively, but it will be assumed hereafter that these factors are respectively in locations **72** and **75** of memory **1** for factor *a* and **72** to **77** of memory **2** for factor *b*, the scanning chains being originally positioned in locations **75** and **77** respectively. This implies that chain A has started from location **75** (triggers switched are **7D** and **5U**) and that chain B has been started from location **77** (triggers switched are **17D** and **17U**). However, as triggers **5U** and **17U** have not been represented, the circuits will be described for memory location **71** (triggers switched, **7D** and **1U** or **17D** and **11U**). The extraction of factor *a* will be assumed to be controlled by chain A, whereas the extraction of factor *b* and its replacement by the result of the addition will be controlled by chain B.

Time A—Chain A Is in Location 75

(In the description of the circuits, it will be assumed that chain A is in position **71**.)

Lead **122***a* is in positive. Trigger **B8** (FIGURE 4*h*) is switched, thus lead **272** is positive. Coincidence circuit **205** also is favored on its two inputs, thus causing lead **188** to go positive. The latter goes through FIGURES 4*g* to 4*c* and particularly connects to coincidence circuits **190** (FIGURE 4*g*), **206** (FIGURE 4*e*) and **194** (FIGURE 4*c*).

Trigger **1M** being switched, coincidence circuit **194** is favored on both its inputs, so that leads **197**, **195**, **324** and **324***a* are positive (see also FIGURES 4*d* to 4*g*).

Trigger **7D** (FIGURE 4*e*) is also switched, thus making leads **216**, **193** positive (because coincidence circuit **206** is favored on both its inputs) and making **326** positive because coincidence circuit **325** is also favored on both its inputs. Coincidence circuits **327** (FIGURE 4*n*) and **327***a* are thus favored. The results will be analyzed later. If chain A is assumed to be in position **71**, trigger **1U** (FIGURE 4*g*) is switched, thus applying a positive voltage to leads **213**, **191** (because coincidence circuit **190** is favored on both its inputs) and to that of group **331** which is further referenced **1**, because coincidence circuit **330***c* is also favored on both its inputs. Coincidence circuits **333** (FIGURE 4*n*) and **333***a* are also favored. The results will be noted later.

A branch line of lead **272** (FIGURE 4*h*) connects to coincidence circuits **219**, FIGURE 4*i*, and **220** which have as second inputs leads **101** and **103** respectively. As already seen, these leads will periodically go positive, as is shown in the diagram of FIGURE 16, as will leads **99** and **98** which are the output lines of coincidence circuits **219** and **220**. Also lead **97**, which is the output line of coincidence circuit **207** will go positive. The latter is supplied by leads **98** and **122***a*, which are now positive.

The results from the application of all these voltages will be analyzed later. Now it will be simply pointed out that the application of all these voltages causes the quantity stored in the memory location which it is desired to address to be read out and re-recorded. This quantity is sensed, or inserted into an adding organ during these operations.

Let it be supposed now that chain A is in location **75**; circuits similar to those already described and only partially represented cause the location storing the unit digit, 1 (after the quoted example) to be scanned. Let it be noted that some of triggers R (FIGURE 4*p*) are switched, and restored practically immediately, whereas other triggers W (FIGURE 4*q*) are also switched, but are restored only at the end of time B. This will be explained in detail later.

Lead **180** (FIGURE 4*h*) being negative, lead **181** (FIGURE 4*i*) conforms to the voltage of lead **125***a*. The result is, at the end of time A, an advance pulse which brings chain A to position **74**. This advance is made in a way similar to that already described.

As has been already explained, at the end of time A, trigger **B1** is switched (FIGURE 4*i*) and lead **122***a* returns to the negative potential. At the same time, lead **122** is brought to a positive voltage.

Time B—Chain B in Position 77

Lead **122** is positive. Coincidence circuit **208** (FIGURE 4*h*) is favored on both its inputs, thus applying a positive voltage to lead **265**. This lead particularly connects to coincidence circuits **214** (FIGURE 4*c*), **206***a* (FIGURE 4*e*) and **190***a* (FIGURE 4*g*) if chain B is assumed to be in position **71**.

Trigger **12M** (FIGURE 4*c*) being switched, lead **218** is at a positive voltage as are leads **195***a*, **336**, and **324***a* (see also FIGURES 4*d*, 4*e* and 4*g*). Trigger **17D** being also switched, lead **193** is positive as is one of the leads of group **337**, because coincidence circuit **325***b* is favored simultaneously on both its inputs. Leads **337** are connected to leads **338** (FIGURE 4*n*) by means of circuits similar to choose connecting leads **326** and **329**. Trigger **11U** (FIGURE 4*g*) being also switched (if it is supposed that chain B is in position **71**), lead **191** is also positive and causes the lead **331** further referenced **1** to be positive.

If it is supposed now that chain B is in position **77**, the application of a voltage to lead **265** (FIGURE 4*h*) causes voltages to be applied to some of the leads of groups **337** and **331** (FIGURE 4*e*), which causes location **77** of memory **M2** to be scanned, i.e. the location storing factor *b* unit digit, 5. This scanning is performed due to the voltages applied to leads **98** and **99** (FIGURE 4*i*) as will be seen later. At the same time, the addition with the digit read out during the preceding time is performed, as well as the re-recording of the result of that addition.

Since lead **180** (FIGURE 4*h*) is at a negative voltage, lead **187** (FIGURE 4*i*) conforms to the voltage of lead **125**. The result is, at the end of time B, an advance pulse acting in the already described way and resulting in bringing chain A to position **76**.

The voltage of lead **125** is also applied to coincidence circuit **270**, which delivers a switching pulse which restores trigger **B9** to its original state.

Time A—Chain A in Location 74

Lead **188** (FIGURE 4*h*) is supplied a positive voltage which causes the second digit of factor *a*, namely, 2, to be scanned. At the end of that time, chain A is advanced to position **73**.

Time B—Chain B in Position 76

Lead **265** is supplied a positive voltage which causes the second digit of factor *b*, namely 6, to be read out. At the same time that digit is added to the preceding digit, possibly taking into account the carry from the immediately lower order, and the result of the addition, namely 8, is re-recorded instead of digit 6. At the end of that time, chain B is advanced to position **75**.

Time A—Chain A in Position 73

Time B—Chain B in Position 75

Successively:

The third digit of factor *a* is scanned, namely 3; chain A is advanced to location **72**;

The third digit of factor *b*, namely 7, is scanned;

These two digits are added, which gives 10;

Zero is recorded instead of 7;

Chain B is advanced to position **74**.

Time A—Chain A in Position 72

The fourth and last digit of factor *a*, i.e. 0, is scanned. Further, it is necessary to interrupt the advance of chain A and to de-energize it simultaneously; this result is obtained in the following way:

Hub **139** (FIGURE 4*h*) is assumed to be connected to hub **149*b***, a connection must be made between hub **151*a*** and that of hubs **153** (FIGURE 4*d*) bearing number **71**. Leads **122*a*** (FIGURE 4*h*) and **272** are at a positive voltage, as are hub **139**, hub **149*b***, hub **151*a*** (because coincidence circuit **279** is simultaneously favored on both its inputs) and that of hubs **153** (FIGURE 4*d*) which is also referenced **71**. Leads **201–1** and **202–7** are thus made positive. It may be noted that this is the case at each time A, as soon as trigged **B8** is switched; however, these voltages are operative only when chain A is in position **72**. Triggers **7D** (FIGURE 4*e*) and **2U** (FIGURE 4*g*) are then switched.

Trigger **7D** is switched and lead **216** is positive. Lead **188** (time A) and consequently lead **193** are also positive. The latter connects in particular to coincidence circuit **221** which has for its second input a branch line of lead **202–7**. The lead which constitutes its output is therefore supplied a positive voltage as well as lead **222**, diode **223** permitting the equalization of the voltages.

Trigger **2U** (FIGURE 4*g*) is also switched and leads **339** and **211** are positive. The latter feeds coincidence circuit **224** which has for its second input a branch line of lead **201–1**. The lead therefrom is thus positive as is lead **225**, diode **223*a*** permitting the voltages to be equalized.

Leads **222** and **225** feed to coincidence circuit **226**. The latter being favored on both its inputs, lead **227** is at a positive voltage, and so is lead **180** (FIGURE 4*h*) from mixing circuit **228**. The positive voltage of lead **180** is applied to mixing circuit **186** (FIGURE 4*i*) and through lead **181**. Thus the latter is kept at a positive voltage, so that the advance pulses from lead **125*a*** cannot be transmitted and preventing therefore any new advance of chain A.

The positive voltage of lead **180** is also applied to inverter **183** (FIGURE 4*h*) which makes lead **182** negative. The latter connects to mixing circuit **229** (FIGURE 4*i*) which has for its second input a branch line of lead **125*a***, and to mixing circuit **231**, which is also fed by lead **125**. The latter is always positive during a time A as is lead **232**, which is the output line of mixing circuit **231**.

On the contrary, lead **230** from mixing circuit **229** conforms to the voltage of lead **125*a***, which allows various switching pulses to be transmitted at the end of time A.

A branch line of lead **230** connects to trigger **B10** (FIGURE 4*h*) which therefore will be switched. A second branch line connects to coincidence circuit **233**, which receives on its second input positive lead **232**. Lead **235** from coincidence circuit **233** is therefore positive or negative according to the voltage of lead **230**, thus permitting the same switching pulses to be transmitted.

A first branch line of lead **235** connects to coincidence circuit **236** (FIGURE 4*g*) which has, for its second input a branch line of postive lead **339** (because trigger **2U** is now switched). Consequently a switching pulse is applied to trigger **2U** in order to restore it to its original state.

A second branch line of lead **235** reaches coincidence circuit **237** (FIGURE 4*e*) which has for its second input a branch line of positive lead **216**. The result is the application of a second switching pulse which restores trigger **7D** to its original state. Chain A is thus completely de-energized. It may be noted that trigger **1M** (FIGURE 4*c*) remains switched, however the circuits are arranged in such a way that the switching of trigger **1M** is inoperative when chain A is de-energized.

It may be noted that the connection which has been assumed to exist between hub **151*a*** (FIGURE 4*h*) and that of hubs **153** (FIGURE 4*d*) which bears number **71** is inoperative if chain A is initially started in position **71** or in a lower position, for example, in position **30**. In such a case, the de-energization of chain A occurs in one of the following ways:

(1) On the de-energization of chain B; this will be seen later.

(2) When chain A has come to position **1**.

In the latter case, triggers **0D** (FIGURE 4*e*) and **1U** (FIGURE 4*g*) are switched, thus applying a positive voltage to leads **193*a*** (FIGURE 4*e*) and **191** (FIGURE 4*g*). These two leads feed coincidence circuit **341**. Lead **342** therefrom is therefore positive and so is lead **180** (FIGURE 4*h*). The results are those already described (de-energization of chain A).

Time B—Chain B in Position 74

Chain A is de-energized, as has just been seen. The operations relating to the last digit of factor *a* (0 in the case of the example) are not completed so far, because this digit must be added to the digit of the same order in factor *b*. All these operations are performed during the presently described time. In particular:

The fourth digit of factor *b*, that is 8, is scanned.

This digit is added to the digit of the same significance of factor *a*, account being taken of a possible carry from the next lower order, i.e., 9.

Nine is re-recorded instead of 8.

Chain B is advanced to position **73**.

Time A

Chain A is de-energized. Trigger **B10** (FIGURE 4*h*) is switched. This trigger is used to complete fictitiously factor *a* by a series of zeros. The corresponding circuits have not been represented.

Time B—Chain B in Position 73

The fifth digit of factor *b* is scanned and added fictitiously to 0, so as to permit a possible carry to be added. At the end of that time, chain B is advanced to position **72**.

Time A—Chain A is De-energized

The sixth and last digit of factor *b* is scanned and added fictitiously to 0, so that the carries may be added. Parallelly the scanning of factor *b* being completed, it is necessary to de-energize chain B and to cause the operations to go on. It was assumed above that hub **140** (FIGURE 4*h*) was connected to a hub **149*p***, unshown. Hub **151*p*–1** is still connected to the hub **153** which bears number 71 (FIGURE 4*c*), if it is desired that the scanning operations controlled from chain B should be interrupted as soon as this chain comes to position 72. In a way quite similar to that previously described, voltages are applied to leads **222** (FIGURE 4*e*), **225** and **227** (FIGURE 4*g*); however this positive voltage is applied during time B, since hub **140** is now acting as the emitter (FIGURE 4*h*). As previously, this results in a positive voltage being applied to lead **180** (FIGURE 4*h*) at the same time, lead **182** goes negative.

The positive voltage of lead **180** is applied to mixing circuit **189** (FIGURE 4*i*) and therethrough to lead **187**, thus preventing a new pulse for advancing chain B from being transmitted. The negative voltage of lead **182** is applied to mixing circuits **229** and **231**. The first of which is also supplied through a branch line of lead **125a**, which is now positive. It gates through a positive voltage from lead **230**. Circuit **231** receives a branch line of lead **125**. Lead **232** therefrom conforms to the voltage of lead **125**, thus insuring the transmission of various switching pulses. This particularly results in the restoration of triggers **17D** (FIGURE 4*e*) and **12U** (FIGURE 4*g*) which takes place in a way similar to that already described.

Lead **230** (FIGURE 4*h*) is positive, thus the voltage variations of lead **232** are applied as a whole to lead **235**, thus restoring chain A, if not already restored. Lead **232** also connects to coincidence circuits **305** and **274**. Circuit **305**, already favored on its second input, transmits a switching pulse to restore trigger **B10** to its initial state. Circuit **274**, also favored on its second input because lead **272** is positive, transmits a switching pulse on lead **238** and restores trigger **B8** to its original state. At the same time, the state of trigger **B6** (FIGURE 4*i*) is switched, which causes a positive voltage to be applied to lead **111** and a negative voltage to be applied to lead **128**.

SWITCHING TIME OF TRIGGER B6

The switching of trigger **B6** indicates the end of a program stage. This trigger is switched at the end of a time B and remains switched during the following times A and B.

Lead **122a** being initially positive, coincidence circuit **240** is favored on both its inputs, and delivers a positive voltage on lead **241**. This voltage is particularly applied to the left side of triggers **1M** (FIGURE 4*c*) **2M**, **3M**, **11M**, **12M**, **13M** . . . and restores these triggers. Said restoration is performed in the already described way.

On the other hand, an advance pulse is transmitted through lead **134** at the end of time A, as was already explained. This pulse is particularly applied to coincidence circuit **242** (FIGURE 4*h*) thus restoring trigger **P1**. That same pulse may be applied also to coincidence circuit **131a**, if it is desired that the program step controlled by trigger **P2** should follow that controlled by trigger **P1**. In such a case, it is necessary to interconnect hubs **138** and **130a**.

PROGRAM END

In the case when the program step which has just been developed is the last one of the series; hub **138** (FIGURE 4*h*) and the corresponding hub of the last program stage which has just been developed, must be connected to hub **243** (FIGURE 4*m*).

It has been seen that hub **138** (FIGURE 4*h*) or its correspondent, was positive, as soon as a trigger such as **P1** was switched. This hub remains On during the development of the corresponding program step, and particularly during that part of the switching time of trigger **B6**, up to the end of time A. If it is assumed that this hub is connected to hub **243** (FIGURE 4*m*), the latter therefore is positive as are leads **244** and **245**. The latter connect to coincidence circuits **246** and **247** thus favoring them. The advance pulse is transmitted thereto by lead **134** (see also FIGURE 4*i*) and triggers **B12** and **B3** are restored to their original state. The voltage of lead **174** returns to a positive value, which makes it possible to apply another control signal to trigger **B2** if lead **117** is positive, i.e. if any one of triggers **B13** to **B16** is switched.

If it is assumed, for example, that trigger **B13** is switched, a positive voltage will appear on hub **129a**, thus permitting the control of a new series of program steps. The corresponding circuits will not be described; they are identical or similar to those already described when it was assumed that trigger **B12** was switched. It will be observed that when lead **169** is brought to a positive voltage, so will be lead **169a** and hub **129a** since lead **109a** is positive at that moment.

The end of that new series of program steps will be characterized by a positive voltage at hub **243a** and a pulse which will restore trigger **B13** to its original state.

There may possibly be performed:

(1) A third series of program steps controlled from hub **129b**;

(2) A fourth series of program steps controlled from hub **250**;

(3) A fifth series of program steps controlled from hub **250a**, not shown, etc.;

(4) A last series of program steps controlled from hub **251**.

These series of program steps are developed only if the triggers controlling them have been controlled themselves.

ARITHMETICAL OPERATIONS

The arithmetical operations relating to the addition of two digits will now be described with more details. The operations relating to the addition of two numbers comprising any number of digits are but a repetition of the elementary operations which will be presently described.

It will be assumed that the operation performed is of the type $a+b=b'$, a and b having as respective values 7 and 5, for example. Also, it will be assumed that a is stored in location **71** of memory **1**, so that triggers **1M** (FIGURE 4*c*), **7D** (FIGURE 4*e*) and **1U** (FIGURE 4*g*) must be considered as switched. Similarly, b will be assumed stored in location **71** of memory **2** so that triggers **12M**, (FIGURE 4*c*), **17D** (FIGURE 4*e*) and **11U** (FIGURE 4*g*) are also to be assumed as switched.

The arithmetical operations are generally controlled by trigger **B8** (FIGURE 4*h*). It should be assumed that trigger **B9** (FIGURE 4*i*) also is switched. Of course, there are cases when other triggers might be switched, such as **B10** (FIGURE 4*h*) or some others, also not shown.

Time A.—Lead **122a** is positive, as is lead **272**, a branch line of which feeds to coincidence circuits **219** and **220** (FIGURE 4*i*). Coincidence circuit **205** (FIGURE 4*h*), favored on both its inputs, gates a positive voltage through, which is applied to lead **188** (FIGURES 4*c* to 4*h*).

Triggers **1M**, **7D** and **1U** being switched (see FIGURES 4*c*, 4*e* and 4*g*), leads **217**, **216**, and **213** are positive and so are, as has been seen, leads **195**, **324**, **324a**, **193**, **326**, **191**, and **331-1**. Leads **326** and **331-1** connect to coincidence circuits **327**, **327a** and **333**, and **333a** respectively (FIGURE 4*n*).

The operations will develop in three times according whether they coincide with a positive voltage of leads **100** (FIGURE 4*i*), **101** or **103**.

(A) RESULTS FROM THE OCCURRENCE OF PULSE 100

Lead **100** is positive. Lead **122a** also being positive, coincidence circuit **252** is favored on both its inputs and delivers a positive voltage on lead **96**.

The positive voltage of lead **100** is applied to the left side of triggers **1R**, **2R**, **4R**, **8R**, **AR**, **BR**, and **CR** (FIGURE 4*p*) so that all the triggers which might happen to be switched are restored. This restoration is made in the already described way.

The positive voltage of lead **96** is similarly applied to the left side of triggers 1W, 2W, 4W, 8W, AW, BW, (FIGURE 4*q*) so that all among these triggers which might be switched are restored.

(B) RESULTS FROM THE OCCURRENCE OF PULSE 101

The voltage of lead **111** is applied through coincidence circuit **219**, already favored on its second input because lead **272** is positive, and thence through lead **99** (see also FIGURES 4*n* and 4*p*), coincidence circuits **327** and **333**, already favored also on their second inputs, to units **328** and **334**. These units are emitters capable of delivering current of a particular amplitude and especially insufficient to change the magnetic state of a magnetic core if that current operates by itself. The current supplied by unit **328** scans all memory locations corresponding to ordinate $y=8$. Similarly, the current provided by unit **334** scans all memory locations corresponding to abscissa $x=1$. As mentioned above, these currents are not sufficient to change the magnetic state of the cores, however, they will be cumulative in the memory location having the following coordinates $x=1$, $y=8$.

In the latter case, it is known that the currents are arranged so that all the cores are in the same magnetic state, and in particular to switch all the cores which are in a different magnetic state. The first one will conventionally be called Off state and the second one On state. The core rows conventionally represent (according to the given example with that code type) digits 1, 2, 4, 8, and the auxiliary arguments A, B and C. Consequently, if digit 7 is recorded in the location scanned in the memory, cores **1**, **2** and **4** are in the On state, whereas core **8** is in the Off state. The cores corresponding to the auxiliary argument will be left until later.

When the cores are switched Off, there appears an induced current in leads **347** and which finally operates amplifiers **348** (FIGURE 4*p*). The latter have been described in detail in FIGURE 12*a*. They are operated only if lead **99** is positive which is precisely the case. They have been assigned subscript 1, 2, 4, 8, A, B and C which relates to code elements which they represent. Some leads **349** are thus brought to a positive voltage (leads L, 2, 4, in the described example) which is applied to triggers 1R, 2R, 4R, 8R, AR, BR and CR (the prefix corresponding to the code elements) triggers 1R, 2R and 4R are thus switched. Corresponding leads **350** thus are positive and favor some of coincidence circuits **351** (FIGURE 4*q*). Parallelly some of leads **352** (FIGURE 4*p*) are negative.

Let it be mentioned that there has been selected a code type so that perforation 0 is recorded by means of combination 2—8, so as to associate thereto a positive recording, and so that the presence of a zero and the absence of a perforation may be differentiated later. When a zero is recorded, the cores which are On are cores **2** and **2** which will afterwards cause triggers 2R and 8R (FIGURE 4*p*) to be switched (FIGURE 4*p*). This switching is quite similar to that just described. In such a case it is necessary that leads **350–2** and **350–8** should not be brought to a positive voltage, and this is obtained through coincidence circuits **343** and **343*a***. These are locked when triggers 2R and 8R are switched simultaneously.

(C) RESULTS FROM THE OCCURRENCE OF PULSE 103 (FIGURE 4I)

Lead **98** is positive. So is lead **97** because coincidence circuit **207** is already favored on its second input. This voltage is applied to the second input of coincidence circuit **351** (FIGURE 4*q*) and thence to some of triggers 1W, 2W, 4W and 8W which are switched thereby. The switched triggers are 1W, 2W and 4W in the described example (extraction of a 7).

The voltage of lead **98** is applied to coincidence circuits **355** (FIGURE 4*p*). Some of leads **352** being also positive (the leads further referenced **8**, A, B and C in the described example) a positive voltage is applied to some of the emitters further referenced **8**, A, B and C. These emitters are identical to emitters **328** and **334** (FIGURE 4*n*).

The voltage of lead **98** is also applied to coincidence circuits **327*a*** and **333*a***, already favored on their second input. It results in the actuation of current emitters **328*a*** and **334*a***. These emitters are identical to emitters **328** and **334**; however, they are wired so that the current flows now in the direction opposite to the previous current flow. Emitters **328*a*** and **334*a*** deliver a current which, if single, is not sufficient to modify the magnetic state of a core. Let it be supposed that emitters **328** and **334** deliver each a current $-\frac{1}{2}$, and that emitters **328*a*** and **334*a*** deliver each a current $+\frac{1}{2}$. These two currents will respectively scan all the memory locations corresponding to ordinate $y=8$ and to abscissa $x=1$. Their magnetic effects will be cumulative at the memory location having for its coordinates $x=1$, $y=8$ which tends to turn On all the cores in that location.

It has been seen that a positive voltage was applied also to those of emitters **356** (FIGURE 4*p*) further referenced **8**, A, B, C. These emitters deliver a current $+\frac{1}{2}$ in all the magnetic cores of all the memories corresponding to a same code argument **8** in the memory location having for its coordinates $x=1$, $y=8$ and is finally energized by currents $+\frac{1}{2}$, $+\frac{1}{2}$ and $-\frac{1}{2}$, i.e. by a resulting current $+\frac{1}{2}$ which is not sufficient to switch the core's magnetic state. Similarly, as concerns the cores corresponding to arguments A, B and C. Therefore, only the cores **1**, **2** and **4** will be switched to the On state, thus restoring the considered location to its initial state (recording of a 7).

The parity element (or non-parity element), as well as the way it is controlled and recorded will not be discussed further.

Time B.—Lead **122** is now positive. It was assumed that the digit to be extracted was a 5, stored in location **71** of memory **2** and that triggers 12M (FIGURE 4*c*), 17D (FIGURE 4*e*) and 11U (FIGURE 4*g*) were switched. The operation is developed again in three times, the first one corresponding to lead **100** being positive (FIGURE 4*i*), the second one to lead **101** being positive, and the third one to lead **103** being positive.

(A) RESULTS FROM THE OCCURRENCE OF A PULSE 100

Lead **100** is positive. Lead **96** is negative because lead **122*a*** is itself negative and locks coincidence circuit **252**. The voltage of lead **100** is applied to triggers 1R, 2R, 4R, 8R, AR, BR, CR (FIGURE 4*p*) thus restoring all the triggers that happen to be switched. Triggers 1W, 2W, 4W, 8W, AW, BW (FIGURE 4*q*) retain their state.

(B) RESULTS FROM THE OCCURRENCE OF PULSE 101

A five is read out in a way quite similar to that which has already been described, thus switching triggers 1R and 4R (FIGURE 4*p*) and possibly AR in the case when the corresponding quantity should correspond to a sign. Leads **350–1** and **350–4** therefore are positive.

Leads **350–1, 2, 4, 8**, from triggers 1R to 8R and leads **358–1, 2, 4, 8** (FIGURE 4*q*) from triggers 1W to 8W are connected to the input of an adder (not shown) of a known type, which adds the inserted digits, and according to the result of that addition, brings some of leads **361** (FIGURE 4*p*) to a negative voltage. In the described example, sum 7+5 is equal to 12, so that only the lead **361** further referenced **2** will become negative. Parallelly, the carry is preserved, to be added during the addition of the following digits.

(C) RESULTS FROM THE OCCURRENCE OF A PULSE 103

The circuits have been represented but partially, their details form no part of the present invention. The addition result (i.e. 2 in the described example) is re-recorded by means of a positive voltage applied to lead **363** (FIGURE 4*p*). The latter connects to coincidence circuits **362** which have for their other inputs leads **361**. A positive voltage is therefore applied to emitters **356**, with the exception however of that referenced **2** (because the corresponding one of leads **361** is negative). Therefore all these emitters will deliver a current —½ which will be deducted from the current emitted by emitters **328***a* and **334***a* (FIGURE 4*n*) or by homologous emitters. Under these conditions, only the core coresponding to arguments code **2** will be switched On, whereas the cores which are previously in that state were those corresponding to code arguments **1** and **4** (recorded digit **5**).

It may be remarked that the circuits of FIGURE 4*l* have been arranged so as to make lead **98** position. That lead connects to coincidence circuits **355** (FIGURE 4*p*) which have for their second inputs leads **352** from triggers **1R, 2R, 4R, 8R, AR, BR** and **CR**. In such a case, the quantity which had been read out when pulse **101** occurred is re-recorded. As will be seen, this operating mode corresponds to the operations which are to be effected when it is desired to compare two factors, for example the comparison of the indices contained in two different circuits **355** must become negative, when an addition is performed; however, the corresponding circuits have not been represented, in order not to overload the figures. The circuits controlled from that lead have not been represented. All the explanations given above concerning the way an addition is performed have been provided only to show the general working of the circuits. The latter is preserved during the related operations necessary to the operation of the device which is more particularly the object of the invention, so as to use the same circuit elements for several purposes and also to use, as far as is possible, the circuit elements which else would be useless.

MEMORY SPLITTING

It has already been seen how the memories were disposed, how the scanning chains, the program steps were arranged and controlled. A few more details will be given as to the way generally, the memories are split and how any split area may be addressed. It will be described for a memory of any type, for example, for memory M1, and assuming that this memory records its factors directly from a punched card by means of any one of the known reading processes.

It will be supposed that the card reader is fed with cards of various types suitably classified, and comprising for example name cards, address cards and operation cards, etc. For example, it will be supposed that these cards are punched in the following way and recorded into memory M1, position by position:

(1) Name card:
- Columns 5 to 12—account number
- Columns 13 to 40—trade name

(2) Operation card:
- Columns 1 to 4—operation date
- Columns 5 to 12—account number
- Columns 13 to 23—operation wording
- Columns 24 to 27—date of the operation
- Columns 28 to 30—code corresponding to the preceding date
- Columns 31 to 40—amount of the operation

It will be seen that in each case it is necessary to address well determined areas of a one memory, and that the access must be related to the nature of the quantities recorded in that memory.

FIGURE 6 represents an example of the access connections. It will be recalled that these connections are generally made by connecting some of hubs **139** and **140** (figure 4*h*) to some of hubs **149** and in similarly connecting some of hubs **150** and **151** respectively to some of hubs **132** (FIGURE 4*c*) or **153** (FIGURE 4*d*). In FIGURE 6, on the left, some of the just mentioned references have been noted. Hubs **149** have been numbered **1, 2, 3, 4**. Hubs **150** and **151** associated with the first ones have been represented as above. The shown hubs **153** correspond to no logical order, but essentially refer to the nature of the connections. The reference numbers have been quoted in each case. Reference **40** for example, appears three times, which means that the corresponding hub **153** in fact receives three connections; hubs **139** and **140** (FIGURE 4*h*) or homologous hubs corresponding to any one of the program steps must be connected in the following way (FIGURE 6):

(1) To hub **149–10** to address the area storing the amount of the operation (locations **31** to **40**);

(2) Hub **149–9** to address the date code (positions **28** to **30**);

(3) Hub **149–8** to address the area storing the month of the operation date (positions **26** and **27**);

(4) To hub **149–7** to address the area storing the day of the month of same date (positions **24** and **25**);

(5) To hub **149–6** to address the operation code (positions **13** to **23**);

(6) To hub **149–5** to address the account number (position **5** to **12**);

(7) To hub **149–3** to address the name or trade name (locations **13** to **40**).

No connection has been provided to the input of hub **149–2**; the output connection to hub **153–12** is a scanning end connection. The latter connection may be eliminated in case of a transfer to an area of another memory but having the same ampltiude. It has been seen, according to the adopted notation conventions, that the de-energization of scanning chain B is automatically followed by that of scanning chain A, whether there is or not a connection limiting the scanning field.

The same connection to hub **149–3** would have been replaced by a connection to hub **149–6** associated with a selector for moving the connection with hubs **153** further referenced **23** to **40**. In such a case, the scanning starts in location **40**. The scanning is stopped by the first connection immediately to the left, i.e. by the connection with hub **153–12**.

Finally, a connection to hub **141–1** allows the first forty memory locations to be transferred together whatever may be their content. It is well understood that the various controls should be associated with the type of card, which may be done in a known way, by means of selectors.

As concerns hubs **150**, they are all interrelated and connected to hub **132–1** (FIGURE 4*c*).

After the above, the connections to be made to address any area of any memory and to increase or decrease at will this area will be determined.

COMPARISON OF TWO NUMERICAL FACTORS

The numerical factors are compared in a way which will be now described. The general process of the arithmetical operations has been explained. During a first time (time A) a positive pulse applied to lead **99** (FIGURES 4*i*, 4*n* and 4*p*) causes a given location of one of the memories to be scanned, according to the quantity recorded in that location, some of the triggers followed with suffixes R and W (FIGURES 4*p* and 4*q*) are switched, the first ones being restored at the end of the same time, whereas the second ones (triggers with suffix W) remain switched during the whole following time.

During a second time (time B), a positive pulse applied to lead **99** causes another memory location to be scanned, and causes some of the triggers with suffix R (FIGURE 4*p*) to be switched.

Two quantities are compared at the end of that time, whereas triggers **1W, 2W, 4W, 8W** . . . (FIGURE 4*q*) still store the quantity read out during time A, triggers **1R, 2R, 4R, 8R** . . . (FIGURE 4*p*) preserving, on the other hand, the quantity read out during time B. Some of the leads generally referenced **350, 352, 359**, (FIGURE 4*q*) and **360** are positive, thus automatically starting circuits of the comparison device. As will be seen, a positive voltage will be collected on lead **364** if the quantity read out during time B is greater than that read out during time A. Similarly, a positive voltage will appear on lead **365** if the quantity read out during time B was less than that read out during time A. Also, a positive voltage may appear if the two quantities are equal, however, this possibility has not been contemplated because the general arrangement of the circuits makes it useless.

Before analyzing the mechanism, let it be recalled how digits 0 to 9 are recorded in triggers **1R, 2R, 4R, 8R** (FIGURE 4*p*) and **1W, 2W, 4W, 8W** (FIGURE 4*q*):

Digit Recorded	Switched Triggers	
	R Series	W Series
0	8R—2R	None
1	1R	1W
2	2R	2W
3	2R—1R	2W—1W
4	4R	4W
5	4R—1R	4W—1W
6	4R—2R	4W—2W
7	4R—2R—1R	4W—2W—1W
8	8R	8W
9	8R—1R	8W—1W

Apart from digit 0, it is seen that the result of the comparison is obtained by comparing first the state of the triggers with prefix 8, then by comparing the state of the triggers with prefix 4, etc.

Thus for digits 6 and 4, respectively recorded in the triggers of the R and W series, the comparison provides:

Triggers **8R** and **8W** reset in both cases;
Triggers **4R** and **4W** switched in both cases;
Only trigger **2R** is switched, thus indicating that the quantity recorded in the triggers of series R is greater.

Let it be mentioned, for the numerical comparison, that no positive voltage must be applied to hub **366** (FIGURE 4*q*). The voltage at that hub is negative and so is the voltage of lead **367** connected to that hub. Inverter **368** returns a positive voltage which is applied through lead **369**, mixing circuit **71**, lead **72**, to coincidence circuits **73, 73*a*, 73*b*** and **73*c***. Four cases are to be contemplated (refer also to FIGURE 4*p*):

(1) Trigger **8R** is switched, whereas trigger **8W** is Off (it will be supposed that trigger **2R** is also Off) leads **350–8** and **360–8** are positive. Coincidence circuit **73** is favored simultaneously on its three inputs, thus applying a positive voltage to leads **74** and **364**, which indicates that the quantity recorded in the triggers of the R series is the greater. After the above table, this quantity is 8 or 9, whereas the quantity recorded in the triggers of the W series reached 7 at the utmost.

(2) Trigger **8W** is switched, whereas trigger **8R** is off. Leads **352–8** and **359–8** are positive. Coincidence circuit **73*b*** is favored simultaneously on its three inputs, thus applying a positive voltage to leads **74*a*** and **365**, and indicating thereby that the quantity recorded in the triggers of the W series is the greater.

(3) Triggers **8R** and **9W** are both switched; leads **350–8** and **359–8** are positive. Coincidence circuits **73*c*** is favored simultaneously on its three inputs, thus applying a positive voltage to lead **75**.

(4) Triggers **8R** and **8W** are both off. Leads **352–8** and **360–8** are positive. Coincidence circuit **73*a*** is favored simultaneously on its three inputs, thus applying a positive voltage to lead **75**. This positive voltage of lead **75** indicates that triggers **8R, 8W** are equal and that the result of the comparison will be obtained but by extending the comparison to triggers **4R—4W** first, then triggers **2R—2W** and triggers **1R—1W**.

The positive voltage of lead **75** is applied to coincidence circuits **76, 76*a*, 76*b*** and **76*c***. It may be shown that the results are the following:

(1) A positive voltage across leads **77** and **364** if trigger **4R** only is switched;

(2) A positive voltage across leads **77*a*** and **365** if trigger **4W** only is switched;

(3) A positive voltage across lead **78** if they are equal, i.e. if both of them are off or if both of them are switched.

In the latter case, the comparison must be extended to trigger stage **2R—2W**, which is obtained due to the positive voltage of lead **78**, which favors coincidence circuits **79, 79*a*, 79*b*, 79*c***. Similarly it will be easily shown that the results are:

(1) A positive voltage across leads **80** and **364**, if trigger **2R** only is switched;

(2) A positive voltage across leads **80*a*** and **365**, if trigger **2W** only is switched;

(3) A positive voltage across lead **81** if equal, i.e. if triggers **2R—2W** are both off, or both switched.

In the latter case, the comparison must be once more extended to trigger stage **1R, 1W**, which is done because of the positive voltage of lead **81**, which causes coincidence circuits **82** and **82*a*** to be favored. The result is:

(1) A positive voltage across leads **83** and **364**, if trigger **1R** only is switched;

(2) A positive voltage across leads **83*a*** and **365**, if trigger **1W** only is switched.

No positive voltage appears in case of an equality, i.e. if both triggers **1R—1W** are switched off. However, corresponding circuits may easily be added, if needed.

Finally, it is seen that one scans first the state of triggers **8R—8W**, and that this scanning is successively extended to triggers **4R—4W**, then to triggers **2R—2W, 1R—1W**, if the scanning has provided no positive result, i.e. in case of an equality, if there is an inequality, there is obtained: either a positive voltage across lead **364**, thus indicating that it is the quantity recorded into triggers W which is the greater.

In the first case, coincidence circuit **370** is favored; when the voltage of lead **95** (see also FIGURE 4*i*) goes positive at the end of time B, a switching pulse is applied, through lead **371** to the right side of trigger F and to the left side of trigger H. Trigger F is restored to its initial state (unless already done), whereas trigger H is switched. Leads **372** and **373** are supplied with a positive voltage, whereas leads **374** and **375** are supplied a negative voltage.

In the second case (lead **365** positive) coincidence circuit **376** is favored. When lead **95** goes positive, a switching pulse is applied to lead **377** and transmitted on one hand to the right side of trigger F, and on the other hand to the left side of trigger H. The latter trigger is restored to its initial state (unless already done) whereas trigger F is switched. The voltage across leads **374** and **375** goes positive, whereas that across leads **372** and **373** goes negative.

Let us refer now to the whole of the operations such as they develop effectively on the comparison of two numerical factors. It will be assumed that these operations concern the comparison of a first factor A equal to 87352 with a second factor B equal to 87361, recorded in some areas of some memories. Neither these areas nor the corresponding memories will be specified. For a better understanding of the circuits, it will suffice to know that these factors are scanned digit by digit beginning with that to the right, and these digits are finally recorded in the triggers of the W series for one of the factors, and in the triggers of the R series for the second factor. The result of the comparison is inverted, if the function of the factors is reversed so that it will be specified that the factor, the digits of which will be finally recorded into the triggers of the W series, is factor A, namely 87352. The digits of factor B are assumed to be recorded into the triggers of the R series.

It will be further supposed that the comparison is controlled from any one of the triggers of the P series

(FIGURE 4*h*) for example trigger **P1**. It was seen that this trigger has been switched by a pulse provided by lead **134**, during the switching time of trigger **B6** (FIGURE 4*i*). Lead **111** is then positive. Then, trigger **B7** is switched (FIGURE 4*h*), and it was seen that, at that moment, the scanning chains (FIGURES 4*e*, 4*f* and 4*g*) are positioned, whereas those among triggers **1M**, **2M**, **3M** . . . **11M**, **12M**, **13M** . . . (FIGURE 4*c*) corresponding to the memories to be scanned are switched. Lead **178** (FIGURE 4*h*) being positive, also triggers F and H are restored (FIGURE 4*q*) in case one of these triggers should not be in its initial state. This restoration is effected in the way which has been explained because of the voltage of lead **178**. As may be seen, a branch line of that lead connects to the left side of triggers F and H. The switching time of trigger **B7** (FIGURE 4*h*) is followed with the switching time of trigger **B8**, and it was seen that it is during that time that the arithmetical operations were performed. The various memory locations are then scanned one after the other, whereas the corresponding quantities were recorded into triggers R and W (FIGURES 4*p* and 4*q*). It was explained how each memory location was scanned, how triggers R and W were controlled, how the quantities were re-recorded into the memories. This will therefore not be explained again. It will only be assumed that triggers R and W successively receive the various required digits and the operations occurring at that moment are analyzed. However, it will be reminded that triggers R record on each time A and B, and that they control particularly the re-recording; triggers W record only during time A. The comparison operations are performed during times B, and when triggers R and W store two quantities from different sources.

(a) *Comparison of the unit digits.*—This comparison is performed when trigger **B8** is switched, at the end of the first time B. From the example, triggers W store digit 2 (switched trigger **2W**), triggers R, digit 1 (switched trigger **1R**). From the description of FIGURE 4*q* it may be seen that lead **365** is positive, thus causing trigger F to be switched when the control pulse provided by lead **95** occurs. Lead **374**, in particular, is at a positive voltage.

(b) *Comparison of the tens digits.*—This comparison is performed at the end of the second time B. After the example, trigger W stores digit 5 (switched triggers **4W** and **1W**); the triggers R, digit 6 (switched triggers **4R** and **2R**). Lead **364** is positive, which causes, on the appearance of the control pulse provided by lead **95**, trigger H to be switched and trigger F to be restored to its original state. The voltage across lead **374** returns to a negative value, whereas that of lead **373** becomes positive.

(c) *Comparison of the hundreds digits.*—This comparison is performed at the end of the third time B. In the described example triggers R and W store digit 3 (switched triggers **2R** and **1R**, **2W** and **1W**). Leads **364** and **365** are both negative, so that there occurs no pulse changing the state of triggers F and H.

(d) *Comparison of the hundreds digits.*—This comparison is performed at the end of the fourth time B. In the chosen example, triggers R and W store digit 7 (switched triggers **4R**, **2R** and **1R**, **4W**, **2W** and **1W**). Leads **364** and **365** are both negative, so that there occurs no pulse changing the state of triggers F and H.

(e) *Comparison of the ten thousands digit.*—This comparison is performed at the end of the fifth time B. In the selected example triggers R and W store digit 8 (switched triggers **8R** and **8W**). Leads **364** and **365** are again both negative, so that the state of triggers F and H remains unchanged. It was seen that trigger H had been switched during the comparison of the tens.

(f) *Comparison of still more significant digits.*—There is no reason to suppose that the memory scanning is completed, and that said scanning does not extend to higher order digits, for example up to the hundreds of millions. The scanning areas must be identical for both factors (unless one of the factors is systematically provided with a series of zeroes on the left of its significant digits).

(g) *End of the scanning.*—The end of the scanning must be signalled in the above mentioned way, by means of connections made between hubs generally referenced **151** (FIGURE 4*h*) and **153** (FIGURE 4*d*) unless the scanning is desired to be performed up to memory location bearing number **1**. In any case, the end of the scanning is marked by a positive voltage applied to lead **180** (FIGURE 4*h*) with the already described results: restoration of trigger **B8** to its original state and switching of trigger **B6** (FIGURE 4*i*). The latter keeps switched during the time period composed of a time A and of a time B. It was seen that trigger **B6** particularly controlled the pulses provided by lead **134** and the advance of the program unit; in the considered case restoration of trigger **P1** (FIGURE 4*h*) and switching of any one of triggers **P2** to **P*n***, or of the triggers of FIGURE 4*m*, according to the interconnections between hubs **137** (FIGURE 4*h*) it was seen that the program is changed at the end of time A.

Before the program is changed, the following operations take place: lead **122*a*** (FIGURE 4*i*) being positive (time A), coincidence circuit **240** is favored on both its inputs, causing a positive voltage to be applied to lead **241**. This lead connects to coincidence circuit **378** (FIGURE 4*q*), so that there appears a positive voltage on lead **380**, if lead **379** is itself positive. It results in favoring coincidence circuits **84**, **84*a*** and **84*b***, which have for their other inputs leads **372** to **375** from triggers F and H. According to the state of the triggers, some of leads **381** to **384** and some of hubs **381*a*** to **384*a*** are thus applied a positive voltage. They are:

(1) Lead **381** and **381*a*** if triggers F and H are in their original state, i.e. equal;

(2) Lead **382** and hub **382*a*** if trigger H is switched, i.e. if factor B is the greater of the two factors being compared;

(3) Lead **383** and hub **383*a*** if trigger F is switched, i.e. if factor A is the greater of the two factors being compared;

(4) Lead **384** and hub **384*a***, if either of the two triggers F or H is switched, i.e. for an unequality.

These voltages fully indicate the result of the comparison. They appear only if lead **379** is supplied a positive voltage, i.e. if lead **386** or hub **385** were supplied a positive voltage. If the comparison is controlled from any trigger of the P series (FIGURE 4*h*), the latter result is obtained by making a connection between hub **385** and **138** or any of the homologous hubs.

COMPARISON OF TWO ALPHABETICAL CHARACTERS OR TWO CHARACTERS COMPRISING BOTH DIGITS AND LETTERS

This comparison will be assumed to be also controlled from trigger **P1** (FIGURE 4*h*), hub **138** being connected to hub **385** (FIGURE 4*q*) and to hub **366**. It was seen that the voltage of hub **138** (FIGURE 4*b*) was set to a positive value at the time when trigger **P1** was switched, and that this voltage remained at that same value during all the switching time of that trigger. It is the same in particular for hub **366** (FIGURE 4*q*).

The comparison of the information comprising both digits and letters is arbitrary to a certain extent, in that it is necessary to arbitrarily assign a relative value to a letter compared to a digit. To such a problem there will be but an arbitrary solution. This problem may be extended to other arguments than the letters of the alphabet and the various digits, for example to the punctuation and to some special characters, with the only provision that these new elements are assigned a perfectly defined recording code. In such a case, the classification of the various arguments one with respect to the other also is arbitrary. The selected recording code comprises 6 elements on the whole (namely: bits **1**, **2**, **4**, **8**, and auxiliary bits A and B); and permits a total of 64 combinations permitting the recording of digits, alphabet letters and a number of special characters; however, for obvious reasons of simplification, it will be kept hereinafter to digits and letters. A general classification is chosen comprising, in the increasing order, letters A to Z of the alphabet, then digits 0 to 9.

It is possible to adopt the reverse classification, or any other classification, provided the circuits are adjusted accordingly.

The selected recording mode for the alphabet is the following:

A	1AB	J	1B	S	2A
B	2AB	K	2B	T	3A
C	3AB	L	3B	U	4A
D	4AB	M	4B	V	5A
E	5AB	N	5B	W	6A
F	6AB	O	6B	X	7A
G	7AB	P	7B	Y	8A
H	8AB	Q	8B	Z	9A
I	9AB	R	9B		

Digits 1 to 9 are recorded in the usual way by means of binary argument **1—2—4—8**. It may be remarked that the selected classification leads to assign a low value to any character comprising an argument B, and in case of an equality to any character comprising an argument A.

Hub **366** is at a positive voltage as is lead **367**, which connects to coincidence circuits **85**, **85*a***, **85*b***, **85*c***. Lead **369** is negative, so that the voltage of lead **72** from mixing circuit **71** is now related to that of lead **90**. This voltage depends upon the result of the comparison between the auxiliary arguments A and B. As concerns the comparison of argument B, four cases follow:

(1) Trigger BR is switched, whereas trigger BW is Off. Leads **350–B** and **360–B** are positive. Coincidence circuit **85*c*** is favored on its three inputs, and therefore delivers a positive voltage onto leads **86*a*** and **365**, thus indicating that the quantity recorded into the triggers of the W series is the greater. That is actually so after the adopted classification, if this quantity is for example a digit.

(2) Trigger BW is switched whereas trigger BR is off. Leads **352–B** and **359–B** are positive. Coincidence circuit **85** is favored on its three inputs and therefore delivers a positive voltage onto leads **86** and **364**, indicating thereby that the quantity recorded into the triggers of the R series is the greater.

(3) Triggers BR and BW are both switched. Leads **350–B** and **359–B** are positive. Coincidence circuit **85*a*** has its three inputs favored simultaneously and delivers a postive voltage onto lead **87**.

(4) Triggers BR and BW are both off. Leads **352–B** and **360–B** are positive. Coincidence circuit **85*b*** is favored simultaneously on its three inputs and therefore delivers a positive voltage on lead **87**.

The latter voltage indicates that triggers BR and BW are equal, and that the operations must be extended to triggers AR and AW. This voltage is applied to coincidence circuits **88**, **88*a***, **88*b***, **88*c***. It may be seen that the results are:

(1) A positive voltage across leads **89*a*** and **365** if only trigger AR is switched;

(2) A positive voltage across leads **89** and **364** if trigger AW only is switched;

(3) A positive voltage across lead **90** in case of an equality, i.e. if triggers AR and AW are either both off or both switched.

In the latter case, the comparison must be extended to triggers 8R, 8W, which is performed in the way previously explained: the voltage of lead **90** is applied to lead **72**, which favors coincidence circuits **73**, **73*a***, **73*b***, **73*c*** . . .

Finally, a positive voltage appears on one of leads **364** or **365** according whether the quantity recorded in the triggers of the R series is greater than that recorded into the triggers of the W series or conversely. This results in switching one of the triggers F or H when there occurs a positive voltage on lead **95**, and simultaneously with that switching, the second trigger is turned off if needed. At the end of the program switching time of trigger B6—FIGURE 4*i*—and when lead **241** turns positive, voltages are applied on leads **381** to **384**, as well as on hubs **381*a*** to **384*a*** and complete the operations.

COMPARISON OF THE INDICES FROM THE VARIOUS CARD READERS

It has been seen that the invention is generally applicable to a machine directly fed with a number of different series of recording cards. The embodiment being described relates to a machine, or an arrangement of machines comprising three card readers by means of three different series of recording cards. It is logical to suppose at first that these cards are classified according to some order, which is the same for all series; however, it is not known at first how these card sets are arranged; the cards corresponding to some classes may be missing, so that it is necessary to compare systematically the indices of the various cards. The comparisons to be performed are of two different types according whether they are effected within a same series of cards or between different series. If the various series of cards are generally designated A, B, C, the comparisons to be performed may be:

(1) Either of the type: AA′, BB′, CC′ (sequence comparisons);

(2) Or of the type: AB, BC and CA (inter-series comparisons).

It will be recalled that the various card readers comprise at least two reading stations, the first one being provided for a previous scanning of the cards, whereas the second one is used as an operation station. Each card is advanced first past the pre-scanning station, then past the operation station. An index, or an index area corresponding to a readout performed by the pre-scanning station will be generally designated by A, B or C. Similarly, the primed letters A′, B′ or C′ will designate an index of an index area corresponding to a readout performed by the operation station. . Thus, terms AB′, BB′, CC′ or AB, BC or CA comparisons may be explained by themselves: comparison BB′ for example is a comparison operation concerning two indices or index areas corresponding to readouts performed respectively by the pre-scanning and operation stations of card reader B. Similarly, comparison BC, for example, is a comparison of two indices of index areas corresponding to a readout performed respectively by means of the pre-scanning stations of card readers B and C.

The indices are not necessarily stored in adjacent card areas, so that one is led to repeat the whole of the comparisons of each type, for each area.

As will be seen, the whole of these operations are performed under the control of triggers HV (FIGURE 4*b*), TA, TB, TC and Q1, Q2 . . . QN. Trigger HV controls the general comparison type: sequence comparison or inter-series comparison operations relating to the indices corresponding to a given card reader. Tirgger TA, for example, particularly controls the comparisons of types AA′, or AB, trigger TB controls the comparisons of types BB′ or BC, trigger TC then controls comparisons of types CC′ and CA. On the other hand, triggers Q1, Q2 . . . QN, control the various index areas. It is to be pointed out that these areas should be classified according to their importance, and that they must be distributed in that order between triggers Q1 to QN, trigger Q1 is provided to correspond always to the more important area.

Triggers HV, TA, TB, TC and Q1 to QN cooperate to define an assembly of 6N comparison programs, i.e. for example 30 programs, if N is equal to 5. The sequence order for these programs to be performed is at first unimportant. Means have been provided to perform the whole of the sequence comparisons, then all the inter-series comparisons. Similarly for each comparison type, there has been provided means to perform first the comparison operations corresponding to the scanning area defined by trigger Q1, then all the comparisons corresponding to the scanning area defined by trigger Q2 . . . . It is obvious that this order may be changed without departing from the spirit of the invention, provided the circuits are adjusted accordingly.

Thus, as will be seen, the comparisons of each type develop until an inequality is detected. Thus various automatic arrangements act to eliminate the whole of the comparisons still to be performed (or at least to eliminate the greater part of the corresponding operations). Similarly, means have been provided to restart the whole of the 6N comparison programs; it will be seen, that by a series of relatively simple arrangements, it is possible to limit oneself in all cases, to the only comparisons wherein the indices of the newly fed card interfere. It is obvious that all other comparisons are in fact but a loss of time: as there has been no change in the factors, there is no change in the results. Among comparisons AA′, BB′, CC′, AB, BC and CA, the feeding of a card of the A series, for example, causes a change but in comparisons AA′, AB and CA.

As will be seen, the general purpose of the 6N comparison operations controlled from triggers HV, TA, TB, TC and Q1 to QN is to cause some of triggers HA, HB, HC, FA, FB, FC (FIGURE 4*a*) or HAB, HBC, HCA, FAB, FBC, FCA (FIGURE 4*j*) to switch, so that these operations are interrupted as soon as the corresponding purpose is reached. The latter triggers are designed to record and store the general result of the comparison operations of each type, the triggers assigned to that effect being respectively:

(1) HA, FA for the comparisons of type AA′;
(2) HB, FB for the comparisons of type BB′;
(3) HC, FC for the comparisons of type CC′;
(4) HAB, FAB, for the comparisons of type AB;
(5) HBC, FBC, for the comparisons of type BC;
(6) HCA, FCA, for the comparisons of type CA.

COMPARISON CONTROL

The comparison operations are placed under the general control of trigger B11 (FIGURE 4*m*). As has already been explained, this trigger is controlled systematically on each card feed, by means of a positive voltage provided by any one of cams C1A, C1B or C1C. It parallelly results in the control of trigger B16, as well as in the control of some of triggers B12, B13 and B14, according to how hubs 148, 148*a*, and 148*b* have been connected to hubs 158, 158*a* and 158*b*.

As soon as trigger B11 is switched, lead 108 is set to a positive voltage as is lead 117. The latter causes the pulse generator, which, as seen, is composed of emitters 100*a*, 101*a*, 102*a* and 103*a* (FIGURE 4*i*) to be energized. Switching pulses are then applied alternately to each side of trigger B1, thereby alternately applying positive voltages to leads 122 and 122*a*. At the same time leads 125 and 125*a* alternately emit other switching pulses, which cause, in particular, trigger B6 to be switched (so as to switch trigger B6 and to apply a positive voltage to lead 128), then trigger B7 (FIGURE 4*h*), then trigger B8 and trigger B7 is restored to its initial state. Trigger B8 remains switched during a certain time until contacts C2A, C2B, C2C (FIGURE 4*m*) happen to open. It has been seen that these contacts were provided to neutralize all the circuits until the completion of the card read out.

Contacts C2A, C2B, C2C open, the voltage across lead 142 goes positive, as does the voltage of leads 177 and 162 because leads 174 and 117 are positive themselves. This results in switching trigger B2, when there occurs a first advance pulse which is transmitted by lead 125. Thus, the voltage across lead 116 goes positive as does the voltage of leads 168 and 253, because leads 117 and 108 are positive and the coincidence circuits are simultaneously favored on both their inputs.

Trigger B2 will remain switched during a time A, a time B and again during the following time A. The results thereof are the following:

First time A.—Trigger B8 (FIGURE 4*h*) being switched, lead 272 is positive, as is lead 98 (FIGURE 4*i*) when pulse 103 appears (because coincidence circuit 220 is favored simultaneously on both its inputs). At the same time, lead 97 is positive because coincidence circuit 207 also is favored on both its inputs (lead 122*a* is always positive during a time A).

A branch line of lead 97 connects to coincidence circuit 254 (FIGURE 4*b*). The latter has, for its second input, a branch line of positive lead 253 (see also FIGURE 4*m*). Thus it transmits a positive voltage which is applied, through lead 255 to the right side of trigger HV, thereby switching it immediately. Lead 291 thus goes positive, whereas lead 286 becomes negative.

The voltage of lead 255 is also applied to the left sides of triggers HA, HB, HC, FA, FB, FC (FIGURE 4*a*) and HAB, HBC, HCA, FAB, FBC, FCA (FIGURE 4*j*). This restores all those among these triggers which happened to be switched.

If it is assumed first that contacts 7A–1, 7B–1, 7C–1 (FIGURE 4*a*) are all open, the output generally bearing references 256, 257, 258, 259 (see also FIGURE 4*j*) are all set to a positive voltage, so that a positive voltage is applied to leads 260*a*, 260*b*, 260*c*, and leads 261*a*, 261*b*, 261*c*. The outputs referenced generally 262, 263, 264, 266, on the contrary are negative, as are leads 267*a*, 267*b*, 267*c*, and leads 268*a*, 268*b*, 268*c*.

Contacts 7A–1, 7B–1, 7C–1 are connected to positive terminal 144*a* respectively to leads 271*a*, 271*b*, 271*c*, to resistances 273 and to negative terminal 146*a*. Leads 271*a*, 271*b*, 271*c*, are further connected to the right side of the following triggers (see also FIGURE 4*j*).

FA, HAB, FCA, for lead 271*a*;
FB, HBC, GAB, for lead 271*b*;
FC, HCA, FBC, for lead 271*c*.

When these contacts are open, leads 271*a*, 271*b*, 271*c*, are negative, so that there is no result. If one of these contacts is kept closed, positive voltage is applied to the right side of some triggers so that these triggers conduct through their left side so as to counter the restoration performed by the positive voltage applied to lead 255. For example, if contact 7A–1 is maintained closed, triggers FA, HAB and FCA are switched, thus applying a positive voltage to leads 263*a*, 267*a* (FIGURE 4*a*), 264*a*, 268*a*, 266*c* and 268*c* (FIGURE 4*j*). It will be seen later under which conditions contact 7A–1, 7B–1, and 7C–1, are maintained open or closed. However, it may be mentioned for now that these contacts are constantly maintained closed whenever the corresponding card reader is not used.

Time B.—The positive voltage of lead 168 (FIGURE 4*m*) is applied to mixing circuit 288 (FIGURE 4*h*), to lead 180 and to inverter 183, thus applying particularly a negative voltage of lead 182. The results are those already described: restoration of the scanning chains (if that has not already been done); switching of trigger B6 (FIGURE 4*i*) and voltage inversion in leads 11 and 128; and resetting of the trigger to its initial state.

Second time A.—Lead 11 is positive, as well as lead 241. The result is the restoration of all those of triggers

1M, 2M, 3M . . . 11M, 12M, 13M (FIGURE 4*c*) which happen to be switched. Lead **128** (FIGURE 4*i*) is negative, which makes it possible that switching pulses may be applied to lead **134** from **125*a***.

Switching of triggers Q1 and TA.—Lead **253** (FIGURE 4*m*) is positive, as are leads **276** (FIGURE 4*b*) and **277**, mixing circuits **278** and **280** permitting the voltages to be equalized. Coincidence circuit **281** is favored thereby. Triggers B17 and QN being restored as mentioned on the figure by dots within the squares, outputs **282** and **283** placed on the right are negative. Coincidence circuit **284** is locked on both its inputs so that the voltage across lead **285** is negative. Trigger HV being switched (because of the positive voltage from lead **255**), output **291** is set to a positive voltage and output **286** is negative. The latter output feeds in particular to coincidence circuit **287** which has also, for its second input, negative lead **285**. Thus said coincidence circuit is locked which causes a negative voltage to be applied to lead **288**. This lead connects in particular to mixing circuit **289** which receives on its second input a branch line of lead **134**. Lead **288** being negative, lead **290** from mixing circuit **289** conforms to the voltage of lead **134**. This causes the occurrence of various switching pulses, occurring, as has been seen, at the end of time A, and particularly switching trigger Q1. A branch line of lead **290** connects to coincidence circuit **281**.

Trigger QN being restored, as mentioned, left output **292** is positive. It has been seen that the right output of trigger HV is also positive. Therefore coincidence circuit **293** is favored on both its inputs, and delivers a positive voltage on lead **294** which favors coincidence circuits **69*a***, **69*b***, **69*c*** and **70*a***, **70*b***, **70*c***; lead **283** is negative, and coincidence circuit **295** is locked. Mixing circuit **296** being fed on both its inputs by a negative voltage (lead **286** and the output of coincidence circuit **295**), the voltage of lead **297** is negative so that coincidence circuits **68*a***, **68*b***, **68*c*** and **67*a***, **67*b***, **67*c*** are locked. Coincidence circuits **67*a***, **68*a***, **69*a*** and **70*a*** are connected to a branch line of positive lead **277**. This provides no result for the first two, because they are locked by the negative voltage of lead **297**. The two others are respectively connected to a branch line of leads **267*a*** and **260*a***.

Let it be assumed that contacts 7A–1, 7B–1, 7C–1 (FIGURE 4*a*) are all open. Triggers HA, HB, HC, FA, FB, FC, are all restored so that their right side is conducting, and that their left output is positive. Leads **256*a*** and **257*a*** particularly are positive, so that coincidence circuit **298*a*** applies a positive voltage to lead **260*a***. Outputs **262*a*** and **263*a*** are negative as is lead **267*a***. Coincidence circuit **69*a*** (FIGURE 4*b*) is locked, whereas coincidence circuit **70*a***, which is favored simultaneously on its three inputs, transmits a positive voltage which is applied successively to leads **66** and **66*a*** and to coincidence circuit **299*a***. As the latter receives on its second input the voltage of lead **290** which, as seen, conforms to the voltage of lead **134**, a switching pulse is applied at the end of the considered time to the left side of trigger TA, thus switching it and making lead **300*a*** positive.

CASE WHEN SOME OF CONTACTS 7A–1, 7B–1, 7C–1 (FIGURE 4*a*) ARE MAINTAINED CLOSED

It may be remarked first that if contacts **7B–1**, **7C–1** are retained open, this has no particular result at the present time. It results in the application of a positive voltage to the right side of triggers FB or FC, so that these triggers are conducting on their left side. The restoration operation performed under the control of the positive voltage of lead **255** is inoperative. Right outputs **263*b*** and **263*c*** are positive as are leads **267*b*** or **267*c***. The result is the application of a positive voltage to one input of coincidence circuits **69*b*** and **69*c*** (FIGURE 4*b*), however they do not gate any signal since leads **65*a*** and **64*a*** are negative.

If contact **7A–1** (FIGURE 4*a*) is maintained closed trigger FA is constantly conducting on its left side. Output **257*a*** is negative, whereas output **263*a*** is positive. Therefore, there is a positive voltage across lead **267*a***. Parallelly, lead **260*a*** is set to a negative voltage. Coincidence circuit **70*a*** (FIGURE 4*b*) is locked, because of the negative voltage across lead **260*a***, which causes coincidence circuit **299*a*** to be locked and makes it impossible to switch trigger TA. Coincidence circuit **69*a*** is favored simultaneously at its three inputs, and delivers a positive voltage to leads **65** and **65*a***. A positive voltage is thus applied to one of coincidence circuits **69*b*** and **70*b*** which have for their second inputs a branch line of lead **294**, now positive. Consequently, one of coincidence circuits **69*b*** or **70*b*** is favored according to the voltage state of leads **260*b*** or **267*b***, i.e. according to the state of trigger FB (FIGURE 4*a*) and contact **7B–1**.

If contact **7B–1** is open, the restoration pulse applied to trigger FB through lead **255** causes the right side to become conductive, so that leads **257*b*** and **260*b*** are positive and coincidence circuit **70*b*** (FIGURE 4*b*) is favored. Leads **63** and **63*a*** are positive so that coincidence circuit **299*b*** is favored. The latter receiving on its second input, the voltage of lead **290** and results in the application of a switching pulses to trigger TB, which is thereby switched. Lead **300*b*** thus goes positive.

If contact **7B–1** (FIGURE 4*a*) is maintained closed, a positive voltage is applied to the right side of trigger **FB** which makes its left side conducting. In such a case, output **263*b*** is positive, and consequently lead **267*b*** is positive, and coincidence circuit **69*b*** (FIGURE 4*b*) is favored. Leads **64** and **64*a*** are positive, and favor one input of coincidence circuits **69*c*** and **70*c***. They have for their second input a branch line of lead **294**, now positive, and for other inputs leads **260*c*** and **267*c***. Therefore coincidence circuit **69*c*** or **70*c*** is favored according to the voltage state of these leads, i.e. according to the state of trigger FC (FIGURE 4*a*). The latter actually depends upon the state of contact **7C–1**. This contact should be assumed open, so that trigger FC is restored under the action of the positive voltage which has been applied to lead **255**. In such a case, the left output is positive, as is lead **260*c***. Coincidence circuit **70*c*** (FIGURE 4*b*) is then favored on its three inputs and delivers a positive voltage to leads **62** and **62*a***, and therefore coincidence circuit **299*c*** is favored. As the latter receives on its second input the voltage of lead **290**, a switching pulse is applied to the right side of trigger TC, thereby switching that trigger, and making lead **300*c*** positive.

The exact conditions wherein contacts **7A–1**, **7B–1**, 7C–1 (FIGURE 4*a*) are maintained open or closed will be seen later. However, it may be stated that, as there are three card readers, one may use either all the card readers or only two of them, or any one of them. This depends upon the exact nature of the work the machine is to perform. Operations requiring three card readers, operations requiring two card readers only, or operations requiring but one single card reader may be performed. In the event only two, or one, card readers are required, it is obviously advantageous to select freely these card readers, with the only provision that this free selection does not require too elaborate a circuitry. In such a case, it is obvious that the partial use of the card readers simplifies greatly the comparison operations. As was seen, an operation requiring the three card readers A, B and C requires that six comparisons, AA′, BB′, CC′, AB, BC, CA should be performed. An operation requiring but two card readers (for example card readers A and B) will require three series of comparison operations: AA′, BB′, AB. An operation requiring one card reader, for example card reader A, requires only operation comparison series AA′.

Contacts **7A-1**, **7B-1**, **7C-1** have for one of their functions to eliminate automatically some comparison operations. These contacts must be kept off in case the corresponding card reader is not used. As will be seen, the comparisons of type AA' are controlled by trigger TA (FIGURE 4*b*) whereas the comparisons of types BB' and CC' are controlled respectively from triggers TB and TC. As already seen, and for sequence comparisons, if contact **7A–1** is kept off (FIGURE 4*a*) it prevents trigger TA from being controlled (FIGURE 4*b*) while automatically directing the circuits towards trigger TB. Similarly, if contact **7B–1** is kept off, (FIGURE 4*a*) trigger TB cannot receive any control signal (FIGURE 4*b*). At least one of the card readers is used, so that if trigger TA is not controlled, it is necessary to control either trigger TB or TC.

Without going now into the details, it will be seen that when one of contacts **7A–1, 7B–1, 7C–1** (FIGURE 4*a*) are off, two of the inter-series comparisons are eliminated, while when two of these contacts are kept off all are eliminated.

Similarly, it will be seen that contacts **7A–1, 7B–1, 7C–1** are still maintained closed under some conditions and particularly:

At the beginning of the operations to cause automatically the cards to advance in each of the feeding heads used, so long as the first card of each series has not been recorded into the memory assigned thereto;

At the end of the operation, when a feeding head has exhausted the card set corresponding thereto, to cause the cards to advance towards the other heads.

The purpose of the comparison programs generally controlled from triggers HV, TA, TB, TC and Q1 to QN (FIGURE 4*b*) is to cause, if needed, some of triggers HA, HB, HC, FA, FB, FC (FIGURE 4*q*) or HAB, HBC, HCA, FAB, FBC, FCA (FIGURE 4*j*) to switch in case an inequality is detected and according to the direction of that inequality. Then the comparison is to be interrupted, in particular as concerns the triggers of FIGURE 4*j*. Just as keeping contact **7A–1** in the off state causes trigger FA to have its left side conductive, a positive voltage to be applied to leads **263*a*** and **267*a***, the control of trigger BA to be eliminated, and the circuit to be directed towards trigger TB, similarly, one of triggers HA or FA being switched (FIGURE 4*a*) causes a positive voltage to be applied to one of leads **262*a*** or **263*a***, and to lead **267*a*** thereby producing the same results.

SWITCHING OF TRIGGERS B2 AND B3 (FIGURE 4*m*)

Let it be assumed again that all contacts **7A–1, 7B–1, 7C–1** (FIGURE 4*a*) are open. The triggers of FIGURE 4*a* then are all conductive through their right side, and a positive voltage is applied to all their left outputs. Outputs **256*a*, 257*a***, particularly, are positive, so that a positive voltage is applied to lead **260*a*** and trigger TA is switched again (FIGURE 4*b*) at the end of time A when lead **290** returned to a negative voltage. It was seen that the latter was coincident with a positive voltage of lead **134**. It was seen also, that the positive voltage applied to lead **253** had two particular results: switching of trigger TA and switching of trigger Q1.

Prior to that, trigger HV had switched, and the triggers of FIGURES 4*a* and 4*j* had been restored.

At the same time as the switchings of triggers Q1 and TA, triggers B2 and B3 are also switched (FIGURE 4*m*), all these switchings being performed simultaneously, when lead **134** goes positive. It was seen that lead **116** was positive, which caused, particularly, lead **253** to be also positive. The voltage of lead **116** is applied to coincidence circuit **163** which has for its second input a branch line of lead **134**. When this lead returns to a positive voltage, at the end of time A, there occurs a switching pulse which switches triggers B2 and B3. Lead **116** thus returns to a negative voltage and so does **253**. At the same time, lead **174** returns to a negative voltage, so that a negative voltage is applied to leads **177** and **162** and momentarily prevents any other control signal being applied to trigger B2.

CONTROL OF TRIGGERS TB (FIGURE 4*b*), TC, Q2 ETC.

The comparison operations corresponding to the simultaneous switchings of triggers HV, TA and Q1 will be explained later. Let it be noted that there occurs successively:

(1) The switching of trigger **B6** (FIGURE 4*i*), the return of lead **11** to a negative voltage and the switching of trigger B7 (FIGURE 4*h*);

(2) A positioning of the scanning chains because of the comparison operations, under the control of trigger B7;

(3) The switching of trigger **B8** and the return of trigger B7 to its original state;

(4) The performance of the comparison operation under the control of trigger B8, and the possible switching of triggers F or H (FIGURE 4*q*);

(5) The switching of trigger **B6**, the return of the voltage of lead **11** to a positive value and resetting of trigger **B8** (FIGURE 4*h*) to its initial state.

At that moment during time A, the operations are the following:

Leads **111** and **122*a*** are positive as is lead **241** (FIGURE 4*i*). Triggers F and H are thus scanned, if an inequality is detected. In case one of triggers F or H is switched, coincidence circuits **84** or **84*b*** are favored on both their inputs, and consequently a positive voltage is applied to one of leads **382** or **383**. These leads are incorporated to cable **387**, thus going through FIGURES 4*p* to 4*k* to reach FIGURES 4*j* and 4*a*. According to the voltage state of leads **382** and **383**, one of coincidence circuits **301*a*** or **302*a*** is favored on its two inputs, so that a positive voltage is applied to the right side of one of triggers HA or FA, and thus one of these triggers is switched.

Trigger TA (FIGURE 4*b*) being still switched, lead **300*a*** is positive. The positive voltage is applied to coincidence circuit **303*a***, to mixing circuit **304**, to lead **65*a*** and therethrough to coincidence circuits **69*b*** and **70*b***. The latter are already favored on a second input since leads **291** and **294** are positive. Their third input is also positive, according to the voltage state of leads **260*b*** and **267*b***, i.e. according to the state of triggers HB and FB (FIGURE 4*a*). If it is assumed that these triggers have their right side conducting, the left outputs **256*b*** and **257*b***, are positive, so that a positive voltage is applied to lead **260*b*** and coincidence circuit **70*b*** is favored on its three inputs (FIGURE 4*b*). Leads **63** and **63*a*** are consequently positive, so that coincidence circuit **299*b*** is also favored. The latter has for one input a branch line of lead **290** which also connects to coincidence circuit **303*a***. When leads **290** again receive a positive voltage, two switching pulses result which switch trigger TB and restore trigger TA to its initial state.

SWITCHING TIME OF TRIGGERS HV, TB, Q1

Triggers B6 (FIGURE 4*i*), **B7, B8** (FIGURE 4*h*), then again B6, are switched again and new comparison operations are performed under the control of **B8**. One of triggers F or H (FIGURE 4*q*) may be switched when an inequality has been detected, so that one of triggers HB or FB is switched later (FIGURE 4*a*).

Trigger TB (FIGURE 4*b*) being switched, lead **300*b*** is positive which causes a positive voltage to be applied to coincidence circuit **303*b***. The positive voltage of lead **300*b*** is applied also to mixing circuit **306** and to lead **64*a***, thus causing coincidence circuits **69*c*** and **70*c*** to be favored. Let it be assumed that triggers HC and FC (FIGURE 4*a*) are conducting through their right side, left outputs **265*c*** and **257*c*** are positive, so that lead **260*c*** is positive, and coincidence circuit **70*c*** is favored on its three inputs (FIGURE 4*b*). Leads **62** and **62*a*** are thus at a positive voltage so that coincidence circuit **299*c*** is favored. The latter being connected by lead **290** to coincidence circuit **303*b***, there appear, on the return of lead **290** to a positive voltage, two switching pulses which switch trigger TC and restore trigger TB to its initial state.

SWITCHING TIME OF TRIGGERS HV, TC, Q1

Triggers **B6** (FIGURE 4*i*), B7, **B8** (FIGURE 4*h*) are switched again, then B6. New comparison operations are performed under the control of B8. One of triggers F or H (FIGURE 4*q*) may be switched, so that later one of triggers HC or FC (FIGURE 4*a*) is caused to switch.

Trigger TC (FIGURE 4*b*) being switched, lead **300*c*** is positive, so that coincidence circuit **303*c*** is favored. The voltage of lead **300*c*** is also applied to mixing circuit **307**, so that lead **308** is supplied a positive voltage and coincidence circuit **309** is favored. Coincidence circuits **303*c*** and **309** each receive a branch line of leads **290** and **134**. Two switching pulses appear when leads **134** and **290** reassume a positive voltage, which switch trigger **B17** and restore trigger TC to its initial state. Lead **308**, in particular, goes negative again.

SWITCHING TIME OF TRIGGERS HV, B17 AND Q1

Trigger **B17** having been switched in the described way, lead **282** is set to a positive voltage, whereas lead **310** is negative. A branch line of the latter head connects to coincidence circuit **143** (FIGURE 4*i*) which locks it. This trigger is momentarily isolated from the switching pulses from lead **125**. Thus lead **111** remains at a positive voltage during several adjacent times. Under the same conditions, lead **128** remains negative, so that, one after the other, several switching pulses are transmitted by lead **134**.

Another branch line of lead **310** (FIG. 4*c*) connects to mixing circuit **311**, which has for its second input a branch line of lead **134**. Lead **310** being negative, lead **312** from mixing circuit **311** conforms to the voltage of lead **134**. This lead reaches in particular coincidence circuit **313**, which has for its second input a branch line of positive lead **314**. This results in a switching pulse which switches trigger Q2 and restores trigger Q1.

Lead **282** and **277** are positive thus favoring one input of coincidence circuits **69*a*** and **70*a***. It being assumed that triggers HA and FA (FIGURE 4*a*) are conducting through their right side, leads **256*a***, **257*a*** are positive so that a positive voltage is applied to lead **260*a***, coincidence circuit **70*a*** is favored (FIGURE 4*b*), a positive voltage is applied to leads **66** and **66*a***, and coincidence circuit **299*a*** is favored. Consequently, trigger TA is switched.

Lead **282** also connects to coincidence circuit **315**, which also receive lead **316** from mixing circuits **317**. The latter receives lead **134**, and negative lead **308**. Lead **316** thus conforms to the voltage of lead **134**, so that a switching pulse is applied to the left side of trigger **B17** when lead **134** returns to a positive value. Trigger **B17** is thus restored to its initial state, and thereby applies a positive voltage to lead **310**. Coincidence circuit **143** (FIGURE 4*i*) is unlocked, so that triggers **B6** and **B7** may be switched (see also FIGURE 4*h*) when lead **125** transmits its next pulse.

SWITCHING TIME OF TRIGGERS Q2, Q3 . . . (FIGURE 4*b*)

It will be assumed that the successive comparisons performed do not detect any inequality. Trigger TA being originally switched the operations performed are successively as follows:

(1) Trigger TB is switched, and trigger TA returns to its original state;

(2) Trigger TC is switched, and trigger TB is restored to its original state;

(3) Trigger **B17** is switched and trigger TC is restored to its initial state.

Each trigger TA, TB, TC is switched when trigger **B6** (FIGURE 4*i*) is conducting through its left side (lead **11** being positive, lead **128** negative) and remains switched up to the return of trigger **B6** to that same state. During that time:

(1) Trigger **B6** is switched, as is trigger **B7**;

(2) The scanning chains are positioned under the control of trigger **B7**;

(3) Trigger **B8** is switched and trigger **B7** returns to its initial state;

(4) Comparison operations are performed under the control of trigger **B8**;

(5) Trigger **B6** is switched again, and trigger **B8** is restored to its initial state.

After trigger **B17** is switched:

(1) Triggers Q3 and TA are switched;

(2) Triggers TB, TC and again **B17** are switched.

The operations are the same for triggers Q4, Q5 . . . not shown, and for trigger QN. Triggers TA, TB, TC are successively switched and reset, then trigger B17.

SWITCHING TIME OF TRIGGERS QN AND B17

Leads **282** and **283** are positive. Lead **292** is negative. Coincidence circuit **293** is locked, so that a negative voltage is applied to lead **294**, and coincidence circuits generally referenced **69** and **70** are locked. Coincidence circuits **284** and **295** on the other hand are favored simultaneously on both their inputs, and therefore they deliver a positive voltage to leads **285** and **297**, and thence coincidence circuit **317** is favored. Coincidence circuits generally referenced **67** and **68** are thus favored on one of their three inputs.

It being assumed that contacts 7A–1, 7B–1 (FIGURE 4*a*) are all open, triggers HAB, FAB (FIGURE 4*j*) are conducting through their right side, so that a positive voltage is applied to the left outputs, **258*a*** and **259*a***, as well as to lead **261*a***, a branch of which connects to coincidence circuit **68*a*** (FIGURE 4*b*). The latter, which has for its second input a branch line of positive lead **277**, is favored on its three inputs and delivers a positive voltage to leads **66*a*** and **66*b***, and thereby favors coincidence circuit **299*a***.

Lead **286** is negative, which causes coincidence circuit **287** to be locked and a negative voltage to be applied to lead **288**. The voltage across lead **299** thus is related to that of lead **134**. When lead **134** assumes a positive voltage: trigger TA is switched, since coincidence circuit **229*a*** is favored on one of its inputs and has for its second input a branch line of lead **290**; trigger Q1 is switched, because coincidence circuit **281** is favored by the positive voltage of lead **276**, and has also for its second input a branch line of lead **290**; a pulse, applied to the left side of trigger HV through coincidence circuit **317** switches the right side of that trigger to conduct.

The voltage across lead **291** goes negative and triggers QN and B17 are restored to their initial state.

CONTROL OF INTER-SERIES COMPARISONS

The switching of triggers TA and Q1 indicates the beginning of a new series of operations during which there are effected inter-series comparisons. As will be seen, these operations are depending upon the voltage of lead **286**. Then successively: triggers TB, TC and B17 are switched; triggers TA, TB, TC and B17 are switched successively while trigger Q2 . . . is switched; the same triggers are successively switched, while trigger QN is switched.

These switchings are performed in a way quite similar to that already described, with the only difference that they now depend upon the coincidence circuits generally referenced **67** and **68** and upon the state of triggers HAB, FAB, HBC, HCA, FCA (FIGURE 4*j*). These triggers are normally conducting through their right side (if contacts 7A–1, 7B–1, 7C–1 are assumed to be open). In such a case, the left outputs generally referenced **258** and **259** (FIGURE 4*j*) are positive, so that coincidence circuits such as **258*a***, **258*b***, **258*c*** are favored on two inputs and deliver therefore a positive voltage to leads such as

261a, **261b** or **261c**. Leads such as **268a**, **268b** or **268c** on the contrary are negative. Consequently, coincidence circuits **68a**, **68b** and **68c** (FIGURE 4*b*) are successively favored and triggers TA, TB, TC successively controlled.

If some of triggers HAB, FAB, HBC, FBC, HCA, FCA (FIGURE 4*j*) happen to be switched (because of the detection of an inequality, or because one of contacts 7A–1, 7B–1, 7C–1 is maintained off some of leads such as **258a** or **259a** (FIGURE 4*j*) go negative to apply a negative voltage to the corresponding lead **261**, whereas some of leads such as **264a** or **266a** become positive and apply a positive voltage to corresponding lead **268**. Consequently, some of coincidence circuits **68a**, **68b**, **68c** (FIGURE 4*b*) are locked, which inhibits the control of that of triggers TA, TB or TC having its coincidence circuit **68** locked. At the same time some of coincidence circuits **67a**, **67b**, **67c** are favored, so that the control is directed towards the following trigger or trigger B17.

The timing of the switchings of triggers HV, TA, TB, TC, B17, Q1 to QN, and of the switchings of triggers B6 (FIGURE 4*i*), B7 and B8 (FIGURE 4*h*) will appear more clearly from the analysis of FIGURE 17 which schematically indicates how the various trigger switchings are timed and repeated. First the two long periods during which the sequence comparisons and the inter-series comparisons are effected will be noted: the first one of these periods is characterized by a certain state of trigger HV (see also FIGURE 4*b*) and by a positive voltage across lead **291**. The second one of these periods is characterized by a second state of trigger HV and by a positive voltage of lead **286**. Each period is subdivided into a certain number of sub-periods, during which triggers Q1, Q2 . . . Q*n* are successively switched. These sub-periods are themselves subdivided into bit periods during which triggers TA, TB, TC, then B17 are successively switched. During each bit period, the effects of triggers B6 (FIGURE 4*i*), B7, B8 (FIGURE 4*h*), occur successively, then again B6. The passage from one period to the next is made during the switching of trigger B6.

SEQUENCE COMPARISONS

These comparisons are made when lead **291** (FIGURE 4*b*) is at a positive voltage. Leads **300a**, **300b**, **300c** go to a positive voltage when triggers TA, TB, TC respectively are switched. Then the following operations take place:

(1) Coincidence circuits **318a**, **318b**, **318c** (FIGURE 4*k*) are favored on both their inputs;

(2) A positive voltage is applied to leads **319a**, **319b**, **319c**;

(3) Coincidence circuits **301a**, **302a**, **301b**, **302b**, **301c**, **302c** (FIGURE 4*a*) are favored, so that one of the triggers of groups HA, FA—HB, FB—HC—FC may be switched, when leads **382** or **383** are supplied a positive voltage on the detection of an inequality;

(4) Coincidence circuits **321a**, **321b**, **321c** (FIGURE 4*l*), the function of which will be seen later are favored;

(5) Coincidence circuits **320a**, **320b**, **320c**, which have for their second input a branch line of lead **122a**, are favored;

(6) A positive voltage is applied to leads **346a**, **346b**, **346c** when lead **122a** is itself positive;

(7) Coincidence circuits **322a**, **322b**, **322c** which have for their second input a branch line of lead **122** are favored;

(8) A positive voltage is applied to leads **353a**, **353b**, **353c** and leads **354a**, **354b**, **354c**, when lead **122** itself is positive;

(9) A positive voltage is applied to lead **345** whenever one of leads **300a**, **300b**, **300c** is itself positive.

Lead **345** connects to coincidence circuit **388** (FIGURE 4*d*) and to inverter **357**, so that a negative voltage is applied to lead **185**, and coincidence circuit **184** is locked. Lead **176a** thus is constantly negative. Therefore coincidence circuits such as **200** (FIGURE 4*c*) or **196**, are locked, which makes it impossible to switch triggers 1M, 2M, 3M . . . or 11M, 12M, 13M . . . As will be seen the function of the latter triggers is assumed by triggers TA, TB, TC (FIGURE 4*b*).

Trigger HV is conducting through its left side, thus lead **286** is negative, so that coincidence circuit **389** is locked and a negative voltage is applied to lead **390**. This voltage is applied to lead **418** (FIGURE 4*a*) and to inverter **391**, which delivers a positive voltage, applied to coincidence circuit **388**. Consequently, coincidence circuit **388** is favored on both its inputs, and a positive voltage is applied to lead **386**. The latter goes through FIGURES 4*e*, 4*f*, 4*g*, to reach mixing circuit **392** (FIGURE 4*q*). Thus the voltage of lead **379** is set to a positive value, so that the result of each comparison is read out whenever the voltage of lead **241** goes positive.

Leads **346a**, *b* and *c* (FIGURE 4*l*) connect respectively to mixing circuits **393a**, **393b**, **393c** (FIGURE 4*c*) and **394a**, **394b**, **394c**. It was seen that these leads are at a positive voltage whenever lead **122a** (see FIGURES 4*l* and 4*i*) is positive and whenever one of triggers TA, TB, TC (FIGURE 4*b*) is switched. Leads **395a**, **395b**, **395c** (FIGURE 4*c*) and **396a**, **396b**, **396c** from mixing circuits generally referenced **393** and **394** are therefore positive under the same conditions.

Leads **354a**, *b*, *c* (FIGURE 4*l*), which are positive whenever lead **122** is itself positive, and whenever one of triggers TA, TB, TC (FIGURE 4*b*) is switched, connect to mixing circuits **397a**, **397b**, **397c** (FIGURE 4*c*) as well as to mixing circuits **394a**, *b* and *c*. Therefore leads **398a**, **398b**, **398c** and **396a**, **396b**, **396c** therefrom are positive under the same conditions.

As already seen, leads **398a**, also referenced **195** or **M1**, when positive, controls the circuits provided for the scanning of the various locations of memory M1 (see also FIGURE 4*n*). Similarly, leads **398b**, **398c**, when positive, respectively control the circuits provided for the scanning of memories M2 and M3, whereas leads **395a**, *b* and *c*, when positive, respectively control the circuits provided for the scanning of the various locations of memories M4, M5, M6. Leads **398b** and *c*, and **395a**, *b* and *c*, have also been referenced M2 to M6 respectively, in order to designate which memory is controlled when said leads are positive. Thus, as specified before, the cards successively fed in card readers A, B and C, are recorded respectively into memories M1, M2, M3 then into memories M4, M5, M6. It will be noted: that the switching of trigger TA results in controlling memories M1 and M4 where the cards from card reader A are recorded; that the switching of trigger TB results in controlling memories M2 and M5 wherein the cards from card reader B are recorded; that the switching of trigger TC results in controlling memories M3 and M6 where the cards from card reader C are recorded.

Leads **396a**, *b* and *c* are positive under the same conditions as leads **300a**, *b* and *c* (see also FIGURES 4*b* and 4*l*). The voltage of lead **396a**, for example, depends upon that of leads **346a** and **354a**, which are related to the voltage of lead **300a** and the voltages of leads **122** and **122a** respectively. Leads **396a**, *b*, *c*, are respectively connected to coincidence circuits **399a**, **399b**, **399c**, **401a**, **401b**, **401c** and **403a**, **403b**, **403c**, which have for their second inputs leads **314**, **314a** and **314b** from the right side of triggers Q1, Q2 . . . Q*n* respectively (FIGURE 4*b*). Consequently, a positive voltage is applied successively to hubs **400a**, **400b**, **400c**, **402a**, **402c**, **404a**, **404b**, **404c** (FIGURE 4*c*). The voltage of the hubs generally referenced **400** is related to the switching of triggers Q1 (see also FIGURE 4*b*), while the voltage of the hubs generally referenced **402** or **404** is related to the switching of triggers Q2 or Q*n*. In each series, the voltage of the hubs further referenced *a*, *b* or *c*, is connected to switch of triggers TA, TB, TC. It is obvious that these circuits further comprise other hubs corresponding to the triggers of the Q series which have not been represented.

Hubs **400**, **402**, **404** which are directly connected to the right outputs of triggers **Q1**, **Q2** . . . *Qn* and which therefore ar positive as soon as the corresponding trigger is switched are to be connected when required: either to hub **366** (FIGURE 4*q*) when the comparison is made between arithmetical arguments, or to hub **405** (FIGURE 4*b*) if it is desired to limit the comparisons, or some of them, to the only sequence comparison operations; or to one of hubs **406** (FIGURE 4*l*) if it is desired to make sure of the matching of the cards; or to one of hubs **408***a*, **408***b*, **408***c* (FIGURE 4*j*) in case some comparison fields exist only in some cards, and in case it is desired that the cards having no such field should be fed in priority; or to one of hubs **409***a*, **409***b*, **409***c* if some comparison fields exist only in some cards, and if it is desired that these cards should be fed prior to the cards having no such field.

Hubs **400***a*, *b*, *c*, **402***a*, *b*, *c*, **404***a*, *b*, *c* (FIGURE 4*c*) must be connected to the hubs generally referenced **149** (FIGURE 4*h*) in a way quite similar to that in which the latter hubs may be connected to hubs **139** and **140**. However, the connections made from hubs **150** may be of any type since these connections are normally provided to control triggers 1M, 2M, 3M . . . 11M, 12M, 13M (FIGURE 4*c*) and since the control of these triggers has been made impossible. The hubs generally referenced **151** (FIGURE 4*h*) must be connected to hubs **153** (FIGURE 4*d*) as described above.

Let us assume that it is desired to keep a series of current accounts, and that the card readers are fed respectively with the series of the following cards:

(a) *Reader A*.—Name cards and address cards comprising specifically:

Columns 1 to 3—the number of the agency;
Columns 8 to 12—the account number;
Columns 13 to 40—the name or trade name, and possibly the address.

(b) *Card reader B*.—Previous balance cards comprising specifically:

Columns 5 to 7—number of the agency;
Columns 19 to 23—account number;
Columns 1 to 4—date when the previous balance card was made up.

(c) *Card reader C*.—Operations cards, comprising specifically:

Columns 5 to 7—number of the agency;
Columns 8 to 12—account number;
Columns 24 to 27—date when each operation becomes operative.

In this case, it is necessary: for all cards to perform a comparison as to the subsidiary number, and as to the account number; for previous balance cards, and for operation cards, to perform a comparison as to the date.

It will be supposed generally: that the comparison as to the subsidiary number will be performed under the control of trigger **Q1** (FIGURE 4*b*); that the comparison as to the account number will be performed under the control of trigger **Q2**; that the comparison as to the date is effected under the control of trigger **QN**.

In such a case, the connections to be made from the hubs generally referenced **400**, **402** and **404** (FIGURE 4*c*) are those indicated in FIGURE 15. Connection **410**, between hub **400***a* and that of hubs **149** which is further referenced **11** (see also FIGURES 4*c*, 4*h* and 4*d*) determines the scanning of the memories from location **3** to location **1**, provided no connection has been made from that of hubs **151** which bears the immediately lower order, or that such a connection is made with one of hubs **153** bearing a higher number. This scanning area corresponds to the area of the name card which bears the number of the agency.

Connections **411** between hubs **400***b* and **400***c* and that of hubs **149** further bearing number **14** similarly cause the memories to be scanned from location **7** to location **4** excluded, i.e.: a scanning corresponding to the area of "previous balance" and "operation" cards, also bearing the number of the subsidiary.

Connections **412** between hubs **402***a* and **402***c* and that of hubs **149** further bearing number **15** similarly cause the memories to be scanned from location **12** to location **7** excluded, i.e., a scanning corresponding to the "account number" area of the name and operation cards.

Connection **413** between hub **402***b* and that of hubs **149** further referenced **19** causes the memories to be scanned from location **23** to location **18** excluded, i.e., a scanning corresponding to the "account number" area of the "previous balance" card.

Connection **414** also causes the memories to be scanned from location **4** to location **1**, which corresponds to the date of the previous balance.

Connection **415** causes the memories to be scanned from location **27** to location **23** excluded, which corresponds to the area of the operation card bearing the date when the operation becomes operative.

As to hub **404***a*, it must be connected to one of hubs **417** (FIGURE 4*d*) and to one of hubs **408***a* or **409***a* (FIGURE 4*j*). As will be seen, the first connection is used to indicate that no comparison has to be effected when triggers TA and QN (FIGURE 4*b*) are simultaneously switched (since there exists no scanning field associated with the control of that trigger combination). The second connection is used to give priority, either to the feeding of the "name" and "address" cards (if this connection is made to hubs **408***a*), or to the feeding of one of the "previous balance" or "operation" cards (if this connection is made to hub **409***a*).

Generally, all hubs such as **400***a*, *b*, *c*, **402***a*, *b*, *c*, **404***a*, *b*, *c* (FIGURE 4*c*) which are unused may possibly be connected to one of hubs **417**.

SWITCHING TIME OF TRIGGERS Q1 AND TA (FIGURE 4*b*)

Supposing first that triggers Q1 and TA are switched, whenever leads **122***a* and **122** (FIGURE 4*i*) are positive, a voltage is applied to leads **346***a* and **354***a* (FIGURE 4*l*), and consequently, a positive voltage is applied to lead **396***a* (FIGURE 4*c*), hub **400***a* and that of hubs **149** further referenced **11** (FIGURE 19). As a result:

(1) Each scanning chain is positioned in location **3** of the memories, when it is time for trigger B7 to be switched (FIGURE 4*h*). This positioning is made in a way quite similar to that already described.

(2) On the switching of trigger **B8**, at each time **A**, one of locations **3**, **2**, **1** of memory **M4**, lead **346***a*, FIGURES 4*l* and 4*c*, is positive, thus causing memory **M4** to be energized.

(3) At each time, one of locations **3**, **2**, **1** of memory **M1**, lead **354***a*, is at a positive voltage, which causes memory **M1** to be energized.

Triggers F and H (FIGURE 4*q*) may be supplied various switching pulses, in case an inequality is detected. Then the state of the triggers is tested, when trigger **B6** is switched (FIGURE 4*i*) and a positive voltage is applied to lead **241**. There will be supplied:

(1) A positive voltage across lead **283** (FIGURE 4*q*) if the quantity contained in memory **M1** is superior to that stored in memory **M4**.

(2) A positive voltage across lead **383** in the opposite case.

These voltages are applied to coincidence circuits **301***a* and **302***a* which have for their second input a branch line of lead **319***a*, now positive. Consequently, a positive voltage is applied to the right side of one of triggers **FA** or **HA**, which makes the corresponding trigger conducting on its left side, whereas, a positive voltage is applied to one of inputs **262***a* or **263***a*. At the same time, one of outputs **256***a* or **257***a* goes negative. This results in a positive voltage across lead **267***a* and a negative voltage across lead **260***a*, which locks coincidence circuit **70***a*

(FIGURE 4*b*), and favors coincidence circuit **69***a*, and momentarily prevents trigger TA from receiving a control signal. This occurs only when an ineouality has been detected. Otherwise, triggers FA, HA (FIGURE 4*a*) remain in their initial state, and trigger TA is periodically and repeatedly controlled.

SWITCHING TIME OF TRIGGERS Q1, TB (FIGURE 4*b*)

As seen previously, trigger TB is controlled immediately after TA. Whenever leads **122***a* and **122** (FIGURE 4*i*) are positive, leads **346***b* and **354***b* (FIGURE 4*l*) are supplied a positive voltage, and therefore a positive voltage is applied to lead **396***b* (FIGURE 4*c*), to hub **400***b*, and to that among hubs **149** which is further referenced **14** (FIGURE 19). Consequently:

(1) Each scanning chain is positioned in location **7** of the memories on the switching of trigger **B7** (FIGURE 4*h*);

(2) On the switching of trigger **B8**, and during each time A, one of locations **7**, **6**, **5**, of memory **M5** is scanned (lead **346***b*, FIGURES 4l and 4*c*, is then at a positive voltage which controls memory **M5**);

(3) During each time B, one of locations **7**, **6**, **5**, of memory **M2** is scanned (lead **354***b*, which is positive, causes memory **M2** to be controlled);

(4) The two chains stop scanning when they have reached location **5**.

Triggers F and H (FIGURE 4*q*) which were restored at the beginning of the operation may be again supplied various switching pulses in case an inequality is detected. The state of these triggers is then tested when lead **241** goes positive. The results are then:

(1) A positive voltage across lead **382** if the quantity stored in memory **M2** is greater than that stored in memory **M5**;

(2) A positive voltage across lead **383** in the opposite case.

These voltages are applied to coincidence circuits **301***b* and **302***b* (FIGURE 4*a*) which have for their second input a branch line of lead **319***b*, now positive. Consequently, a positive voltage is applied to the right side of one of triggers FB or HB, which results in switching one of said triggers. Lead **267***b* then becomes positive (only if an inequality has been detected) whereas lead **260***b* becomes negative. This results in momentarily prohibiting any new control of trigger TB (FIGURE 4*b*).

SWITCHING TIME OF TRIGGERS Q1, TC

As already seen, trigger TB is restored to its initial state, whereas trigger TC is switched. Whenever leads **122***a* and **122** go positive, leads **346***c* and **354***c* are supplied with a voltage (FIGURE 4*l*), and thence a positive voltage is applied to lead **396***c* (FIGURE 4*c*), hub **400***c*, and that among hubs **149** which is further referenced **14** (FIGURE 19). Consequently, in the same way:

(1) Each scanning chain is positioned in location **7** of the memories when trigger **B7** is switched (FIGURE 4*h*).

(2) When trigger **B8** is switched, at each time A, one of locations **7**, **6**, **5**, of memory **M6** is scanned (lead **346***c*, FIGURES 4*l* and 4*c*, is now positive, which causes memory **M6** to be controlled).

(3) At each time B, one of locations **7**, **6**, **5**, of memory **M3** is scanned (since it is lead **354***c* which is now positive).

(4) The scanning performed by the two chains is stopped when they have reached location **5**.

Triggers F and H (FIGURE 4*q*) restored at the beginning of the operation may further receive various switching pulses in case an inequality has been detected. The state of these triggers is tested again when lead **241** goes positive. Consequently:

(1) A positive voltage is applied to lead **382** if the quantity stored in memory **M3** is superior to that stored in memory **M6**.

(2) A positive voltage is applied to lead **383** in the opposite case.

These voltages are applied to coincidence circuits **301***c* and **302***c* (FIGURE 4*a*) which have for their second inputs branch lines of lead **319***c*, now positive. Therefore, a positive voltage is applied to the right side of one of triggers FC or HC, so that one of the triggers is switched. The voltages of leads **267***c* and **260***c* are inverted, which provides the same results as above (any new control of trigger TC is prohibited when an inequality has been detected).

SWITCHING TIME OF TRIGGERS Q2, TA, TB, TC (FIGURE 4*b*)

As seen above, after trigger TC, trigger **B17** is switched, then again triggers TA, TB, TC, **B17**, at the same time as trigger **Q2** is switched. The same operations are repeated; however, it is now hubs **402***a*, **402***b*, **402***c* (FIGURE 4*c*) which are successively emitting. This results in a new series of comparison operations which concern the scanning fields defined from these hubs. Some of triggers FA, HA, FB, HB, FC, HC (FIGURE 4*a*) may happen to be switched after these operations, when an inequality has been detected.

SWITCHING TIME OF TRIGGERS QN, TA, TB, TC

Similar operations are performed with triggers **Q3**, **Q4**, not shown, then with trigger **QN**. Hubs **404***a*, **404***b*, **404***c* (FIGURE 4*c*) are then successively emitters when triggers TA, TB, TC (FIGURE 4*b*) are successively switched. As concerns the time when trigger TA is switched, and when hub **404***a* is applied a positive voltage, it is to be noted that the scanning chains are not positioned and, consequently, the memories are not scanned, since the connections made from hub **404***a* define no scanning field. In such a case, hub **404***a* is to be connected to one of hubs **417** (FIGURE 4*d*). A positive voltage thus is applied to the right side of trigger **B5** and switches it immediately so that lead **436** becomes positive. The voltage of lead **418** also goes positive and locks coincidence circuit **388**. Lead **386** is negative. The voltage of lead **418** is also applied to mixing circuit **288** (FIGURE 4*h*) thus applying a positive voltage to lead **180**, a negative voltage to lead **182** and causing all the results seen above. Consequently, trigger **B7** is switched, and then trigger **B8**, and immediately thereafter, trigger **B6** (FIGURE 4*i*). The latter controls the switching of trigger TB (FIGURE 4*b*) in the already described way. At the same time, trigger **B5** (FIGURE 4*d*) is restored to its initial state when lead **134** returns to a positive voltage, since coincidence circuit **437** is favored on one of its inputs by the positive voltage from lead **436**. The switching of trigger TC occurs afterwards, then that of trigger **B17**, which provides the results described above, namely, switching of trigger **Q1** and trigger TA, the latter being now under the control of coincidence circuit **68***a*. The switching of the latter triggers initiates the inter-series comparisons, as will be seen hereinafter. While it is still a question of the sequence comparisons, it should be noted that the switching of any of the triggers of groups FA, HA, FB, HB, FC, HC (FIGURE 4*a*) changes the sequence order of the control of triggers TA, TB, TC (FIGURE 4*b*) so as to eliminate the control of the among these triggers which has caused an inequality to be detected.

When these inequalities have been recorded in all trigger groups FA, HA—FB, HB—FC—HC (FIGURE 4*a*), coincidence circuits **70***a*, **70***b*, **70***c* (FIGURE 4*b*) are all locked, whereas coincidence circuits **69***a*, **69***b*, **69***c*, are all favored. Trigger **B17** being switched, the positive voltage of lead **282** is applied successively to lead **65**, to lead **64**, and to lead **308**, causing a positive voltage to be applied to mixing circuit 317. Thus, lead 316 remains positive, so that no switching pulse can be applied to the left side of trigger B17, through coincidence circuit 315. Switching pulses are transmitted by lead 312 which causes the triggers of the Q series to be successively switched, up to trigger QN. At that moment, lead 292 goes negative, which causes coincidence circuit 293 to be locked. Lead 294 goes negative and locks coincidence circuits 69*a*, 69*b*, 69*c*. Coincidence circuit 295 on the other hand, is favored on both its inputs, thus causing a positive voltage to be applied to lead 297 and favoring the coincidence circuits generally referenced 67 and 68. The control of triggers TA, TB, TC thus is taken away from the action of the triggers of FIGURE 4*a*, and now depends upon the triggers of FIGURE 4*j*.

INTERSERIES COMPARISONS

These comparisons are effected when lead 286 (FIGURE 4*b*) is at a positive voltage. Leads 300*a*, 300*b*, 300*c*, are then successively supplied with a positive voltage when triggers TA, TB, and TC are switched. Consequently:

(1) Coincidence circuits 419*a*, 419*b*, 419*c*, are favored on both their inputs (FIGURE 4*k*);

(2) A positive voltage is applied to leads 420*a*, 420*b*, 420*c*;

(3) Coincidence circuits 421*a*, 422*a*—421*b*—422*b*—421*c*, 422*c* (FIGURE 4*j*) make it possible for one of the triggers of groups HAB, FAB—HBC, FBC—HCA, FCA, respectively, to be switched when leads 382 and 383 are supplied with a positive voltage on the detection of an inequality;

(4) Coincidence circuits 423*a*, 423*b*, 423*c* (FIGURE 4*l*), the function of which will be discussed later on, will be favored;

(5) Coincidence circuits 424*a*, 424*b*, 424*c*, which have for their second inputs branch lines of lead 122*a*, are favored;

(6) A positive voltage is applied to leads 425*a*, 425*b*, 425*c*, when lead 122*a* is itself positive;

(7) Coincidence circuits 322*a*, 322*b*, 322*c*, which have for their second inputs branch lines of lead 122, are favored;

(8) A positive voltage is applied to leads 353*a*, 353*b*, 353*c*, and to leads 354*a*, 354*b*, 354*c*, when lead 122 itself is positive;

(9) A positive voltage is applied to leads 354*b*, 354*c*, 354*a*, respectively, when lead 122*a* itself is positive;

(10) A positive voltage is applied to lead 345, which provides the same results as in the sequence comparison case (locking of the control of triggers 1M, 2M, 3M . . . 11M, 12M, 13M . . ., FIGURE 4*c*).

As in the case of the sequence comparisons, lead 390 (FIGURE 4*b*) is at a negative voltage so long as no positive voltage is applied to hub 405. Consequently, a positive voltage is applied to leads 386 (see also FIGURES 4*d* and 4*q*) and 379, thus permitting the results of each comparison to be read-out whenever lead 241 is at a positive voltage.

Thus, as seen above, leads 354*a*, *b*, *c* (FIGURE 4*l*), connect to mixing circuits 397*a*, *b* and *c* (FIGURE 4*c*) and 394*a*, *b* and *c*. Consequently, a positive votlage is applied to some of the leads generally referenced 398, 396 and to some of the hubs generally referenced 400, 402 and 404. The application of this positive voltage depends upon the switching state of triggers TA, TB, TC (FIGURE 4*i*) according to whether it is a time A or a time B. The leads and hubs which are thus applied a positive voltage are (see FIGURES 4*b* and 4*c*) as follows:

(1) *When triggers Q1 and TA are switched*

At time A—lead 398*b* and hub 400*b* which control memory M2 and the scanning of the memory area defined from hub 400*b*.

At time B—lead 398*a* and hub 400*a*, which control memory M1 and the scanning of the area of that memory which is defined from hub 400*a*.

(2) *When triggers Q1 and TB are switched*

At time A—lead 398*c* and hub 400*c*, thus permitting the control of memory M3 and the scanning of the area of that memory which is defined from hub 400*c*.

At time B—lead 398*b* and hub 400*b*, the functions of which have already been described.

(3) *When triggers Q1 and TC are switched*

At time A—lead 398*a* and hub 400*a*.

At time B—lead 398*c* and hub 400*c*.

After the above example (refer also to FIGURE 19), a comparison is made, two by two, of the memory areas containing the number of the agency. Leads 382 or 383 (FIGURE 4*q*) are eventually made positive at the end of each comparison in case an inequality has been detected when lead 241 goes positive. These voltages are applied to coincidence circuits 421*a*, 422*a*—421*b*, 422*b*—421*c*, 422*c* (FIGURE 4*j*) causing, when required, one of the triggers of groups HAB, FAB—HBC, FBC—HCA, FCA to be switched. This switching occurs only when an inequality has been detected. Therefore, should the occasion arise, the voltage of leads 261*a*, 268*a*, 261*b*, 268*b*, 261*c*, 268*c* is inverted and that inversion causes some of coincidence circuits 67*a*, 67*b*, 67*c* (FIGURE 4*b*) to be favored, and corresponding coincidence circuits 68*a*, 68*b*, 68*c* to be locked. Thereby, those among triggers TA, TB, TC, which on a comparison have caused an inequality to be detected, are not controlled again. It is to be noted that coincidence circuits 421*a*, 422*a*—421*b*, 422*b*—421*c*, 422*c* (FIGURE 4*j*) receive respectively on one of their inputs branch lines of leads 261*a*, 261*b*, 261*c* which are positive so long as the triggers of groups HAB, FAB—HBC, FBC—HCA, FCA, have recorded no detected inequality. Thus, the second trigger of each group cannot be switched as soon as one of them is switched.

Similar operations are repeated when trigger Q2 is switched. The scanning fields are those defined from the hubs referenced generally 402 (FIGURE 4*c*). Other similar operations are again repeated when triggers Q3, Q4 . . . (not shown) are switched, and again on the switching of trigger QN. During these operations, some of the triggers of groups HAB, FAB—HBC, FBC—HCA, FCA (FIGURE 4*j*) may be switched whenever an inequality is detected. As already explained, each switching of each trigger of these groups restricts the field of the subsequent comparison operations, so as to limit these operations to the scanning and comparison of the memory areas having resulted in no detection of inequality. The switching of one of the triggers HAB, FAB prevents any further control of trigger TA (see also FIGURE 4*b*). The switching of one of triggers HBC, FBC prevents any further control of trigger TB, and the switching of one of triggers HCA, FCA, prevents any further control of trigger TC. As has been explained, these results will be obtained through the action of the voltages of the leads generally referenced 261 and 268 and through the action of the coincidence circuits generally referenced 67 and 68 (FIGURE 4*b*).

CASE WHEN SOME SCANNING FIELDS ARE MISSING

It was seen from the selected example (see also FIGURE 19) that the scanning fields defined from hubs 404*b*, 404*c* (FIGURE 4*c*) had no equivalent as concerns the cards fed in card reader A, and that, consequently, hub 404*a* were not connected to any of hubs 417. After the preceding, hub 404*a* is emitting in two cases:

(1) During each time B (lead 122, FIGURES 4*i* and 4*l*, at a positive voltage) when trigger QN and TA (FIGURE 4*b*) are switched;

(2) During each time A (lead **122a** positive) on the switching of trigger combination QN—TC.

In the first case, hub **404b** is emitting at time A; in the second case, it is hub **404c** which is emitting during time B.

It was seen that the connections made from hub **404a** defined no scanning field (refer to the example of FIGURE 19). Under these conditions, the comparisons controlled from trigger combinations QN—TA and QN—TC do not mean anything, and they have to be suppressed, or at least their result must not be recorded in the combinations of triggers HAB, FAB and HCA, FCA (FIGURE 4*j*). This is accomplished through the connection made between hub **404a** (FIGURE 4*c*) and hub **417**.

On the control of the combination of triggers QN, TA, hub **404a**, emits as soon as these triggers are switched, i.e. at half the switching time of trigger B6 (FIGURE 4*i*); lead **122**, which controls in particular coincidence circuit **322a** (FIGURE 4*i*), turns positive at the same moment. It may be seen:

(1) That lead **300a** (FIGURES 4*b*, 4*k* and 4*l*) is positive;

(2) That coincidence circuit **322a**, at that moment is favored on both its inputs;

(3) That leads **353a**, **354a** (see also FIGURE 4*c*), **396a**, are therefore supplied a positive voltage;

(4) That lead **314b** (FIGURES 4*b* and 4*c*) is itself positive (because trigger QN is switched) so that therefrom coincidence circuit **403a** is favored on both its inputs, and a positive voltage is applied to hub **404a**. This voltage is applied to the right side of trigger B5 (FIGURE 4*d*) thus causing this trigger to switch immediately, as explained above. Thus, lead **436** goes positive, so that a positive voltage is applied to lead **418**. At the same time, lead **386** goes negative, thus momentarily preventing any new read-out of the comparison results which might be recorded in triggers F and H (FIGURE 4*q*).

The positive voltage of lead **418** is applied to mixing circuit **228** (FIGURE 4*h*) and therethrough to lead **180**, to inverter **183** and to mixing circuits **186** and **189** (FIGURE 4*i*). Leads **181** and **187** are thus positive, and prevent the scanning chains (FIGURES 4*e*, 4*f* and 4*g*) from being positioned. Lead **182** from inverter **183** is brought to a negative voltage, but it is inoperative at this time.

The switching of triggers B6 (FIGURE 4*i*) now occurs, in the above described way, which causes a positive voltage to be applied to lead **128** and a negative voltage to be applied to lead **111**. At the same time, trigger B8 (FIGURE 4*h*) is also switched, thus causing a positive voltage to be applied to lead **178**. This results in the restoration of triggers F and H (FIGURE 4*q*), but has no other effects since coincidence circuit **192** (FIGURE 4*h*) is now locked.

Later, trigger B8 is switched, and trigger B7 is restored to its initial state. Said switching lasts only during a time A and a time B. With lead **182** negative, lead **232** (see also FIGURE 4*i*) conforms to the voltage of lead **125**, causing B8 to return to its initial state when that lead goes positive again. Similarly, trigger B6 (FIGURE 4*i*) is switched again (lead **111** being positive, and lead **128** negative) which provides the results already described. At the end of time A, when lead **134** returns to a positive voltage, the results are the following:

(1) The switching of trigger TB (FIGURE 4*b*);

(2) The restoration of trigger TA to its initial state;

(3) The restoration of trigger B5 (FIGURE 4*d*) to its initial state (since coincidence circuit **437** is favored on one of its inputs and its second input is subjected to the voltage variations of lead **134**).

The circuits operate in substantially the same way when the trigger combination QN—TC is controlled. The difference is that trigger B5 is controlled a little later (at the beginning of the switching time of trigger B7). Lead **122a** (FIGURES 4*i* and 4*l*) is then at a positive voltage, just as is lead **300c** (FIGURES 4*b*, 4*k* and 4*l*), since trigger TC is switched. Lead **286** (FIGURES 4*b* and 4*k*) are also subjected to a positive voltage causing coincidence circuit **419c** to be favored on both its inputs, so that:

(1) A positive voltage is applied to lead **420c**;

(2) Coincidence circuit **424c** is favored on both its inputs (FIGURE 41);

(3) A positive voltage is applied to leads **425c**, then **354a** (see also FIGURE 4*c*) and **396a**;

(4) Coincidence circuit **403a** is favored on both its inputs;

(5) Finally, a positive voltage is applied to hub **404a**, hub **417** (FIGURE 4*d*), so that trigger B5 is switched, and all the already described results are provided.

It has been mentioned that all hubs such as **400a**, *b* and *c*, **402a**, *b* or *c*, **404a**, *b* or *c* (FIGURE 4*c*) which are not used to define a scanning field, have to be connected to one of hubs **417**.

The functions of the connections between hub **404a** (FIGURE 4*c*) and one of hubs **408a** and **409a** (FIGURE 4*j*) will be analyzed later.

LIMITING THE COMPARISONS TO ONLY THE OPERATIONS THE RESULTS OF WHICH MAY BE MODIFIED BECAUSE ANOTHER CARD IS FED

It has been explained how the comparison operation field was automatically limited whenever one of the triggers of groups HA, FA—HB, FB—HC, FC—(FIGURE 4*a*)HAB, FAB—HBC, FBC—HCA, FCA (FIGURE 4*j*) was switched. As mentioned before, it is possible to further restrict the comparison operation field, and to limit these operations to only the comparisons the results of which may be modified by the feeding of a new card. For example, the feeding of a new card in card reader A may modify, should the occasion arise, only the results of the comparisons wherein the indices of that new card are concerned, i.e. the results which are recorded by means of trigger groups HA, FA (FIGURE 4*a*), HAB, FAB and HCA, FCA (FIGURE 4*j*). It is unnecessary, in such a case, to resume the comparisons the results of which are to be recorded in trigger groups HB, FB—HC, FC (FIGURE 4*a*) and HBC, FBC (FIGURE 4*j*) since the corresponding operations can only restore the triggers to their previous state.

To get such a result, the restoration of the triggers of FIGURES 4*a* and 4*j* is to be limited to the trigger groups which are concerned with the comparison operations and which will be performed subsequently, for example, to the trigger groups HA, FA—HAB, FAB—HCA, FCA when only card reader A has fed a new card. Similarly, it is necessary to change the control of trigger TA, TB, TC (FIGURE 4*b*), so as to suppress all the controls corresponding to comparisons, the result of which is already known.

The modified circuits are represented in FIGURE 20.

Let it be noted first that each card fed in one of card readers A, B or C, causes one of triggers BA, BB, or BC (FIGURE 4*l*) to be switched, this being done during the read-out of the corresponding card, on the closing of cam contacts C1A, C1B and C1C (FIGURE 4*m*). It has been seen that at the same time triggers B11, B16 and some of triggers B12 to B13 are controlled. Therefore, triggers BA, BB and BC are switched previous to the control of the comparison operations, and it will be seen that the restoration of these triggers is performed only when the comparison operations are completed. The voltage of leads **426a**, **426b**, **426c**, indicates which card reader or readers a card has been fed to. One only of these leads is positive if only one card reader has been another card. Two of these leads or all three of them are positive if two or three card readers have effected simultaneously feeding operations.

If it is desired to limit the comparison operations to only the operations, the results of which might be modified by the feeding of a new card, the connection between lead **255** (FIGURES 4*b*, 4*a* and 4*j*) and trigger groups HA, FA—HB, FB—HC, FC—HAB, FAB—HBC, FBC—HCA, FCA must be made through coincidence circuits **427***a*, **427***b*, **427***c*, and **428***a*, **428***b*, **428***c* (FIGURE 20). The latter have for one input lead **255**, and for a second input leads **426***a*, **426***b*, **426***c* or **430***a*, **430***b*, **430***c*. The latter come from mixing circuits **429***a*, **429***b*, **429***c* which have for their inputs two of leads **426***a*, **426***b*, **426***c*. Consequently:

(1) If lead **426***a* is positive, trigger groups HA, FA—HAB, FAB—HCA, FCA, are restored.

(2) If lead **426***b* is positive, trigger groups HB, FB, HAB, FAB, HBC, FBC, are restored.

(3) If lead **426***c* is positive, trigger groups HC, FC—HBC, FBC—HCA, FCA, are restored.

I.e., the restored trigger groups are those groups recording comparison results which may be modified respectively by the feeding of a new card in one of readers A, B or C.

Similarly, the control of trigger TA, during the sequence comparison operations, can be performed only if coincidence circuit **431***a* is favored simultaneously on both its inputs, which particularly implies a positive voltage across lead **426***a*. This may occur only if trigger BA has been switched after a card has been fed in card reader A. In the opposite case, lead **432***a* is positive, so that coincidence circuit **69***a* is favored, and the control pulse is directed towards trigger TB. The possible elimination of the control signal for triggers TB and TC is performed in quite a similar way. During the inter-series comparison operations, the control of trigger TA can be performed but if coincidence circuit **433***a* is favored simultaneously on its two inputs, which particularly implies a positive voltage of lead **430***a*.

It may be seen that this is the case:

(1) When a card has been fed to card reader A, since lead **426***a* is then positive, and since a branch line of that lead connects to mixing circuit **429***a*;

(2) When a card has been fed in card reader B, since lead **426***b* is positive, then, and since a branch line of that lead connects to mixing circuit **429***a*.

Therefore, trigger TA is controlled whenever a card has been fed to one of card readers A or B. In the case when none of the card readers have received a card, leads **426***a* and **426***b* are both negative, so that lead **430***a* is negative, and coincidence circuits **433***a* and **68***a* are locked. On the other hand, leads **432***a* and **432***b* are at a positive voltage, so that the two inputs of coincidence circuit **434***a* are simultaneously favored, and there appears a positive voltage across lead **435***a*, thus favoring coincidence circuit **67***a*. Thus, the control of trigger TA is prevented. At the same time, the control pulse is directed towards trigger TB. The control of triggers TB or TC during the inter-series comparison operations, may be eliminated in a similar way.

PARTIAL SUPPRESSION OF SOME INTER-SERIES COMPARISONS

One may wish to perform only a series of sequence comparison operations in some fields. In such a case, it is necessary to neutralize the inter-series comparison operations. This is accomplished by applying a positive voltage to hub **405** (FIGURE 4*b*). By interconnecting for example, hubs **405** and **402** (see also FIGURE 4*c*), all inter-series comparisons corresponding to the control of trigger Q2 will be suppressed. Then coincidence circuit **389** is favored on both its inputs (when lead **286** is positive, and on the switching of trigger Q2) and delivers a positive voltage to lead **390** (see also FIGURES 4*c* and 4*d*). Coincidence circuits **388** thus are locked, and therefore lead **386** is negative, so that the comparison results which may be recorded in triggers F and H (FIGURE 4*q*) cannot be read-out. At the same time, lead **418** (FIGURE 4*d*) is positive (see also FIGURE 4*h*), which provides the already described results. The scanning chains are not positioned because coincidence circuit **192** is locked and because the voltage of leads **181** and **187** (see also FIGURE 4*i*) is now positive. Lead **232** conforms to the voltage of lead **125**, which makes an anticipated restoration of trigger **B8** possible, and as well trigger B6 is switched. The results have already been described (switching of one of triggers TB, TC, B17 (FIGURE 4*b*) and restoration of triggers TA, TB, TC to their original state).

CONTROL OF THE FEEDING OF THE CARD READERS

The main function of the inter-series comparison operations is to direct the control of the feeding to the card readers. According to the results of these operations, the triggers of groups HAB, FAB—HBC, FBC—HCA, FCA (FIGURE 4*j*) are either all in their initial state, namely conducting through their right side, or some of them have been switched on the detection of an inequality, and therefore conducting through their left side.

To aid in understanding the way in which the control of the feeding to the card readers is made, and the way in which this control may be made correctly after the state of the triggers of groups HAB, FAB—HBC, FBC—HCA, FCA, the above example should be noted.

Let it be assumed that the cards are grouped in three series A, B, C, having the following respective indices:

Series A	Series B	Series C
07 12-1 12-2 12-3 17-1	05 12-5 12-6 16 19	03 12-4 15 17-2

Let it be assumed that these cards must be fed in the increasing order of their numbers, and when the numbers are identical, according to sequential order series A, series C and series B.

It may be seen that cards 03, 05, 07 are fed sequentially, then cards 12-1 to 12-3 of the A series, since these cards must be fed first, then card 12-4 of the C series, cards 12-5, 12-6 of the B series, and so on . . . (suffixes 1 to 6, affecting the cards bearing index 12, have been mentioned only to differentiate the various cards from one another, and to indicate their feeding order).

Thus, the problem of the well ordered advance of three series of cards raises at first various difficulties when this advance is desired to be automatic. The composition of each series is not known at first, nor the classification of the various cards of these series with respect to one another, so that it is necessary to perform a prior analysis of each new incoming card and a systematic comparison of these indices with those of the already fed cards. Thus, it may be known how the various cards are classified with respect to one another, and it will suffice to feed systematically the card corresponding to the lower index to solve properly the whole problem concerning the card feeding. If there are two or more cards bearing the same index number, it will suffice to use the priority rules, i.e. to feed first the card of the A series, then the cards of the C series, and at last the cards of the B series.

It was seen that all newly fed cards in any one of card readers A, B or C was recorded first and respectively, into memories M1, M2 and M3 and stored therein until the following card of the same series is fed. Let it be supposed that cards A07, B05, C03 are fed and recorded into memories M1, M2, M3 provided for that purpose. It is possible to determine which is the first card reader to be fed by systematically comparing the index numbers of the various cards, two by two, i.e. by making the following comparisons:

AB BC CA

Then, knowing the particular result of each comparison, it is possible to deduct therefrom the result. The latter always corresponds to one of the following results:

(1) One card lower than two others, which may be indifferently any one of cards A, B or C (there may exist any relation between the two other cards—equal or unequal);

(2) Two equal cards, lower than the third one (which would be the case for cards bearing respectively index numbers 07, 07, 12);

(3) Three equal cards.

In the illustrative example (analysis of cards A07, B07, C03), card C03 is less significant, so that it is necessary to feed first card reader C. Card C12–4 is thus advanced and recorded into the corresponding memory, i.e. memory M3, so that the next comparison will now concern cards A07, B05 and C12–4 (prefixed A, B and C are no part of the index numbers, but are used only to indicate to which series the various cards under consideration belong).

Let us examine the various possible cases, according to whether the card bearing index number 03 belongs to one of series A, B or C, or according to whether the same index number may be found simultaneously in two or three series.

(A) COMPARISON OF CARDS A03, B05, C07

As seen before, trigger TA (FIGURE 4*b*) controls the comparison of the index numbers of cards A and B and causes, after that comparison, the switching of trigger FAB (FIGURE 4*j*) because the index number of card A is the lower. Similarly, trigger TB, which controls the comparison of the index numbers of cards B and C, switches trigger FBC, following that comparison, because the index number of cards B is lower than that of card C. Trigger TC, after the comparison between the index numbers of cards C and A, causes trigger HCA to switch, because the index number of card C is greater than that of card A. Leads **266***a*, **266***b*, and **264***c* (FIGURE 4*j*) are then at a positive voltage (because the triggers from which they derive are switched) so that coincidence circuit **439***a* (FIGURE 4*k*) is favored and delivers a positive voltage to lead **442***a*. Lead **438***a* from mixing circuit **445***a* will also deliver a positive voltage. The latter voltage indicates that a feeding operation in card reader A is to be performed.

(B) COMPARISON OF CARDS A05, B03, C07

Without going into the details, it will be seen that the switch triggers are HAB, FBC, HCA (see FIGURES 4*j* and 4*k*). Leads **264***a*, **266***b*, **264***c* are positive so that coincidence circuit **439***b* is favored on both its inputs and delivers a positive voltage to leads **442***b* and **438***b*. As in the preceding case, the positive voltage of lead **438***b* indicates that a feeding operation has to be performed in card reader B.

(C) COMPARISON BETWEEN CARDS A05, B07, C03

The switched triggers are triggers FAB, HBC, FCA. Leads **266***a*, **264***b* and **266***c* are positive, so that coincidence circuit **439***c* is favored on both its inputs and delivers a positive voltage to leads **442***c* and **438***c*. The voltage of the latter lead indicates that a feeding operation has to be performed in card reader C.

(D) COMPARISON BETWEEN CARDS A03, B03, C07

The triggers switched are triggers FBC, HCA, Lead **264***c* in particular is positive, as is lead **261***a*, the latter because triggers HAB and FAB are in their initial state. Thus coincidence circuit **440***a* is favored on both its inputs and delivers a positive voltage to lead **443***a*. As the latter particularly connects to mixing circuit **445***a* and **445***b*, and results simultaneously in the application of a positive voltage to leads **438***a* and **438***b*, thus indicating that card readers A and B are simultaneously enabled to perform a feeding operation.

(E) COMPARISON BETWEEN CARDS A07, B03, C03

The triggers switched are triggers HAB and FCA. Leads **261***b* and **266***c* in particular are positive so that coincidence circuit **440***b* is favored on both its inputs and delivers a positive voltage to leads **443***b*, **438***b* and **438***c*.

(F) COMPARISON BETWEEN CARDS A03, B07, C03

The triggers switch are triggers FAB, HBC, so that a positive voltage is applied to leads **266***a* and **261***c*. Coincidence circuit **440***c* is favored simultaneously on both its inputs, thus causing a positive voltage to be applied to leads **443***c*, **438***a* and **438***c*.

(G) COMPARISON BETWEEN CARDS A03, B03, C03

None of triggers HAB, FAB—HBC, FBC—HCA, FCA is switched. Leads **261***a* and **261***b* in particular are positive, so that coincidence circuit **441** is favored on both its inputs and delivers a positive voltage to lead **444**. As the latter connects to mixing circuits **445***a*, *b*, *c*, it results simultaneously in a positive voltage across leads **438***a*, **438***b*, **438***c*, thus signalling that all the card readers are simultaneously able to perform a feeding operation. Let it be also mentioned that a branch line of leads **444** and **443***a*, *b* and *c*, connects to mixing circuit **446**. Therefore, a positive voltage is applied to hub **447** whenever one of these leads is itself positive.

FEEDING PRIORITY

The circuits of FIGURE 4*k* are arranged so as to provide, when there is no other special control, a general priority to card reader A with respect to card readers B and C, and a priority to card reader B over card reader C. Leads **438***a*, *b* and *c*, being all positive, inverters **448** and **448***a* deliver on leads **449** and **449***a* negative voltages which lock coincidence circuits **450** and **451** and cause a negative voltage to be applied to leads **452***b* and **452***c*. It being supposed that no connection has been made between hub **447** and hubs **453***a*, *b* and *c*, hubs **454***a*, *b* and *c*, are negative, so that lead **455** also is negative. In such a case, inverter **456** restores lead **452***a* to a positive voltage, which is applied to mixing circuit **457***a*, lead **458***a* and one input of coincidence circuit **459***a*. Under the same conditions, mixing circuits **457***b* and **457***c* receive on both their inputs a negative voltage, so that there is a negative voltage on leads **458***b* and **458***c* and one input of coincidence circuits **459***b* and **459***c* is locked.

If it is assumed that no positive voltage is applied to hubs **460***a*, *b* and *c*, leads **461***a*, *b* and *c* are negative, to that lead **462** is also negative. Inverter **463** restores lead **464** to a positive voltage which is applied to one input of coincidence circuits **459***a*, *b* or *c*. It does not change anything for the two latter since their second input **458***b* or **458***c* is negative. Coincidence circuit **459***a*, on the contrary, receives on its second input the voltage of lead **458***a*, now positive, and on a third input, the voltage of lead **438***a*, also positive. It is therefore favored on its three inputs and delivers a positive voltage to leads **465***a* and **466***a*. As will be seen, the positive voltage of lead **466***a* will permit subsequent control of relay **10**A (FIGURE 4*l*) which has for its function the advance of the cards towards card reader A.

Let it be assumed that the three series of cards have respectively for index numbers:

Series A	Series B	Series C
12-1 12-2 12-3 17	12-4 12-5 18	12-6 15

numbers 1 to 6 which are coupled to the cards bearing index number 12 being provided only to indicate the feeding sequence order of these cards.

The comparison of cards 12–1, 12–4 and 12–6 shows a triple equality, so that a positive voltage is applied to lead **466a** (FIGURE 4*k*) and relay **10A** (FIGURE 4*l*) is energized as just seen. Card reader A thus feeds a new card, whereas all the cards previously fed advance one position. The next comparison will concern cards 12–2, 12–4 and 12–6. Once more a triple equality results, and therefore a new feeding operation in card reader A, so that the next comparison is made between cards 13–3, 12–4 and 12–6. Generally, there will take place a series of successive feeding operations in card reader A, until the running out of the cards having the same index number as the cards momentarily waiting in card readers B and C. In the case of the example, there will occur a series of successive feeding operations which will go on until the card bearing index number 17 is recorded so that subsequently, there will occur the comparison operations concerning cards 17, 12–4 and 12–6. Consequently, triggers HAB and FCA are switched (FIGURE 4*j*). The voltage of lead **438a** (FIGURE 4*k*) goes negative, whereas leads **438b** and **438c** remain positive, this voltage being applied to leads **438b** and **438c** through coincidence circuit **440b** (instead of **441** as previously in the case of triple equality).

Lead **438a** being negative, coincidence circuit **459a** is locked, so that a negative voltage is applied in particular to lead **466a** and any other control of card reader A is prohibited. Parallelly, inverter **448** restores a positive voltage to lead **449**, which connects to coincidence circuit **451**. The latter has for its second input a branch line of lead **452a**, which, as seen above, is now positive. Consequently, a positive voltage is applied to leads **452b** and **458b**, and coincidence circuit **459b** is favored on its three inputs and delivers a positive voltage to leads **465b** and **466b**. As in the preceding case, the positive voltage of lead **466b** permits relay **10B** to be controlled subsequently, which controls the advance of the cards towards card reader B. Thus the latter feeds a new card, whereas, the cards previously fed are all advanced one position. In the described example, the new comparison will be made between cards 17, 12–5 and 12–6, which causes triggers HAB and FCA to be switched once more (FIGURE 4*j*). As previously, therefore, a negative voltage is applied to lead **438a** (FIGURE 4*k*), a positive voltage to leads **438b** and **438c** and therefore a positive voltage to lead **466c**, which causes another card to be fed to card reader B. Generally, there will occur a series of successive feeding operations to card reader B, until the running out of the cards bearing the same index as the card momentarily stored in card reader C, i.e. in the described example until the card bearing card number 18 is recorded. The subsequent comparison operations will concern cards 17, 18, and 12–6, thus causing triggers FAB, HBC and FCA (FIGURE 4*j*) to be switched. Consequently, as already seen, coincidence circuit **439c** is favored on both its inputs and delivers a positive voltage to lead **438c**. Leads **438a** and **438b**, on the other hand, are negative so that coincidence circuits **459a** and **459b** are locked, thus ensuing a negative voltage of leads **466a** and **466b** and momentarily prohibiting any other feeding operation in card readers A and B.

Leads **438a** and **438b** being therefore negative, inverters **448** and **448a** restore on leads **449** and **449a**, a positive voltage which causes coincidence circuit **450** to be favored on both its inputs and to deliver a positive voltage to leads **452c** and **458c**. Thus, coincidence circuit **459c** is favored simultaneously on its three inputs, delivers a positive voltage to leads **465c** and **466c** and permits a subsequent energization of relays **10C** (FIGURE 4*l*). Card reader C thus feeds a new card, whereas the cards previously fed are all advanced one position. In the described example, this will result in a new series of comparison operations bearing on cards 17, 18 and 16 and causing another feeding operation of card reader C.

It should be noted that the operation is similar when two only of leads **438a**, *b* and *c* are supplied a positive voltage. For example, if leads **438a** and *b* only are supplied a positive voltage, there occurs first a series of feeding operations in card reader A, which are repeated until it results in a series of comparison operations bringing the triggers of groups HAB, FAB—HBC, FBC—HCA, FCA, to a state so that lead **438a** goes negative. These feeding operations are followed with a series of card feeding operations in card reader B which go on until the comparisons occurring after these feeding operations bring lead **438b** to a negative voltage. The results are similar if only leads **438a** and **438c** are supplied a positive voltage. Similarly, if one of leads **438a**, *b* or *c* only is applied a positive voltage, control of the feeding of the corresponding card reader results, which is then repeated so long as the comparison operations made after that feeding operation do not change the relative voltages of these various leads.

CHANGES IN THE FEEDING PRIORITY

As will appear from the following, the feeding priorities may be changed at will by properly connecting hubs **447**, **447a** and **453a** to *c* (FIGURE 4*k*).

If it is desired that card readers B and C should feed first, it will suffice to connect hub **447** to one of hubs **453b** and **453c**. As seen before, hub **447** is positive whenever one of leads **444** or **443a**, *b* or *c*, is positive, i.e. whenever two of leads **438a**, *b* and *c* are positive. Hub **447** being itself connected to one of hubs **453a**, *b* or *c*, a positive voltage is applied to one of leads **454a**, *b* or *c*, as well as to lead **455** whenever hub **447** is itself positive. In the same case, leads **452a**, *b* and *c* are always negative. Inverter **456** restores lead **452a** to a negative voltage which is applied in particular to coincidence circuit **451**, thus placing a negative voltage across lead **452b**. One of leads **438a** and **438b** is positive (if not, at least two of leads **438a**, *b* and *c* could not be positive). Inverters **448** and **448a** therefore place a negative voltage on at least one of leads **449** and **449a**, causing coincidence circuit **450** to be locked and a negative voltage to be applied to lead **452c**. Consequently, leads **458a**, *b* and *c* can be supplied a positive voltage only if positive voltages are applied to hubs **453a**, **453b** or **453c**.

Let it be assumed that hub **447** is connected to hub **453b**. This results in a positive voltage across leads **454b** and **458b**, whenever hub **447** is itself positive, however, it results in controlling the feeding of card reader B only if lead **438b** is supplied a positive voltage, i.e. in case of a triple inequality or in case of an equality AB or BC. There is no feeding control if lead **438b** is negative, i.e. in case of an equality AC. In the latter case, one of the triggers of groups HAB, FAB—HBC, FBC (FIGURE 4*j*) is switched causing a positive voltage to be applied to leads **268a** and **268b**. A branch line of these leads reaches mixing circuit **467**, thus applying a positive voltage to lead **468** and favoring coincidence circuit **469**. It is to be noted that circuit **469** is favored in case of a triple equality, because leads **268a** and **268b** are then both negative. A branch line of lead **454b** connects to coincidence circuit **470b**, which has for its second input a branch line of lead **261c**. The latter is positive in case of an equality AC and provides a positive voltage across leads **471b** and **472**. Coincidence circuit **469** is favored on both its inputs and therefore delivers a positive voltage to hub **447a**.

If it is assumed that hub **447** is connected to hub **453b**, hub **447a** must be connected to one of hubs **453a** or **453c** according to whether it is desired that card reader A or card reader C feed in the second place. One of leads **454a** or **454c** is thus supplied a positive voltage permitting the application of a positive voltage to one of leads **458a** or **458c** and also permitting the control of one of card readers A or C in case card reader B is not able to feed. Similar connections and circuits permit:

(1) The control of one of card readers A or B when hub **447** is connected to hub **453c**, and in case card reader C is not in a position to feed;

(2) The control of one of card readers B or C in case hub **447** is connected to hub **453a**, and in case card reader A is not in a position to feed.

These connection and devices operate only when at least two of leads **438a**, *b* and *c* are supplied a positive voltage. If one only of these leads is supplied a positive voltage the control of the card feeding operation is made through previously described circuits.

SIMULTANEOUS CONTROL OF THE CARD READERS

One may cause a simultaneous control of the card readers by inter connecting hubs **473a**, **473b** and **473c**, for example hubs **473a** and **473b**, if it is desired to control simultaneously card readers A and B. This control is operative only to the extent that the corresponding leads **438a**, *b* or *c* are simultaneously positive.

FEEDING IN ABSOLUTE PRIORITY

It is possible to feed some cards in absolute priority, by applying a positive voltage to one of hubs **460a**, **460b** or **460c**. In such a case, one of the leads **461a**, *b* or *c*, is at a positive voltage, thus applying a positive voltage to one of leads **466a**, *b* or *c* and permitting subsequently the control of one of relays **10A**, **10B** or **10C** (FIGURE 4*l*). At the same time, lead **462** (FIGURE 4*k*) is supplied a positive voltage so that a negative voltage is applied to lead **464** (because of the presence in the circuit of inverter **463**), therefore locking coincidence circuits **459a**, *b* and *c*.

CARD FEEDING CONTROL FOR CARDS IN WHICH SOME SCANNING FIELDS ARE MISSING

It has already been explained that hubs **400a**, **400b**, **400c** (FIGURE 4*c*) and the homologous hubs referenced **402** and **404** were used to define the respective scanning fields between which the comparisons should be made, that these hubs were operative as well during the sequence comparisons as during the interseries comparisons, and that in particular these hubs were to be connected to hub **417** (FIGURE 4*d*) whenever these hubs were not used to define a scanning field. It was seen that trigger B5 was switched whenever one of the hubs connected to one of hubs **417** was supplied a positive voltage, that the switching resulted in a positive voltage across leads **436** and **418**, and a negative voltage across leads **345a** and **386**. The testing of the state of triggers F and H (FIGURE 4*q*) was eliminated in particular.

As will be seen later, various special arrangements are to be made to ensure a correct feeding of the cards.

Let it be assumed that each series of cards is made of a number of cards having respectively as index numbers:

Series A	Series B	Series C
07 12 15	07–X 12–X 15–X	07–Y 12–Y 15–Y

letters X and Y designating any index number, which may vary from one card to the next, but however having a well determined number of digits. Let us now refer to the comparison operations which are to develop when the cards bearing index number 07 run out, i.e. on the appearance of the first cards bearing index number 12.

As far as the inter-series comparisons are concerned, a first series of operations will be effected on the switching of trigger Q1 (FIGURE 4*b*) concerning index number 12. No inequality will be detected, so that, at the end of that first series of operations, the triggers of groups HAB, FAB—HBC, FBC—HCA, FCA (FIGURE 4*j*) will all be restored to their initial state and will be conducting through their right side. It may be assumed that other comparisons are effected under the control of trigger Q2, which still results in no detected inequality. Thus it may be assumed that the comparisons which have been controlled from trigger QN are effected in the way already explained, hub **404a** (FIGURE 4*c*) being connected to one of hubs **417**.

In the latter case, it was seen that the comparisons controlled from triggers TA and TC (FIGURE 4*b*) were eliminated, and that they are followed with no switching of the triggers of groups HAB, FAB, HCA, FCA (FIGURE 4*j*). These triggers are thus maintained in their initial state, to which there corresponds in particular a positive voltage across leads **261a** and **261c**. Only the comparison controlled from trigger TB (FIGURE 4*b*) may cause an inequality to be detected. It will possibly result in the switching of one of triggers HBC, FBC (FIGURE 4*j*) according to the relative value of index numbers X and Y. The state of the triggers of groups HAB, FAB—HBC, FBC—HCA, FCA, is inconsistent, which might cause the cards to be fed incorrectly.

If now the practical problem is examined, it may be remarked that the cards of the A series are cards of a nature quite different from that of the cards of the B and C series, for example name and address cards. In such a case, it is known that such cards are generally printed either as a heading of a statement or at the end thereof, so that it must be possible, at will, to give the priority to the cards of the A series or to the cards of the B and C series. This result is obtained, as will be explained, by connecting hub **404a** (FIGURE 4*c*) to one of hubs **408a** or **409a** (FIGURE 4*j*).

(a) *Connection With Hub 408a*

When hub **404a** (FIGURE 4*c*) goes positive, hub **408a** (FIGURE 4*j*) will go positive, thus causing a positive voltage to appear across leads **474a**, **475a** and **476a** and coincidence circuits **477c** and **478a** to be favored. The latter have for other inputs:

(1) A branch line of leads **261c** and **261a**, so as to make the connection with hub **408a** operative only if the groups of triggers HAB, FAB or HCA, FCA, are in their initial state.

(2) A branch line of leads **420c** and **420a**, so that the connection reaching hub **408a** is counteracted during the sequence comparison operations and is operative only during the inter-series comparisons.

A positive voltage may be applied to the right side of triggers FAB and HCA thus switching these triggers, causing a positive voltage to be applied to lead **438a** (FIGURE 4*k*) and therefore causing a card to be fed in card reader A.

The same operations are repeated until the cards of the A series bearing index number 12 are run out. The comparison effected afterwards concerns cards 15, 12–X, 12–Y and causes triggers HAB and FCA to be switched, thus permitting the cards of the B and C series to be advanced. This feeding operation lasts until the cards bearing index number 12 are run out.

(b) *Connection With Hub 409a*

Similarly, it will be seen that the application of a positive voltage to hub **409a** renders leads **479a**, **475a**, **476c** positive; coincidence circuits **477a** and **478c** are favored and triggers HAB and FCA are switched. Consequently, a positive voltage is applied to leads **438b** or **438c** (FIGURE 4*k*) according to the state of triggers HBC, FBC and therefore a card of the B and C series is fed. The same operations are repeated until the cards bearing index number 12 run out. The comparison made afterwards concerns cards 12, 15–X and 15–Y and results in switching triggers FAB and HCA, as well as in applying a positive voltage to lead **438a** (FIGURE 4*k*). A series of successive feeding operations in card reader A results, until the cards bearing index number **12** are run out.

Similar operations are repeated if the hub which corresponds to no definition of field is hub **404b** or **404c** (FIGURE 4*c*), or one of the homologous hubs. However, hub **404b** must be connected to one of hubs **408b** or **409b** (FIGURE 4*j*), whereas hub **404c** must be connected to one of hubs **408c** or **409c**.

CONTROL OF SOME SPECIAL PROGRAMS WHEN A SEQUENCE BREAK HAS OCCURRED SUCCESSIVELY IN ALL FEEDING HEADS

Referring to the example which has just been analyzed, it may be remarked that the flow of the cards bearing index number 07, then the flow of the cards bearing index number 12 or 15, indicate a step in the machine operation, and the end of these flows has to be noted, since quite a series of special functions is to be controlled at that moment. If the general operation concerns the account keeping of deposits in a bank, each end of a flow indicates that the operations relating to a given customer are completed, and the operations relating to another customer will be initiated. There exists no relation between the two series of operations, so that it is necessary to avoid mixing them. Various special operations are to be performed when, in particular, the account change occurs and all that relating to the just completed account must be erased. On the other hand, one may wish to perform the computation of the account care expenses, to be able to invoice them to the customer.

As will be seen, the group changes may be detected during the sequence comparisons in association with the control of some of triggers Q1, Q2 . . . (FIGURE 4*b*), and after the scanning fields controlled from hubs **400a**, *b*, and *c*, **402a**, *b*, and *c* (FIGURE 4*c*), with the prerequisite that hubs **400**, **402** . . . should be connected to one of hubs **407** (FIGURE 4*l*). Triggers B15A, B15B, B15C are switched when an inequality is detected, these triggers respectively corresponding to one of card readers A, B, or C. This results in controlling trigger B15 (FIGURE 4*m*) whenever the three preceding triggers are simultaneously switched. Of course, one may provide several units such as that composed of triggers B15, B15A, B15B, B15C.

Let it be assumed that the comparison of the index numbers is controlled from trigger Q1 (FIGURE 4*b*), i.e., from hubs **400a**, **400b**, **400c** (FIGURE 4*c*), hub **400** being connected to one of hubs **407** (FIGURE 4*l*). With reference to the development of the operations from the moment when the cards bearing index number 07 have run out, and when a restoring pulse has been applied to the left side of triggers B15A, B15B, B15C, so as to turn these triggers conductive through their right side, and to drive leads **480a**, **480b**, **480c** negative, the inter-series comparisons concern the cards bearing index number 12. It will be assumed that these cards are all followed with a series of cards bearing the same index number, and that the card feed is made according to the following order: series A, series B, series C. As seen above, there occurs first a series of feeding operations to card reader A, which go on up to the run out of the cards bearing index number 12 and until the occurrence of the first card bearing index number 15. The interseries comparison operations, which occur at that moment, concern index numbers 15, 12 and 12. This results in a series of feed control operations to card reader B, which also go on until the cards bearing index number 12 have run out and until the appearance of the first card bearing index number 15. The interseries comparison operations then concern index numbers 15, 15 and 12. A series of feed control signals in card reader C result, which go on until the cards bearing index number 12 have run out, and until the appearance of the first card bearing index number 15.

SEQUENCE COMPARISONS OCCURRING DURING SUCCESSIVE FEEDING OPERATIONS TO CARD READER A

It will be assumed that the corresponding operations are limited to the scanning fields defined from hubs **400a**, **400b**, and **400c** (FIGURE 4*c*), to which corresponds trigger Q1 being switched (FIGURE 4*b*). It may be seen that triggers TA, TB, TC control the respective comparison operations:

(1) Trigger TA—index number 12 with index number 12 (since the card just fed bears that index number and since this card is supposed to be followed with others bearing the same index number);

(2) Trigger TB—index number 12 with index number 07;

(3) Trigger TC—index number 12 with index number 07.

It will be noted that:

(1) Lead **291** is positive;

(2) Leads **300a**, **300b**, **300c** are successively supplied a positive voltage (according to whether one of triggers TA, TB, and TC is controlled);

(3) Leads **319a**, **319b**, **319c** (FIGURES 4*k* and 4*l*) are successively supplied a positive voltage;

(4) Coincidence circuits **321a**, **321b**, **321c** are successively favored.

The latter also have for other inputs lead **481**, as well as leads **426a**, **426b**, **426c** from the right side of trigger BA, BB, BC. As seen before, these triggers are switched respectively whenever there occurs a card feed in one of card readers A, B or C, and they are restored later when the comparison operations are completed. Now only trigger BA is switched, so that lead **426a** is positive.

The control of trigger TA (FIGURE 4*b*) is inoperative, since the index numbers compared are identical (12 compared with 12). The control of triggers TB and TC causes index numbers 12 and 07 to be compared. Consequently, trigger H (FIGURE 4*q*) is switched, thus applying a positive voltage to leads **373**, **382**, and **384**, the latter being made positive only when there appears the positive voltage across lead **241**. Lead **384** connects to coincidence circuit **482** (FIGURE 4*l*) which is already favored on its second input because one of hubs **407** is supplied with the positive voltage of lead **400** (FIGURE 4*c*). Lead **281** is set then to a positive voltage, but this results in no effect because leads **426b** and **426c** are negative.

Similar operations are repeated on the successive feeding of the cards bearing index number 12.

When the first card bearing index number 15 appears, trigger TA (FIGURE 4*b*) controls the comparison between index number 15 and index number 12. Consequently, trigger H (FIGURE 4*q*) is switched, a positive voltage is applied across leads **384** and **481** (see also FIGURE 4*l*), and therefore, coincidence circuit **321a** is favored on its three inputs. Leads **319a** and **426a** are at a positive voltage at that moment. Therefore, a positive voltage is applied to the right side of trigger B15A causing it to conduct through its left side. Lead **420a** thus goes to a positive voltage. The inter-series comparison operations which develop immediately after concern index numbers 15, 12 and 12. This results in a negative voltage across lead **438a** (FIGURE 4*k*), so that the following feed control signal will be applied to card reader B.

SEQUENCE COMPARISONS OCCURRING DURING SUCCESSIVE FEEDING OPERATIONS TO CARD READER B

It may be seen that triggers TA, TB, TC (FIGURE 4*b*) control the respective comparison operations:

(1) Trigger TA—index 15 with index 12 as when trigger B15A (FIGURE 4*l*) has been switched, because no feeding operation has been made in card reader A;

(2) Trigger TB—index number 12 with index number 12, since the card which has just been fed relates to that index number, and this card was followed with several cards bearing the same index number;

(3) Trigger TC—index number 12 with index number 07 as previously.

The comparison being performed at the moment of the control of trigger TA leads to the detection of an inequality, thus causing a positive voltage to be applied to lead **384** (FIGURE 4*q*) when lead **241** is itself positive. This produces no effect since this voltage can operate only coincidence circuits **321*a*** (FIGURE 4*l*) and the latter is locked because of the negative voltage of lead **426*a*** (there has occurred a card feeding to card reader B, which has caused trigger BB to be switched, thus making lead **426*b*** positive).

The comparison being made at the moment of the control of trigger TB provides no particular effect because of the identity of the index numbers.

The comparison being made at the moment of the control of trigger TC also causes an inequality to be detected; however, there results no effect therefrom since lead **426*c*** is negative, and therefore coincidence circuit **321*c*** is locked.

Similar operations are repeated during each successive feeding operation in card reader B, so long as the card newly fed bears index number 12.

When the first card bearing index number 15 appears, there occurs a change in the relative value of the index numbers compared under the control of trigger TC FIGURE 4*b*), which change causes an inequality to be detected. Lead **384** goes positive, so that coincidence circuit **321*b*** is favored on its three inputs. This results in the application of a positive voltage to the right side of trigger B15B, thereby switching it, and applying therefore a positive voltage to lead **480*b***. The inter-series comparison operations which develop immediately after concern index numbers 15, 15 and 12. As already seen, this results in a negative voltage on leads **438*a*** and **438*b*** (FIGURE 4*k*), so that the following feeding operations will concern card reader C.

SEQUENCE COMPARISONS OCCURRING DURING THE SUCCESSIVE FEEDING OPERATIONS IN CARD READER C

It will be seen that triggers TA, TB, TC (FIGURE 4*b*) now control the respective comparison operations:

(1) Trigger TA—index number 15 with index number 12, as previously;

(2) Trigger TB—index number 15 with index number 12, as when trigger B15B (FIGURE 4*l*) has been switched, since the feeding operations to card reader B are momentarily stopped;

(3) Trigger TC—index number 12 with index number 12, since the card just fed bears index number 12, and this card was assumed to be followed with several cards bearing the same index number. Similarly, trigger BC is switched (FIGURE 4*l*) on each feeding operation.

The comparisons effected on the energization of triggers TA and TB permit an inequality to be detected, but there is no other effect since leads **426*a*** and **426*b*** (FIGURE 4*l*) are now positive. The comparison effected at the moment of the energization of trigger TC is inoperative because the index numbers compared are identical. One of the compared index numbers changes when the first card bearing index number 15 is advanced. This results in a positive voltage across lead **384** (FIGURE 4*q*) when lead **241** itself goes positive, so that coincidence circuit **321*c*** is favored on its three inputs (FIGURE 4*l*) and trigger B15C is controlled. Thus lead **480*c*** goes positive, so that coincidence circuit **483** is favored on its three inputs and delivers a positive voltage to lead **484**. This voltage is applied to the right side of trigger **B15** (FIGURE 4*m*) thus causing this trigger to be switched, and a positive voltage to be applied to lead **110**. Coincidence circuits **489*a***, **489*b***, **489*c*** (FIGURE 4*l*) are thus favored on one input.

It being further supposed that hub **400** (FIGURE 4*c*) is connected to one of hubs **406** (FIGURE 4*l*), positive voltages are again applied to the left side of triggers EAB, EBC, ECA, thereby making these triggers conductive on their right side, and applying a negative voltage to leads **486*a***, **486*b***, **496*c***. Coincidence circuits **485*a***, **485*b***, **485*c*** have respectively for other inputs:

(1) A branch line of lead **487** from hub **406** which is now positive;

(2) A branch line of lead **291** which is also positive;

(3) Two of leads **420*a***, **420*b***, **420*c***.

Therefore, the coincidence circuits are favored on their four inputs, thus causing a positive voltage to be applied to the left side of the above-mentioned triggers. It may be noted that this quadruple energization of the coincidence circuits occurs for coincidence in card reader B, and that it is repeated whenever a card is fed to card reader C. The restoration of trigger EAB is made when the card feed to card reader B is interrupted (and each time is switched again immediately after).

Let us refer now more in detail to the inter-series comparison operations which are effected then, hub **400** (FIGURE 4*b*) is connected to one of hubs **406** (FIGURE 4*l*), and to one of hubs **488**. Lead **286** (FIGURE 4*b*) is then at a positive voltage and causes a positive voltage to be applied to leads **420*a***, **420*b***, **420*c*** (FIGURE 4*k*) successively, and causes one input of coincidence circuits **423*a***, **423*b***, **423*c*** (FIGURE 4*l*) to be favored. The control of trigger TA (FIGURE 4*b*) causes two identical index numbers to be compared (during the time trigger Q1 is switched). Consequently, none of triggers F and H are switched (FIGURE 4*q*), so that leads **372** and **375** are maintained at a positive voltage. Therefore, coincidence circuit **84*a*** may be favored on its three inputs when the positive voltage across lead **241** occurs, thus causing a positive voltage on lead **381**. A branch line of that lead particularly connects to coincidence circuit **423*a*** (FIGURE 4*l*) which is already favored on its two other inputs since leads **420*a*** and **487** are positive now. Consequently a positive voltage is applied to the right side of trigger EAB, which causes a positive voltage to be applied across lead **486*a***. It is to be pointed out that the same results are repeated whenever leads **420*a***, **487**, and **381** are simultaneously at a positive voltage, i.e., whenever an inter-series comparison, controlled by the cooperation of triggers Q2 and TA (FIGURE 4*b*) shows an identity. (It might be the same for the comparison controlled by the combined action of triggers Q2 and TA, with the requirement that hub **402** (FIGURE 4*c*) is connected also to one of hubs **406**, FIGURE 4*l*.)

It may be shown in the same way that the combined action of triggers Q1 and TB (FIGURE 4*b*), Q1 and TC causes two identical index numbers to be compared (in the given case); consequently, a positive voltage is applied to the right side of triggers EBC and ECA (FIGURE 4*l*) which are thereby conductive through their left side, thus causing a positive voltage to be applied to leads **486*b*** and **486*c***. As mentioned with reference to trigger EAB, the same results are repeated for triggers EBC and ECA, whenever leads **487**, **381**, **420*b*** or **420*c*** are simultaneously positive.

If no inequality has been detected, the triggers of groups HAB, FAB—HBC, FBC—HCA, FCA (FIGURE 4*j*) are all in an equality condition, and it was seen that, in such a case, leads **438*a***, **438*b***, **438*c*** (FIGURE 4*k*) are all positive. A branch line of the latter leads connects to coincidence circuits **489*a***, **489*b***, **489*c*** (FIGURE 4*l*) which, as seen, are already favored on one input because lead **110** is positive.

The control of trigger TC (FIGURE 4*b*) is followed, as seen, by the control of trigger **B17**. The control of trigger Q2 and the restoration of trigger Q1 to its initial state occur afterwards. Hub **400** (FIGURE 4*c*), therefore, is always positive, and so is consequently that of hubs **488** (FIGURE 4*k*) to which the former was supposed to be connected. Lead **282** (FIGURE 4*b*) is also at a positive voltage (since trigger B17 is switched), as is lead **286**. Coincidence circuit **490** (FIGURE 4*k*) is favored on its three inputs, thus causing a positive voltage to be applied to lead **491**, which voltage is applied also to coincidence circuits **489***a*, **489***b*, **489***c* (FIGURE 4*l*). The latter are thus favored on their three inputs, thereby applying a positive voltage to the left side of triggers B15A, B15C. The state of these triggers is switched, so that their right side is made conducting, and a negative voltage is applied to leads **480***a*, **480***b*, **480***c*. Consequently, coincidence circuit **483** is locked, thus preventing any new control of trigger B15 (FIGURE 4*m*). At the same time, coincidence circuits **485***a*, **485***b*, **485***c* (FIGURE 4*l*), are also locked, thus preventing momentarily triggers EAB, EBC, ECA from being switched. These triggers are now conducting through their left side (since it is assumed that there is a triple equality). During the inter-series comparisons which will be performed later on, they may be supplied positive voltages on their right side; however, these voltage applications will be momentarily inoperative since they are only able to make the triggers conductive through their left side, and that these triggers are already conducting through that side.

It has been seen that the restoration of triggers B15A, B15B, B15C, has been placed under the control of the voltage of leads **438***a*, **438***b*, **438***c* (FIGURE 4*k*) and that this restoration is made now at the end of the switching time of trigger Q1, i.e., when the inter-series comparison operations are not wholly completed. There are two reasons therefore.

The cards series may be composed in one of the following ways:

FIRST CASE

Series A	Series B	Series C
07	07-X	07-X
12	12-X	12-Y
15	15-X	15-Y

i.e. cards bearing index number 12 followed, in all series by cards bearing index number 15, letters X and Y representing any index number existing but in series B and C.

SECOND CASE

Series A	Series B	Series C
07	07-X	07-Y
12	12-X	12-Y
15	27-X	15-Y
32	32-X	29-Y

I.e. card bearing index number 12 followed with cards bearing any index number, letters X and Y having the same meaning.

In such a case, the control of trigger B15 (FIGURE 4*m*) must occur after the cards bearing a common index number have run out. Therefore, in the second case, this control occurs:

(1) After the cards bearing index number 07, which may be found in all series, have run out;

(2) After the cards bearing index number 12, which may be found in all series, have run out;

(3) After the cards bearing index number 15, which may be found only in series A and C, have run out;

(4) After the cards bearing index number 27, which are found only in the B series, etc. . . ., have run out.

Consequently, for the cards bearing index number 15, only the feeding in cards readers A and C need be controlled. This will result in the control of triggers BA and BC (FIGURE 4*l*), so that only triggers B15A and B15B will be switched when needed. The switching of trigger B15B will not occur because card reader B will not be fed, and therefore, trigger BB will not be picked up.

Similarly, for the cards bearing index number 27, only card reader B need be controlled by controlling only triggers BB and B15B.

Consequently, triggers B15A, B15B, B15C are to be restored only in proportion to the feeding of the cards which feeding will be performed after this restoration which will permit triggers BA, BB, BC, to be controlled, and will therefore permit the control of same triggers (B15A, B15B, B15C). The voltage state of leads **438***a*, **438***b*, **438***c* (FIGURE 4*k*) indicates which card readers will be operated, so that it will suffice to condition the restoration of triggers B15A, B15B, B15C (see also FIGURE 4*l*) to the voltage state of leads **438***a*, **438***b*, **438***c* to solve completely the problem. Thus, those of triggers B15A, B15B, B15C, which correspond to card readers which are not to feed will be maintained in their initial condition. Leads **438***a*, **438***b*, **438***c* are positive after the cards bearing index number 07 have run out. All triggers B15A, B15B, B15C will then be restored since index number 12 which appears afterwards may be found in all the series. Only leads **438***a* and **438***c* are positive after the cards bearing index number 12 have run out. Then triggers B15A and B15C only will be restored, since index number 15 which appears then is found only in series A and C. Similarly, only lead **438***b* is positive after the cards bearing index number 15 have run out; consequently, only trigger B15B will be restored, since index number 27 which comes afterwards is found only in the B series, etc.

The voltage condition of leads **438***a*, **438***b*, **438***c* is not definitive. This voltage condition results from the inter-series comparison operations which are generally performed under the control of trigger Q1 (FIGURE 4*b*). This may be modified during the comparison operations controlled on the switching of any one of triggers Q2 . . . QN, since these operations may cause inequalities to be detected, and some of the triggers of groups HAB, FAB—HBC, FBC—HCA, FCA (FIGURE 4*j*) to be switched. It was seen that the voltage condition of leads **438***a*, **438***b*, **438***c* (FIGURE 4*k*) depends upon the condition of these latter triggers, and it was seen also that the condition of these triggers could be modified by connections made with one of hubs **408***a*, **408***b*, **408***c* or **409***a*, **409***b*, **409***c* (FIGURE 4*j*).

It was further seen that contacts (7A–1, 7B–1, 7C–1, FIGURE 4*a*) were maintained closed whenever the corresponding card reader was unused. This resulted in a positive voltage on one of leads **271***a*, **271***b*, **271***c*, which voltage is applied to the right side of triggers B15A, B15B, B15C (FIGURE 4*l*), respectively. All among these triggers corresponding to an unused card reader are thus maintained in such a state that they are conducting through their left side.

The control of triggers B15A, B15B, B15C may be placed, if needed, under the control of two or more scanning fields, for example, under the control of the scanning fields corresponding to the successive control of triggers Q1 and Q2 (FIGURE 4*b*). In such a case, hubs **407** (FIGURE 4*l*) must be connected both to hubs **400** and **402** (FIGURE 4*c*). As concerns hubs **488** (FIGURE 4*k*) which control the restoration of triggers B15A, B15B, B15C, it is necessary to connect them only to hub **402**.

Card Matching Check

It has been explained previously how triggers EAB, EBC, ECA (FIGURE 4*l*) were successively switched and restored to their initial state, thus causing a positive voltage to be applied to one of leads **486***a*, **486***b*, **486***c* (when the corresponding triggers are switched) or **492***a*, **492***b*, **492***c*, when the triggers are in their initial state. These triggers are switched respectively whenever leads **381**, **487**, and **420***a*, **420***b*, **420***c* are positive simultaneously. Their restoration is initiated during the sequence comparisons (lead **291** positive), as soon as two of triggers B15A, B15B, B15C are switched (to be switched back immediately after, if the corresponding conditions are again met).

These triggers are provided to deliver, during the card feeding operation, various pulses indicating the matching or unmatching state of the card just advanced with respect to the cards of same group which are about to be advanced or already advanced.

Leads **493***a*, **493***b*, **493***c* (FIGURE 4*m*) are normally negative. They are connected to negative terminal **146** through resistance **498**. On the occurrence of the feed control signal of one of the card readers, control of card reader A for example, one of leads **493***a*, **493***b* or **493***c*, is brought to a positive voltage because it is then connected to the positive terminal **144** through the corresponding contacts C3A, C3B or C3C. Consequently, according to the state of triggers EAB, EBC, ECA (FIGURE 4*l*), a positive voltage is applied to one of the hubs generally referenced **494**, **495**, **496**, and **497**. Two of hubs **494***a*, **495***a*, **496***a*, and **497***a*, for example, are supplied with a positive voltage when a card is fed to card reader A. Hubs **494***a* and **495***a*, if positive, are used to indicate that the card previously advanced in card reader A has at least one card corresponding thereto in the cards which are advanced or to be advanced in card readers B and C, respectively. Under the same conditions, hubs **496***a* and **497***a*, if positive, are provided to indicate that the card previously advanced has no equivalent among the cards of card readers B or C, respectively. Hubs **494**, **495**, **496**, and **497** further referenced *b* or *c* have similar functions with respect to the cards fed in card readers B and C, respectively.

With the voltages applied to the hubs generally referenced **494**, **495**, **496**, and **497**, it is possible to cause various special functions according to the case which occurs (control or noncontrol of the computation programs). It is possible to perform at the same time a sorting of the cards according to whether they have caused a computation or not.

Several devices, such as that formed with triggers EAB, EBC, ECA may be provided, and these devices may be associated with other groups of triggers similar to triggers B15A, B15B, B15C and performing the same function.

Completion of the Inter-series Comparison Operations

On the completion of the inter-series comparison operations, triggers ON and B17 (FIGURE 4*b*) are simultaneously switched. Leads **282** and **283** are then positive as is lead **286** because of the state of trigger HV. Consequently, coincidence circuit **284** is favored on both its inputs, a positive voltage is applied to lead **285**, coincidence circuit **287** is favored on both its inputs, and lead **288** is also supplied with a positive voltage. The voltage of lead **290** is thus maintained positive, which prevents trigger Q1, TA, TB or TC from being switched again.

Lead **312** conforms to the voltage of lead **134** or remains positive. Thence, under the same conditions, trigger B17 is restored to its initial state.

A branch line of lead **288** connects to coincidence circuit **499** (FIGURE 4*m*) and to mixing circuit **100**, thus driving lead **245** positive. Consequently coincidence circuits **499** and **247** are favored, since they have for another input lead **134**. Two switching pulses are thus applied to the left side of triggers B3 and B11. These pulses occur on the return of lead **134** to a positive voltage, and therefore, at the same time as trigger QN and possibly B17 are switched back to their initial state (FIGURE 4*b*). The voltage of lead **108** (FIGURE 4*m*) thus goes negative. Leads **174** and **167** on the other hand go positive. The voltage of the latter lead is applied to the left side of trigger B17 (FIGURE 4*b*), which restores this trigger to its initial state if it is not already in such state.

Control of Relays 10A, 10B, 10C (FIGURE 4l)

All the operations which are performed on each card feed after the control of trigger B11 (FIGURE 4*m*) have been described. As seen, these operations are followed with other operations controlled from any one of triggers B12, B13, B14, since it was seen that one at least of these triggers was controlled on each card feed. This results in a new control of trigger B2 which causes a positive voltage on lead **116**. Coincidence circuit **166** is thus favored on both its inputs, thus causing a positive voltage to be applied to lead **169**, coincidence circuit **171** to be favored on both its inputs (in case trigger B12 has been controlled) and a positive voltage to be applied to hub **129**. The function of that hub has already been explained. A branch line of lead **169** connects to coincidence circuit **501**, which has for its second input a branch line of lead **107** which is now positive since trigger B16 is systematically controlled on each card feed. Consequently, the coincidence circuit **501** is favored on both its inputs, a positive voltage is applied to lead **502** and coincidence circuits **503***a*, **503***b*, **503***c* (FIGURE 4*l*) are favored. Some of thyratrons **504***a*, **504***b*, **504***c* are thus controlled according to the voltage state of leads **466***a*, **466***b*, **466***c*, and cause the corresponding one of relays **10A**, **10B**, **10C** to be energized. The relays are held afterwards through contacts **10A–1**, **10B–1**, or **10C–1** (FIGURES 21*b*, 21*c* or 21*d*), when contacts C10–*a*, C10–B or C10–C are closed again.

Control of Transfers From Memories M1, M2, M3 to Memories M4, M5, M6

Let it be noted first that triggers B11 and B16 (FIGURE 4*m*) are controlled systematically on each card feed, at the same time as some of triggers B12, B13, B14 according to the connections of hubs **148**, **148***a*, **148***b* and hubs **158**, **158***a*, and **158***b*. Trigger B15 is controlled occasionally, for example, whenever a triple inequality has been detected and triggers B15A, B15B, B15C (FIGURE 4*l*) are simultaneously switched. It has been seen how triggers B11, B12 (FIGURE 4*m*) operated and how these triggers were restored to their initial state at the end of the program.

The programs controlled from triggers B11, B12, B13, B14, and possibly B15 being completed, there occurs a new control of trigger B2 since lead **107** is positive. Lead **116** being at a negative voltage, a positive voltage is also applied to leads **169**, **169***a*, **169***b*, **169***c*, **169***d*, since coincidence circuits **166**, **172**, **172***a*, **172***b* and **172***c* are simultaneously favored on both their inputs. Coincidence circuit **171***d* is also favored on both its inputs, so that a positive voltage is applied to lead **251** and to lead **505**. Thus a positive voltage is applied to the left side of triggers BA, BB, BC (FIGURE 4*l*) which results in restoring to their initial state all the triggers which might happen to be switched. This restoration is necessary because if it is trigger BA for instance which is switched, the following feed control may operate one of card readers B or C, thus causing one of triggers BB or BC to be controlled.

The positive voltage of hub **251** (FIGURE 4*m*) is used to control the general transfer of memories M1, M2, M3 to memories M4, M5, M6. It was seen that it was simpler or, at any rate quicker, to record respectively into memories M1, M2, M3 the cards advanced in front of the prescanning stations of card readers A, B, and C, and then to transfer the content of these memories to memories M4, M5, M6 rather than at the same time performing the recording into memories M1, M2, M3 from the prescanning station of each card reader and record into memories M4, M5, M6 from the operation station of the same card readers.

The transfer must be performed only to the memories corresponding to the card readers which are actually to perform a feeding operation.

The control of the transfer program may be performed as indicated in FIGURE 23. It will be noted that relays **10A**, **10B**, and **10C** (FIGURE 4*l*) are energized if the corresponding card reader performs a feeding operation, several relays being possibly energized simultaneously in case some of leads **438*a***, **438*b***, **438*c*** (FIGURE 4*k*) are simultaneously positive, or some of hubs **473*a***, **473*b***, **473*c*** are interconnected. Contacts **10A–2**, **10B–2**, **10C–2** (FIGURE 23) are off or transferred as the case may be.

The connections to be made are the following:

(1) Hub **251** (FIGURE 4*m*) to hub **506** (see also FIGURE 23).

(2) Hub **507*a*** to one of hubs **130** (FIGURE 4*h*) provided for the control of program steps, for example, to the hub for controlling the program step bearing index number **71**.

(3) Similarly, hub **507*b*** to that of hubs **130** which permits control of the program step bearing, for example, number **72**.

(4) Similarly, hub **507*c*** to that of hubs **130** which permits control of the program step bearing reference number **73**.

(5) The hub **137** corresponding to the program step bearing reference number **71** to hub **508*a***.

(6) The hub **137** corresponding to the program step bearing reference number **72** to hub **508*b***.

(7) The hub **137** corresponding to the program step bearing reference number **73** to hub **508*c***, which must be further connected to hub **509** (FIGURE 4*m*).

It is seen that the program step bearing number **71** is controlled only when contact **10A–2** is transferred, i.e., when there is to be a card feed to card reader A. In another case, the control pulse is directed towards program **72** or program **73**. Similarly, program **71** controls program **72**, only when there is to be a card feed to card reader B. In still another case, the control is directed towards program **73** or towards hub **509**.

Hubs **138** must be connected as a whole to a hub **510** (unshown in FIGURES 4*a* to 4*q*), controlling the transfer from one memory to another. Hubs **139** and **140** must be connected as represented to some of hubs **149** (FIGURE 4*h*), for example, to those among hubs **149** which are further referenced **33** to **38**. The corresponding hubs **159** must be connected as a whole to that among hubs **153** (FIGURE 4*d*) which are further referenced **80**. The corresponding hubs **150** (FIGURES 23 and 4*h*) must be connected respectively:

(1) To hubs **132–1** (FIGURE 4*c*) and **132–4** (the latter being unshown) for program **71**.

(2) To hubs **132–2** and **132–5** for program **72**.

(3) To hubs **132–3** and **132–6** for program **73**.

Program **71** thus controls the transfer from memory **M1** to memory **M4**, thus making the former available for a new record. Programs **72** and **73** control also respectively the transfers from memory **M2** to memory **M5** and the transfer from memory **M3** to memory **M6**. The control of each program is effected in a way quite similar to that described. Finally, trigger **B16** is restored to its initial state in a way similar to that described when the positive voltage occurs on hub **509** (see also FIGURE 23).

Leads **107**, **108**, **109*a***, **109*b***, **109*c***, **110** are thus all negative, so that a negative voltage is applied to leads **117**. The later locks coincidence circuit **118** (FIGURE 4*i*), thus causing the pulse distributor to stop.

Main Circuits

Main switch **513** (FIGURE 21*a*) being switched, row leads **514**, **514*a*** are all supplied with a voltage, thus causing motors **515** to start and feeding unit **516** to be operated. The terminal and row lead **517** are thus supplied with a voltage permitting the relay circuits to be fed to. Other terminals **518**, **519** permit the delivery of various positive and negative voltages necessary to the energization of the electronic circuits. Motors **515** control the continuously rotating mechanisms of card readers **48*a***, **48*b***, **48*c*** (FIGURE 1) of printing unit **50** and of punching unit **51**.

Switch **521*a*** (FIGURE 21*b*) must be closed if work requiring the use of card reader A is performed. Similarly, for switch **521*b*** (FIGURE 21*c*) if a work requiring use of card reader B is performed and for switch **521*c***, if the work performed requires card reader C. The three switches **521*a***, **521*b***, **521*c*** must be closed, if work requiring the simultaneous use of the three card readers is performed. Relays **1A**, **1B**, **1C** (FIGURES 21*b* to 21*d*) are then picked up as soon as lead **517** is supplied a voltage. These relays are maintained energized up to the opening of main switch **513** (FIGURE 21*a*).

Cards having been arranged in the hoppers of card readers A, B, and C, contacts **510*a***, **510*b***, **510*c*** (FIGURES 21*b* to 21*d*) are closed, thus causing relays **2A**, **2B**, **2C** to be energized.

The starting of all the units may be accomplished in two ways as follows:

(1) By operating for a short time push button **522** (FIGURE 21*a*). In such case, one card feeding operation only is performed in one of card readers A, B or C, and the whole unit stops.

(2) By operating push button **523**. In such a case, the machine operates in an automatic manner and stops only when there appears one of the usual stop causes. Among the latter are:

(*a*) A manual operation of stop button **524**,

(*b*) A card run-out in one of the hoppers, causing one of contacts **2A–3**, **2B–3**, **2C–3** to open,

(*c*) The filling-up of one of the stackers.

Relays **1A**, **1B**, **1C**, **2A**, **2B**, **2C** (FIGURES 21*b* to 21*d*) being all energized operating switch **523** (FIGURE 21*a*) causes relay **R34** to be energized through contact **524**, contacts **2A–3**, **2B–3**, and **2C–3** are closed, and contacts **525*a***, **525*b***, and **525*c*** are in the off condition. Relay **R34** is maintained through its contact **R34–*a*** and causes relay **R–35** to be energized through its contact **R34–*b***. Contacts **C4–A**, **C4–B**, **C4–C** are then closed because all the feeding units are stopped and the closing times of contacts **C4–A**, **C4–B**, **C4–C** have been arranged so that these contacts are closed at that moment. It will be noted that operating push button **522** gives the same results as the closing of contact **R34–*b***. Relay **R35** causes contact **R35–*a*** (FIGURE 4*m*) to be transferred, which results as seen previously in a positive voltage being applied to the right side of trigger **B16**, and therefore the trigger is switched. Lead **107** goes positive, as does lead **117**, thus starting the pulse distributor. This results in the momentary switching of trigger **B2** in a positive voltage on leads **116** and **169**, as well as in a positive voltage on lead **502** which results in controlling one of relays **10A**, **10B** or **10C** (FIGURE 4*l*).

Similar results are repeated on each control of relay **R35** (FIGURE 21*a*), for example, if push button **522** is used) until the energization of relay **R31**. Contact **R31–*a*** (FIGURE 4*m*) is opened then, preventing any new control from trigger **B16** through contact **R35–*a***.

The triggers of groups HAB, FAB—HBC, FBC—HCA, FCA may be assumed in any condition. Similarly, memories **M1**, **M2**, **M3** (FIGURE 4*n*) may also be assumed in any condition.

As concerns the first feed control, some of leads **438*a***, **438*b***, **438*c*** (FIGURE 4*k*) are originally at a positive voltage. At least one of leads **466*a***, **466*b*** and **466*c*** is also positive after the connections effected between hubs **447*a***, **447**, and the hubs generally referenced **453**, **460** or **473**. Therefore, when the positive voltage occurs on lead **502** (FIGURE 4*l*), one of relays **10A**, **10B**, **10C** at least is energized. Let it be assumed that relay **10A** is energized. This relay is maintained by cam contact **C10–A** (FIGURE 21*b*), now closed, contact **10A–1** and winding 10AM. At the same time a circuit is made with clutch magnet 526a, through contact R35–e. Thus there occurs a first feed control to card reader A, which causes the first card to be advanced to position 55 (FIGURE 3) to close contact 511a (see also FIGURE 21b) and to energize relay 3A. This energization occurs on the closing of cam contact C15A.

At the same time cam contacts C1A, C2A (FIGURE 4m) are operated, thus causing triggers B11 and B16 to be controlled and all the functions controlled from these triggers to be controlled. Lead 502, in particular, is made momentarily positive, thus causing relays 10A, 10B, 10C (FIGURE 4l) to be energized.

Let it be supposed that this control affects again relay 10A. A new card feed in card reader A results, which will advance the first card from location 55 (FIGURE 3) to location 57. At the same time the second card will come to location 55. During its advance from location 55 to location 57, the first card will be scanned by prescanning brushes 56 and recorded into memories M1.

During that cycle, relay 5A in particular is energized (see FIGURE 21b) when cam C16A closes its contact and is maintained through contact 5A–1 and cam contact C6A. Contact 5A–3 being closed, the pulses delivered by cams C11A and C12A are directed towards roll 527a and brushes 56a. Later contact 512a is closed, and relay 2A is energized, the latter energization being performed when cam C15A closes its contact. The opening of contact 4A–2 results, which prevents relay 7A from being energized and prohibits temporarily any new feed in card reader A. As seen above, the first card in card reader A has been recorded into memory 1 and therefore the feeding operations in that card reader are to be conditioned to the scanning of the cards contained in card readers B and C. It may be remarked that relay 7A is energized originally as soon as contact 1A-1 (of relay 1A) is closed, contacts 4A–2 and 8A–1 being off at that time. The opening of contact 4A–2 causes relay 7A to be de-energized, which causes contact 7A–1 to be reset (FIGURE 4a). Cams C1A and C2A (FIGURE 4m) operating in the usual way results in a series of comparison operations controlled as already described under the control of trigger B11, which comparison operations are particular in that the condition of triggers HAB and FCA (FIGURE 4j) is set in advance because contact 7A–1 (FIGURE 4a) is reset and lead 271a (FIGURE 4j) is at a negative voltage. In such a case, as seen previously, lead 438a (FIGURE 4k) is at a negative voltage, so that the following feed control can affect only card readers B and C.

Let is be supposed that these controls affect first card reader B. The results will be successively:

(1) Control of relay 10B (FIGURE 4l);

(2) This relay is held by cam contact C10B (FIGURE 21c);

(3) Clutch 526b is controlled;

(4) Relays 3B, 5B, 4B are successively energized (it will be noted that FIGURE 21c is identical in all points to FIGURE 21b, except, of course as concerns index numbers and references). The first one of the cards stored in the hopper of that card reader will be successively advanced to position 55 then to position 57, and during the passage from position 55 to position 57, this card is recorded into memory M2. At the same time, contact 4B–2 is opened, so that relay 7B is de-energized, and contact 7B–1 is reset (FIGURE 4a), and so that any new feed control is prohibited in card reader B.

The following feed control will therefore affect card reader C so that successively:

(1) Relay 10C is energized (FIGURE 4l);

(2) The same relay is held through contact C10C (FIGURE 21d);

(3) Clutch 526c is controlled;

(4) Relays 3C, 5C, and 4C are successively energized. At the same time the first one of the cards contained in card reader C will be advanced successively to position 55 (FIGURE 3) then to position 57, and during the advance from position 55 to position 57, this card is recorded into memory M3. Contact 4C–2 (FIGURE 21d), on opening, will cause relay 7C to be de-energized; however, this relay will be re-energized immediately after, at the same time as relays 7A and 78.

It may be noted that the first cards contained in card readers A, B, and C are now recorded into their respective memories. These cards may be compared two by two, and the card readers may be controlled respectively in accordance with the card content.

Relay 4C (FIGURE 21d) being energized, relay RB1 (FIGURE 21a) may be energized in turn when contact C5C is closed because contacts C5A and C5B are now closed, as are contacts 4A–4, 4B–4, and 4C–4. This relay is held by its winding R31M, its contact R31–b and contact R32–a in the off condition. Through its contacts R31–d, R31–j, R31–h (FIGURES 21b to 21d), it immediately causes relays 7A, 7B, 7C to be re-energized; and through its contacts R31–c, R31–e, R31–g, it prepares the energization of relays 8A, 8B, 8C. It is to be noted that none of the latter relays may be energized now because contacts 5A–2, 5B–2, 5C–2 are open.

At the same time as the recording of the first card contained in card reader C into memory M3, the control of triggers B11, B16 (FIGURE 4m) is effected through cam contact C1C. One of relays 10A, 10B, 10C (FIGURE 4l) may be controlled according to the results from the comparisons effected at that moment. Let is be supposed that this control concerns relay 10A, a new control of clutch 526a (FIGURE 21b) results, which causes the cards to be advanced in card reader A. Relay 6A is energized on the closing of contact C16A to be held through cam contact C6A. Contact 6A–3 being closed, the pulses of cams C11A, C12A, are distributed to roll 528a and therethrough to brushes 58a, which permits the card passing under these brushes to be recorded into memory M4 (see FIGURE 3).

End of the Operation

The circuits will be described only for card reader A, the circuits of card readers B and C operating similarly.

The run out of the cards in the hopper of card reader A causes contact 510A (FIGURE 21b) to open and relay 2A to be de-energized. Contact 2A–3 (FIGURE 21a) is opened, which causes relays R34, R35 to be de-energized because of the opening of contact R34–b and contacts R35–e, R35–f, R35–g (FIGURES 21b to 21d) to open. The control of clutch magnets 526a, 526b, 526c is thus momentarily deferred, momentarily prohibiting any card feed, and permitting the hopper to be refilled if the operation has not come to an end.

When the work to be performed is completed, the operations may be caused to come to an end by operating push button 529 (FIGURE 21a). Relay R33 is energized thereby which causes relays 9A to be immediately energized (FIGURE 21b). Cam contact C9A is now closed, as is contact 2A–1, the latter because of the de-energization of relay 2A. Relay 3A is still energized so that contact 3A–3 is made. Relay 9A is held by its winding 9AM (FIGURE 21a) its contact 9A–2 and contact R32–a. At the same time contact 9A–1 closes, thus restoring the control circuit of relay R34, which may be energized again by operating push button 523. The last card contained in card reader A, which was in position 55 (see FIGURE 3) is advanced to position 57. At the same time this card is recorded into memory M1. It may be noted that relay 5A (FIGURE 21b) is then de-energized.

On the following card feed control, this last card is advanced past brushes 58 (FIGURE 3) and is directed towards card stackers 54. Relay 6A is de-energized and relay 8A is energized. Contact R31–c is now closed. Contact 5A–2 is reset when relay 5A is de-energized, i.e., on the preceding feed control. Relay 8A is held by its winding 8AM (FIGURE 21*a*), its contact 8A–3 and contact R32–*a*. By its contact 8A–1 (FIGURE 21*b*), it interrupts the pick-up circuit of relay 7A, thus resetting contact 7A–1 (FIGURE 4*a*). Consequently, as seen before, triggers HAB and FCA (FIGURE 4*j*) are systematically switched, which makes lead 438*a* (FIGURE 4*k*) negative and directs all the new feed controls to card readers B and C.

Similar operations may be repeated for card reader B about the opening of contact 510*b* (FIGURE 21*c*) and when relay 2B is de-energized provided push buttons 529 and 523 (FIGURE 21*a*) are operated again. Similarly, the energization of relays 9B and 8B (FIGURE 21*c*) and the holding of these relays (FIGURE 21*a*) is realized. Relay 7B (FIGURE 21*c*) in particular is de-energized, thus resetting contact 7B–1 (FIGURE 4*a*) and systematically switching triggers FAB and HBC (FIGURE 4*j*). Lead 438*b* (FIGURE 4*k*) goes negative, so that all the new feed control signals will now affect card reader C.

Similarly, relays 9C and 8C (FIGURES 21*a* and 21*d*) will be energized when the cards run out in card reader C. Relay R32 is then energized, thus causing all relays which are held through contact R32–*a* to be de-energized.

Ejection of the Cards Without Any Computation

Operating push button 530 (FIGURE 21*a*) will cause relay R37 to be energized. Relay 11*a* (FIGURE 21*b*) for card reader A may be then energized when contact 2A–2 has been turned off, i.e., when the cards have been removed from the hopper. Contact 11A–1 controls clutch magnet 526*a*, whereas contact 11A–3 interrupts the transmission of the pulses from contacts C11A, C12A. Under the same conditions, contact R37–*d* (FIGURE 4*m*) interrupts feeding to cams C1A, C1B, C1C.

Stacker Control

Connections made, for example, from the hubs generally referenced 494, 495, 496, 497 (FIGURE 4*l*) and directed towards hubs 531*a* or 532*a* (FIGURE 21*b*) for card reader A, permit the control of one of relays 12A or 13A. Magnet 533*a* controlled either on the closing of cam contact C13A or on the closing of cam contact C14A permits the cards to be directed towards the second or the third of stackers 54 (see FIGURE 3).

While the invention has been particularly shown and described with reference to preferred embodiments thereof, it will be understood by those skilled in the art that the foregoing and other changes in form and details may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. In a data processing machine, a plurality of card feeds, first and second storage units for each of said card feeds, means for entering data from successively fed cards from said card feeds into the respective ones of said first and second storage units, a program unit, a comparison unit under control of said program unit for comparing selected data from said storage units, auxiliary storage units for storing the results of said comparisons, and means under control of the results of said comparisons for selectively controlling said card feeds and for altering the control exercised by said program unit on said comparison unit.

2. Apparatus according to claim 1 wherein said program unit includes means for selectively establishing priorities among said plurality of cards.

3. Apparatus according to claim 2 wherein said program unit further includes means for selectively establishing priorities for said card feeds in accordance with the condition of the cards fed.

4. Apparatus according to claim 2 wherein said program unit further includes means for eliminating comparisons between certain fields under predetermined conditions.

5. Apparatus according to claim 2 wherein said comparison unit includes controls for selectively altering the type of comparison performed.

6. Apparatus according to claim 3 wherein said first and second storage units are scannable magnetic card devices adapted to deliver characters serially.

7. Apparatus according to claim 3 wherein said program unit includes operator controllable means for changing the selective control exercised by said program unit.

8. In a data processing machine, a plurality of record feeds, first and second storage units for each of said record feeds, means for entering data from each record feed successively into the corresponding ones of said storage units, a program unit, a comparison unit under control of said program unit for comparing selected data from said storage units, auxiliary storage units for storing the results of comparisons made in said comparison unit, and means under control of said auxiliary storage units for selectively controlling the operation of said card feeds and for altering the control exercised by said program unit on said comparison unit.

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