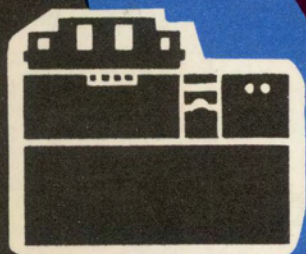


# IBM



• READING BRUSH • CONTACT ROLL • PUNCH • ESCAPEMENT • SENSING PIN • DOG • CLUTCH •

## FUNCTIONAL UNITS



# IBM<sup>®</sup>

Customer  
Engineering  
Manual of  
Instruction

## FUNCTIONAL UNITS

Nachdruck von "FUNCTIONAL UNITS"(US Form 225-6135-1)  
als Lehrbuch für den TECHNISCHEN AUSSENDIENST zum Studium  
der englischen Sprache.

Hierzu in deutsch "Grundelemente in IBM-Lochkartenmaschinen"  
(IBM Form 59 020).

Ausgegeben an: .....

Adresse: .....

.....

.....

Bei Verlust dieses Buches bitten wir den Finder um Rückgabe

# CONTENTS

PREFACE	5	TYPE 24 SPACING	42
<b>CARD FEEDING AND SENSING</b>		DIGIT-BY-DIGIT PUNCHING	42
		Type 513 Punch Selection and Operation	42
CARD FEED UNIT	8	<b>CLUTCH MECHANISMS</b>	
COLUMN-BY-COLUMN FEED	9		
Card Feed Knife	9		
Feed Throat	9		
Feed Rack	10	Clutch Types	45
Card Stacker	11		
Card Feed Unit	13	<b>FRICTION-DRIVE CLUTCHES</b>	45
DIGIT-BY-DIGIT FEED	13	Friction Discs	45
Feed Knives	13	Two Speed Clutch	45
Feed Throat	13	Helical Spring Drive and Clutch	46
Hopper Guide Posts	14	Type 24 Helical Spring Clutch	47
Hopper Side Plates	14	Shoe-Type Clutch	47
Feed Rolls	14	Magnetic Clutch	48
STATIC READING FEED	16	Clutch Construction	48
Feed Unit of the 407	16	<b>POSITIVE DRIVE CLUTCHES</b>	49
CARD SENSING	17	Pawl and Square-Tooth Ratchet	49
Card Reading of the 407	19	Single Tooth Ratchet	52
Brush Tracking	20	Multi-Tooth Ratchet Clutch	52
Brush Tension	21	Saw-Tooth Ratchet	53
Brush Position	21	Face Ratchet Clutch	54
TIMING	22	<b>COMMUTATION AND CONTROL</b>	
Cycle Definition	22		
Cycle Point	22	<b>RELAYS</b>	55
Degrees	23	Duo Relay	55
Knife Timing to Obtain Proper Reading	25	Wire Contact Relay	56
Stacker	25	Latch Type Wire Contact Relay	59
PIN SENSING	32	High Speed Relays	59
Dual Pin Sensing	33	Permissive Make Relays	59
Star-Wheel Sensing	34	<b>CAM-OPERATED CONTACTS</b>	61
MARK SENSING	34	Rocker Arm Type	61
PREVENTIVE MAINTENANCE	35	Unitized Rocker Circuit Breaker	61
Cleaning	35	Plunger Type	62
Lubricating	35	Latching Plunger Type	62
Checking	35	High Speed Plunger Type	63
<b>PUNCHING MECHANISMS</b>		Spring Blade or Strap Type	64
		Circuit Breakers	64
Punch Control	36	<b>CAM CONTACTS AND RELAYS IN A TYPICAL CIRCUIT</b>	65
Punch Requirements	36	Circuit Design and Analysis	66
Punching Sequence	36	Timing Chart	68
COLUMN-BY-COLUMN PUNCHING	36	Sequence Chart	68
Type 31 Punch Selection	36	Function Charts	68
Type 31 Punch Operation	37	<b>COMMUTATORS AND EMITTERS</b>	71
Type 31 Spacing	39	Digit Emitter	71
Type 24 Punch Selection	39	Digit Selector	72
Type 24 Punch Operation	41	Selection Commutator	73
		Contact Emitter - Figure 132	73
		<b>CONTROL PANELS</b>	75



## ACCUMULATING MECHANISMS

Principles of Addition	78
Mechanical Principles - Type 402 Counter	78
Counter Start	79
Counter Stop	79
Add Wheel Detent	80
9-10 Contact and Cam	80
Counter Emitter	82
Counter Chart	82
Counter Operation	82
Carry Operation	85
Timing	86
<b>PRINCIPLES OF SUBTRACTION</b>	87
Subtraction - Type 405 Machine	88
Counter Operation - Subtraction	88
Sign Indication	90
Subtraction - Type 402 Machine	91
Counter Coupling	92
Read Out and Reset	92
<b>COUNTER OPERATION SUMMARY</b>	94
Adding	94
Carrying	94
Subtracting	94
Read Out and Reset	94
<b>RATCHET TYPE COUNTER</b>	94
Mechanical Principles - Type 407 Counter	95
<b>UNIT TYPE COUNTER</b>	104
<b>VACUUM TUBE COUNTER</b>	105
Number Systems	105

## PRINTING MECHANISMS

Printing Systems	107
Serial Printing	107
Parallel Printing	107
<b>TYPE 402 PRINTING MECHANISM</b>	109
Numerical Type Bar	109
Type Bar Synchronism	109
Numerical Type Bar Bail Assembly	110
Hammer Unit Assembly	113
Variable Split Arm	113
Hammerlock Assembly	115
Alphamerical Type Bar	115
Zone Bar and Setup Mechanism	118
Zone Control Drive Unit	119
Zone Unit Assembly	119
Zone Cam 1 - Figures 206 and 207	119
Zone Cam 2 - Figure 208	123
Zone Cam 3 - Figure 208	124
Zone Cam 4 - Figure 209	124
Sequence of Operation	124

Alphamerical Type Bar Bail Assembly	124
Hammer Unit	125
<b>TYPE 407 PRINTING MECHANISM</b>	127
Type Wheel	128
Print Magnet	128
Print Clutch Latch	129
Variable Speed	129
Type Wheel Selection	130
Analyzer (Mechanical Delay) Unit	135
Analyzer Cams and Pawls	136
Selector Clutch	136
Analyzer Operation for Printing a 1	138
Operation for Printing a 7	139
Print Cam Operations (Figure 230)	140
Operations for Printing a G	141
Print Clutch Latch Cam	142
Magnet Armature Knockoff Cam (Figure 231)	142
Trip Cam	142
Rebound Lever (Figure 233)	143
Selector Clutch Gear Detent (Figure 234)	144
Selector Clutch Latch Pressure Bail (Figure 235)	144
Type Wheel Contact (Figure 236)	145
Zero Print Control Contacts (Figure 237)	146
<b>TYPE 421/421-9 PRINTING MECHANISMS</b>	200
Alphamerical and numerical Type Bars	200
Arrangement of Characters in the Type Bars	200
Printing Mechanism	202
Variable Speed Unit	202
Horizontal Drive Shafts	202
Alphamerical Printing Plates	202
Alphamerical Printing Plates, Functional Principles	204
Printing of a Letter by an alphamerical Type Bar	207
Printing of a Zero by an alphamerical Type Bar	208
Printing of a Symbol by an alphamerical Type Bar	208
Numerical Printing Plate	208
Printing of a Figure by a numerical Type Bar	209
Printing of a Symbol by a numerical Type Bar	209
Printing of a Zero by a numerical Type Bar	209
Restoring Bail Assembly	210
Restoring Lever Locking Unit	210
Restoring Lever Dampers	210
Hammer Unit	210
<b>TYPE 552 INTERPRETER PRINTING MECHANISM</b>	147
552 Type Bar	148
Print Unit	148
Zoning and Selecting Principles	150
Print Magnet Unit	154
Printing Plungers and Pressure Bar	155
<b>TYPE 557 PRINTING MECHANISM</b>	156
Zone Unit (Figure 252)	156
Numerical Selection	156
Triggers and Trigger Knockoff Cam (Figure 254)	159
Digit Slide Cam	159
Digit Slide Bail	159
Digit Slide Spring Relief Bail	159
Rack Lifter Arms (Figure 254)	159
Print Aligner (Figure 254)	159
Zero Contacts (Figure 254)	160

Print Gate (Figure 255)	160	Magnetic Core Storage	185
Print Unit (Figure 255)	160	Basic Capacitor Storage Cell	187
Step-by-Step Review of Printing Operation	160		
		<b>CALCULATING MECHANISMS</b>	
<b>TYPE 26 CARD PUNCH PRINTING MECHANISM</b>	162		
Code Plate	163	<b>TYPE 602A CALCULATING PUNCH METHOD OF</b>	
Print Interposers	165	<b>CALCULATION</b>	189
		Arithmetic Principles of Multiplication	189
<b>STORAGE UNITS</b>		<b>COUNTER OPERATION DURING MULTIPLICATION</b>	191
Relay Storage	168	X1 Operation	191
Mark Sense Delay Unit	169	X2 Operation	191
Type 602A Storage Unit	170	X3 Operation	193
Type 77 Storage Unit	172	Arithmetic Principles of Division	193
Type 77 Comparing	174		
Storage Unit Testing	176	<b>604 ELECTRONIC CALCULATOR METHOD OF</b>	
Type 407 Storage Unit (Figure 287)	178	<b>CALCULATION</b>	195
Magnetic Drum Storage	181	Electronic Calculator Method of Multiplication	195
Magnetic Tape Storage	183	Electronic Calculator Method of Division	196
		<b>ELECTRONIC COMPUTERS</b>	198





## PREFACE

IBM ACCOUNTING MACHINES can be classified to perform the following five functions: punching, arranging, accumulating, printing and calculating.

Each machine type is different in its construction, capacity and application; yet many basic units of the machines are common in their construction and in the operations which they perform. When the customer or prospective customer points out a need for a new machine to perform a new accounting operation, a design engineer is assigned to the project of developing such a machine. The engineer's knowledge of the basic units enables him to visualize quickly the overall design of the machine.

Because each unit is capable of performing some particular operation, such as moving the card, punching the card, reading the card, accumulating information or printing information, these may be studied as functional units by the student customer engineer.

The final machine design is a result of assembling the basic units which perform the mechanical work, connecting and controlling them by means of electrical circuits.

This manual is written with the objective of introducing the new customer engineer to the functional principles incorporated in the IBM machines and acquainting him with the terminology which is peculiar to the accounting machine industry.

By studying these mechanisms individually before being introduced to the completely assembled machine, the student is able to reduce his learning responsibilities to a series of small problems. Once the student has learned the need and the application he immediately can appreciate how the machine performs the required operations. He knows what units should be found in the machine and, in general, how they work.

Because of this advanced background, he is able to learn the circuitry of the machine more rapidly, and he has a greater appreciation of the need for care in making adjustments to the machine.

Through functional unit training, a better trained customer engineer is sent to the field with greater knowledge of his equipment.



**IBM**