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Contributing Editor

MANUAL INPUT DEVICES

Manual input to a computer or other data processing system is usually indirect, simply because the human and the machine operate at vastly different rates. Where large quantities of data are involved, it is more efficient and economical for the operator to translate the input information, off-line, onto punch cards, paper tape, or magnetic tape, which the system can then absorb at its own rate.

However, some means of direct manual input is still a necessity in most applications. It may take the dynamic form of real-time query or entry of transient information, or a more static form of setting up constants and operational parameters. The dynamic form of input is generally via a keyboard unit such as a typewriter, which may or may not also produce hard copy for operator use. (Another approach to dynamic input-output, the light-pen/CRT technique, is presently in the development stages. For a description of one technique, see the article on the Rand Tablet in the April 1965 issue of *COMPUTER DESIGN*.) Static input is more often generated by means of manually-preset thumb-wheel switches.

This Product Reference File article surveys currently-available keyboards and thumbwheel switches and outlines the different operating approaches taken by the manufacturers.

Input Typewriters

An input typewriter is a keyboard unit which produces hard copy in ordinary typewriter fashion and at the same time generates electrical output signals that can be fed directly into an EDP system. Some form of buffering is usually required because of timing and noise problems. Any input typewriter is essentially a *typewriter*, with all the high current drain and gross electromechanical movements required to print out copy character-by-character. The coded electrical outputs are something of an afterthought and tend to be contaminated with signal noise. It's a trade-off situation — if the user must have page copy, he must accept the problems.

Individual manufacturers occasionally adapt existing typewriters as input units for a special application. Such adaptation usually takes the form of accepting the signals generated by the typewriter as a by-product of its own operation (e.g., the 7-bit code from IBM solenoids), and re-coding these signals into the required pattern at the required levels.

Manufacturers' input typewriters described below involve internal modifications to the typewriter itself, resulting in a product-line device. One company, Friden, Inc., mentioned below, does not really

PRODUCT REFERENCE FILE

Background concepts, selection criteria, and application information on a class of products used by digital design engineers.

have an input typewriter, but their Flexowriter finds widespread use as one. A summary of the major characteristics of manufacturers' models appears in Table 1.

Manufacturers' Units

Connecticut Technical Corp., Hartford, Conn. — This company's input-output typewriter, shown in Fig. 1, was described in the December 1963 issue of **COMPUTER DESIGN**. Originally designed for use with military Fielddata computers, this unit offers either coded or uncoded output signals. Each typewriter key operates a bifurcated precious metal switch for direct output. For coded outputs, the switch signals are applied to an internal diode matrix. Maximum input rate is 9.3 cps.

Connecticut Technical has also developed a special input typewriter for graphic arts applications. This unit has 19 extra function switches, wired in, in addition to extras on the keyboard. This particular machine is a transmit uncoded partial receive unit and contains at least two unusual functions in addition to the normal standards, namely (1) the operation of the carriage return key furnishes electrical output resulting in the emptying of the computer buffer store into a punched tape with the computer in turn operating the carriage return mechanism,

TABLE 1 • Input Typewriters					
Mfgr.	Model	Chassis	Technique	Code	Rate
Connecticut Technical Corp.	— — — —	Underwood	Electromech.	Direct	9.3 cps
Invac Corp.	TTR 100	RemRand	Photoelectric	8 bits	10 cps
	TTR 200	Selectric	Photoelectric	8 bits	15.5 cps
Soroban Engineering	Computer-iter	IBM	Electromech.	8 bits	10 cps

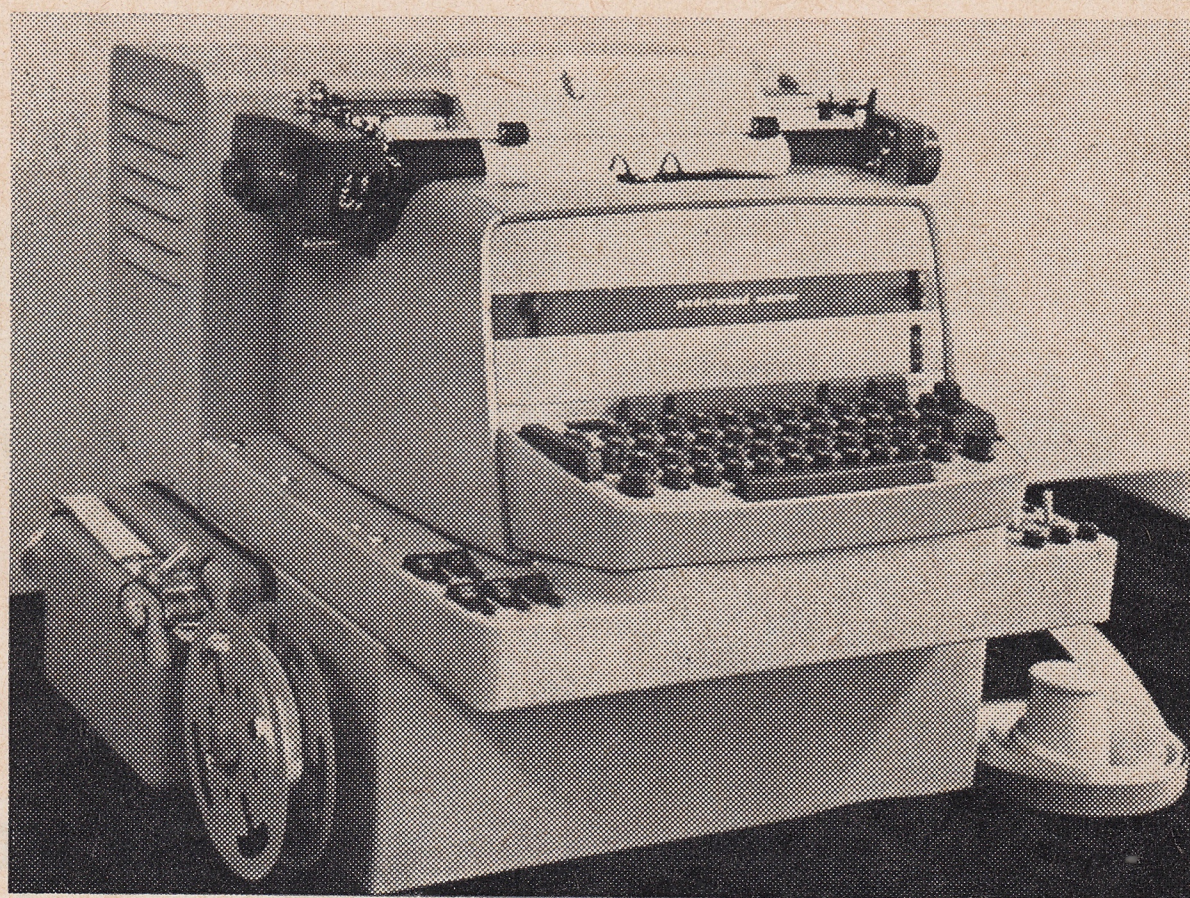


Fig. 1 Connecticut Technical Corp.'s input typewriter incorporates a paper tape punch and reader and input-output communications interface. The keyboard is shiftless except for certain "Fielddata" codes.

anism, and (2) a back space character strike-out system, wherein operation of the back space results in an electrical signal clearing the last character from memory while the

typewriter action, controlled from the computer, back spaces one space and automatically strikes a square around the deleted character from a non-escaping key.

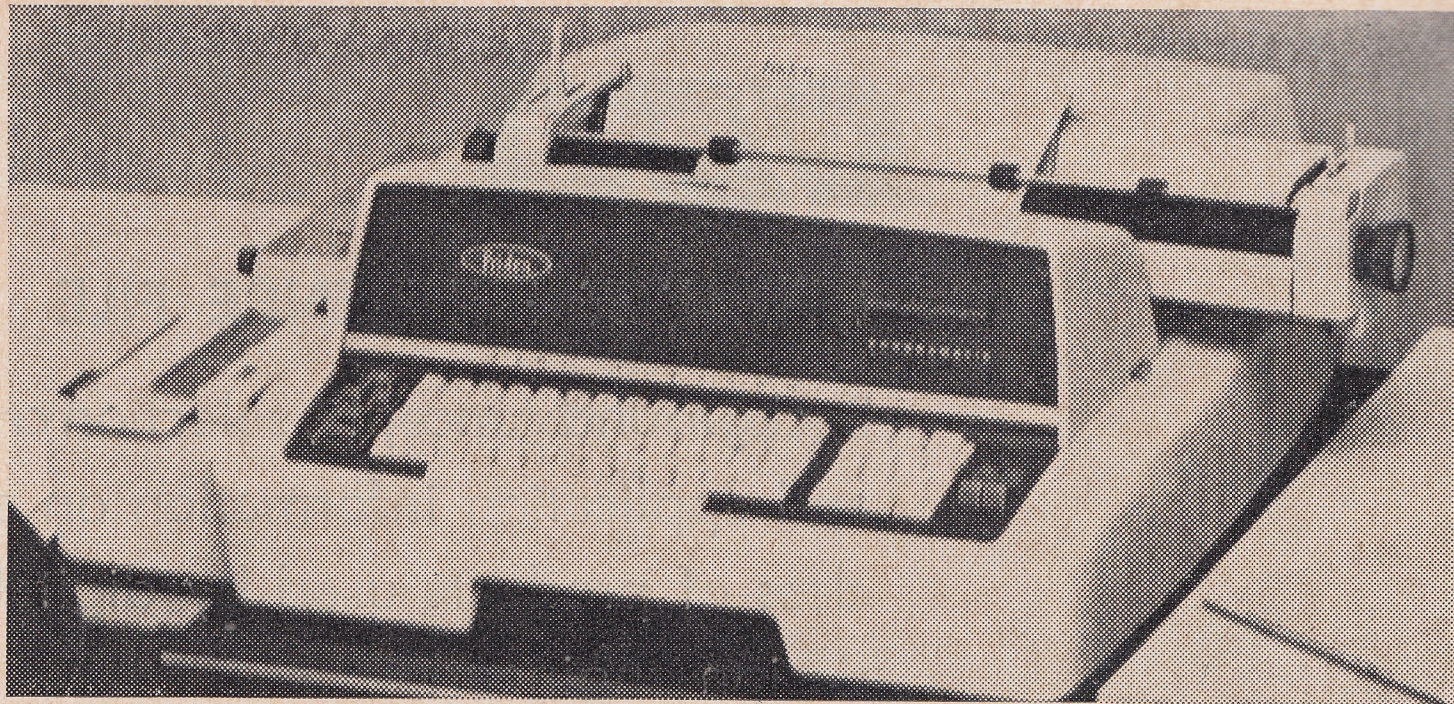


Fig. 2 Friden's new Model 2201 Flexowriter.

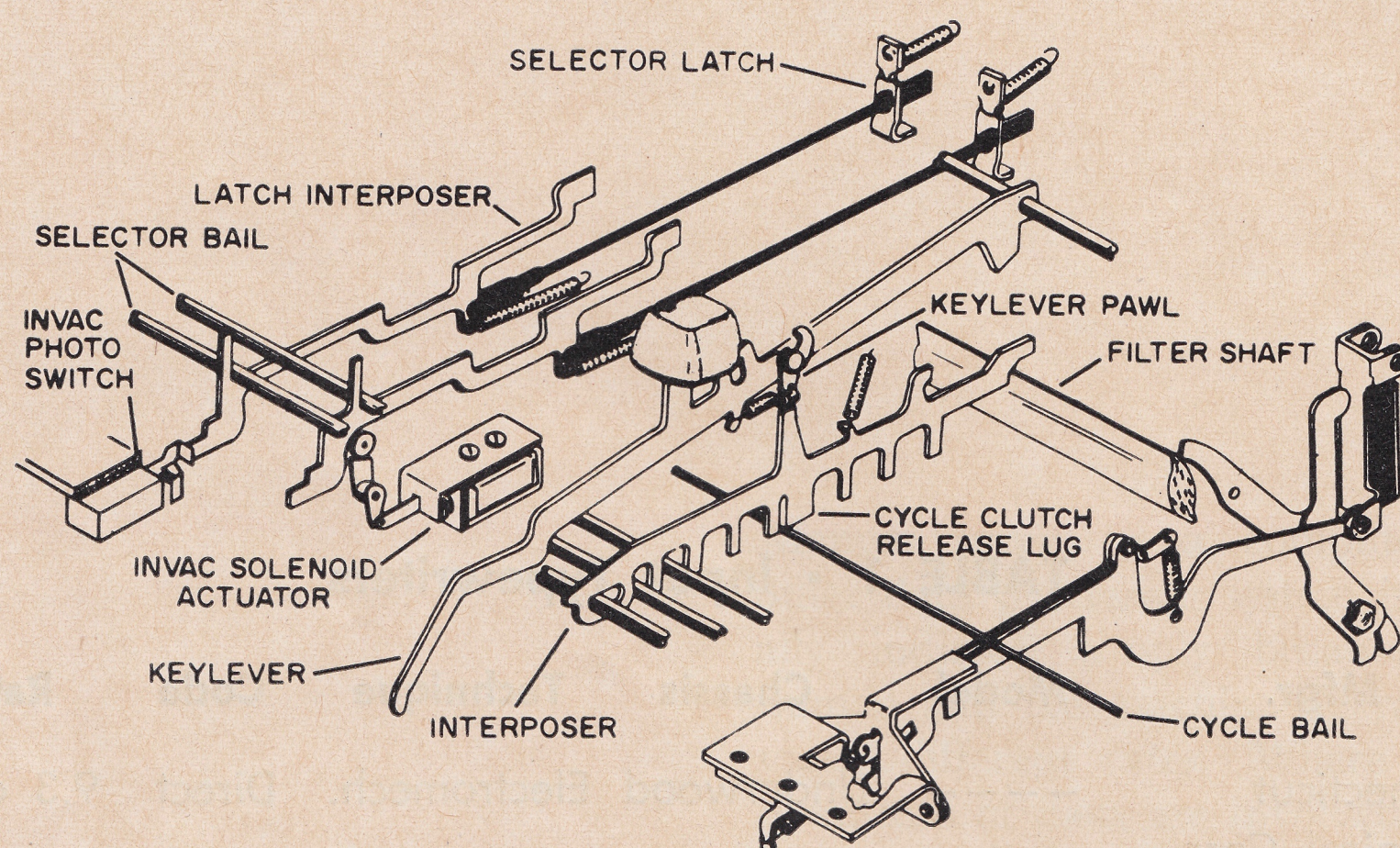


Fig. 3 Invac Corp's Series 200 input typewriter, which uses an IBM Selectric chassis, combines mechanical and photo-electric techniques. Pressing a data key actuates a selector interposer, which engages the selector bails that operate the latch interposers. A bank of six photoswitches senses the movement of the latch interposers to generate electrical signals, which are amplified to produce the output code. Rotation of the print cycle shaft in the unit generates the strobe signal after the photoswitch data has become available.

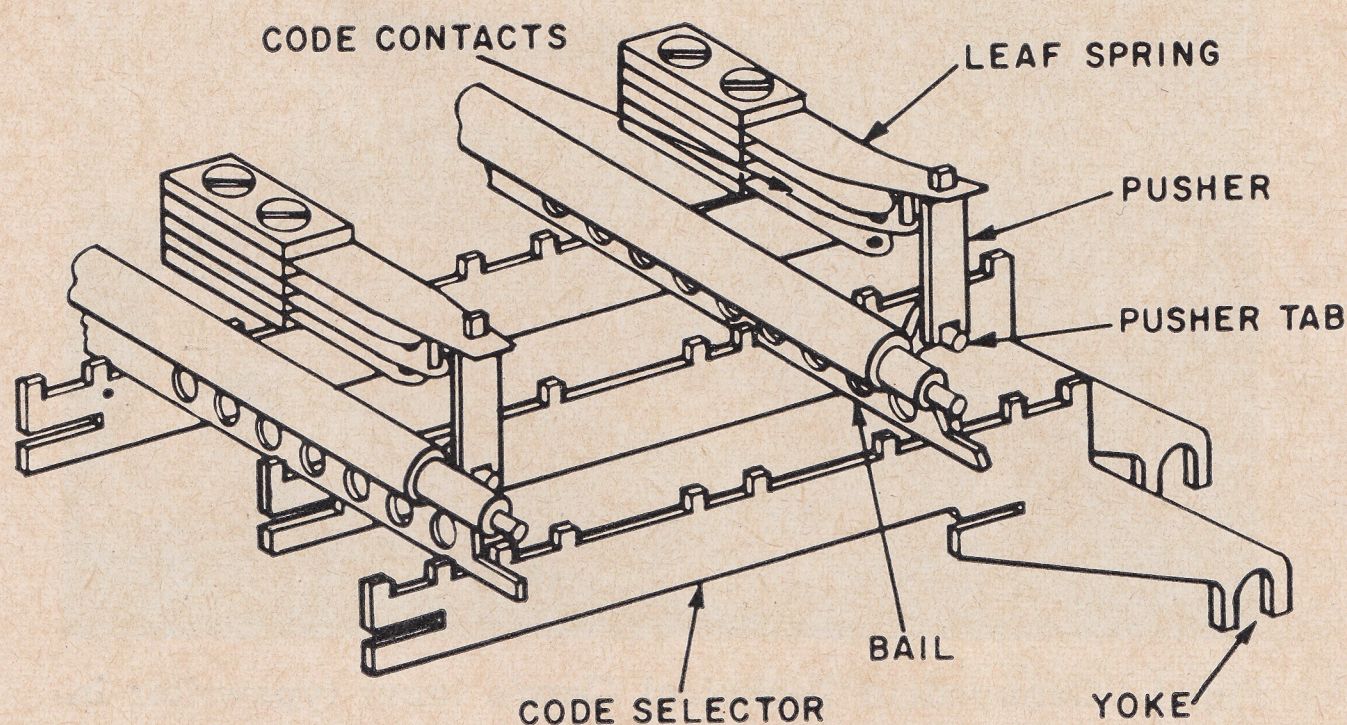


Fig. 4 Soroban Engineering's Computeriter uses a mechanical encoder. The yoke of the code selector fits over a pin projecting from the side of its associated typewriter cam on the keyboard. Pressing the key pulls the code selector, whose notched teeth engage to edges of selected bails, to cause a rocking motion in those bails. A tab projecting from the bail drives a contact pusher to generate one bit of the parallel output code. When the cam releases, springs return the bails and code selectors to normal position.

Friden, Inc., San Leandro, Cal. — Still going strong as a workhorse input unit, even though it does not provide direct input, Friden's Flexowriter is essentially a heavy-duty electric typewriter which has been successfully adapted for operation as a remote-controlled (e.g., computer output) device, a paper tape punch control, a card punch control, and an automatic typewriter capable of combining tape and card data with data entered manually by the operator. It is this flexibility which accounts for the continued popularity of the Flexowriter, despite certain manifest disadvantages as a manual input device, and increasing competition. When used as an input device, the Flexowriter simply produces a perforated tape, which must then be read into the system by a separate reader. The new Model 2201 Flexowriter (Fig. 2) is a re-styled, somewhat faster and quieter machine.

Invac Corp., Waltham, Mass. — By adding mechanical encoders and photoelectric switches, Invac has adapted both IBM Selectric and Remington Rand Model 300 electric typewriters as input devices. Operation of both types of units can be illustrated by Invac's Series 200 Typewriter Transmitter/Receiver, which uses the Selectric "golf-ball" chassis. The Selectric has a spherical, character-embossed print head which moves along the printing line and is rotated in two planes to select the character to be printed. In the IBM unit, the seven solenoids (six control, one check) which drive the print head are brought out as signals. In the Invac Series 200, a bank of six photocells (see Fig. 3) sense the mechanical position of the keyboard interposers to produce output signals. Function codes are derived by encoding outputs in a diode matrix.

Soroban Engineering, Inc., Melbourne, Fla. — This company's "Computeriter" is an IBM electric typewriter chassis with a mechanical encoder (see Fig. 4). Each data key generates an output code of up to eight bits from leaf-spring contacts, and a common contact is available for use as a strobe. Machine function outputs are provided by relay contact closures. Maximum operating rate is 10 cps.

Input Keyboards

Recent years have seen an increasing number of keyboard-only units for applications which do not require printed copy along with the input signals. These units, freed of the necessity of driving relatively massive mechanical printing elements, are simpler, smaller, and generate less electrical noise than input typewriters.

Many manufacturers of pushbutton switches occasionally build up such switches into special-purpose keyboard control panels. However, this article treats only complete keyboard units designed for rapid manual data input operation in the manner of a typewriter.

Most manufacturers of input keyboards have taken some pains to provide a key touch comparable to that of units with which the operator is already familiar (the IBM electric typewriter is commonly chosen as a model). Table 2 lists the major characteristics of manufacturers' models. Such units, described below, range from almost purely mechanical to almost purely electronic devices.

Manufacturers' Units

Burroughs Corp., Pasadena, Cal. — Burroughs uses a small decimal keyboard, the Model 410, with its 205 computing system, and now offers it as a separate item with either 13 or 16 keys. Each key operates a single-pole double-throw switch whose closures are brought out directly.

Connecticut Technical Corp., Hartford, Conn. — The high-speed alphanumeric keyboard being produced by Connecticut Technical has been available in service test quantities for six months. Two versions have been initially produced to satisfy the requirements of the graphic arts industry. Each is capable of being furnished with up to 70 keys. A small standard 44-46 key alphanumeric unit is manufactured by the shortening of the transverse members. One version, shown in Fig. 5, furnishes electrical output for a justifying computer, the other is used in the preparation of tape for justifying computers. The keyboard is a motor-driven mechanical device with switch closure output. Present units

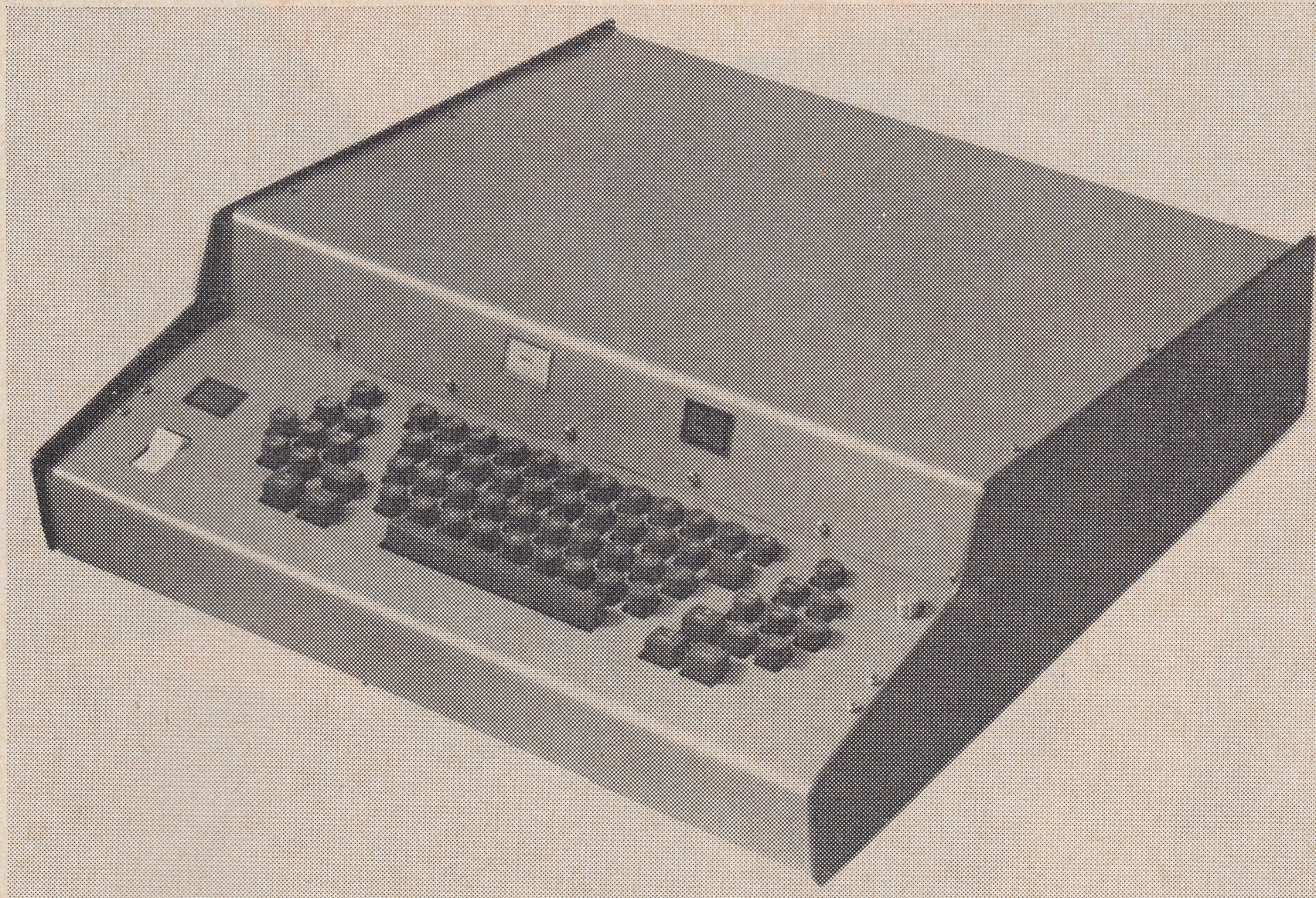


Fig. 5 Connecticut Technical Corp.'s Model KB-100 alphanumeric keyboard.

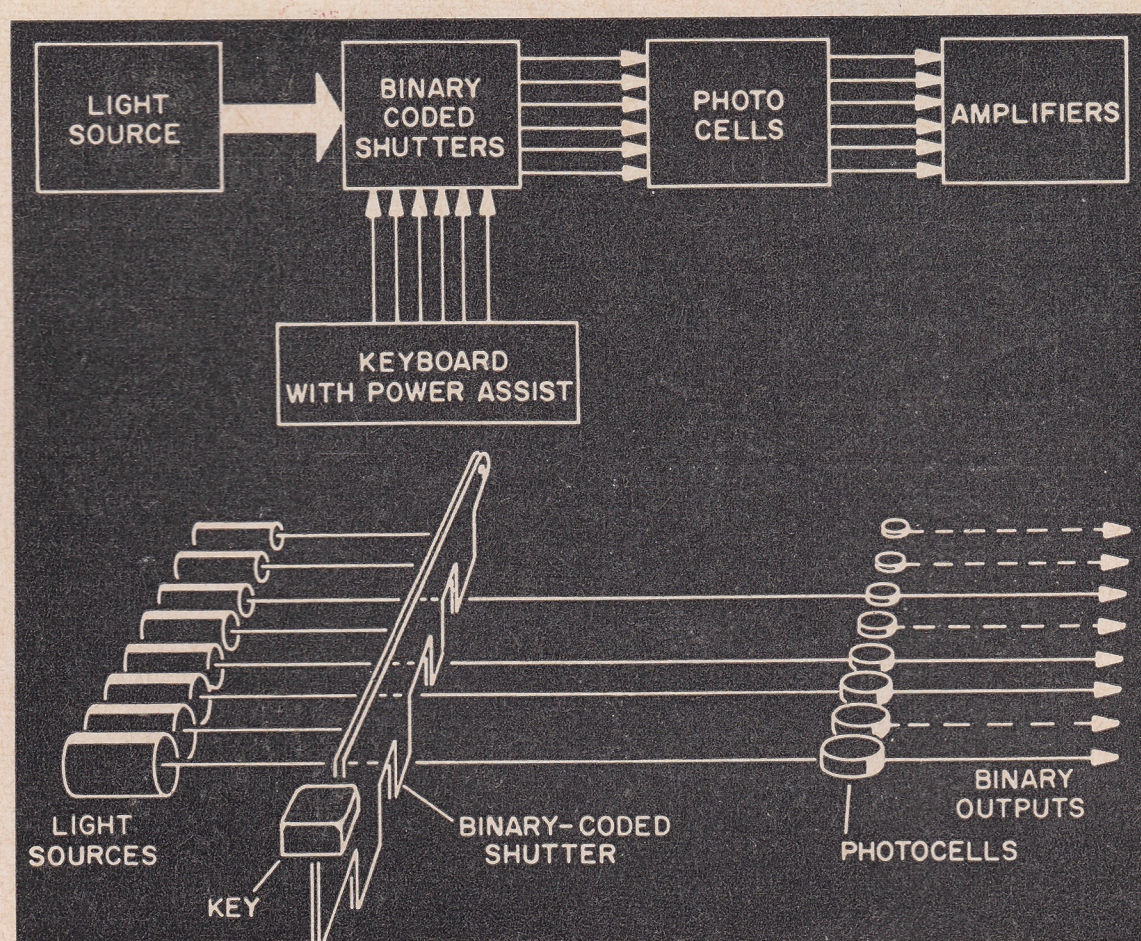


Fig. 6 In the Invac PK-144 and PK-164 keyboards, pressing a key lowers a coded shutter between a bank of light sources and associated photocells, causing a resistive change in the selected photocells. Amplifiers convert the photocell signals into the output code. Operation of the coded shutter also energizes two solenoids which operate a common bail to lock the key lever and shutter while a strobe signal is generated.

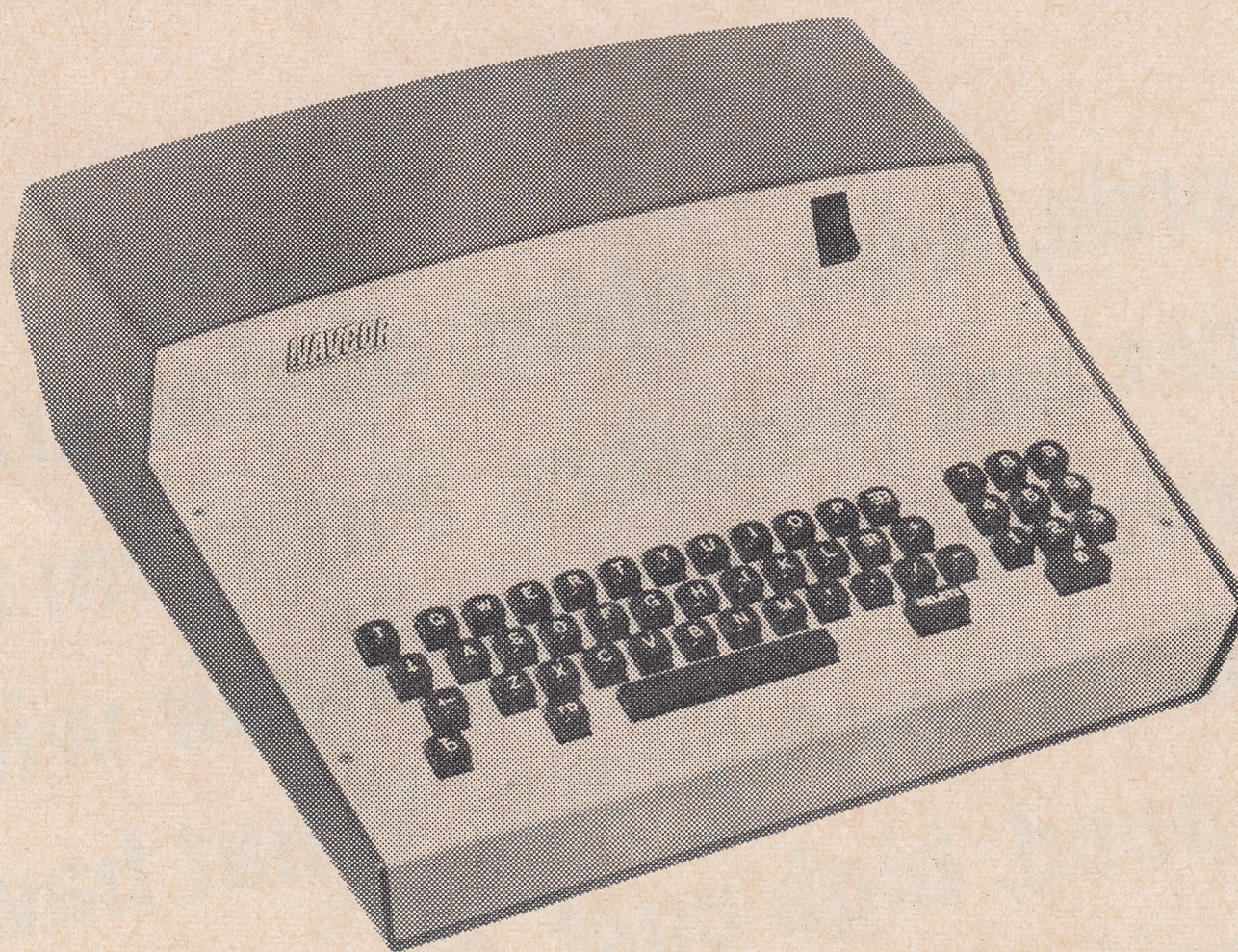


Fig. 7 Navigation Computer Corp.'s Series 1050 keyboards are available in both numeric and alphanumeric versions. Operation is almost entirely electronic.

can provide eight channel code plus strobe while simultaneously furnishing two form A non-coded closures to identify the key depressed. The

keyboard without the punch has an average rate capability in excess of 20 characters per second. Its instantaneous two character rate capability

is 50 character per second. When integrated with a 20 character per second punch, the input rate is timed to 19 char./sec. average to preclude the need for electronic feed back interlocking. The touch is adjustable at the keyboard from 2½ to 6 oz. It is fully interlocked mechanically and has a single character storage capability. The code output switches are gated by a bounce free strobe, and can transfer 48 volts at 1 amp resistive. The data pulse is factory adjustable up to 25 ms. The strobe is adjustable up to 20 ms and is positionable with respect to data pulse. The keyboard's mechanical interlock can be "locked up" remotely by solenoid actuation. Power switches and lights and "state" indicator lights for upper and lower case, etc., are available.

Invac Corp., Waltham, Mass. — Invac's PK-144 and PK-164 keyboards combine photoelectric encoding with solenoids for power assist and strobing purposes. As illustrated in Fig. 6, each key drops a coded shutter between a bank of light sources and a facing bank of photocells to produce the code. The shutter is locked in place until after the strobe signal. The Model PK-144 has 45 alphanumeric keys; the Model PK-164 has 63 alphanumeric keys. Both include a space bar, and the PK-144 can be fitted with additional function keys.

Navigation Computer Corp., Norristown, Pa. — Navcor's 1050 Series keyboards (Fig. 7) are completely modular units which can provide a variety of code and control outputs, according to the requirements of the user. Each key incorporates a magnetically-actuated sealed switch which is available with either direct contact closure or pulse output. The keys are mounted directly on an etched-circuit base panel beneath the keyboard panel. An optional diode matrix board plugs in beneath the base panel to produce coded outputs of up to 15 bits for each key. Still another etched-circuit board can be plugged in (forming a third layer to the sandwich) to provide timing, blanking, electronic interlock, and similar functions. Flip-flop buffer storage is still another option. A further option provides

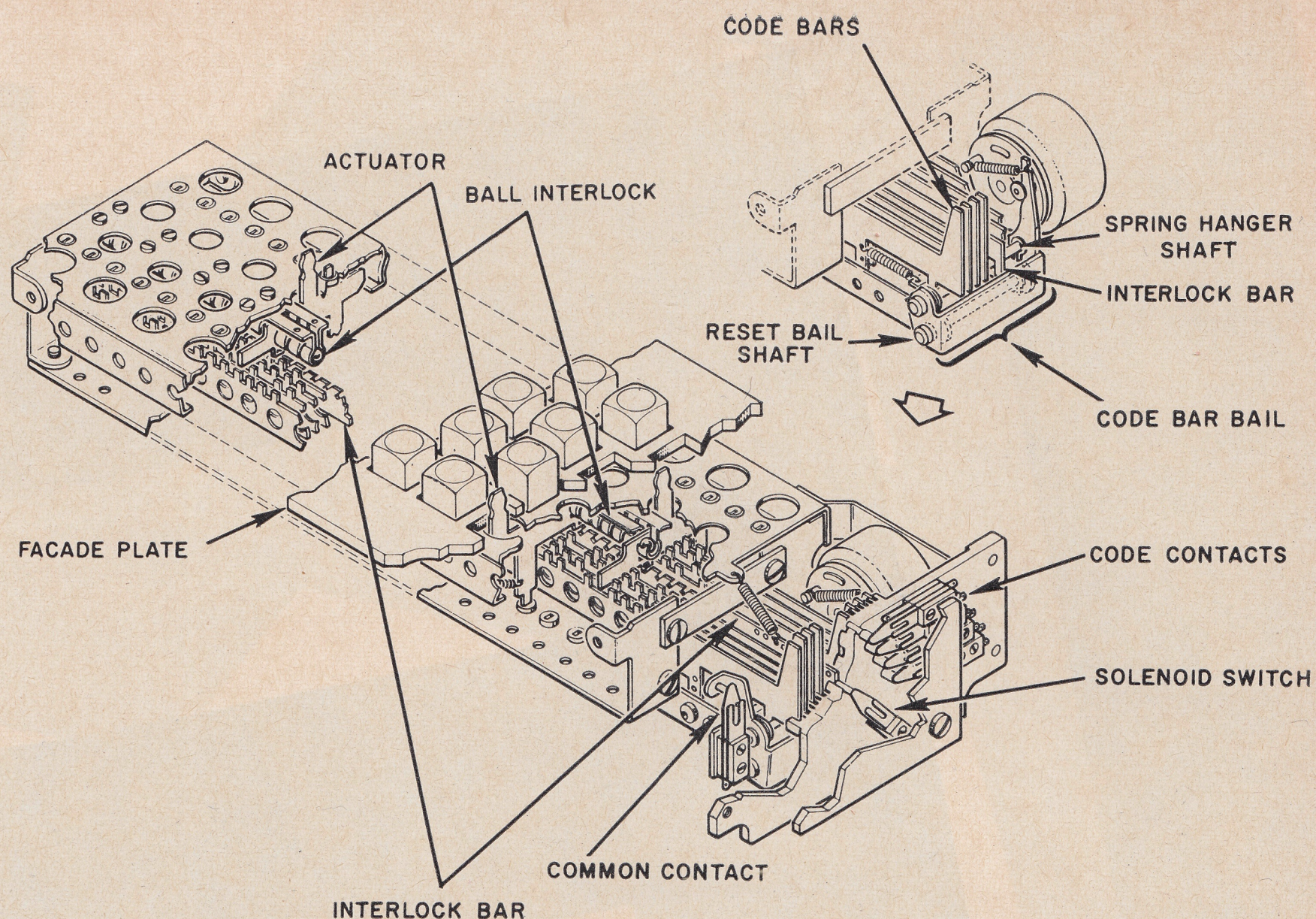


Fig. 8 In the Soroban Series FK keyboards, pressing a key locks all code bars except those directly involved in producing the desired output code, and also actuates a solenoid, which works through a bail to allow the selected code bars to close the code contacts. After the code contacts close, a common strobe contact is operated. A caged row of ball bearings prevents simultaneous operation of more than one key.

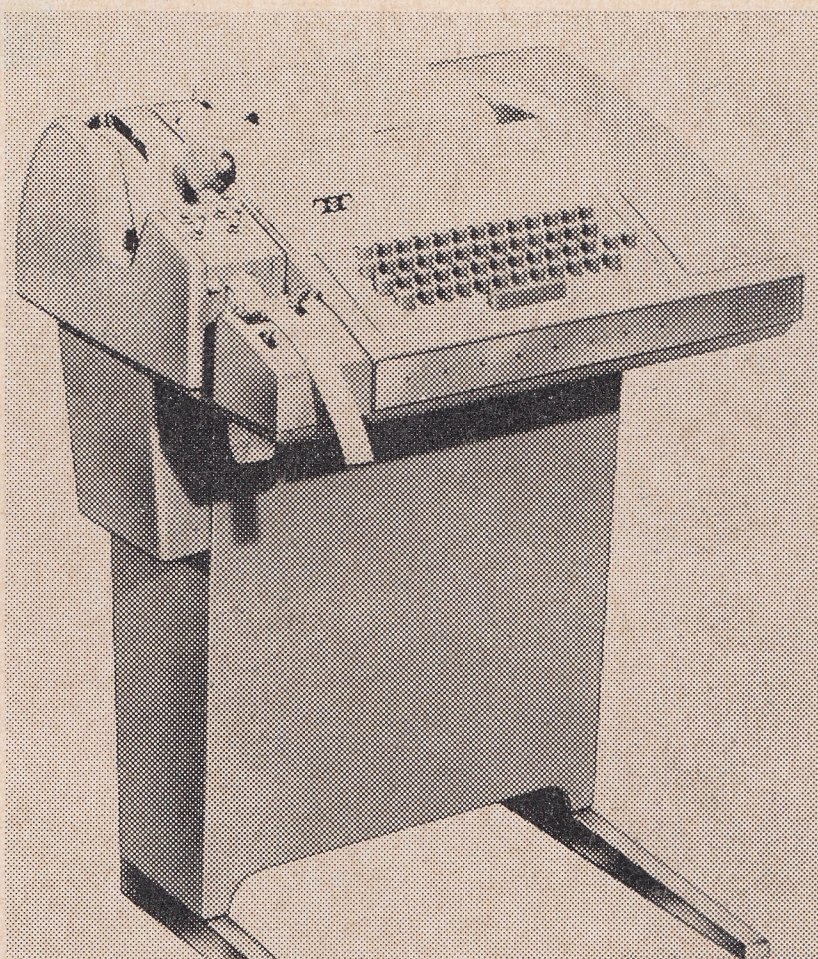
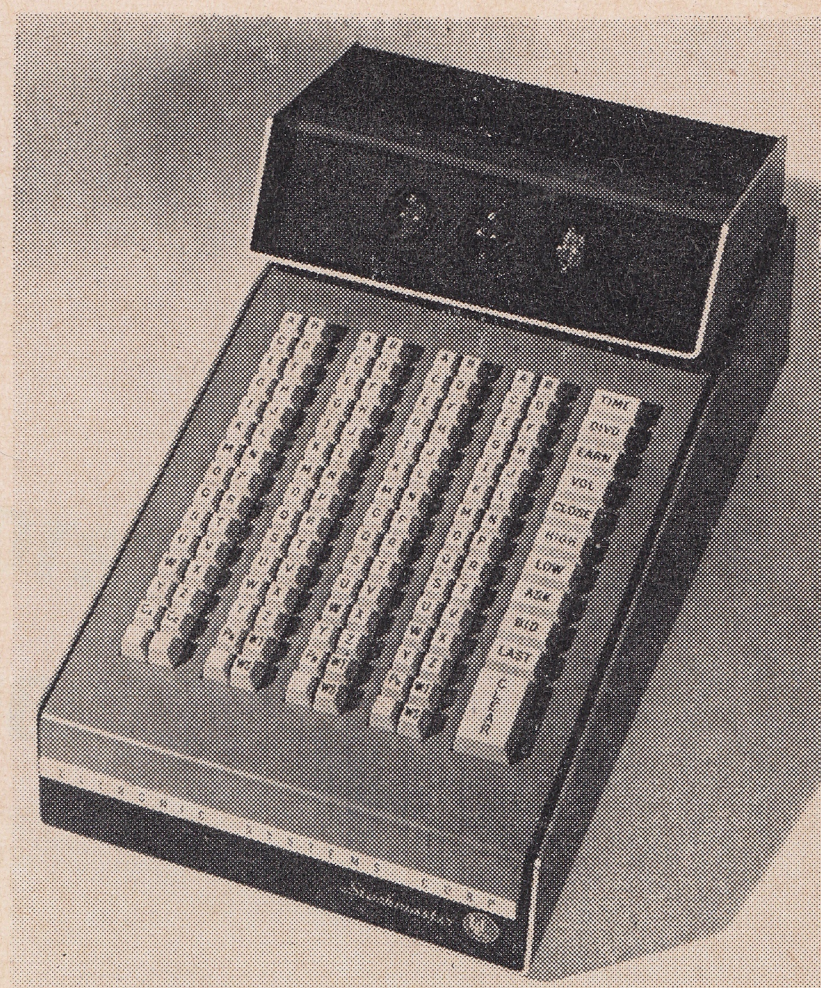


Fig. 9 Teletype Corp.'s Model 33 Numeric Keyboard Automatic Send-Receive Set is one of their many data communication units that can be used for machine input.

Fig. 10 Ultronic Systems Corp's encoding keyboard with visual display.



automatic protection against both double strike and slur errors.

Soroban Engineering, Inc., Melbourne, Fla. — Soroban's Series FK keyboards (Fig. 8) are essentially mechanical devices using

spring-loaded code bars. Pressing a key triggers a solenoid which operates a bail to allow selected code bars to close contacts. Mechanical double-strike protection is included. Keyboards are available with up to 64 keys, including space.

TABLE 2 • Input Keyboards

Mfgr.	Model	Technique	Keys	Code	Comments
Burroughs Corp.	410	Electromech.	13, 16	Direct	—
Conn. Tech. Corp.	KB-100	Electromech.	70	8 bits	High-Speed unit
Invac Corp.	PK-144	Photoelectric	46	8 bits	Other codes
	PK-164	Photoelectric	64	8 bits	Available
Navcor	1050	Electronic	50	8 bits	Pulse, buffered, timing outputs
	1050N	Electronic	16	8 bits	
Soroban Engineering	FK	Electromech.	up to 64	8 bits	Up to 16 bits available on order
Teletype Corp.	—	Electromech.	52	Direct	Special purpose keys
Ultronic Systems Corp.	500	Electromech.	Unlimited	5 bits	Visual display
	600	Electromech.	Unlimited	Unlimited	Visual display

Teletype Corp., Skokie, Ill. — Standard teletypewriter models by Teletype Corp. are often used for machine input although they are primarily data communication sets. However, Teletype also offers self-contained 4-row alphanumeric keyboards that provide direct parallel-

wire entry of variable data into computers.

The standard Teletype sets are available with 3-row keyboards, 4-row keyboards, and numeric keyboards. Their Model 32 line contains 3-row keyboards that operate on 5-level Baudot code. Model 33

sets contain the 4-row keyboards that operate on standard ASCII code. All units are available with many different special purpose keys. Teletype's Model 35 sets are for heavy traffic loads. Model 33 Numeric Keyboard Automatic Send-Receive Set is shown in Fig. 9.

Ultronic Systems Corp., Pennsauken, N.J. — This company's encoding keyboards (see Fig. 10) will allow the input of combinations of any code through the use of either mechanical coding bars operating a miniature switch or a diode encoding matrix driven from reed switches actuated by permanent magnets. Ease of operation, rugged construction, high reliability, and flexibility of design are said to be the major features of these units. The keyboards are made with some visual indication of input format. It is accomplished by either the key remaining in its depressed position until cleared or by means of visual display. Prices average \$4 to \$8 per key, depending on coding requirements, visual display, keyboard layout, etc.

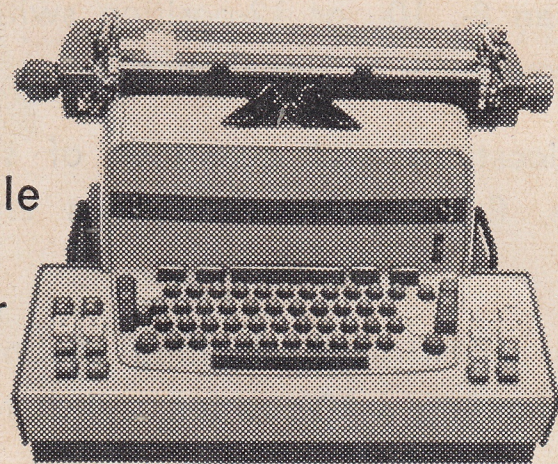
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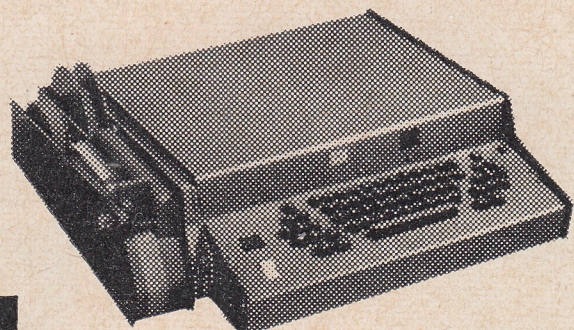
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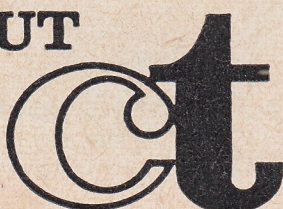


Model KB-100
Input-output computer typewriter
(Graphic Arts Computer Special)



Model KBP-100
Keyboard perforator

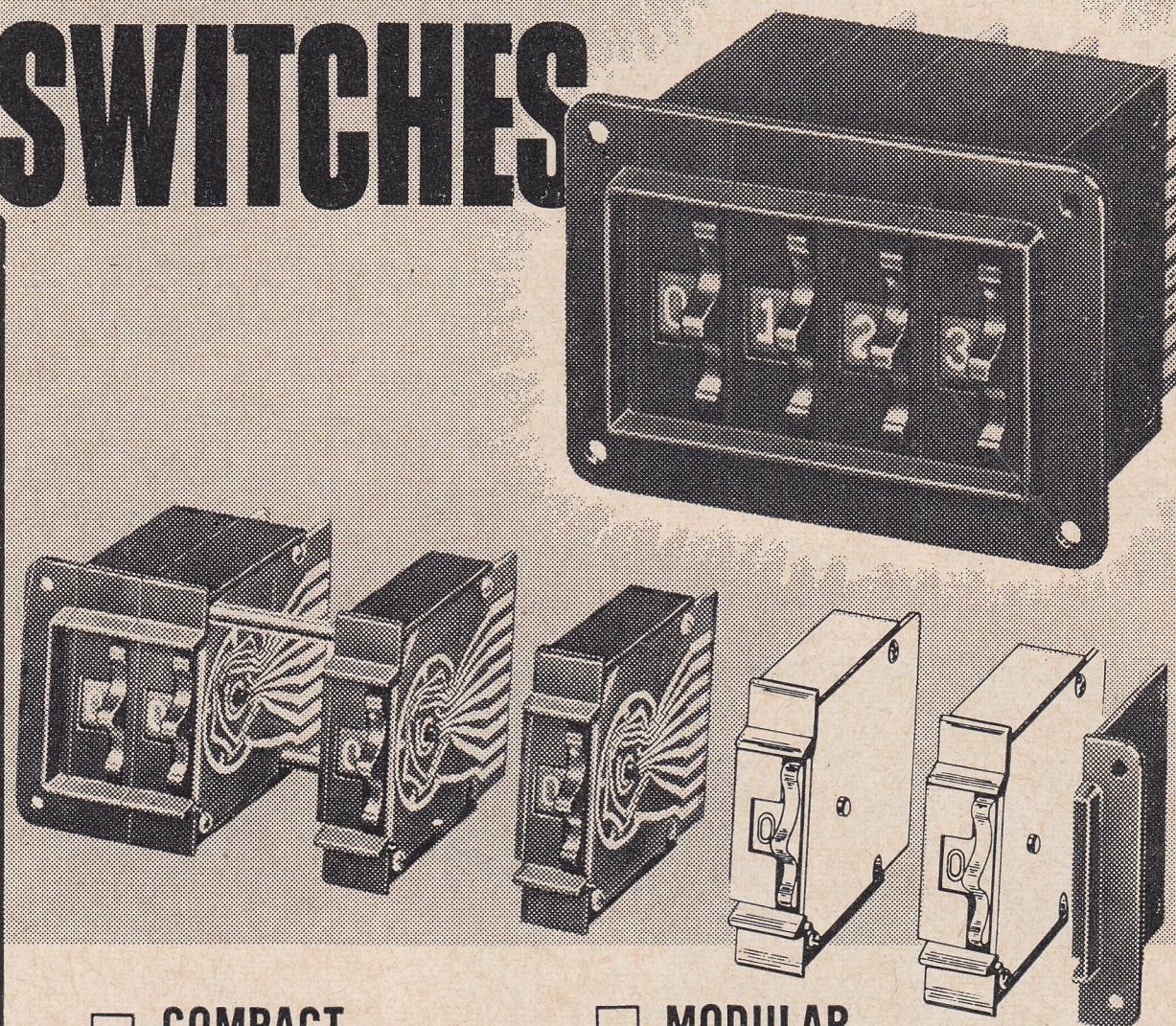
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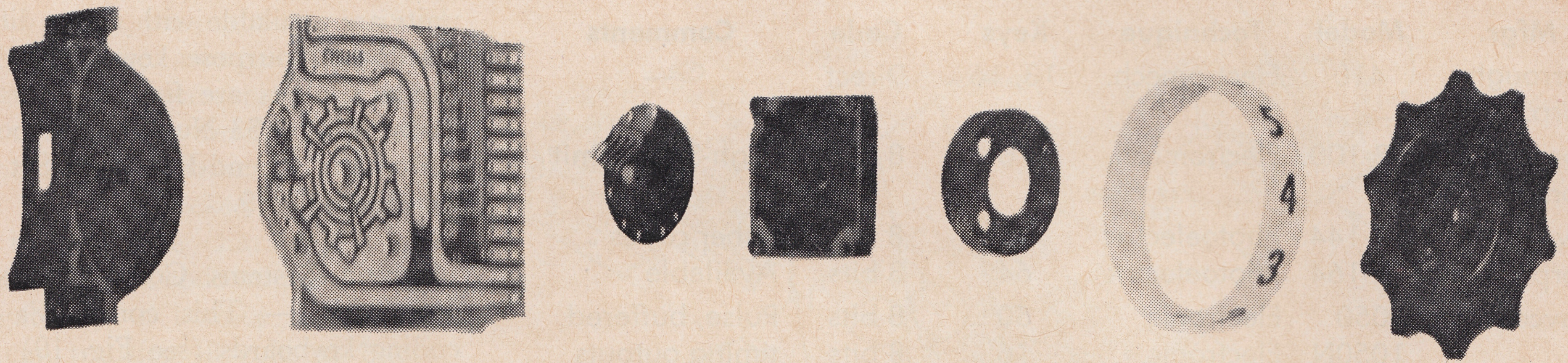


Fig. 11 Engineered Electronic Corp's Series 300 unit illustrates the major parts of typical thumbwheel switches.

Thumbwheel Switches

Thumbwheel switches can be categorized between rapid-fire keyboards and step-by-step pushbuttons, as far as versatility is concerned. They cannot be operated very rapidly, but each is capable of producing a variety of signals, and a full bank of these switches can represent virtually any condition required by the system. They are typically used in setting up data which must remain available to the system, but which must be changed by the operator from time to time — for example, constants for a computation or control process. A glossary of thumbwheel switch terms is given in Table 3.

A typical thumbwheel switch (Fig. 11) includes a rotor which is manually turned to a desired index position, and a detent mechanism which locks in the rotor and prevents hang-up between positions. Each index position is visually displayed on the front of the rotor (typically as a number), and also makes contact with brushes on the body of the switch. The brushes

are usually soldered to conductors on an etched-circuit card and so brought out to the output cable or connector. Stops are used to skip unused portions on the rotor. Spacers are used both to fill out a bank of switches to a desired length

and to divide, functionally, separate groups of switches (integrals vs. fractions, or days vs. months).

The etched-circuit card which provides the outputs may or may not include encoding capabilities. That is, it may indicate the position

TABLE 3 • Glossary of Thumbwheel Switch Terms

SWITCH COMMON: The input connection and wiring that remains active in all switching positions.

BRUSHES: Electrical conductors that transfer the current from the stator to the output lines.

STATOR: Conducting surfaces of the switch. Similar to the commutator in electrical rotating mechanisms.

SHORTING SWITCH: A switch type where contact is made for a new position before breaking contact with the previous position. Classified as "make before break" switch.

NON-SHORTING SWITCH: A switch type where contact is broken from one position before contact is made with the next. Classified as a "break before make" switch.

DETENT: Component that holds the switch at exact indexing positions; prevents hang-up between positions.

INDEXING or SWITCHING POSITIONS: Defines the available output lines of a switch; for instance, an 8-, 10-, or 12-position switch. Various switch positions are usually referenced numerically or alphabetically.

STATIONS: Defines locations and quantities of switches and spacers in an assembly; for instance, five 8-position switches and one spacer make up a six station assembly.

STOPS: Hardware for mechanically limiting the number of active positions in a switch; for instance, limiting a 10-position switch to five active outputs.

SPACERS: Component used when it is desirable to physically separate one or more switches without leaving an open space in the assembly. May replace any compatible switch module.

ESCUTCHEON PLATE or BEZEL: A part designed to cover all but the essential portions of the switch faces.

MOUNTING HARDWARE: Parts used to mount plates, panels, modules, etc., to the assembly proper.

PIN NUMBERS: Numbers used to identify the relationship between the switching positions and the termination points of a circuit card.

Courtesy of Engineered Electronics Co.

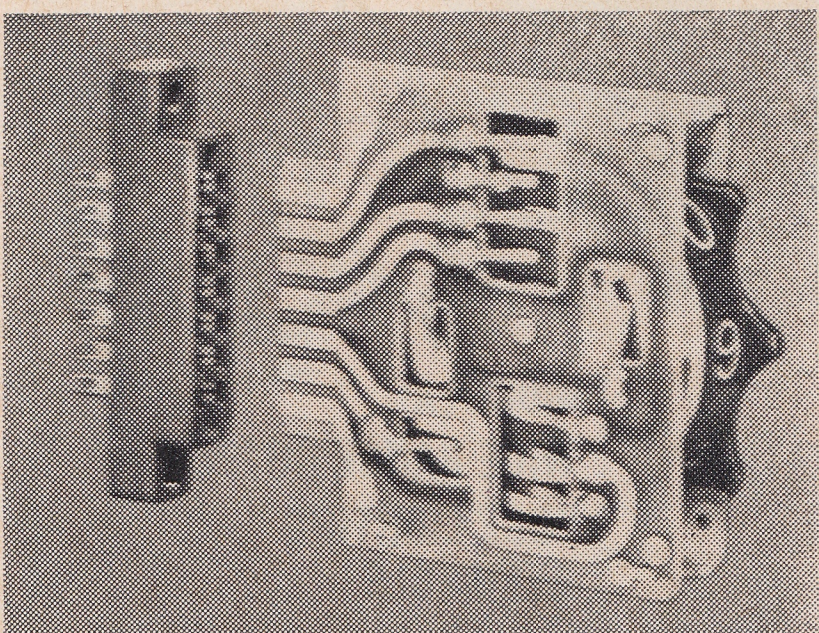


Fig. 12 Open type construction is used in Chicago Dynamic Industries' line of thumbwheel switches. This type of construction allows the user to choose from a wide variety of options — multiple decks, double-width wheels, and extended boards for component mounting.

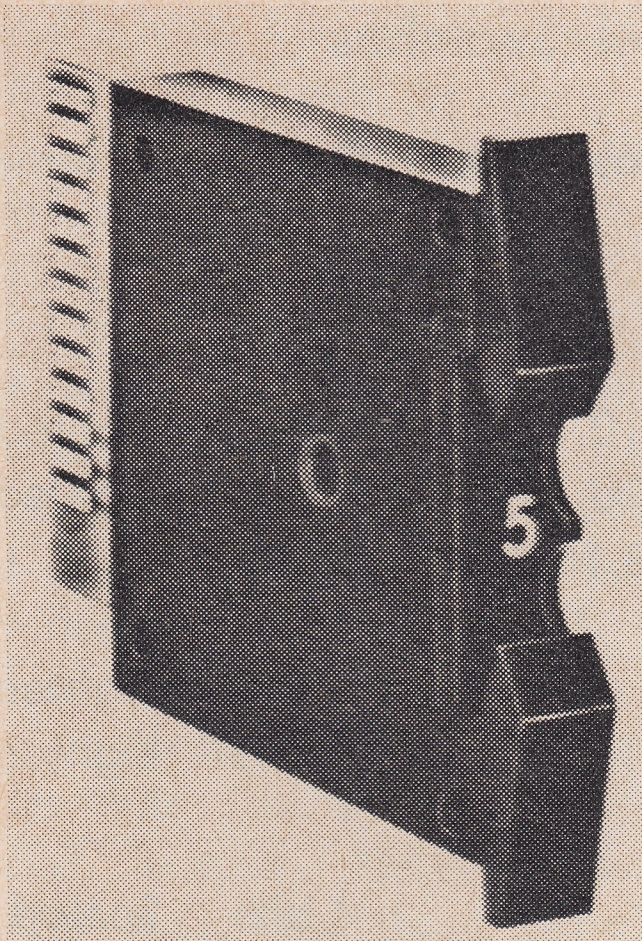


Fig. 13 Digitran's Series 500 switch has a 16-position setting wheel and up to 8-level coded outputs.

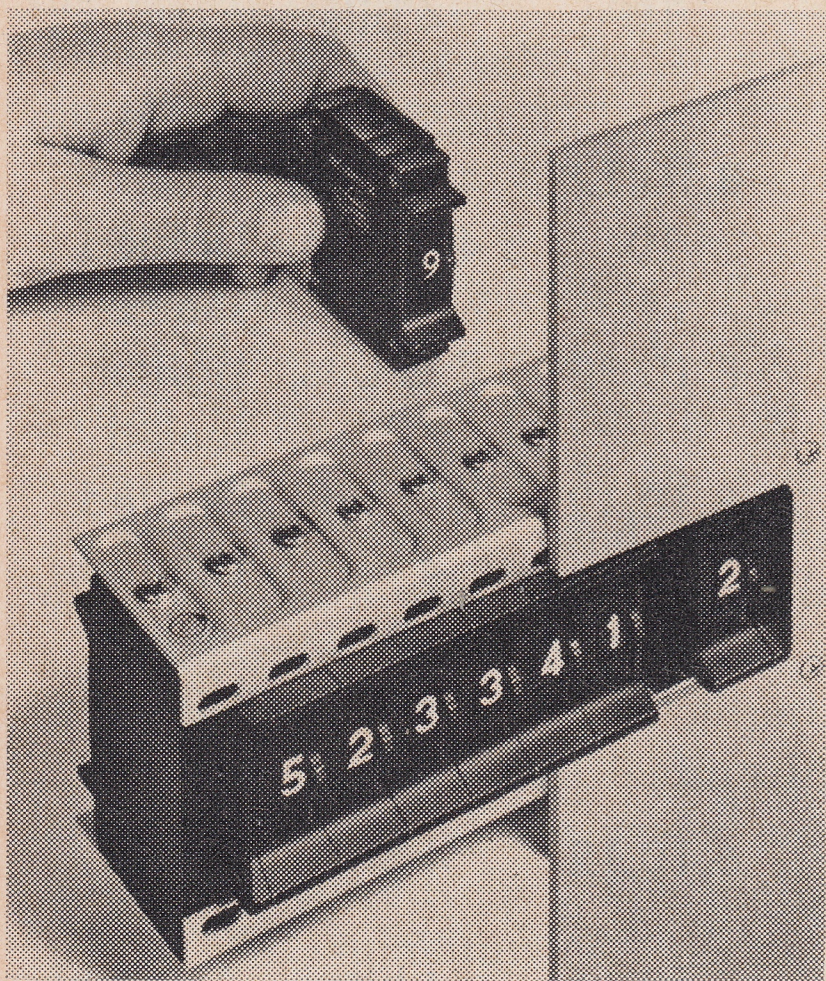


Fig. 14 Engineered Electronics' Series 200 thumbwheel switches feature removable single switches.

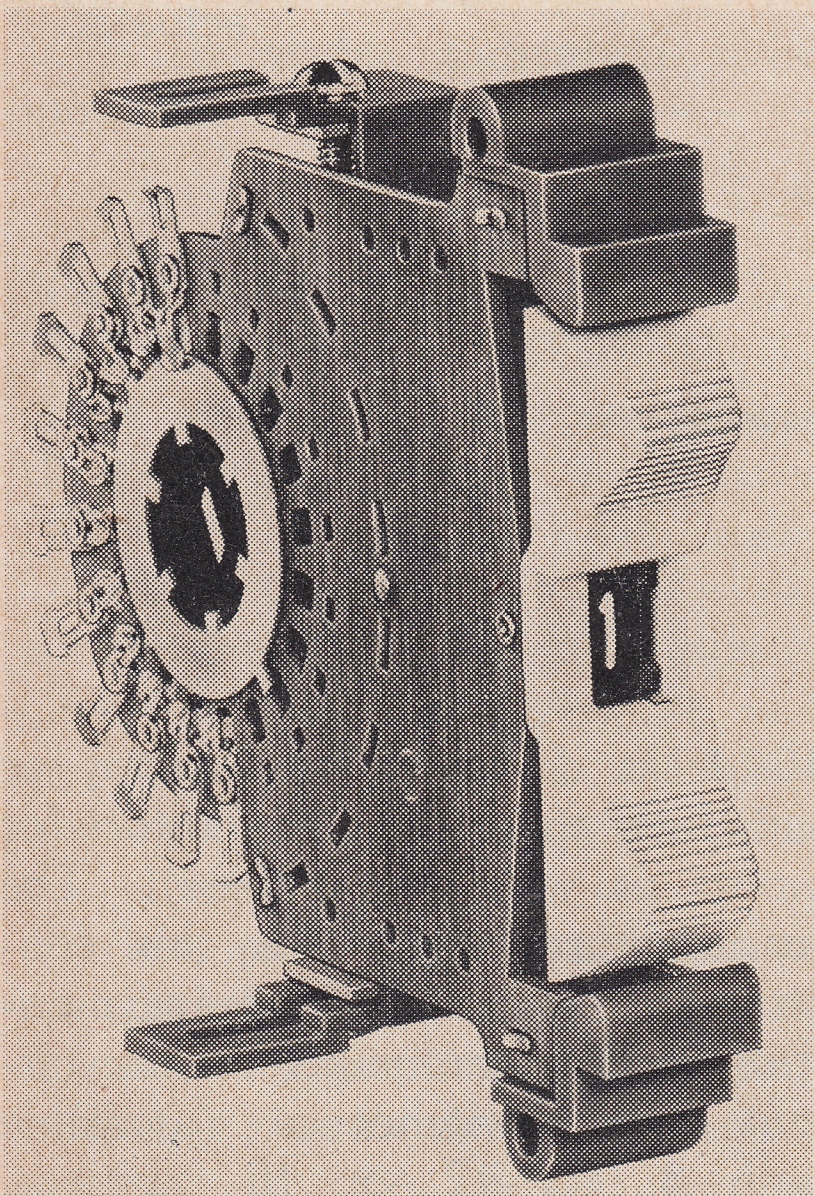


Fig. 16 Oak Manufacturing Co. uses a push-type rocker instead of the conventional tabs projecting from the rotor.

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of the rotor by activating a single line associated with that position, or it may contain a matrix which produces an equivalent digital code as an output. Coded switches thus offer an additional capability in that they can be used as code converters. A switch with 10 positions, which generates a 4-bit binary code, is automatically a decimal-to-BCD converter. The possibilities inher-

ent in this sort of application become obvious when one considers that thumbwheel switches are available with 40 or more index positions, and with outputs ranging up to nearly 100 code configurations.

Table 4 summarizes the major characteristics of commercially-available thumbwheel switches. Brief descriptions of each manufacturer's product line are given below.

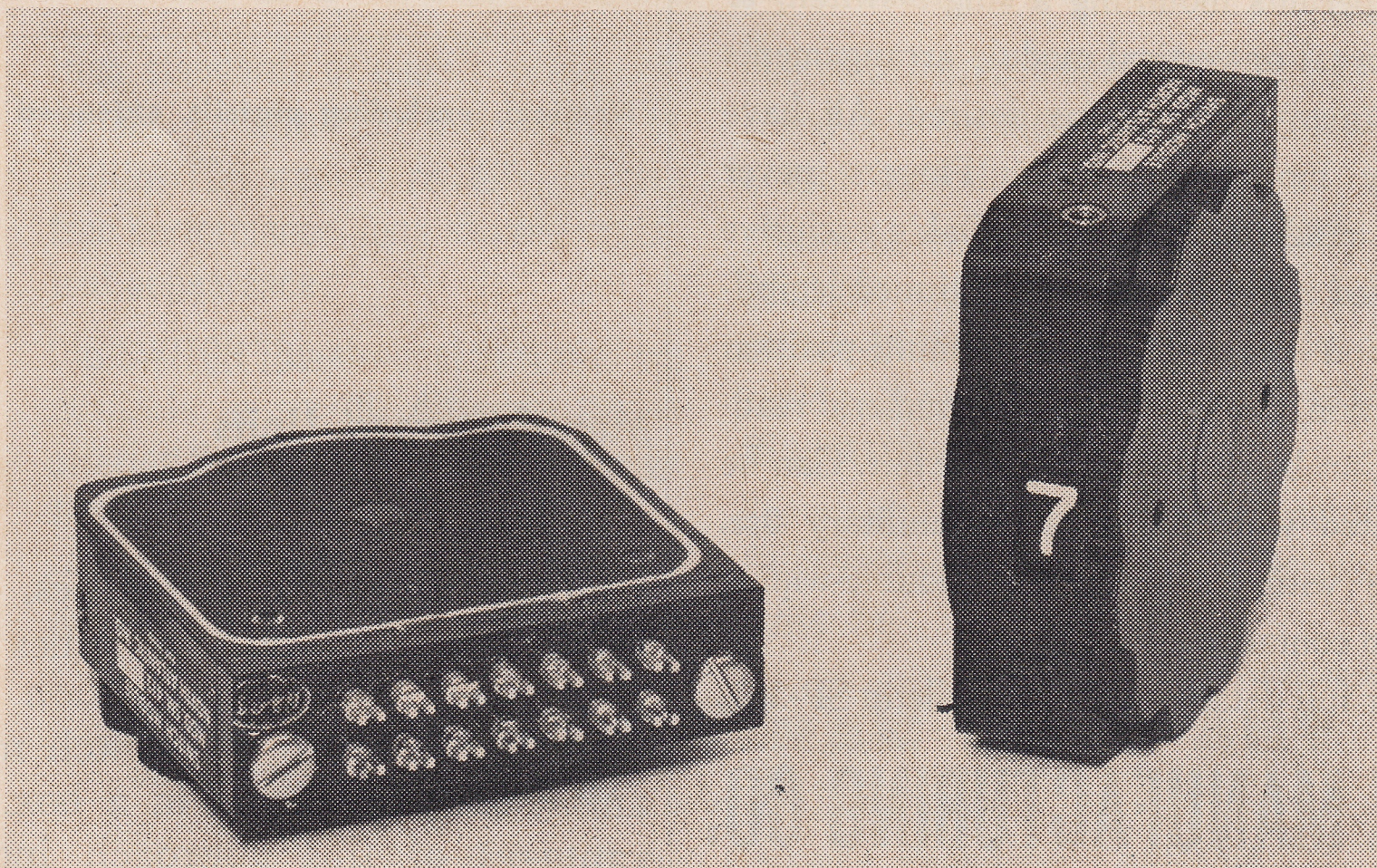
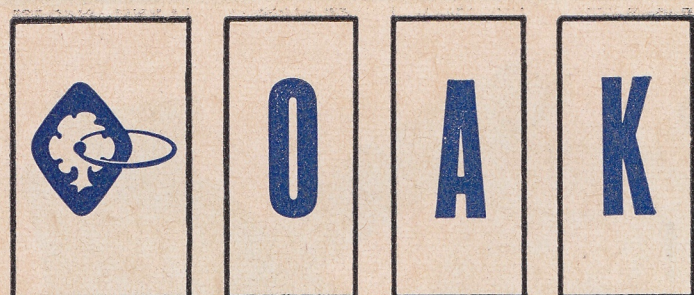
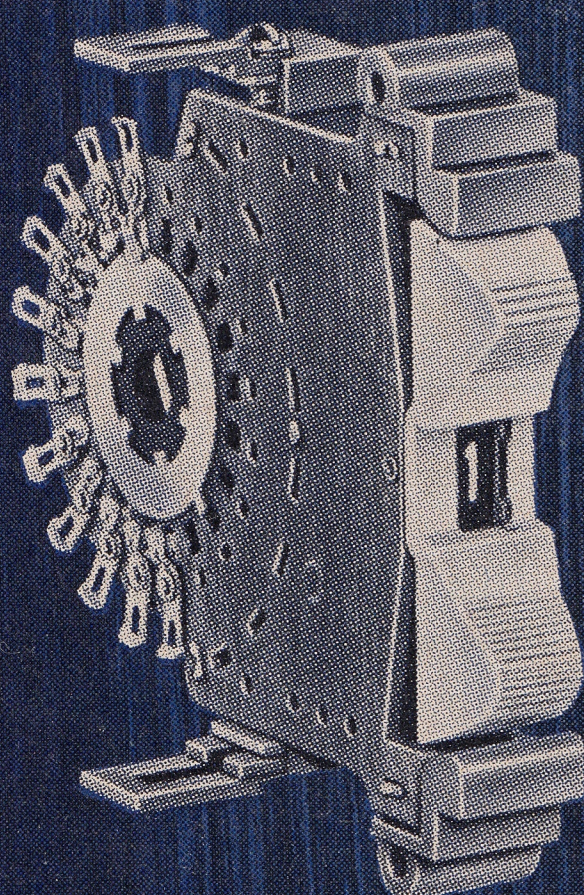


Fig. 15 North Atlantic Industries' Series SM-412 switches are built into complete assemblies to customer specs.



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TABLE 4 • Thumbwheel Switches

Mfgr.	Model	Approx. Size*			Positions	Codes	Comments
		H	W	L			
Chicago Dynamic	TTD	2.1	0.6	2.3	8,10,12,16	Direct	Lighted
	TTB	2.1	0.6	2.3	8,10,12,16	4 bits	Lighted
	MTTD	1.7	0.3	1.4	8,10,12	Direct	
	MTTB	1.7	0.3	1.4	10	4 bits	
	TD	2.1	0.6	2.2	10	Direct	Lighted
	TB	2.1	0.6	2.2	8,10,12,16	4 bits	Lighted
Digitran Co.	200	1.1	0.5	1.2	10	4 bits	Sealed
	300	2.3	0.5	1.6	8,10,12	4 bits,	
	400	1.9	0.6	2.5	8,10	4 bits,	Sealed
	500	3.2	0.5	2.8	16	8 bits,	
	600				40	6 bits	
	700	1.1	0.5	1.2	10	4 bits	
Engineered Electronics Co.	100	2.0	0.5	1.6	8,10,12	4, 5 bits,	
	200	2.0	0.5	1.6	10	4, 5 bits,	Lighted, sealed
	300	2.2	0.5	2.0	8,10,12	4, 5 bits,	Lighted sealed
	400	2.2	0.5	2.0	8,10,12	4, 5 bits,	Lighted
	700	0.9	0.4	1.3	10	4 bits	Lighted, sealed
	800	0.9	0.4	1.3	10	4 bits	Lighted
North Atlantic	SM412	1.8	0.6	2.3	6,10,12	4 bits,	Single Switch
	SM413	2.7	—	2.3	6,10,12	4 bits,	Assembly
	SM414	2.7	—	2.3	6,10,12	4 bits,	Sealed
Oak Manufacturing	—	2.6	1.4	3.1	10,16,20	4 bits	Rocker-actuated
Tech Laboratories	B-6500	1.9	0.5	1.6	2-10	4 bits,	

*Nominal, excluding pigtails, extended cards, and mounting tabs.

Manufacturers' Units

Chicago Dynamic Industries, Chicago, Ill. — CDI's switches feature open type construction (see Fig. 12) in which the switch mechanism is not enclosed in a box. Advantages of this approach include easy adaptation to multiple-deck or extra-width construction (up to

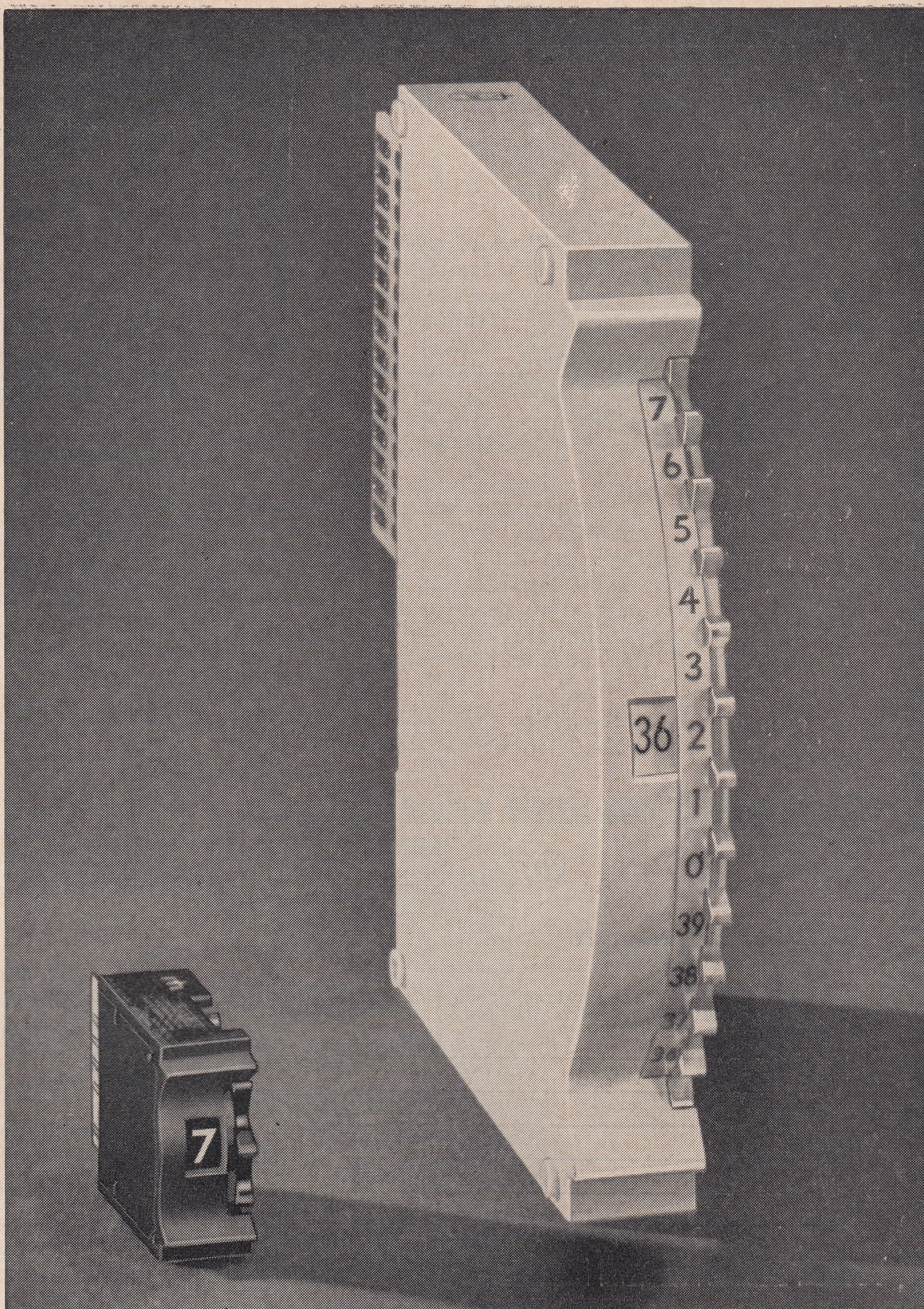
10 decks driven by one rotor, or sufficient space on the rotor for words as well as numbers). The manufacturer also finds this construction helps avoid trapping moisture and contaminants in the circuit area. Switches are available with 8, 10, 12, or 16 positions, direct or binary coded outputs. Certain switch types plug into connectors for quick replacement.

The Digitran Co., Pasadena, Cal.— “Digiswitch,” used by some engineers as a generic term for all thumb-wheel switches, is actually a proprietary trade-name of The Digitran Co. Most Digiswitches are available with direct outputs, resistance decades, or digital codes ranging from binary and BCD to Berkeley and others. The Series 300 is most commonly used in industrial applications; the sealed Series 400 for severe environmental conditions. The Series 500 (see Fig. 13) provides special output codes (including greater than, less than, equal to). The Series 600 offers up to 40 index positions. A smaller size series, called “Miniswitch,” is available either as the standard Series 700 or the sealed Series 200. Digiswitches are readily ganged into banks without special hardware.

Engineered Electronics Co., Santa Ana, Cal. — This company’s EEC Switch Dept. offers internally-lighted switches in addition to the more conventional types, and special mounting hardware. The Series 100 is a militarized switch with 8, 10, or 12 positions, direct or coded outputs. The Series 300 and 400 feature internal lighting, and are sealed and unsealed, respectively. The Series 700 is a miniaturized, lighted, and sealed unit with 10 positions and limited coding, but with provision for diodes. The Series 800 is the Series 700, unsealed. A recently announced Series 200 (Fig. 14) features removable individual switch modules.

North Atlantic Industries, Inc., Plainview, N.Y. — This company offers one basic switch series in three forms. The SM-412 series (Fig. 15) consists of single switch units with 6, 10, or 12 positions and either direct or coded outputs. Codes include 1248 and 1224, with or without complements. An advertised feature of the switch is its coin-silver contacts.

When individual SM-412 switches are assembled into complete banks to customer specifications and with mounting hardware, they become the SM-413 series. Sealed, for military or adverse industrial applications, they are termed the SM-414 series.



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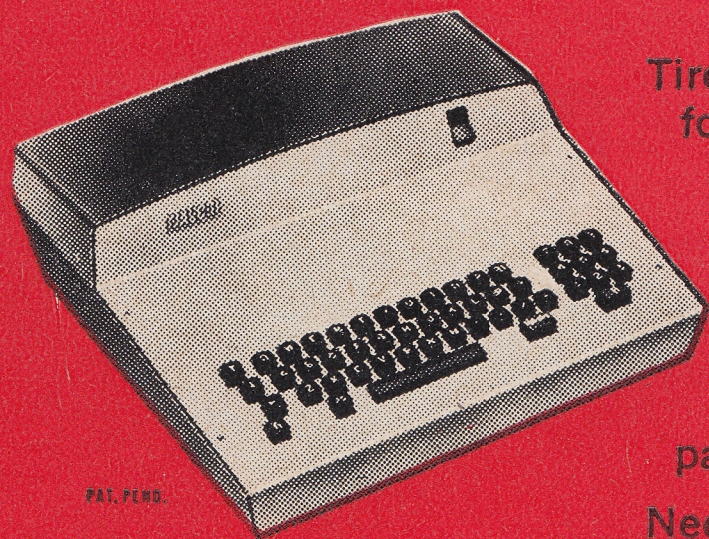
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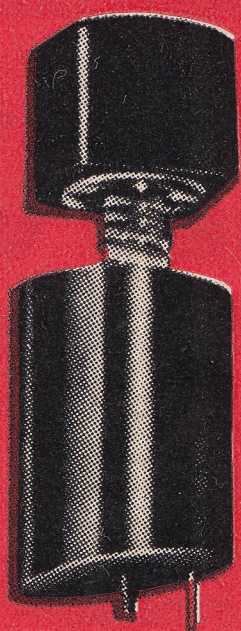
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TABLE 5 • MANUFACTURERS' LITERATURE

For your product reference file, a complete set of manufacturers' literature can be obtained by circling the reader inquiry numbers listed below.

INQUIRY CARD NO.

INPUT TYPEWRITERS

CONNECTICUT TECHNICAL CORP., Hartford, Conn.	70
FRIDEN, INC., San Leandro, Cal.	71
INVAC CORP., Waltham, Mass.	72
SOROBAN ENGINEERING, INC., Melbourne, Fla.	73

INPUT KEYBOARDS

BURROUGHS CORP., Pasadena, Cal.	74
CONNECTICUT TECHNICAL CORP., Hartford, Conn.	75
INVAC CORP., Waltham, Mass.	76
NAVIGATION COMPUTER CORP., Norristown, Pa.	77
SOROBAN ENGINEERING, INC., Melbourne, Fla.	78
TELETYPE CORP., Skokie, Ill.	79
ULTRONIC SYSTEMS CORP., Pennsauken, N.J.	80

THUMBWHEEL SWITCHES

CHICAGO DYNAMIC INDUSTRIES, INC., Chicago, Ill.	81
DIGITRAN CO., Pasadena, Cal.	82
ENGINEERED ELECTRONICS CO., Santa Ana, Cal.	83
NORTH ATLANTIC INDUSTRIES, INC., Plainview, N.Y.	84
OAK MANUFACTURING CO., Crystal Lake, Ill.	85
TECH LABORATORIES, INC., Palisades Park, N.J.	86

Oak Manufacturing Co., Crystal Lake, Ill. — Oak, producers of pushbutton and rotary switches, uses a novel technique in the design of their thumbwheel switches. Instead of direct thumb-turning of the rotor by means of its projecting tabs, the Oak switch has a rocker (Fig. 16) which is pressed up or down to move the rotor one position either way — an advantage when the operator is wearing bulky gloves. Each switch position has a firm and positive mechanical-index feeling. Available in either 10 or 20 position types, the switches offer direct or coded outputs. Codes include 1248-excess 3 and biquinary.

Tech Laboratories, Inc., Palisades Park, N. J. — This company's B-6500 miniature thumbwheel switch is made to mount either in front or behind the panel. Various combinations of BCD outputs are available with or without complements. Decimal and binary outputs with either 1 or 2 poles are also offered. The company also makes a larger model, the B-5575, which handles more current and is rugged enough for operation in steel mills and similar production applications.

Summary

We conclude this survey with a brief reminder that the manufacturers' units mentioned were just examples of each company's capabilities. For a complete reference file, we recommend that the reader supplement this survey with a set of company brochures and technical data sheets. The list of manufacturers in Table 5 is keyed with reader inquiry card numbers for your convenience in requesting this material.

END