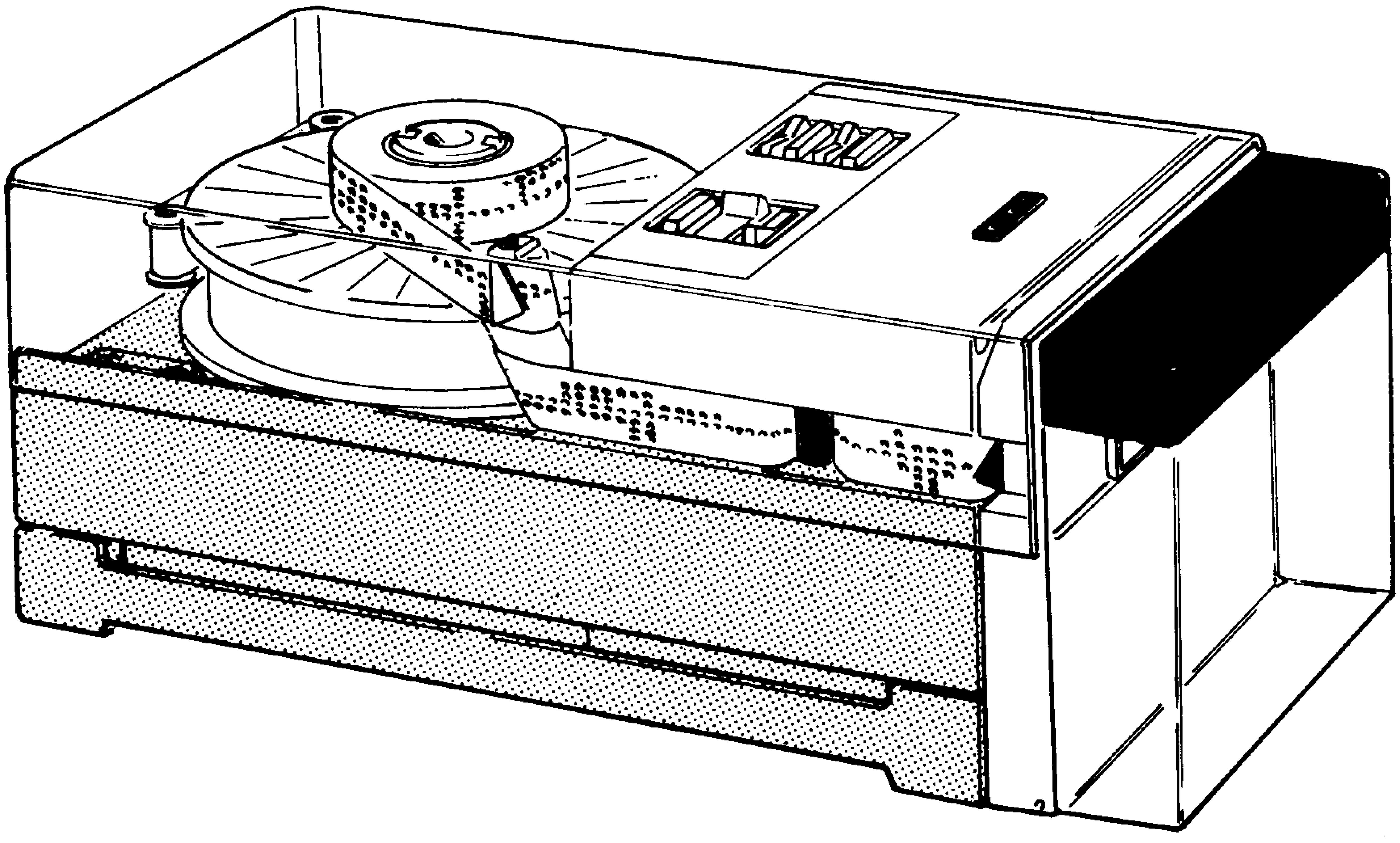
MEB 72 12 11

FACIT 4070

Tape punch

SERVICE MANUAL



FACIT AB · SWEDEN

Printed in Sweden

4070.08.03.Eng. 2M.01.73

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1 INTRODUCTION

FACIT 4070 tape punch records data on 5-, 6/7- or 8-track tape. Punching speed depends on the flow of data to the punch and can vary from 0 to 75 rows per second.

The tape is fed by a tape-feed mechanism that operates independently of the feed holes. All nine punch pins are solenoid-operated, thus enabling the feed-hole track to be used as a code track for recording 9-bit codes. The tape is unwound and rewound inside the punch.

The punch is provided with control circuits that synchronize the tape-feed and punching cycles. The control circuits are mounted on a plug-in circuit board. Beneath this control circuit board is a bridging circuit board.

To adapt the punch to a particular system, the bridging circuit board is replaced with a system adaptation board.

2 SPECIFICATIONS

2.1 TAPE

Fig 2.1	Type:	Paper tapes
		8-track tape as per ISO recommendation. 5 and 6/7 track tape and TS (typesetting) tape as per applicable sections of ISO recommendation for 8-track tape.
	Hole configuration:	ISO standard R 1154 for 8-track punched tape.
		Hole configuration for 5- and 6/7-track tape complies with applicable sections of ISO standard for 8-track tape.
		6-track TS tape punched as shown in Fig 2.1. Other data complies with applicable sections of ISO standard for 8-track tape.
	Width:	5-track tape 17.46 ± 0.08 mm (0.687" ± 0.003"). 6-track tape 22.23 ± 0.08 mm (0.875" ± 0.003"). 7-track tape 22.23 ± 0.08 mm (0.875" ± 0.003"). 8-track tape 25.40 ± 0.08 mm (1.000" ± 0.003").
	Thickness:	0.08 - 0.11 mm
	Tape coil:	Inner diameter, 50.8 - 52 4 mm (2") Outside diameter, max 203 mm (8").

2.2 VARIANTS

Following variants of FACIT 4070 are manufactured partly in desk version and partly in rack version for either AC or DC.

FACIT 4070 variants are available for punching the following tapes:

- 5-, 6/7- and 8-track standard tapes.
- 6-track TS tape.

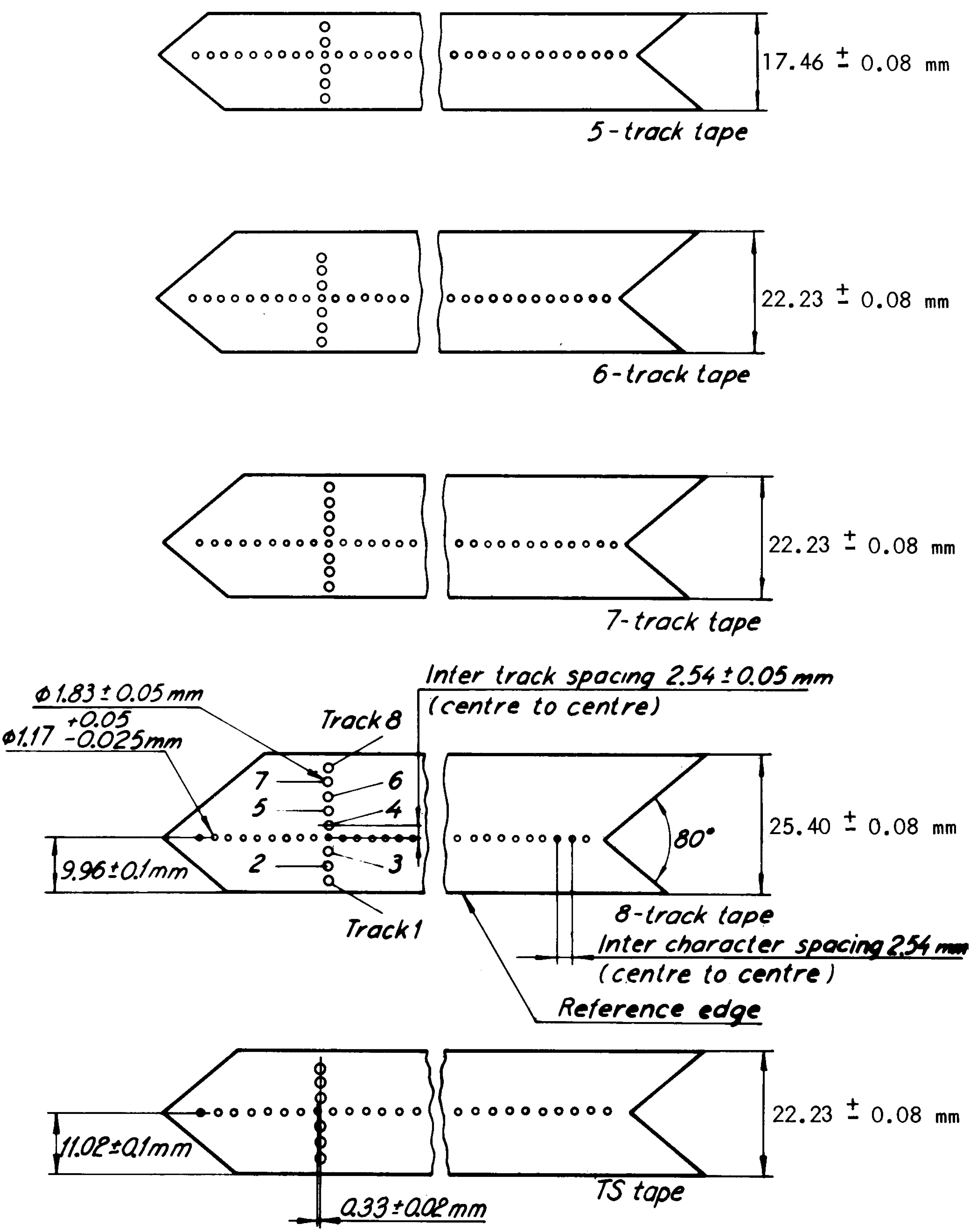


Fig 2.1 Tape dimensions and hole configurations

2.3 MECHANICAL DATA

Punching speed:	Up to 75 rows per second
Tape feed:	Asynchronous, externally controlled
Backspacing:	Up to 10 rows, depending on the tape quality
Feed accuracy: (ISO standard)	Adjacent rows, better than 3% 10 rows, 1% 50 rows, 0.5%
Buffer register:	Built in, stores 1 row
Mark character:	Programmed using diodes on control circuit board
Ambient temperature:	+5°C - +40°C
Relative humidity:	Max 85%
Dimensions:	Length, 432 mm (17"), 482 mm (19") incl. chad box Width, 200 mm (8.7") Height, 198 mm (7.8")
Weight:	AC variants, 13.5 kg (30 lb) DC variants, 9.5 kg (21 lb)

2.4 ELECTRICAL DATA

2.4.1 Input signals

Signals having a duration of less than approx 10 μs are treated as noise (integrated out).

Start pulse (PI):	Duration	- min 100 μs
	Rise time	- max 10 μs
	Input impedance	- min 2.2 kilo-ohms
	Logical 1	- +3.5 V to +12 V
	Logical 0	- -12 V to +1.5 V

Data signals (Ch 1-9):	Duration	- min 200 μs
	Rise time	- max 10 μs
	Input impedance	- min 22 kilo-ohms
	Logical 1	- +3.5 V to +12 V
	Logical 0	- -12 V to +1.5 V

- Data signals shall be defined no later than 1 μs after PI.

Stepping direction signal (SD):	Input impedance	- min 2.2 kilo-ohms
	Forward feed	- -12 V to +1.5 V
	Backspace	- +3.5 V to +12 V

2.4.2 Output signals

Punch ready signal (PR):	Logical 1	- +6 V; output impedance, 1 kilo-ohm
	Logical 0	- max +0.4 V and max 10 mA

- Changes to 0 when data is stored in buffer register. Changes to 1 when punching is completed.

Tape low signal (TL):	Logical 1	- +6 V and max load 10 mA
	Logical 0	- 0 V via 470 ohms

- Becomes 1 when TL signal is generated.

Error signal 1 (ERR 1):	Logical 1	- +5 V at 3 mA; output impedance, 100 ohms
	Logical 0	- max +0.6 V at 1 mA

- Becomes 1 when ERR 1 signal is generated.

Error signal 2 (ERR 2):	Logical 1	- min +3.0 V at 3 mA
	Logical 0	- max +0.6 V at 2 mA

- Available only via system adaptation circuit board. Board connector K2/A20.

External signal (EXT): 0 V when EXT button is depressed.

2.4.3 Supply voltage

AC variants:	100/115/220/240 V $^{+15\%}_{-10\%}$ Single-phase, 50 - 100 Hz. Grounded power inlet.
DC variants:	24 V $^{+20\%}_{-15\%}$
AC variants:	Max 200 W Min 50 W
DC varaints:	Max 180 W Min 2 - 5 W Max peak current, 30 A

Both AC and DC variants are dimensioned to provide an extra current output of 1 A from the +6 V circuitry and 1 A from the +24 V circuitry. These outputs are intended primarily for use with the system adaptation board.

Fuses: 0.63 A (located on control circuit board).

Twelve 2 A fuses on standard version.
Ten 2 A fuses on TS version. On both versions there is one fuse for each punch solenoid and motor winding.

The transformer is provided with a thermal protector that is self-resetting.

DC variants are provided with a 5 A time-delay fuse located on the rear panel.

AC variants are provided with a 2 A time-delay fuse located on the rear panel.

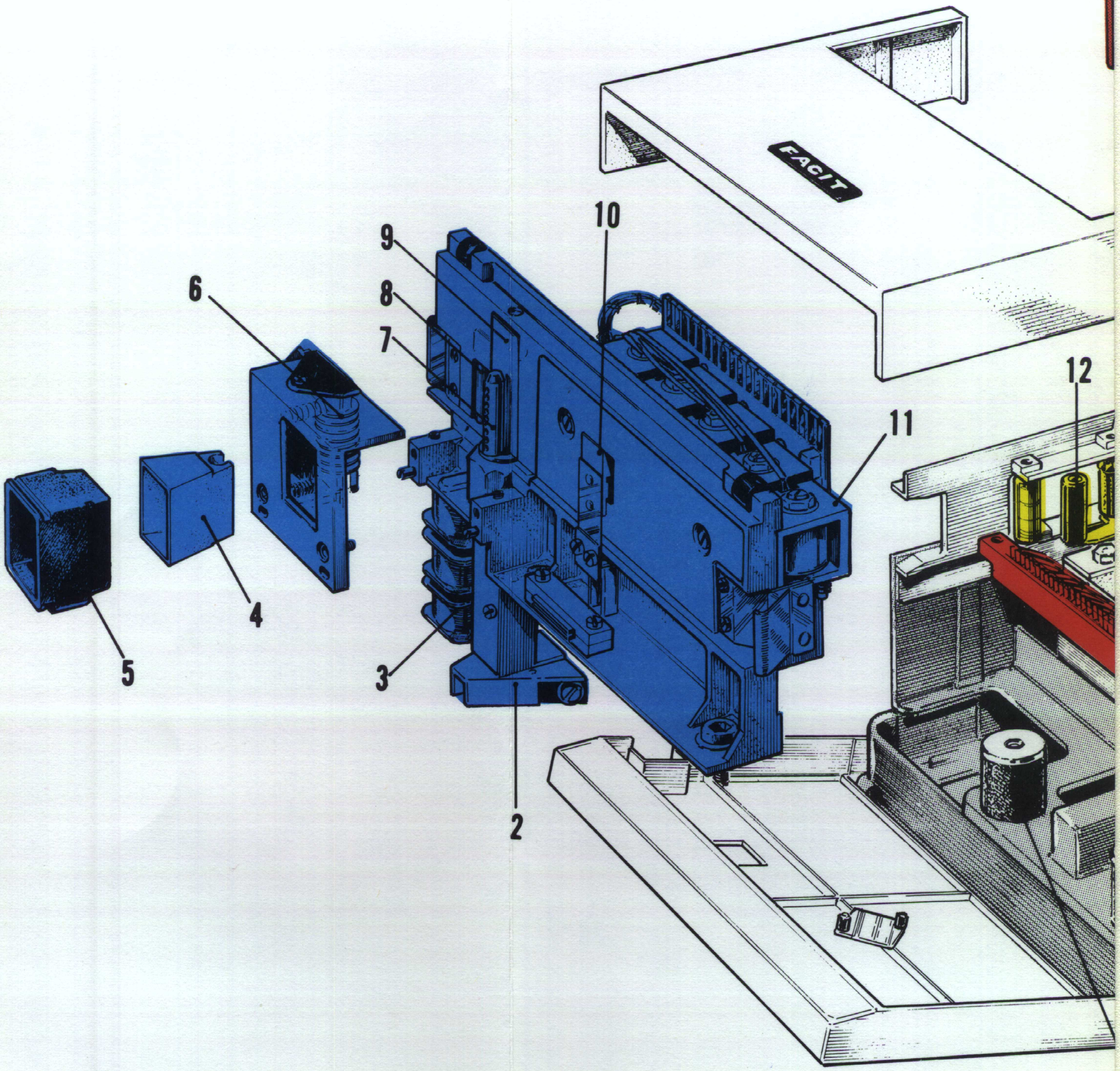
2.4.4 Connections

External connections

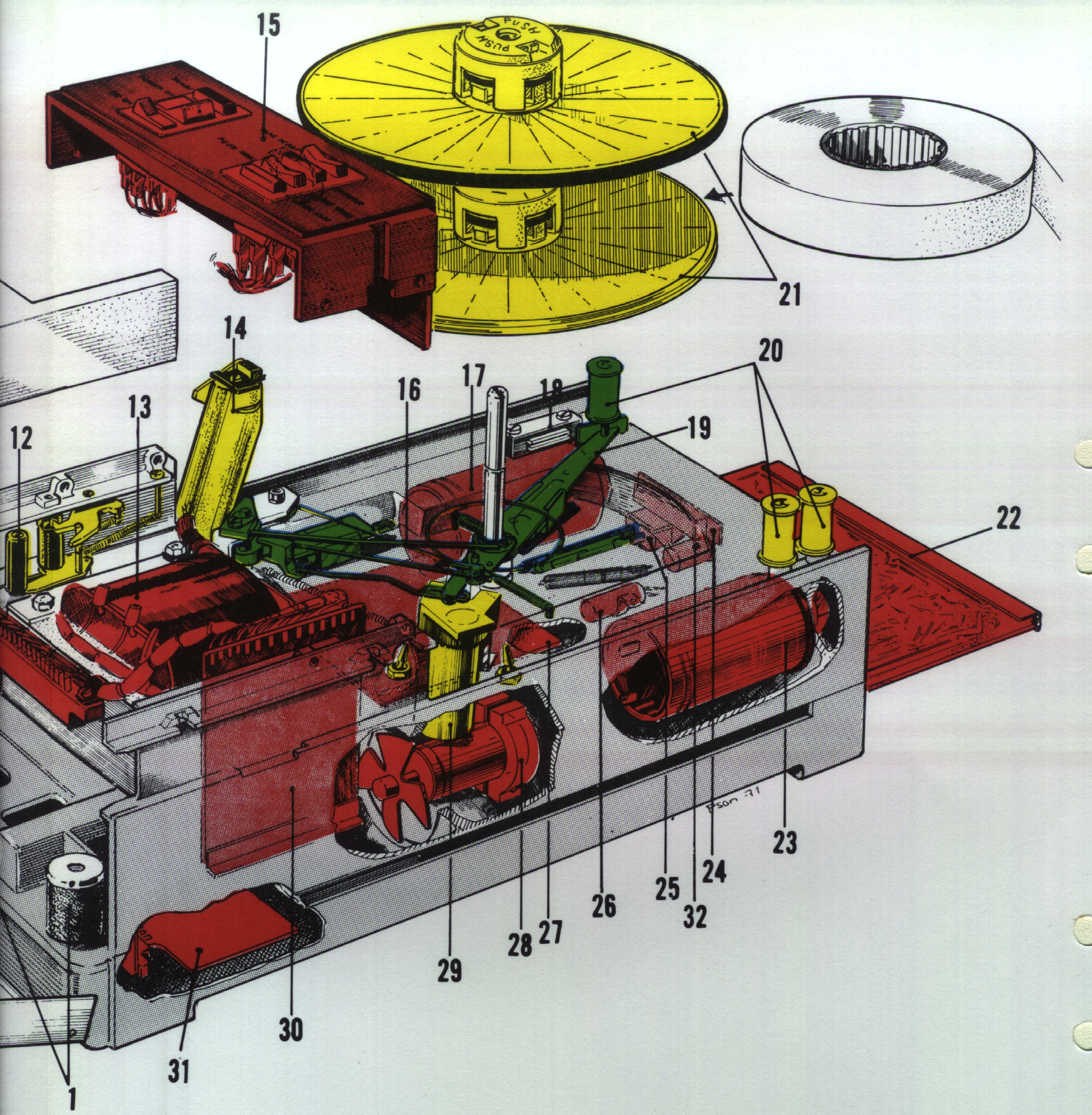
Power inlet P3 (AC):	Grounded CEE 22/VI or standard American 3-pin inlet.
Power inlet P3 (DC):	Grounded 2-pin inlet.
Signal in/output connector P1:	25-pin connector.

Internal connections

K1:	22-contact connector for control circuit board.
K2:	22-contact connector for bridging board or system adaptation board.
K3:	22-contact connector for PC board containing fuses for punch solenoids and incremental motor.



1 Rubber anti-vibration mountings (attached to chassis)
2 Motor brake
3 Incremental motor
4 Chad exhaust
5 Connection for chad tube
6 Pinch roller
7 Die
8 Capstan
9 Punch pin guide
10 Spring-mounted tape guide
11 Punch solenoids
12 Reversing buffer arm
13 Transformer (T1)
14 Tape lifter
15 Control panel
16 Tape low sensor arm
17 Capacitor (C1)
18 Retainer magnet
19 Surge takeup arm
20 Guide rollers



21 Supply and takeup flanges
22 Control circuit board
23 Capacitor (C2)
24 Signal connector (P1)
25 Power inlet (P3)
26 Disturbance suppressor
27 Filter circuit board
28 Fan motor
29 Winding motor
30 Rectifier circuit board
31 Bridging board (can be replaced by a systems adaptation circuit board)
32 Fuse (F1)

Fig 3.1 Exploded view of the 4070

3 DESIGN AND CONSTRUCTION

Fig 3.1 The 4070 is built up on a cast chassis. It contains the following units. See Fig 3.1.

- Punch/feed unit illustrated in blue. Contains punch mechanism and incremental motor.
- Tape supply/takeup unit illustrated in yellow.
- Tape check devices illustrated in green.
- Power supply illustrated in red. Includes filter circuit and circuit boards.

3.1 PUNCH/FEED UNIT

The punch/feed unit is screwed onto two rubber anti-vibration mountings (1) which, in turn, are attached to the chassis.

The punch mechanism comprises punch solenoids (11), the punch pin drivers, the punch pins and the punch head. The punch head comprises punch pin guide (9) and die (7). The punch pins run on greased ways in the punch pin guide.

The incremental motor (3) is screwed onto the punch/feed unit. It drives the tape via capstan (8). Pinch roller (6) presses the tape against the capstan. Brake (2) is located on the lower part of the incremental motor. It damps out motor shaft oscillations.

3.2 TAPE SUPPLY/TAKEUP UNIT

The tape supply/takeup unit comprises supply and takeup flanges (21), winding motor (29), guide rollers (20) reversing buffer arm (12) and tape lifter (14). The takeup flange is located directly above the supply flange.

3.3 TAPE CHECK DEVICES

The tape check devices comprise two movable arms - surge takeup arm (19) and tape low sensor arm (16). On each of these arms there is a permanent magnet that actuates a reed relay when the arm lies within a given sector.

3.4 POWER SUPPLY

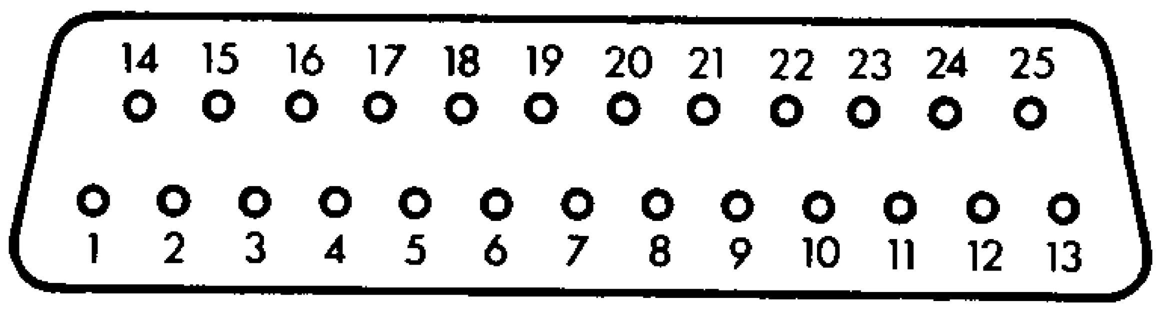
The power supply comprises transformer (13), designated T1, rectifier circuit board (30) and capacitors (17 and 23), designated C1 and C2 respectively.

The transformer is located beneath control panel (15). Changeover for different mains voltages is accomplished with mains voltage selector switch S1 on the rear of the control panel. The rectifier comprises four bridge-coupled power diodes mounted on rectifier circuit board (30) to the right of the transformer. This circuit board is secured by two sheet metal angles that are screwed in place from beneath the chassis. Filter circuit board (27) removes disturbances caused by winding motor (29) and fan motor (28).

In the lower part of the punch there is room for two plug-in circuit board (22 and 31). Circuit board 22 is included in all variants of the punch. It contains the circuits that enable the punch to operate as a stand-alone unit. Board 31 is the board that can be replaced by a system adaptation circuit board. The circuit boards are inserted from the rear of the punch and are secured by one plastic holder. Power inlet (25), designated P3, signal in/output connector (24), designated P1, and fuse holder with fuse (32), designated F1, are located at the rear. Line filter (26), designated C3, is provided inside the power inlet between capacitors C1 (17) and C2 (23).

Layout of signal in/output connector P1:

Pin No	Signal	Pin No	Signal
1	Ch 1	14	-
2	Ch 2	15	-
3	Ch 3	16	-
4	Ch 4	17	-
5	Ch 5	18	-
6	Ch 6	19	EXT
7	Ch 7	20	ERR 1
8	Ch 8	21	TL
9	Ch 9	22	+24 V
10	SD	23	-
11	PI	24	+6 V
12	PR	25	0 V
13	-		



Signal designations:

Ch 1 - Ch 9	Data signals on channels 1-9 (Ch 9 is for feed hole track)
ERR 1	Error signal
EXT	External signal
PI	Punch instruction (start pulse) signal
PR	Punch ready signal
SD	Stepping direction signal
TL	Tape low signal

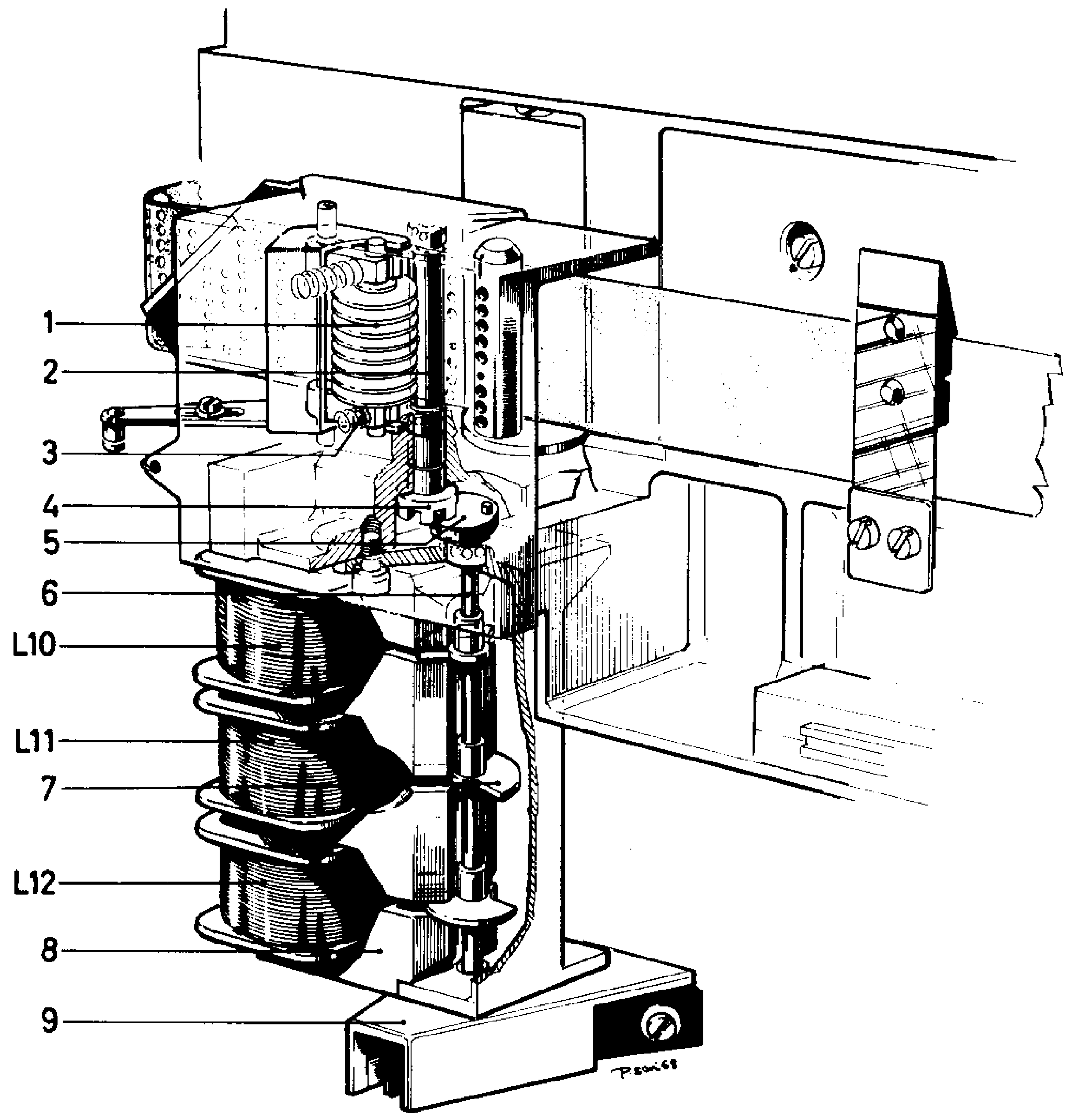


Fig 4.1 Cutaway view of the feed mechanism. At centre is the non-linear transmission 4 and 5. The motor brake 9 is at bottom

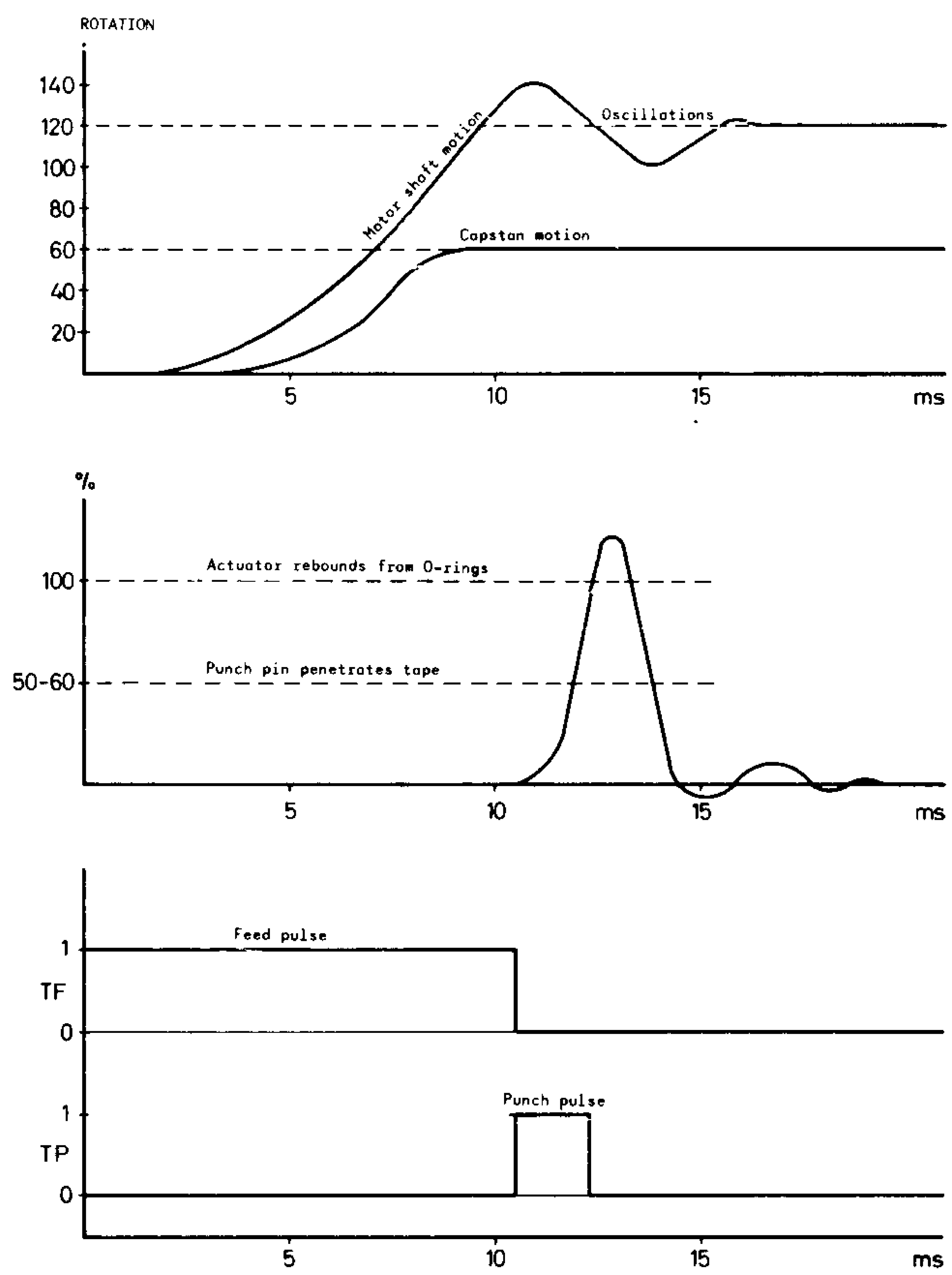


Fig 4.2 Pulse and motion diagrams for punching and feeding

4 MECHANICAL OPERATION

4.1 TAPE FEED

Fig 4.1

The feed mechanism comprises the incremental motor, the capstan and the pinch roller. See Fig 4.1.

Pinch roller (1) presses the tape against capstan (2). Springs (3) provide the pinching force. The capstan is driven by the incremental motor via a non-linear transmission arrangement. Slotted wheel (4) on the bottom of the capstan engages pinwheel (5) that is pressed onto motor shaft (6). The transmission ratio is 1:2, i.e. the capstan turns half a revolution for every motor revolution. The motor shaft (6) is provided with three vanes (7) that are staggered at 120° intervals. Each vane passes through an air gap in stator (8) as the motor shaft turns. There are three motor windings L10, L11 and L12 on the stator. They are energized sequentially by the control circuits. When a winding is energized, magnetic flux passes through the corresponding air gap in the stator, wherewith the associated vane is pulled in and turns the motor shaft through 120°. For backspacing, the motor windings are energized in reverse sequence.

Fig 4.2

Fig 4.2 illustrates the timing of the tape-feed and punching cycles. The motor shaft and capstan motions are shown in the upper diagram. The non-linear transmission between capstan and motor shaft reduces the amplitude of capstan oscillations. The amplitude of motor shaft oscillations is damped by the motor brake (see more detailed explanation below).

The centre diagram shows how the punch solenoids and the punch pins move. Oscillation results when the actuators on the punch solenoid armatures return and rebound from the O-rings. Note that the punch pulse TP vanishes before the punch pin movement is completed.

Fig 4.3

The incremental motor is provided with brake (9) to damp motor shaft oscillations. Triangular shoe (1), made of friction material, is attached to the motor shaft. See Fig 4.3. When the shaft turns one increment (120°), springs (2) are pressed apart, after which they help to turn the shaft to its new incremental position. The brake also serves to hold motor stationary between operations.

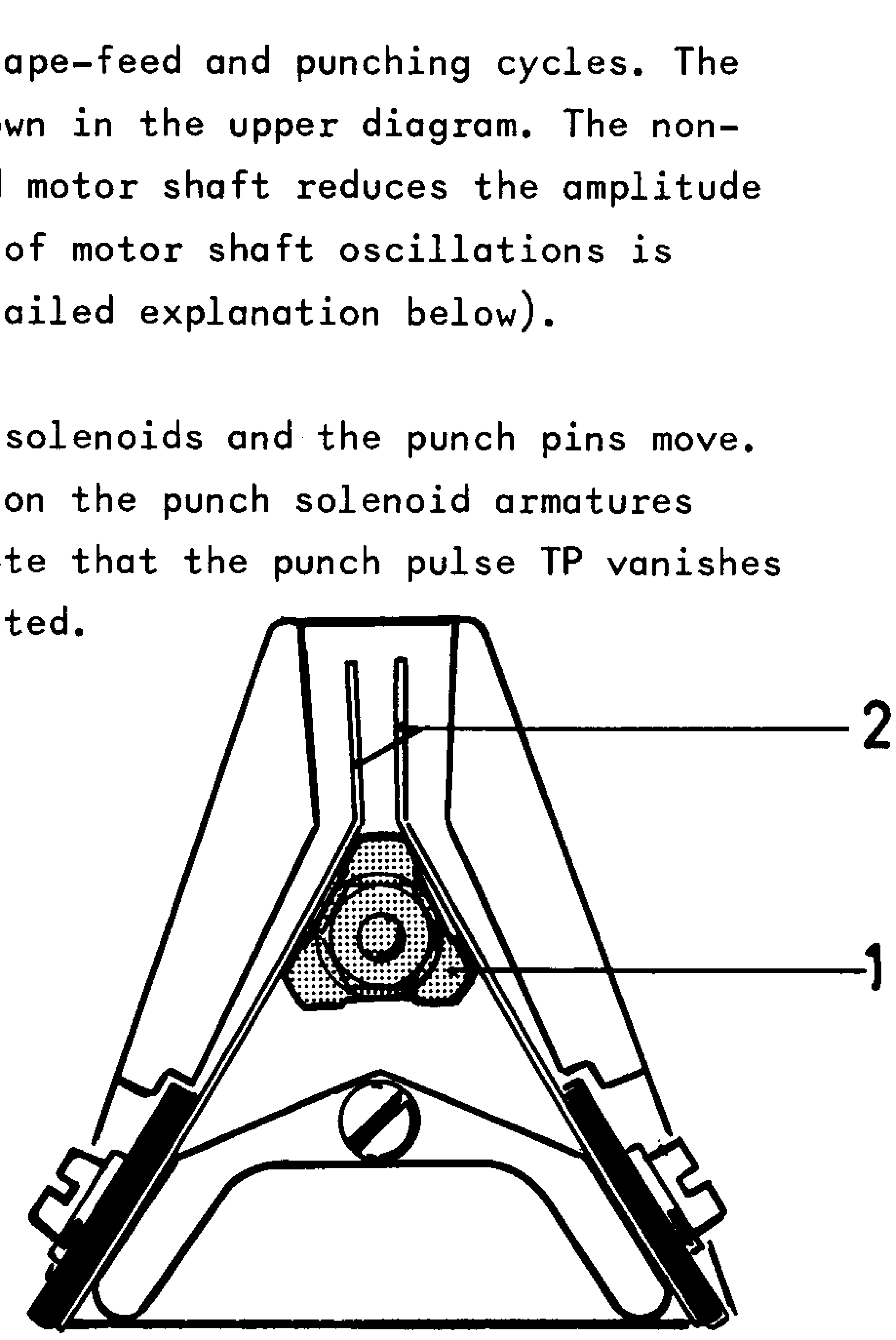


Fig 4.3 Motor brake

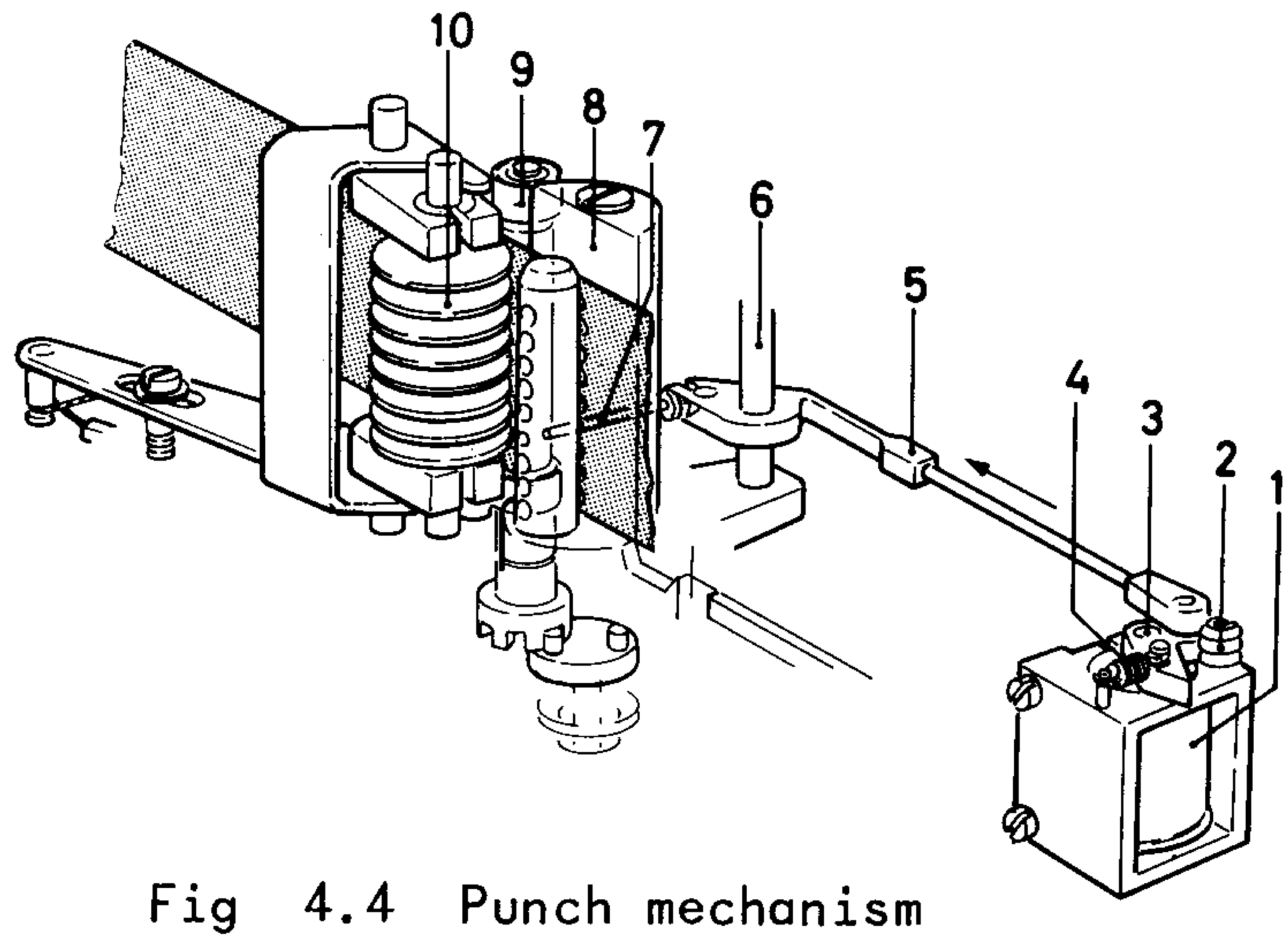


Fig 4.4 Punch mechanism

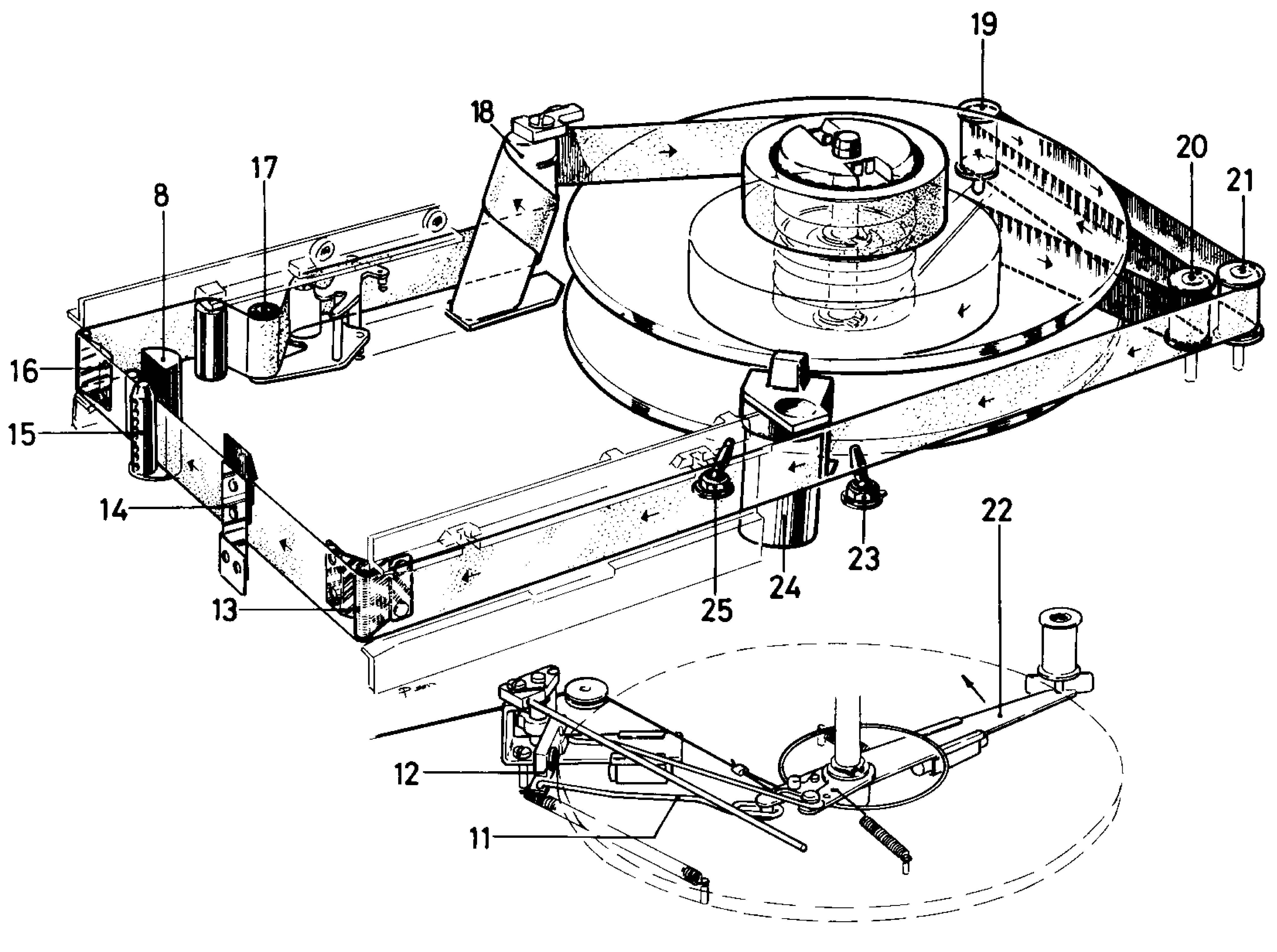


Fig 4.5 Components past which the tape moves. The parts that control the speed of the supply flange are shown at bottom

4.2 PUNCHING

The punch mechanism comprises nine punch solenoids, the punch pin drivers, the punch pins and the punch head. Punching takes place when one or more punch solenoids are energized. The incremental motor first advances the tape one row (one increment), then the data on the channels is punched. Signals for synchronizing the punch solenoids and the incremental motor are obtained from the control circuits.

Operating cycle

Fig 4.4

The tape is first advanced one row between capstan (9) and pinch roller (10). When punch solenoid (1) is energized, its actuator (3) turns to move punch pin driver (5) in the direction shown by the arrow. The punch pin driver turns about shaft (6). Punch pin (7) is thus moved through punch pin guide (8) wherewith a hole is punched in the tape. When the punch solenoid is de-energized the punch pin and the punch pin driver are returned to their initial positions by extension spring (4). At its initial position, the actuator rests against O-rings (2).

4.3 TAPE SUPPLY AND TAKEUP

Fig 4.5

Fig 4.5 shows the various components past which the tape moves. Smooth unwinding is assured by letting the tape loop around guide rollers (19, 20 and 21). Guide roller (19) is mounted on movable surge takeup arm (22) which is carried on the same shaft as the takeup and supply flanges. If tape is unwound to rapidly, the surge takeup arm moves in the direction shown by the arrow and actuates brake shoe (12) via link (11). The brake shoe is pressed against the supply flange, thus braking it until the surge takeup arm re-assumes its normal operating position. From the guide rollers, the tape runs through a slot in the right-hand sidewall and into the punch/feed unit where it passes between punch pin guide (8) and die (15), both in the punch head, and between the pinch roller and capstan.

Two surge takeup springs (13 and 16) and a spring-mounted tape guide (14) are provided on the punch/feed unit. The spring-mounted tape guide holds the tape at the correct position regardless of whether the punch is loaded with 5- or 8-track tape. (However the spring-mounted tape guide must be readjusted vertically to handle 6/7-track tape). At the left-hand sidewall, the tape forms a buffer loop around springloaded reversing buffer arm (17). This buffer permits the tape to be backspaced. Current to the winding motor is shut off during backspacing. From the reversing buffer arm, the tape spirals once around tape lifter (18) from which it

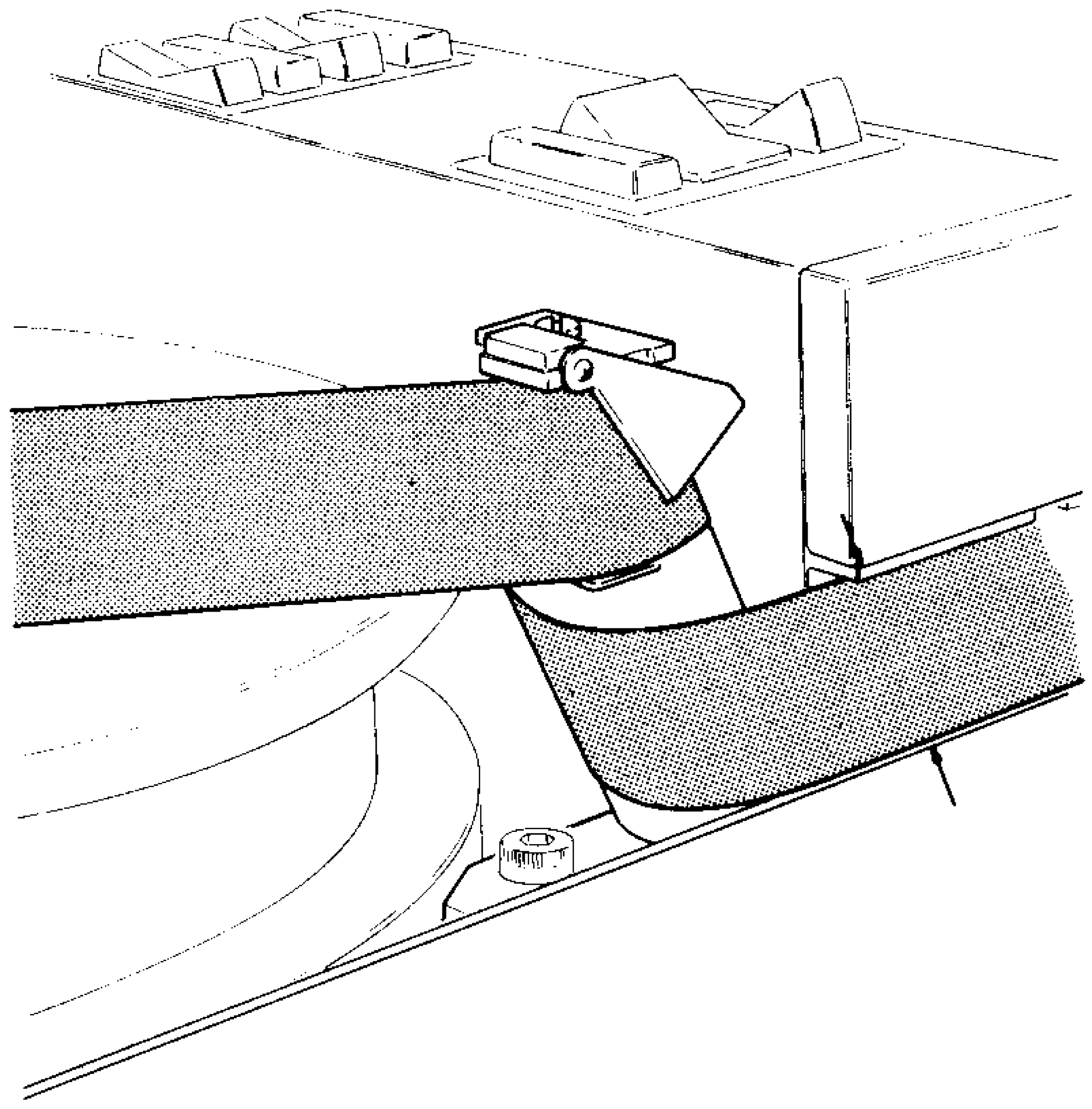


Fig 4.6 Tape lifter

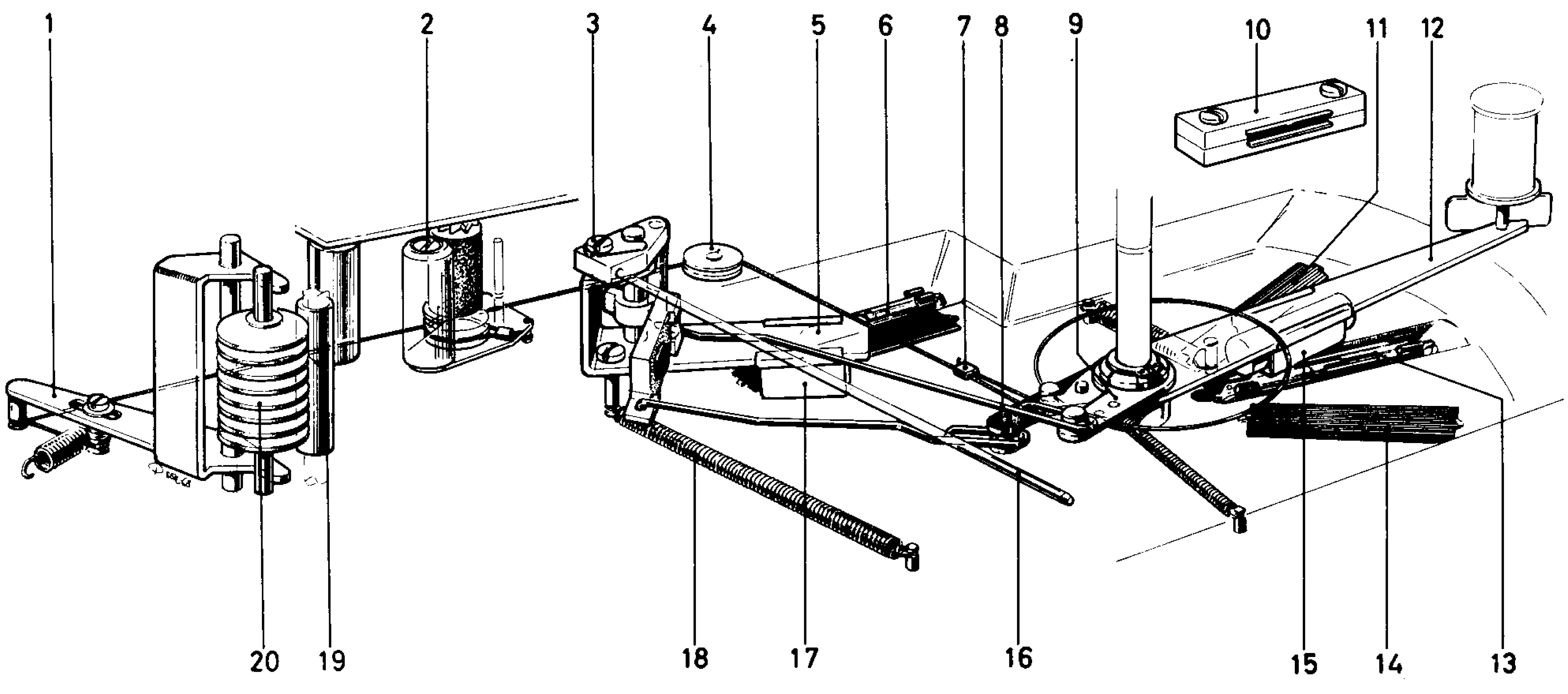


Fig 4.7 Tape check devices located beneath the supply flange. The parts at far left are incorporated into the tape feed mechanism

proceeds to the takeup flange. The tape lifter leans at an angle chosen to prevent the tape from running against the top or bottom edge of the tape slot in the left-hand sidewall. See Fig 4.6. The tape lifter is slightly roughened so that force exerted by the winding motor cannot affect the inter-row spacing on the tape. It is also provided with a tape tearer and with an adjuster for 5-track tape. The takeup flange is driven by winding motor (24) which presses against a rubber ring at the periphery of the flange. Switch (23) can change the direction of rotation of the winding motor. Power to the winding motor can be turned off with switch (25). The supply and takeup flanges are provided with expansion-type latches for securing tape coil cores.

Fig 4.6

4.4 TAPE CHECKS

Tape unwinding is checked automatically when three situations arise (see Fig 4.7):

Fig 4.7

A. Tape ruptured
B. Tape too tight
C. Tape low (supply almost exhausted).

Situations A and B are handled by permanent magnet (15) that is located in its holder beneath surge takeup arm (12). This magnet actuates reed relay (13) within a sector that is bounded by shield plates (11 and 14). When the magnet is within this sector, the reed relay closes a circuit that provides one of the conditions for punching.

When situation A (tape ruptured) arises, surge takeup arm (12) moves toward shield plate (11), when the magnet leaves the working sector, reed relay (13) opens, therewith opening the aforesaid circuit and inhibiting the Punch Ready (PR) signal. In addition, the ERROR lamp on the control panel lights.

When situation B (tape too tight) arises, the surge takeup arm is forced toward shield plate (14); when the magnet leaves the working sector, reed relay (13) opens, therewith inhibiting the Punch Ready (PR) signal (as in situation A) and the ERROR lamp lights.

In situation C (tape low) when a predetermined number of rows remains before end of tape, tape low sensor arm (16) provides an indication by lighting the TAPE LOW lamp on the control panel. Tape low sensor arm (16) is pressed against the periphery of the supply reel by spring (18). Adjusting screw (3) joins the tape low sensor arm with arm (5) on which is mounted permanent magnet (17). This magnet actuates reed relay (6).

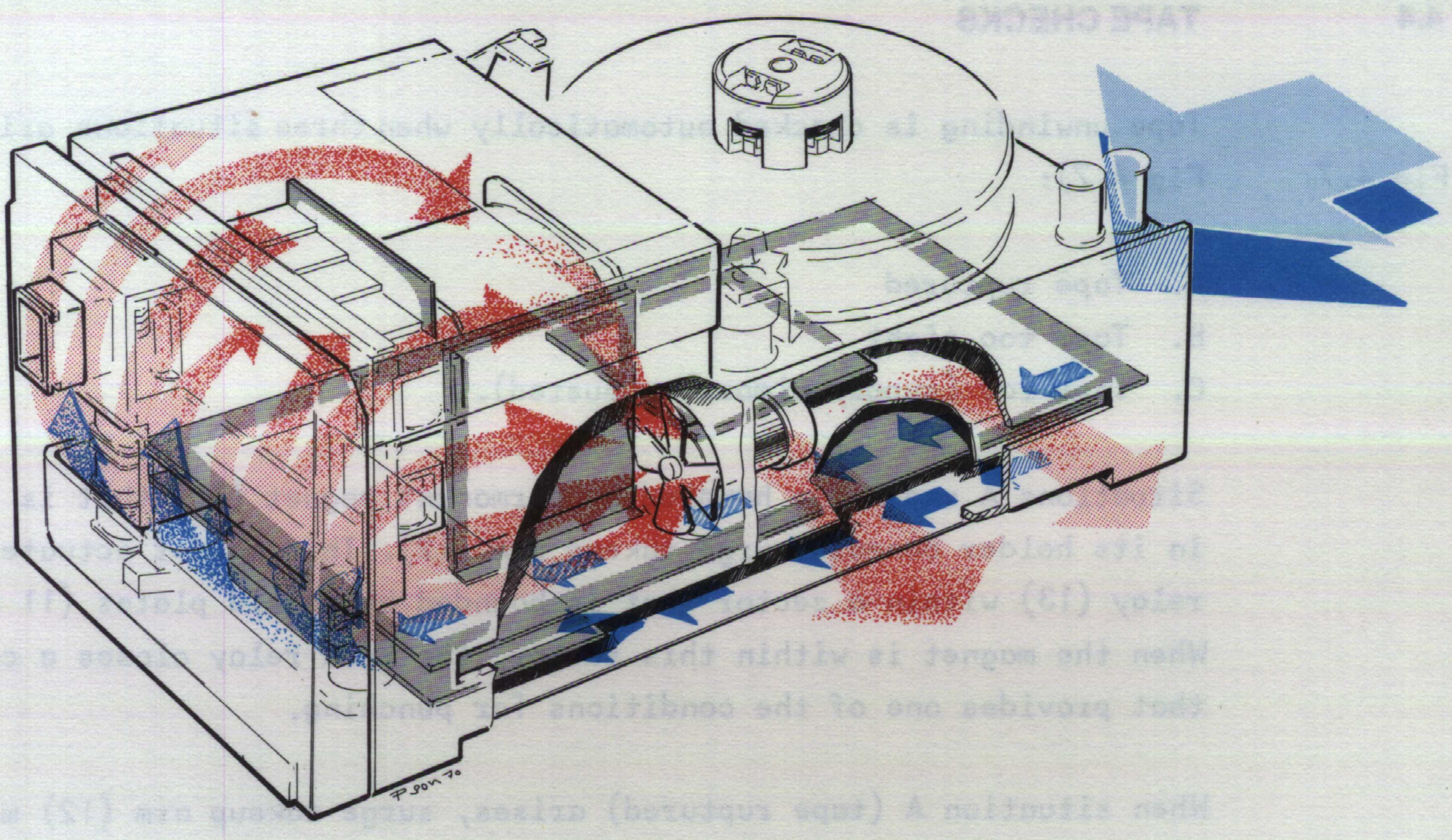


Fig 4.8 Path taken by cooling air

As the tape is unwound, the tape low sensor arm moves gradually toward the centre, taking with its arm (5). When magnet (17) reaches a certain point, reed relay (6) closes the circuit that lights the TAPE LOW lamp on the control panel. The tape low indication can be adjusted from 1,000 to 10,000 rows before end of tape using screw (3).

Loading position

To load a coil of tape, surge takeup arm (12) must first be secured against retainer magnet (10). This will move tape low sensor arm (16) to one side [via lever (9) and link (8)], thus providing room for the coil of tape. In addition, wire (7) will be tensioned, thereby swinging out reversing buffer arm (2) and lifting pinch roller (20) away from capstan (19) via lever (1).

At this position the punch components are ready for loading tape.

4.5 COOLING

The circuit boards and the punch/feed unit are cooled by the motor-driven fan. Cool air is drawn in from the rear of the punch and sweeps across both sides of the control circuit board and the bridging board or system adaptation board, whichever is in use. See Fig 4.8. Fig 4.8

When it reaches the punch/feed unit, the airstream is led past the punch solenoids and past the incremental motor. It then passes the fan motor and is blown out through crevices located on the two long sides of the punch.

Important: position the punch so that air can circulate freely to ensure satisfactory operation.

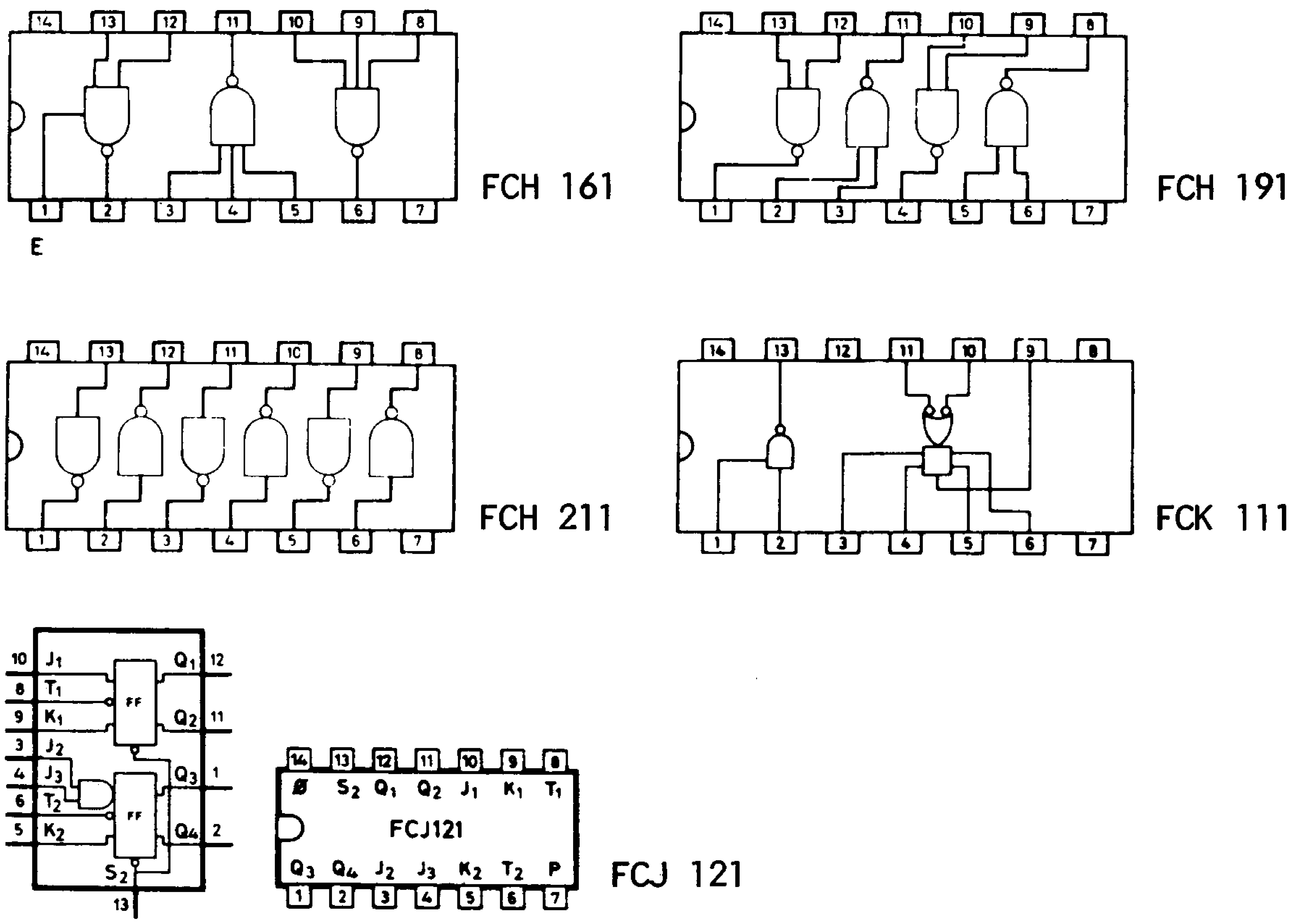


Fig 5.1 IC packages on the 4070. Logic diagrams and pin numbering

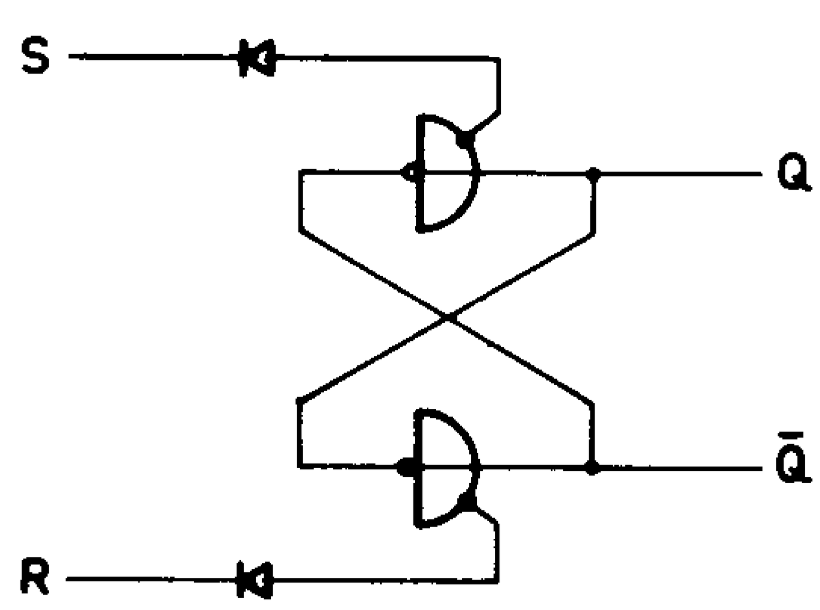


Fig 5.2 Circuit diagram of RS flip-flop with fan-in diodes

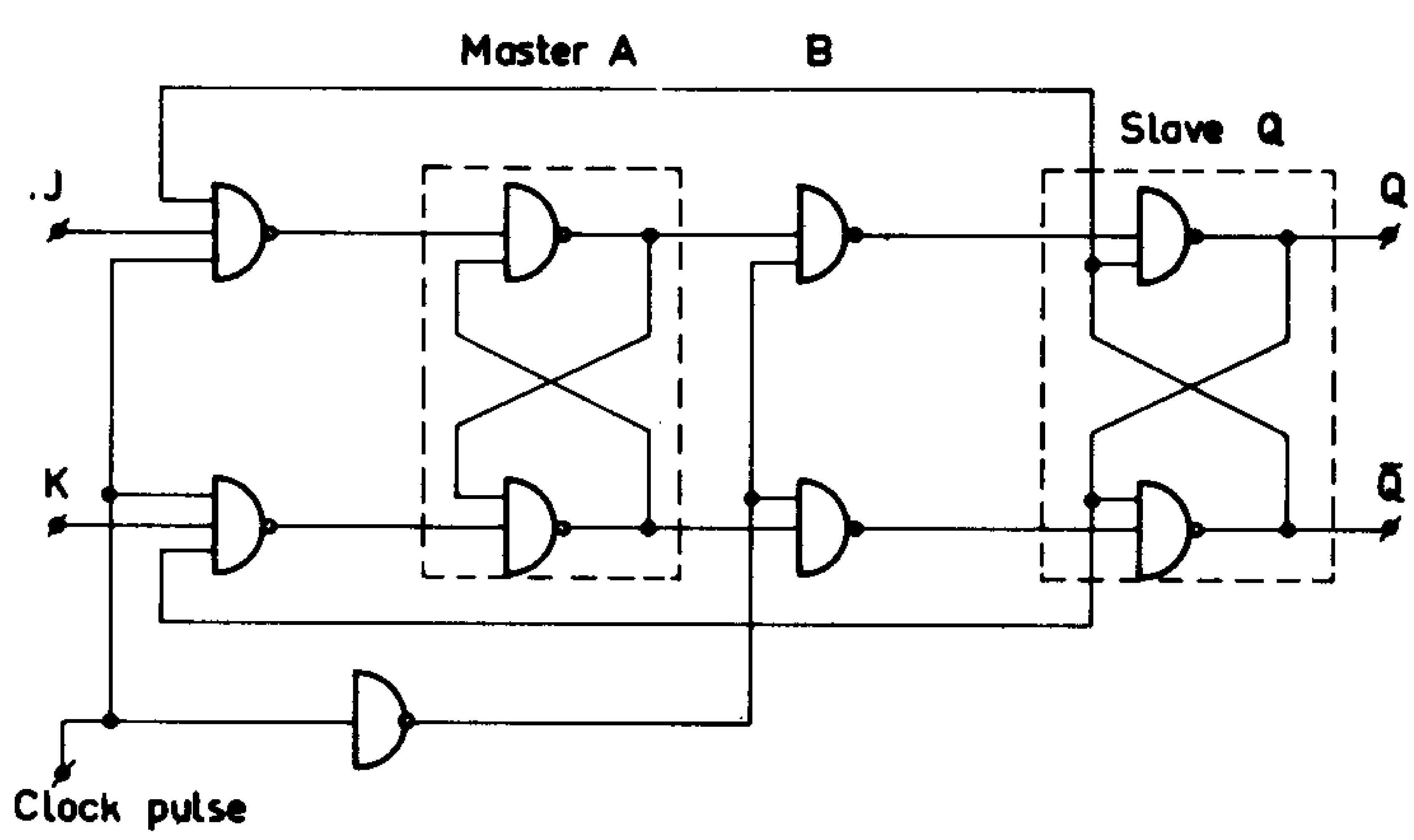


Fig 5.3 Circuit diagram of JK flip-flop

5 ELECTRICAL OPERATION

5.1 GENERAL

The logic circuits in the 4070 are built up of discrete components and IC packages. The voltage level of an active signal - a logical 1 - is positive.

5.1.1 Special circuits

Fig 5.1 The following types of integrated DTL circuits are used in the 4070. Fig 5.1 shows the logic diagrams and pin numbering.

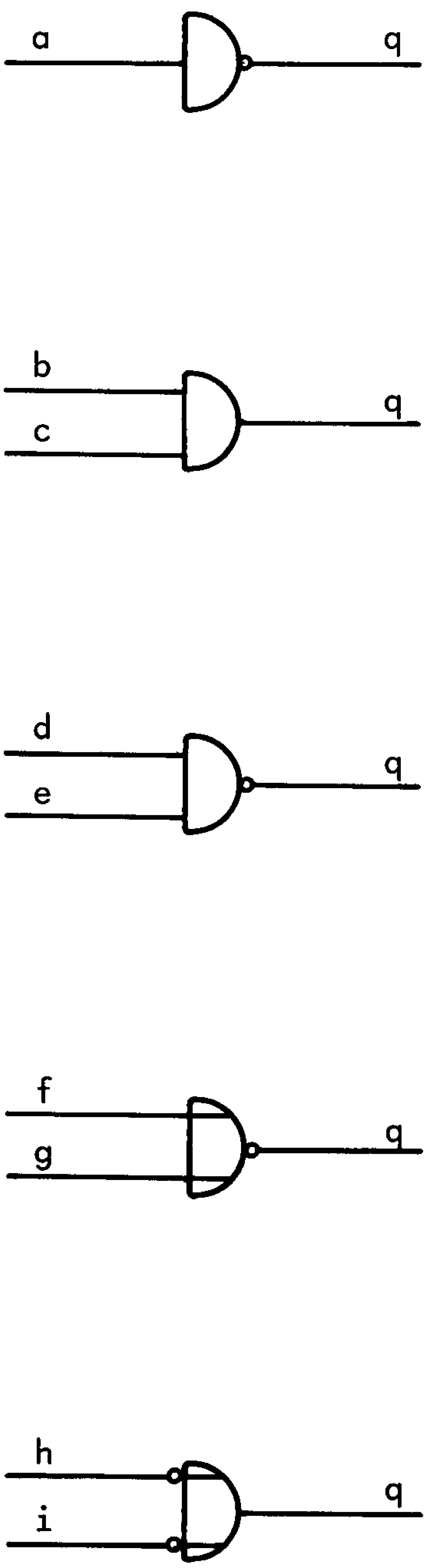
- Type FCH 161 Triple 3-3-2-input NAND gate with expander input
- Type FCH 191 Quadruple 2-input NAND gate
- Type FCH 211 Sextuple inverter
- Type FCK 111 Monostable flip-flop
- Type FCJ 121 Dual JK master-slave flip-flop

Three types of IC flip-flops are used in the 4070:

1. FCK 111 - monostable flip-flop
The FCK 111 package contains a threshold triggered monostable flip-flop and a NAND gate with expander input.

2. RS flip-flop
Fig 5.2 The RS flip-flop comprises two cross-coupled gates. See Fig 5.2. The letters S and R mean set and reset. This threshold-triggered flip-flop changes state when the 1-setting or 0-setting pulse goes low (0 V).

3. JK flip-flop of master-slave type
Fig 5.3 IC package FCJ 121 contains two JK flip-flops. See Fig 5.3. The JK flip-flop comprises two pairs of cross-coupled NAND gates. One pair serves as memory element A (master); the other as memory element Q (slave). These elements are connected via a pair of gates. In addition, there are two input-signal gates designated J and K. Output Q is fed back to gate K; output $\overline{Q}$ is fed back to gate J. The JK flip-flop can thus change state when signals are present at both inputs. The JK flip-flop is triggered by a clock pulse. It operates as follows:



a	b	c	d	e	f	g	h	i	q
H									L
L									H
	H	H							H
	H	L							L
	L	H							L
	L	L							L
			H	H					L
			H	L					H
			L	H					H
			L	L					H
					H	H			L
					H	L			L
					L	H			L
					L	L			H
							H	H	L
							H	L	H
							L	H	H
							L	L	H

Fig 5.4 Truth table for symbols used on logic diagram in Appendix 2 and on circuit diagram in Appendix 3

Assume that input J=1, input K=0 and output Q=0. The leading edge of the clock pulse provides the low level at the output of the J gate, and the master flip-flop is 1-set. Information is now stored in the master flip-flop, and the input signals can be removed without changing its state. The trailing edge of the clock pulse, together with signals from the master flip-flop, provides the low level at the output of gate B and 1-sets the slave flip-flop, i.e. Q=1. If Q had been 1 previously, neither the master nor the slave flip-flop would have had to change state for the input signals assumed above.

If, instead, inputs K=1 and J=0, the JK flip-flop will be 0-set. If both J and K=1, the JK flip-flop will change state each time a clock pulse arrives. In such case, the JK flip-flop is controlled only via outputs Q and $\overline{Q}$. If both J and K=0, the JK flip-flop cannot change state.

Briefly, the master-slave flip-flop functions as follows:

1. Master flip-flop is isolated from slave flip-flop
2. Master flip-flop changes state
3. Master flip-flop is isolated from J and K inputs
4. Slave flip-flop changes state

5.1.2 Logic symbols

Fig 5.4

Positive logic is incorporated into the logic diagram. Circuits within IC packages are represented by logic symbols (positive logic) appearing on the circuit diagram. Fig 5.4 illustrates the functions represented by the various logic symbols.

5.2 DESIGNATIONS

Ch 1 - 9	Data signals on channels 1 - 9 (Channel 9 is for feed hole track)
PI	Punch instruction signal
SD	Stepping direction signal
	SD_f - forward feed
	SD_b - backspacing
PR	Punch ready signal
ERR 1	Error 1 signal
ERR 2	Error 2 signal
TL	Tape low signal
EXT	External signal
TF	Timing signal for tape feed

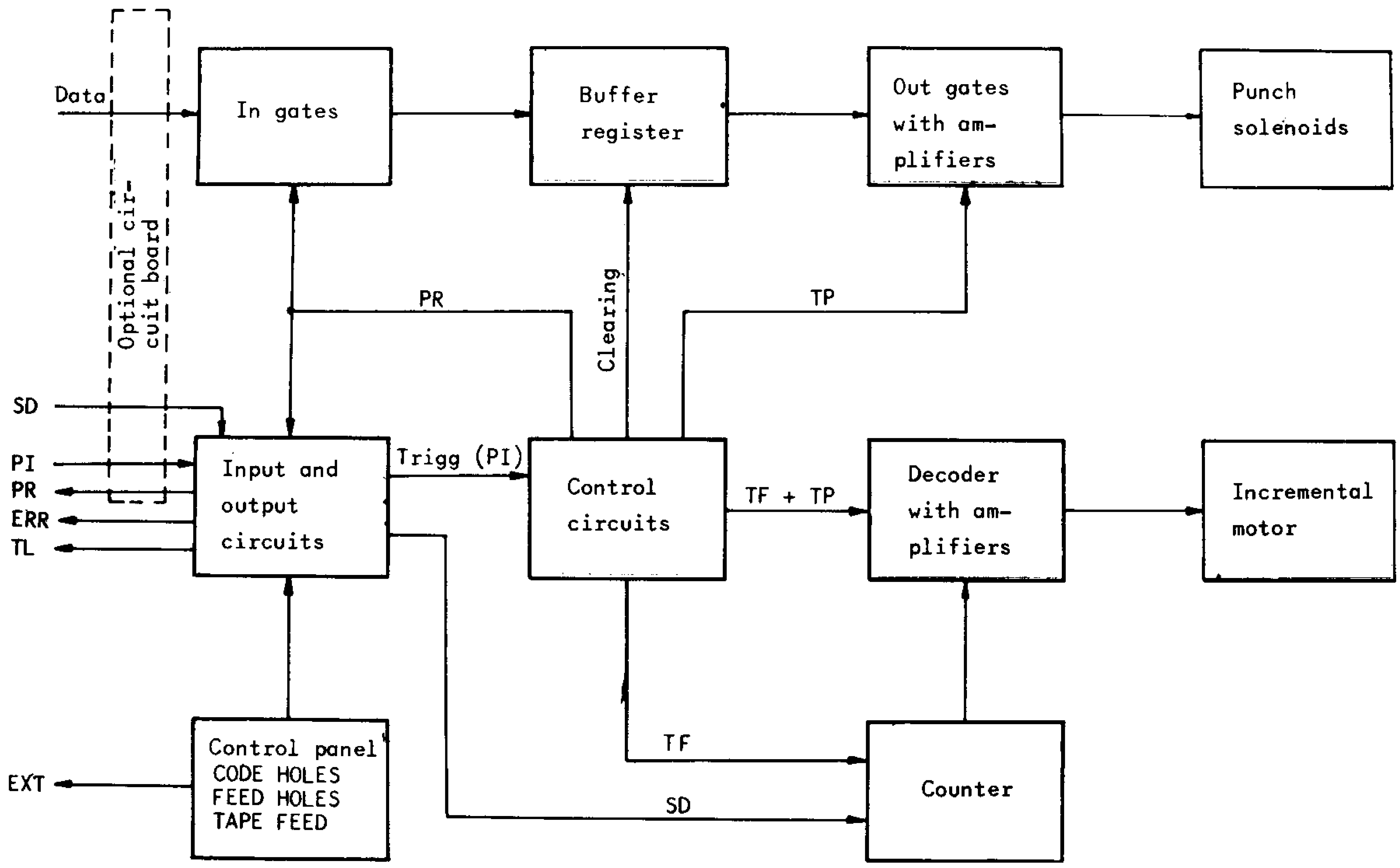


Fig 5.5 Block diagram of 4070

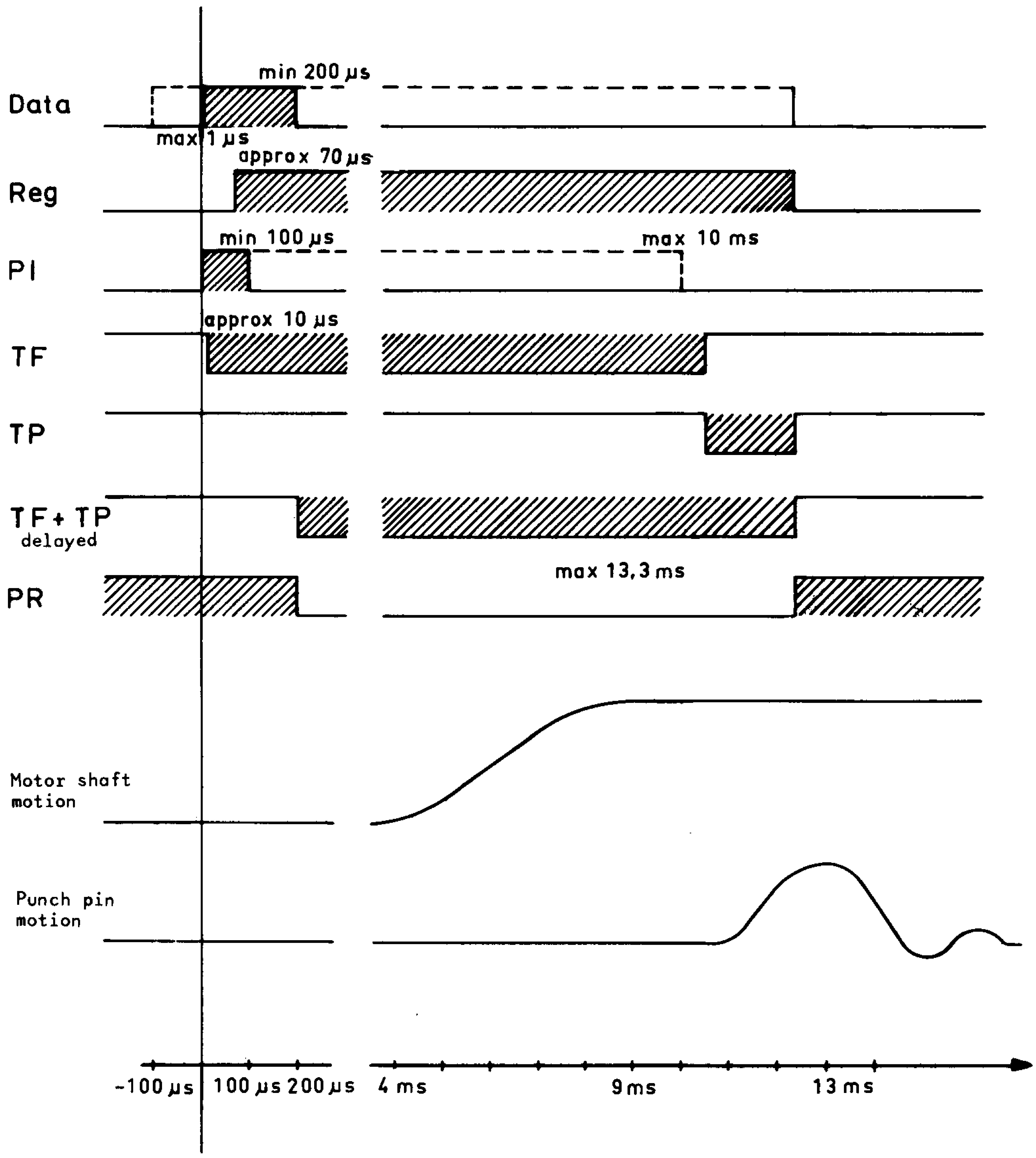


Fig 5.6 Timing diagram of punching cycle

TP	Timing signal for punching
FF-C1 and FF-C2	Counter flip-flops 1 and 2
MAN.FEED	Memory flip-flop for manual tape feed via control panel
LS	Level sensor flip-flop that monitors +24 V
PO	Power on signal

The logic description makes frequent references to the circuit diagram. IC elements mentioned in the description are designated by referring to their outputs. For example, the gate appearing belows is referred to as IC7/1 (pin 1 on IC package 7).

Insofar as possible, symbol designations on the logic diagram correspond to those used in the circuit diagram.

5.3 STARTING THE PUNCHING CYCLE

Fig 5.5

The logic circuits can be divided up into functional blocks as shown in Fig 5.5. The upper blocks represent the route taken by the data; the lower blocks represent the circuits used to control the incremental motor and data output. The data proceeds via input gates to the buffer register which can store one row of information. It then passes through output gates provided with amplifiers for the punch solenoids. The buffer register is cleared after each row is punched. The control circuits comprise timing flip-flops FF-TF and FF-TP (See Appendices 2 and 3) and a 2-bit counter. The output signal from the counter is decoded and used to gate stepping pulses to the incremental motor.

Fig 5.6

The punching cycle comprises two phases: feed and recording. See Fig 5.6. Feed takes place during time TF (approx 10.5 ms); recording takes place during time TP (approx 1.85 ms). Power is supplied to the incremental motor during the entire punching cycle TF + TP. The motor thus keeps the tape stationary while it is punched. 200 μs after the data is entered into the buffer register, signal PR goes low and remains low until the row has been punched.

Signal PI triggers FF-TF via gate V42. IC201/11 goes high simultaneously, and as a result a trigger pulse can proceed to counter flip-flops FF-C1 and FF-C2. The TF signal is differentiated and triggers the counter flip-flops via IC6. When the PI signal vanishes, the inputs to the counter flip-flops are blocked, thus eliminating the effects of any unwanted pulses.

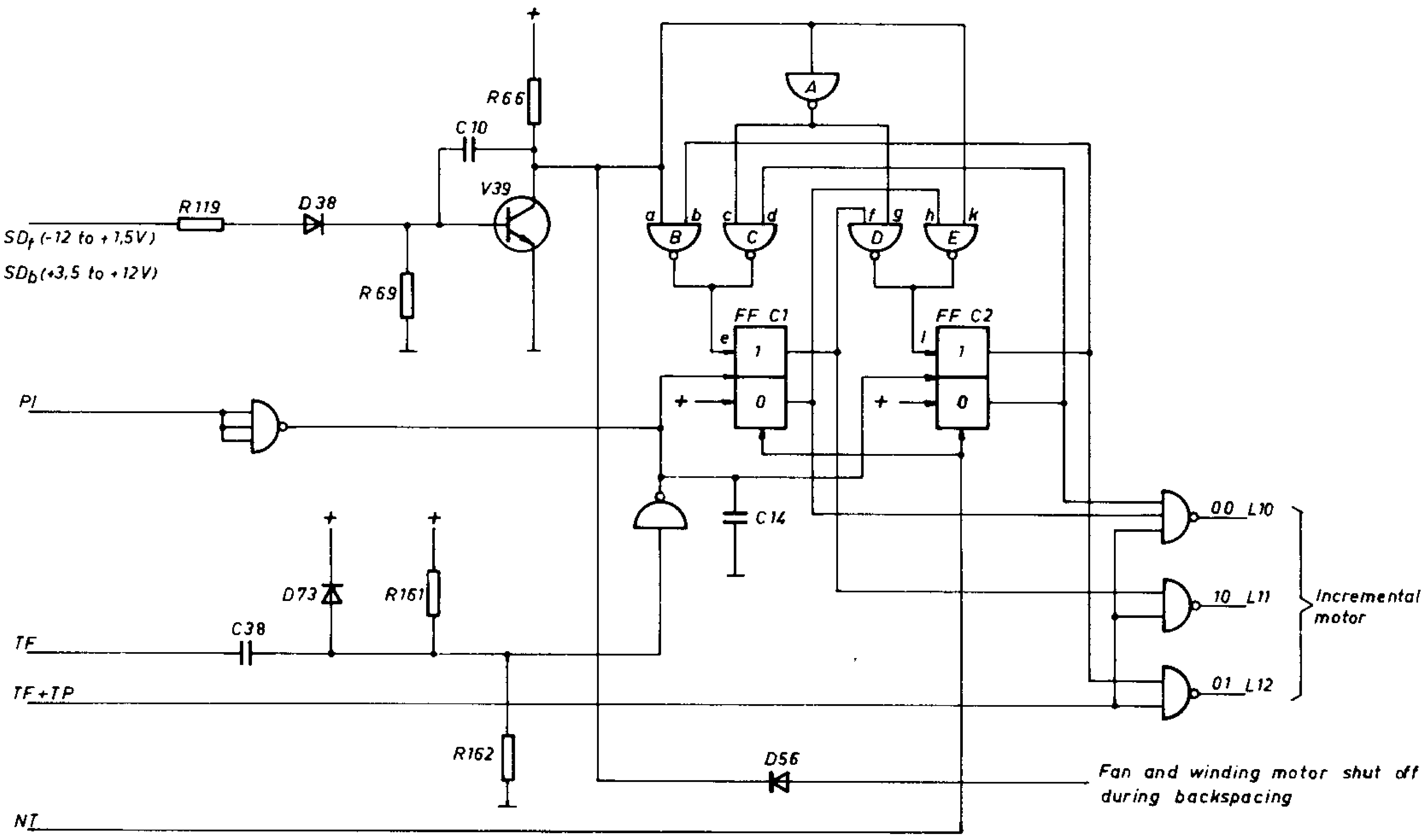


Fig. 5.7 Circuit diagram of incremental motor counter

When FF-TF is triggered, test point S goes high. Transistor V45 therewith becomes conducting and gates out the signal from V42 via diode D45. Consequently, PI cannot trigger FF-TF again before the punching cycle is completed, i.e. when test point S goes low. Capacitor C35 located between the base and collector of V42, prevents signals having a duration of less than about 10 us from starting a punching cycle. When the collector of V45 goes low, the register inputs are opened and the character that is to be punched is entered into the register. Register flip-flops that are 1-set receive holding current via feedback resistors R10 - R18. 0-setting takes place when V45 is cut off.

Signal TF also triggers timing flip-flop FF-A1 which, in turn, triggers timing flip-flop FF-A2. The purpose of these flip-flops is to keep signal PP low for 13.3 ms, thus limiting the punching speed to 75 characters per second.

The signal from the timing flip-flops proceeds via OR circuit IC201 and a 200 µs delay circuit to transistor V43. V43 becomes conducting and gates out data signals via diodes D1 - D9. Simultaneously, the gate used for the PI signal is closed via diode D46, and transistor V38 becomes conducting. The PR signal goes low and remains low during the entire punching cycle.

During time TF (and TP) the incremental motor steps one increment. See section 5.4 below.

When flip-flop FF-TF returns to the 0 state, flip-flop FF-TP is triggered. The TP signal (0 V) cuts off transistor V40, wherewith diodes D28 - D36 are blocked and the information in the register is gated to the punch solenoids. When FF-TP returns to the 0 state, V45 is cut off, wherewith the register is 0-set. When FF-A2 returns to the 0 state, V43 is cut off, wherewith signal PR goes high, thus indicating externally that the punch is ready to receive and punch a new character.

5.4 INCREMENTAL MOTOR CONTROL

The incremental motor windings receive signals from 2-bits counter FF-C1 and FF-C2. These signals are decoded in gating system IC1/6, IC4/1 and
Fig 5.7 IC4/11. The signals are gated out during times TF + TP. See Fig 5.7.

Flip-flops FF-C1 and FF-C2 are JK flip-flops. The way in which they operate is described in section 5.1.1. The counter is triggered by the leading edge of signal TF. It can count to 3, either up or down, depending on the polarity of condition SD. For forward feed, the counter assumes states 10, 01, 00, 10 etc. As a result, the windings in the in-remental motor are energized in ascending sequence L11, L12, L10 etc. For backspacing, the counter assumes states 01, 10, 00, 01 etc. Consequently, the windings are energized in descending sequence L12, L11, L10 etc. See tables on page 5.5

Table 1 - forward feed (10, 01, 00)

Trigger pulse (TF)	Condition a b e	State of FF-C1	Condition h k l	State of FF-C2	Energized motor winding
1	H L H	0	H H L	0	L10 *) initial pos.
2	H L H	1	L H H	0	L11
3	H H L	0	H H L	1	L12
4	H L H	0	H H L	0	L10 initial pos.
5	H L H	1	L H H	0	L11

H = high level. L = low level.
Gates C and D are blocked during forward stepping, SD_f, (inputs c and g obtain the low level via inverter A). This means that the polarity at points e and l is determined by the output signals from gates B and E respectively.
*) When the counter is at its initial state (00) the motor is at its L10-energized position. The motor thus steps to its L11-energized position when the trigger pulse 1 changes the counter state to 10.

Table 2 - backspacing (01, 10, 00)

Trigger Pulse (TF)	Condition c d e	State of FF-C1	Condition f g l	State of FF-C2	Energized motor winding
1	H H L	0	L H H	0	L10 initial pos.
2	H L H	0	L H H	1	L12
3	H H L	1	H H L	0	L11
4	H H L	0	L H H	0	L10 initial pos.
5	H L H	0	L H H	1	L12

Pulses from the counter are sent via the amplifier (V49 - V51) to a) the incremental motor which steps one increment for each pulse and b) the winding motor and fan motor via the pulse-prolonging circuit C24 and R113. For backspacing diode D56 becomes conducting via transistor V39, whereupon power to the winding motor and fan motor is shut off.

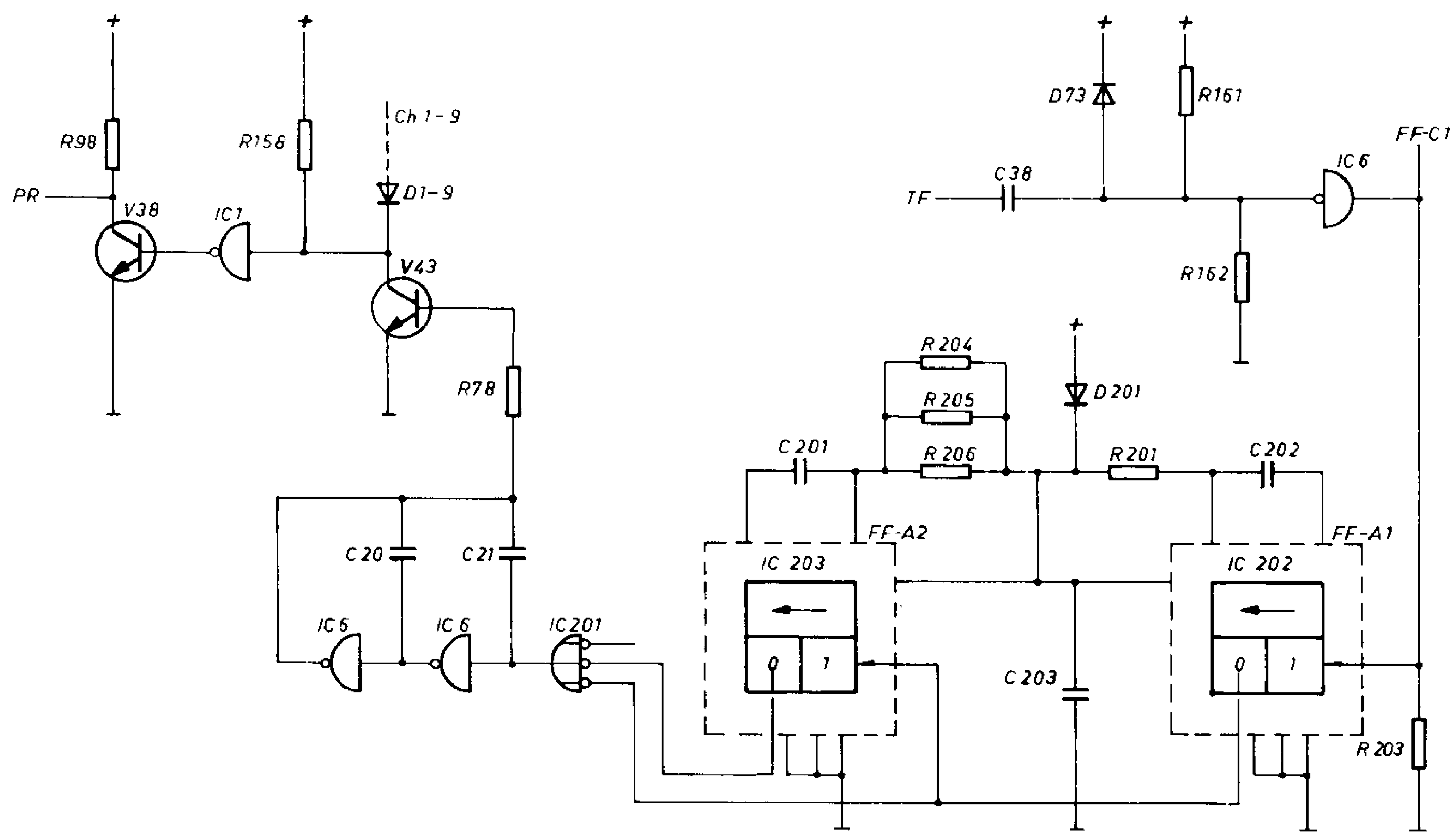


Fig 5.8 Circuit diagram, max. velocity control

Stepping to the initial position

When the power is turned on, the counter flip-flops are always set to state 00 by "power on" circuit V 65. State 00 - the initial state- corresponds to the L10-energized position of the incremental motor.

The position of the incremental motor when the power is turned off is unpredictable. To prevent a backspace when starting up, it is necessary to step the motor to its initial position when the power is turned off. This is accomplished as follows:

When the +24 V supply drops beneath approx +19.0 V, the level monitor flip-flop V56 and V57 is 1-set, whereupon the level at test point T becomes high. Transistor V43 thereupon becomes conducting and gates out data signals and PI signals via diodes D1 - D9 and D46. In addition, one condition is met at gate IC7/8. The gate opens if the counter is at state 10 or 01, herewith 1-setting the MAN.FEED flip-flop via diode D41 and 1-setting buffer register flip-flop 9 via diode D67. This flip-flop is for the feed hole track. Flip-flop FF-TF is triggered via gate IC7/1 when the MAN.FEED flip-flop is 1-set. The incremental motor steps until the counter has reached state 00, after which gate IC7/8 is blocked when the output of gate IC4/4 goes low. When the last punching cycle is finished, the voltage at test point S goes low, and as a result the MAN.FEED flip-flop is 0-set via diode D51. The shutting off of the DC voltage (see section 5.9.1) is inhibited while the motor is being stepped to its initial position. The incremental motor and DC voltage regulator are supplied from filter capacitors C1 and C2 in the power supply during this inhibition interval. See Fig 3.1 and Appendix 4.

5.5 PUNCHING THE MARK CHARACTER

Fig 5.8

The mark character is programmed using diodes D19 - D27 on the control circuit board (see Fig 5.8). Tape punched with the mark character is fed out when the CODE HOLES button is depressed. This 1-sets the flip-flops corresponding to the mark character bits in the buffer register and also 1-sets the MAN.FEED flip-flop, wherewith the counter and motor are stepped in the aforesaid manner.

When the MAN.FEED flip-flop is 1-set, diode D55 is cut off. Transistor V47 then obtains base current from the common point in the motor amplifiers via R102, D52, R111 and D54. When the motor pulse has vanished, capacitor C23 discharges via R111 and D54, and as a result V47 is kept conducting for approx an additional 7 ms. The signal from the collector of V47 triggers FF-TF and the counter via gate IC7/1, whereupon a new punching cycle commences. The punching speed is approx 50 rows per second.

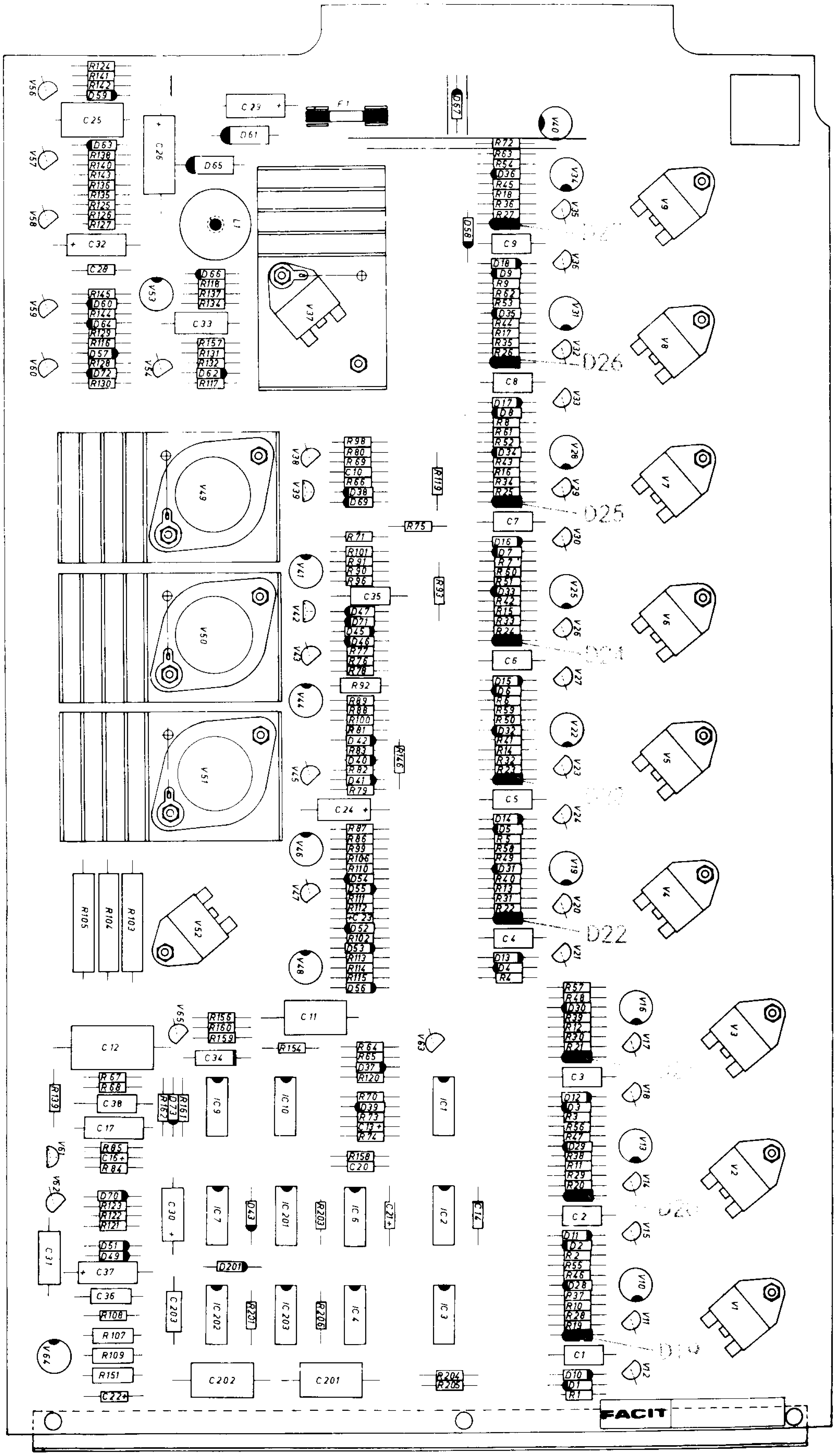


Fig 5.9 Control circuit board Facit 4070

5.5.1 Coding the mark character

The control circuit board is programmed for an all-hole mark character at the factory (usually used as a delete charater to overpunch erroneous rows). If some other mark character is desired, the circuit board must be re-programmed. This is accomplishedby removing diodes for the tracks where no hole is to be punched.

The nine tracks are programmed using the following diodes:

Track	1	corresponds	to	diode	D19
"	2	"	"	"	D20
"	3	"	"	"	D21
"	4	"	"	"	D22
"	5	"	"	"	D23
"	6	"	"	"	D24
"	7	"	"	"	D25
"	8	"	"	"	D26
"	9	"	"	"	D27

The location of these diodes on the control circuit board is shown in
Fig 5.9 blue in Fig 5.9.

5.6 FEEDING OUT BLANK TAPE

Blank tape (feed holes only) is fed out when the FEED HOLES button is depressed. This operation is identical with mark character punching with one exception: only buffer register flip-flop 9 is 1-set (via diode D67).

5.7 FEEDING OUT VIRGIN TAPE

Virgin tape (no holes at all) is fed out when the TAPE FEED button is depressed. The feed operation is the same as for mark character punching.

5.8 TAPE CHECKS

Tape unwinding is checked with regard to:
1. Tape ruptured - provides tape error indication
2. Tape too tight - provides tape error indication
3. Tape about to run out - provides tape low indication

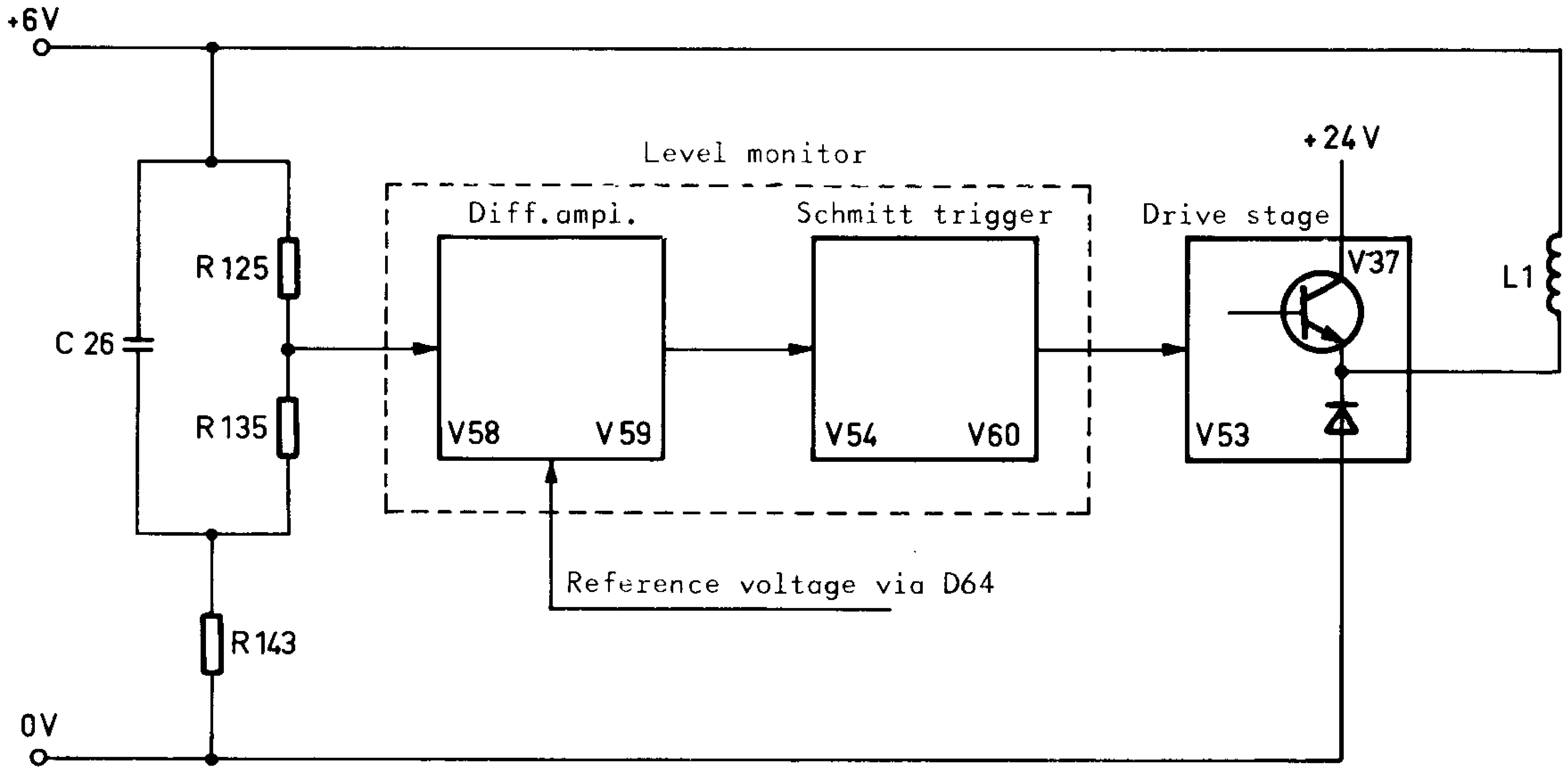


Fig 5.10 Schematic diagram of DC voltage regulator

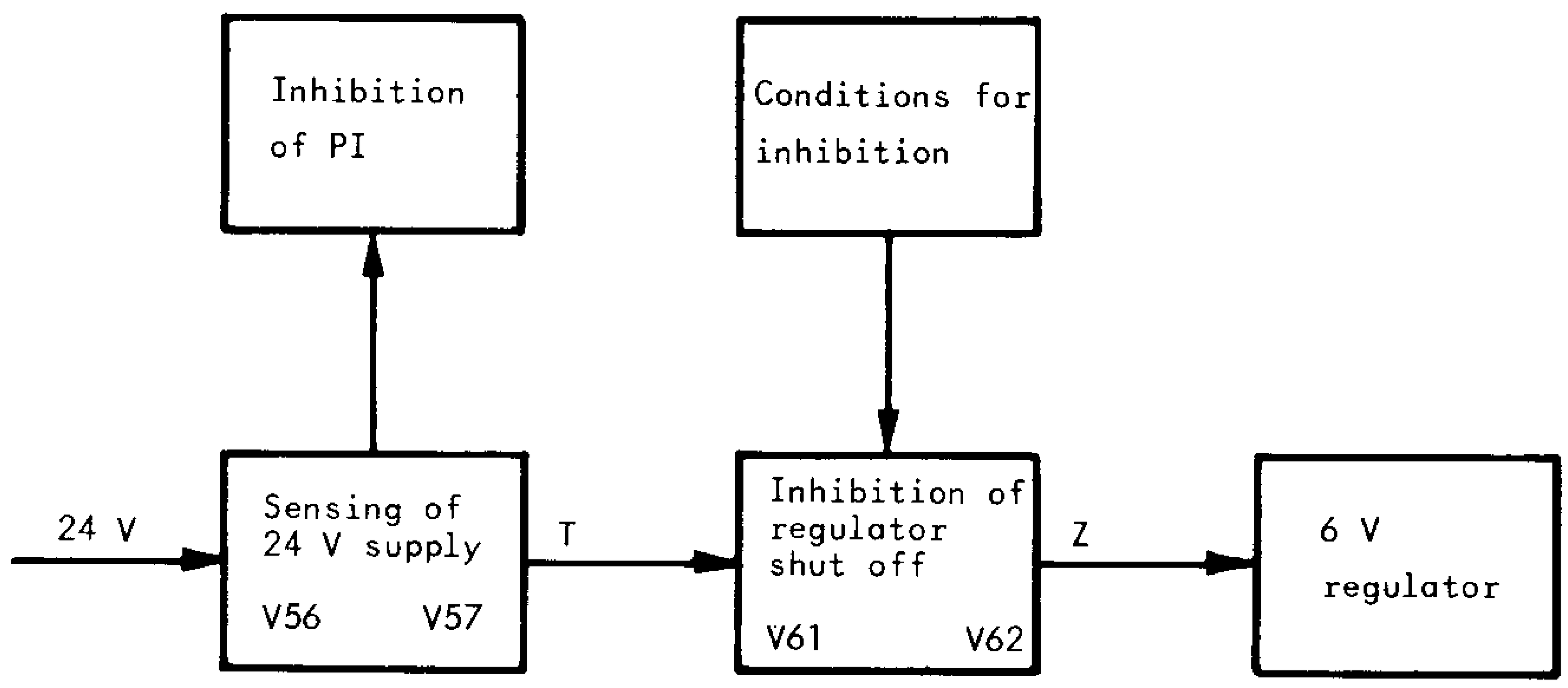


Fig 5.11 Block diagram for regulator shut off inhibition

If the tape breaks or is under too much tension, reed relay S8 opens (see Appendix 2, lower left-hand corner). Since base current can flow through R108, transistor V64 becomes conducting, whereupon the ERROR lamp on the control panel is supplied with current via pin A17. Signal PR goes low, thus indicating that the punch is not ready for punching.

Reed relay S9 closes when the tape is about to run out, whereupon the TAPE LOW lamp on the control panel lights.

5.9 DC VOLTAGE REGULATOR

Fig 5.10 The DC voltage regulator generates and regulates the +6 V supplied to the logic circuitry. See schematic diagram in Fig 5.10. In principles the +24 V supply is switched on and off at a rate that provides the desire +6 V.

The regulator comprises a level monitor made up of differential amplifier V58 and V59 and Schmitt trigger V54 and V60 together with a drive stage V37 and V53. The drive stage is supplied with +24 V from the power supply. The level monitor controls the drive stage by sensing +6 V via resistor bridge R125, R126, R135 and R136. Capqcitor C26 and resistor R143 are connected up in parallel across the +6 V load. When the voltage across this circuit drops just below +6 V, the drive stage is actuated via the level monitor. (R143 senses rapid variations in the output voltage). Current through the drive stage and coil L1 charges capacitor C26, and when the voltage across C26 rises to approx +6 V the drive stage is cut off. The pulse frequency of approx 35 kHz varies somewhat with the load.

5.9.1 DC voltage regulator shutoff

The DC voltage regulator for +6 V is shut off when the +24 V supply drops beneath approx +19.0 V. Voltage is sensed by transistors V56 and V57. When the voltage at the base of V56 drops beneath approx +5.5 V, V56 (and therewith V57) become conducting. The voltage at test point T goes high
Fig 5.11 and cuts off the differential amplifier via diode D63. See Fig 5.11. If the +24 V supply drops while a punching cycle is under way or while the incremental motor is not at its initial position, voltage shutoff is inhibited until the punching cycle has been completed and the counter reaches its initial position. The inhibition circuit comprises transistors V61 and V62. For inhibition, V61 becomes conducting and blocks diode D63. When inhibition ceases, V61 is cut off. V62 then becomes conducting and helps to cut off V61.

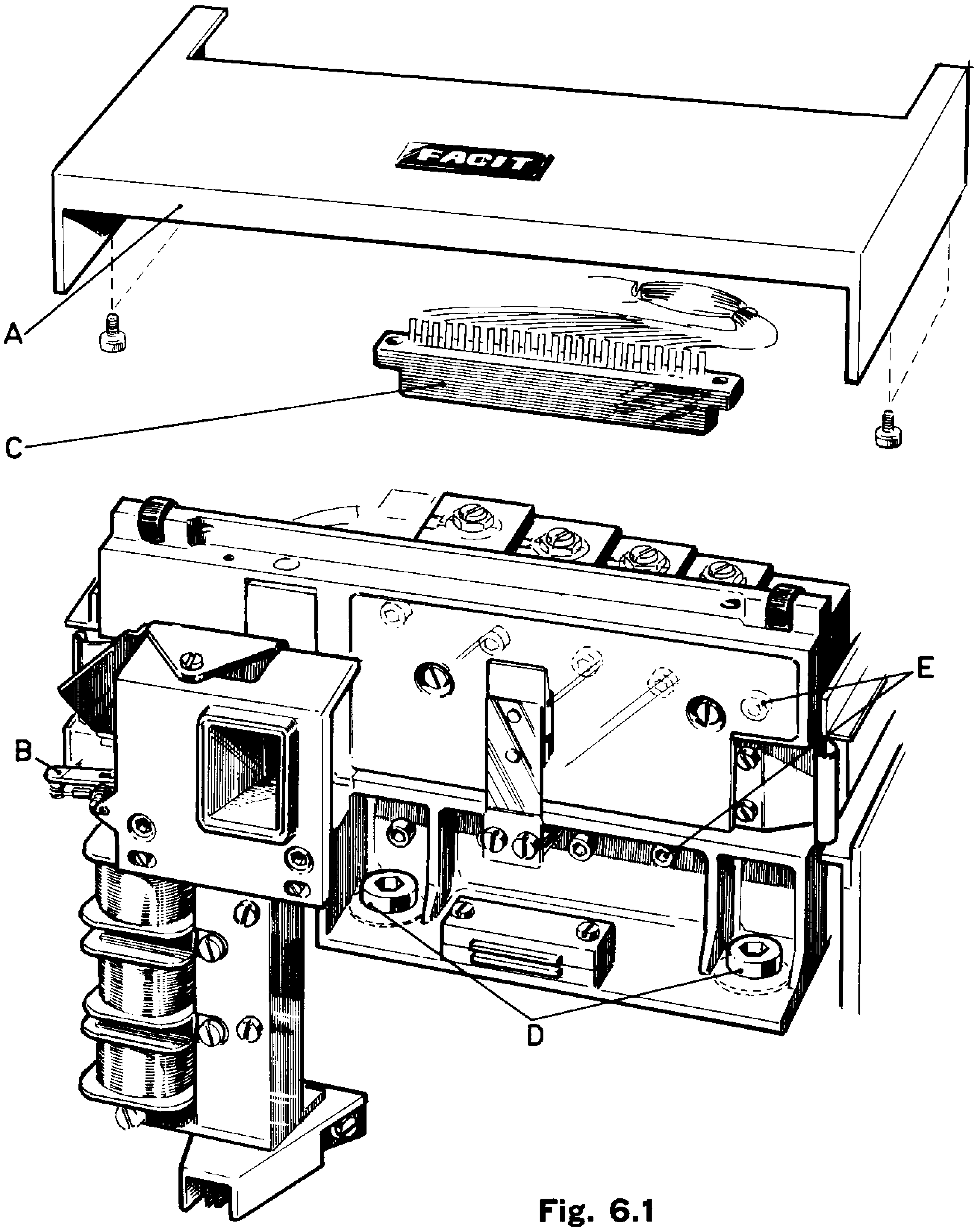


Fig. 6.1

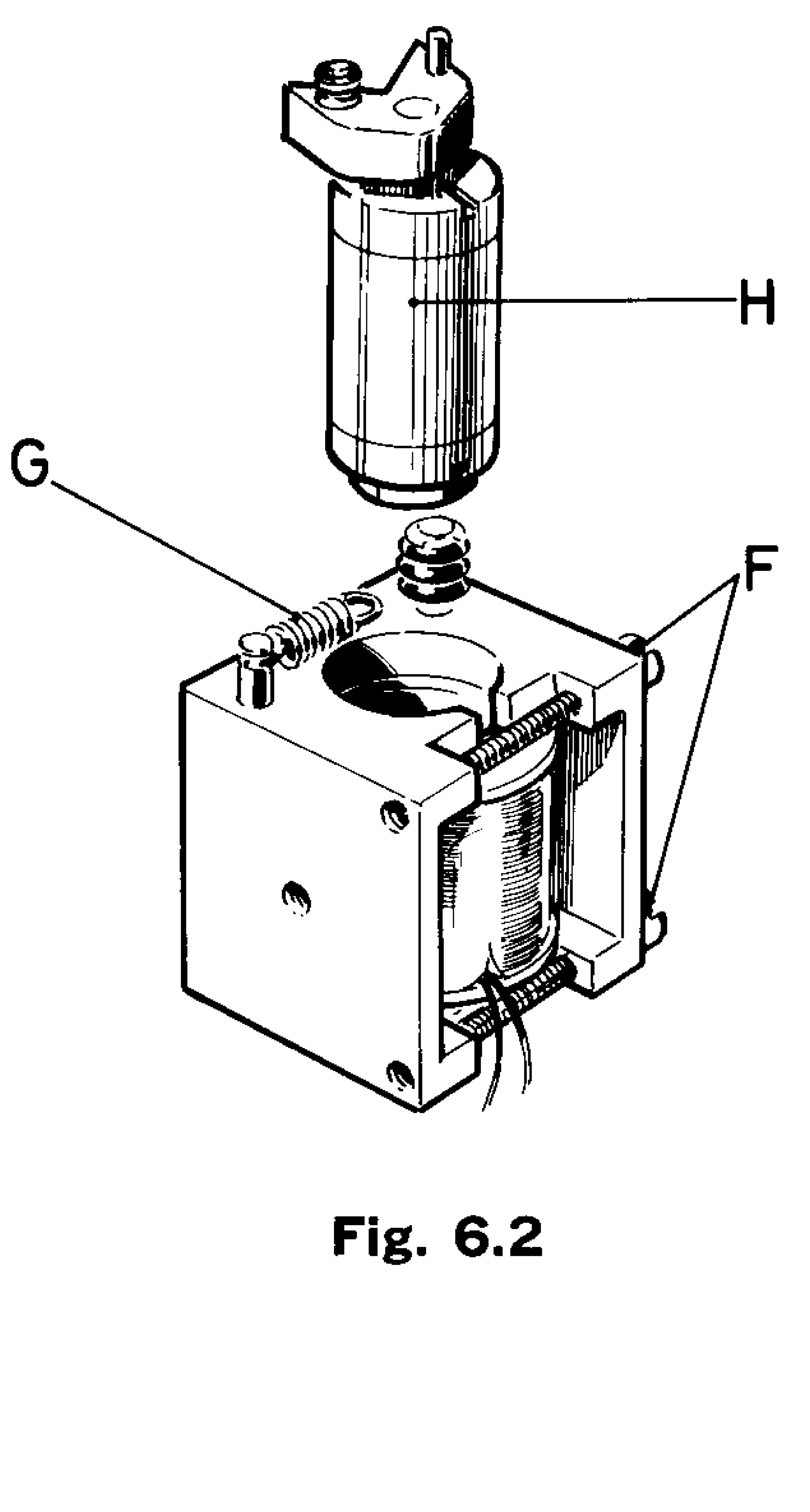


Fig. 6.2

6 SERVICE

The chapter on service is divided into five sections: MECHANICAL CHECKS AND ADJUSTMENTS, CHECKING PRINTED CIRCUIT BOARDS, FAULT TRACING, PERIODIC SERVICING and LUBRICATION INSTRUCTIONS.

Section 6.1 is written in the imperative mood. The steps to be taken are numbered and refer to a particular illustration. The number of the illustration (Fig) appears in the left-hand margin. It is intended that this section is used as a reference when consulting the fault tracing and periodic servicing sections.

The special tools and instruments needed to service the 4070 are listed in Chapter 10 of the spare parts catalogue. Here they are numbered, using Roman numerals.

6.1 MECHANICAL CHECKS AND ADJUSTMENTS

A. Removing punch/feed unit

Fig 6.1

1. Unscrew and remove protective cover A.
2. Unhook the wire from arm B.
3. Remove connector C from the punch/feed unit.
4. Remove screws D and carefully lift out the punch/feed unit.

B. Disassembling and checking punch solenoid

1. Remove retaining screw E for the solenoid(s) that are to be checked.

Fig 6.2

2. Loosen screws F.
3. Unhook spring G and press out solenoid armature H.
4. Check that the spring attachments are not defective.
   Remedy: Replace the spring attachments.

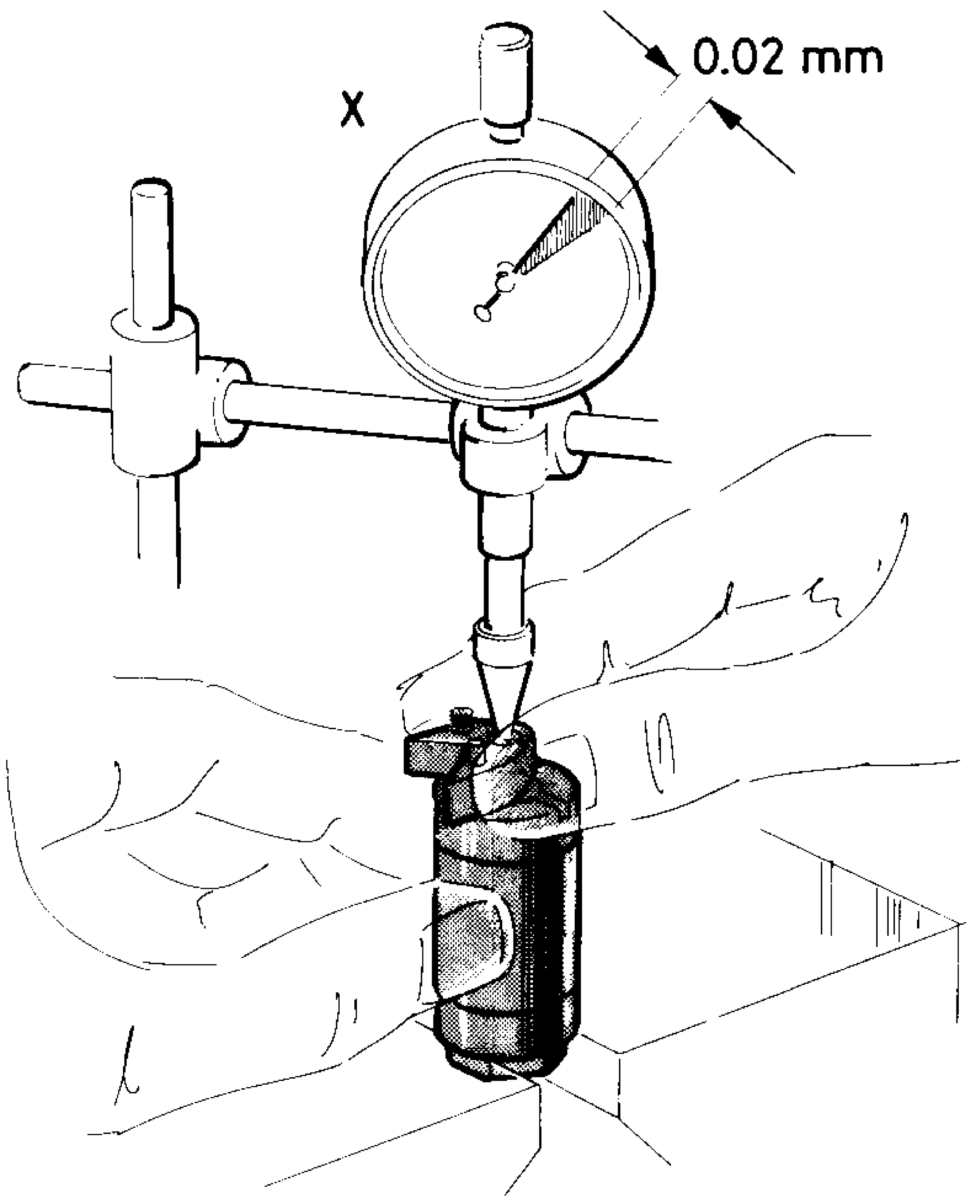


Fig. 6.3

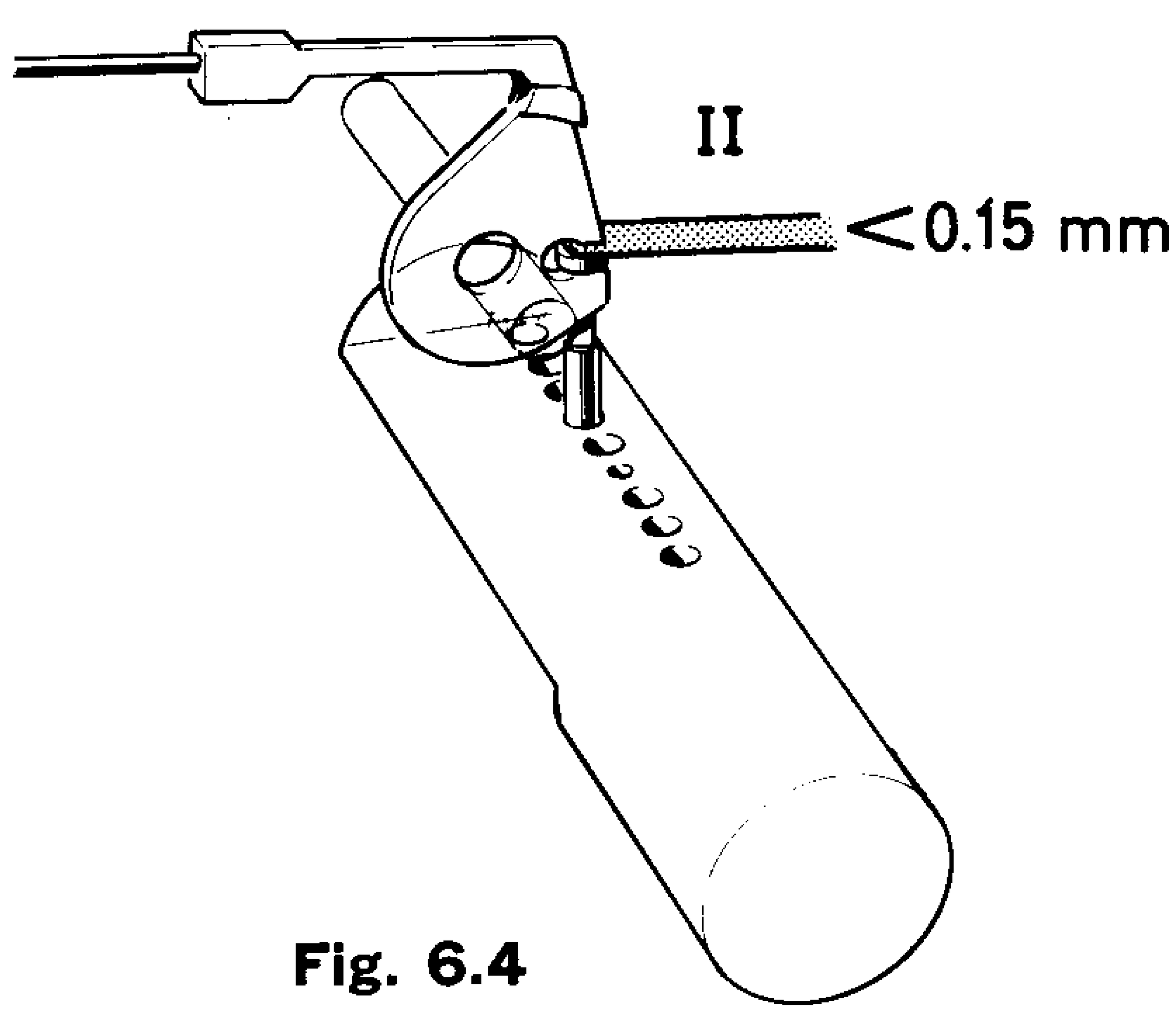


Fig. 6.4

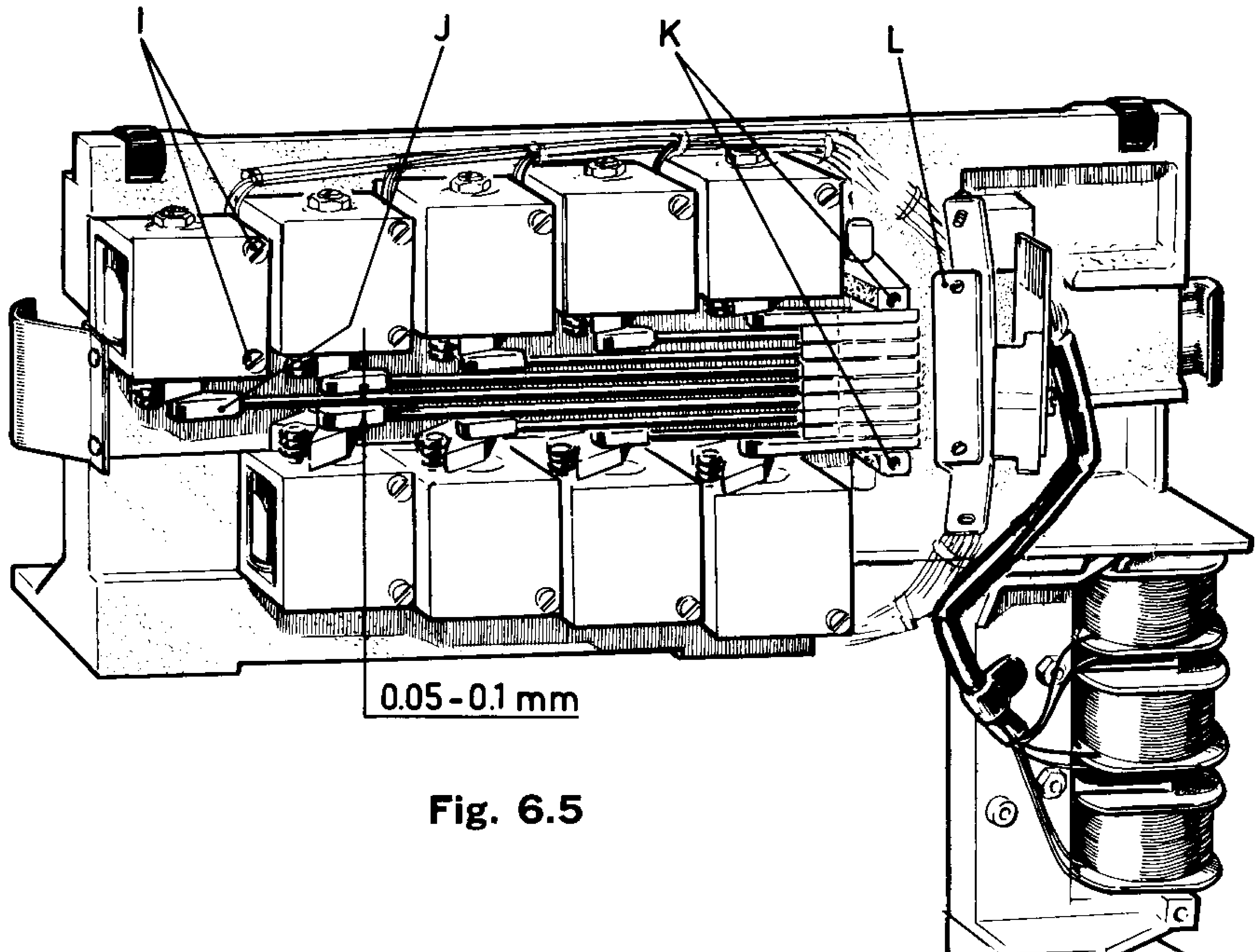


Fig. 6.5

Fig 6.3

5. Check that the axial play does not exceed 0.02 mm.
   Remedy: Replace solenoid armature.
6. Check that the actuator rotates easily and that it does not bind when depressed.
   Remedy: Replace solenoid armature.
7. Check that the spring eyes G are not defective.
   Remedy: Replace the spring G.

C. Assembling punch solenoid

1. Press the solenoid armature into the solenoid.
2. Hook spring G in place making certain that the spring eyelets assume the correct positions in the slots on the spring attachments.

D. Checking punch pin drivers

Fig 6.4

1. Using feeler gauge II, check that the play between the punch pins and the punch pin drivers is less than 0.15 mm.
   Remedy: Replace punch pin drivers having excessive play and defective punch pin drivers.

E. Replacing punch pin drivers

Fig 6.5

1. Remove the punch solenoid for the punch pin driver that is to be replaced.
2. Loosen stop screws K for the punch pin driver shaft and press out the shaft. These stop screws are accessible after bracket L has been removed.
3. Replace the punch pin driver.
4. Press in the punch pin driver shaft, tighten stop screws K and replace bracket L.
5. Carry out steps F1 through F10 (see below).

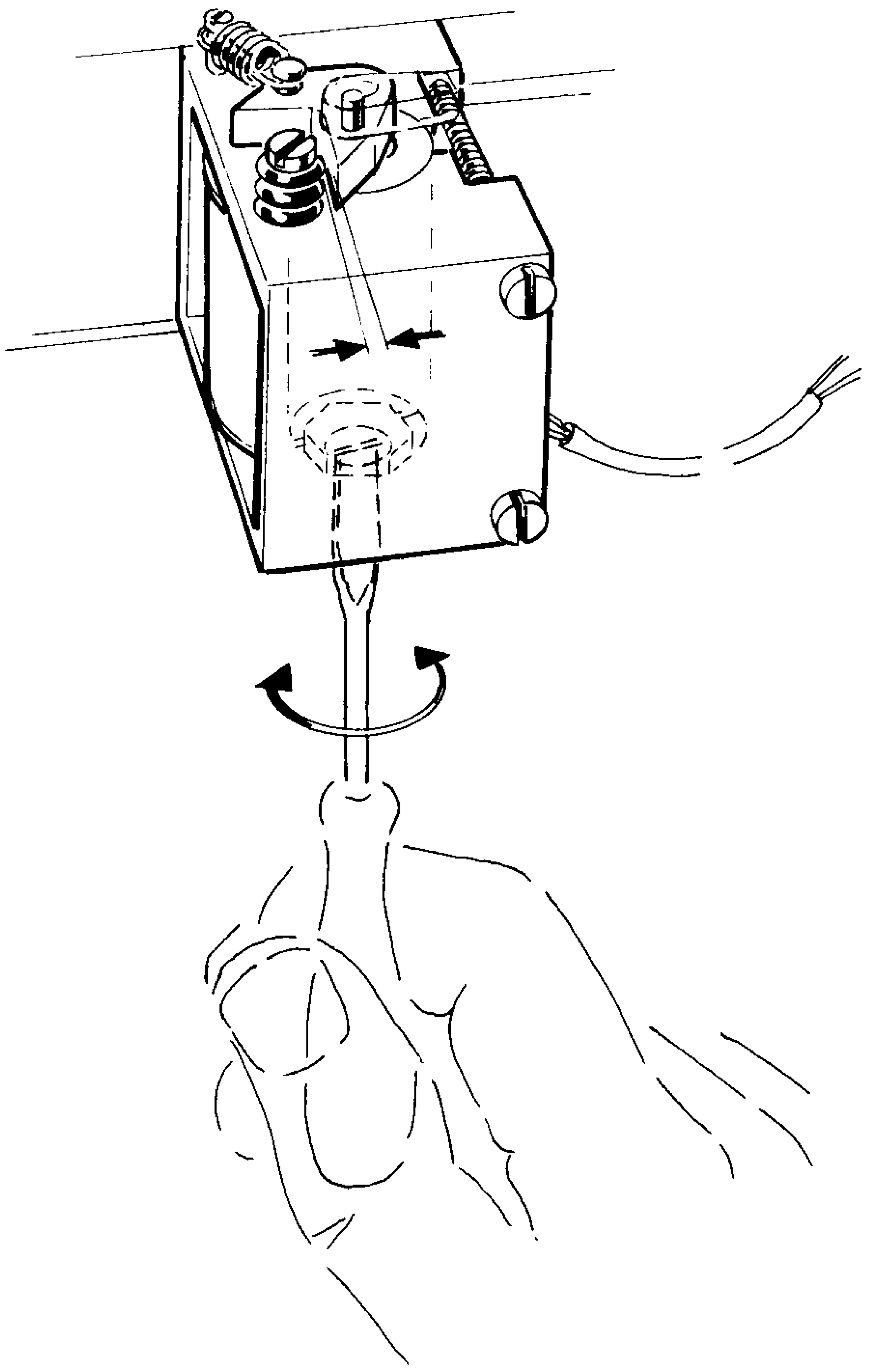


Fig. 6.6

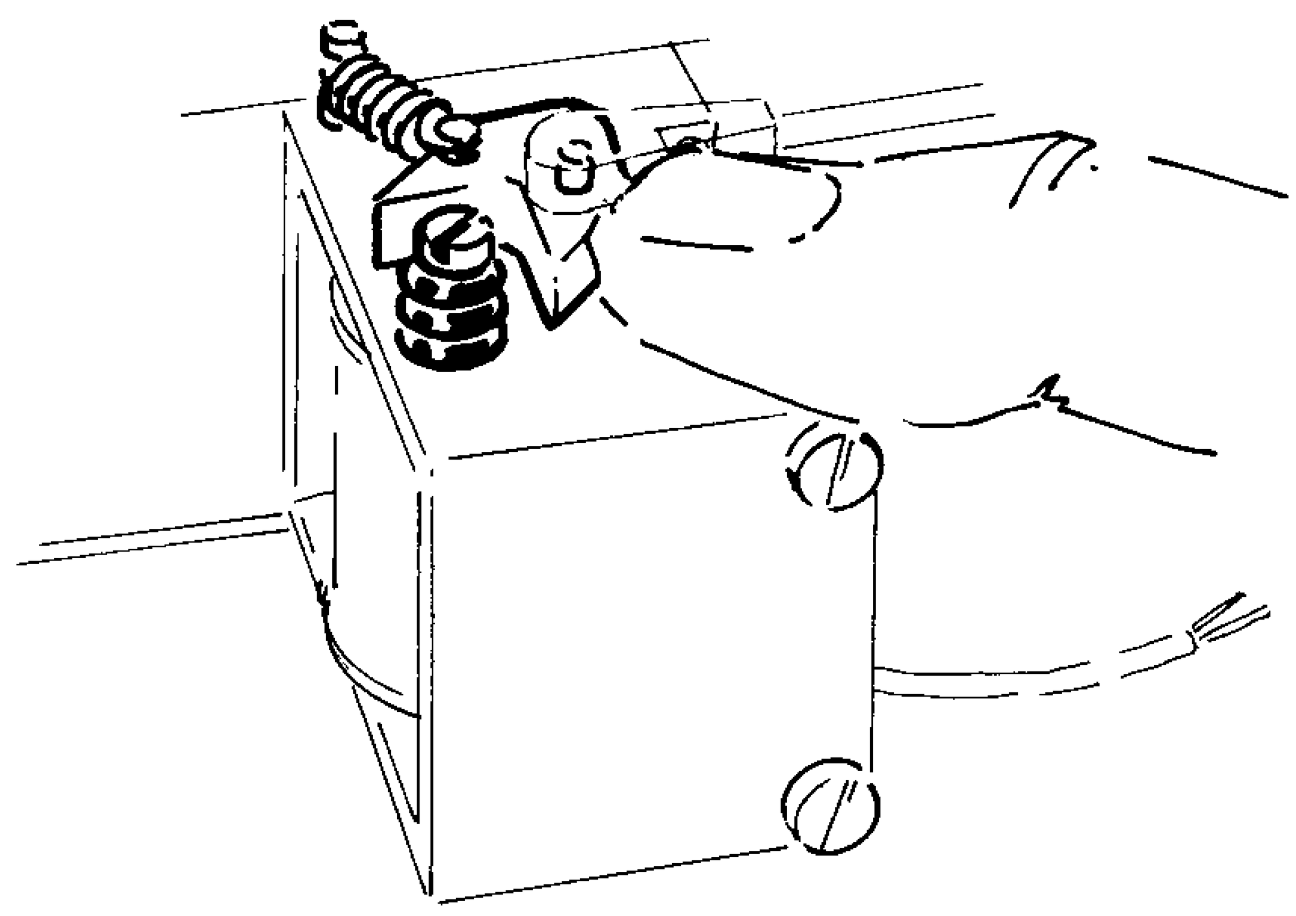


Fig. 6.7

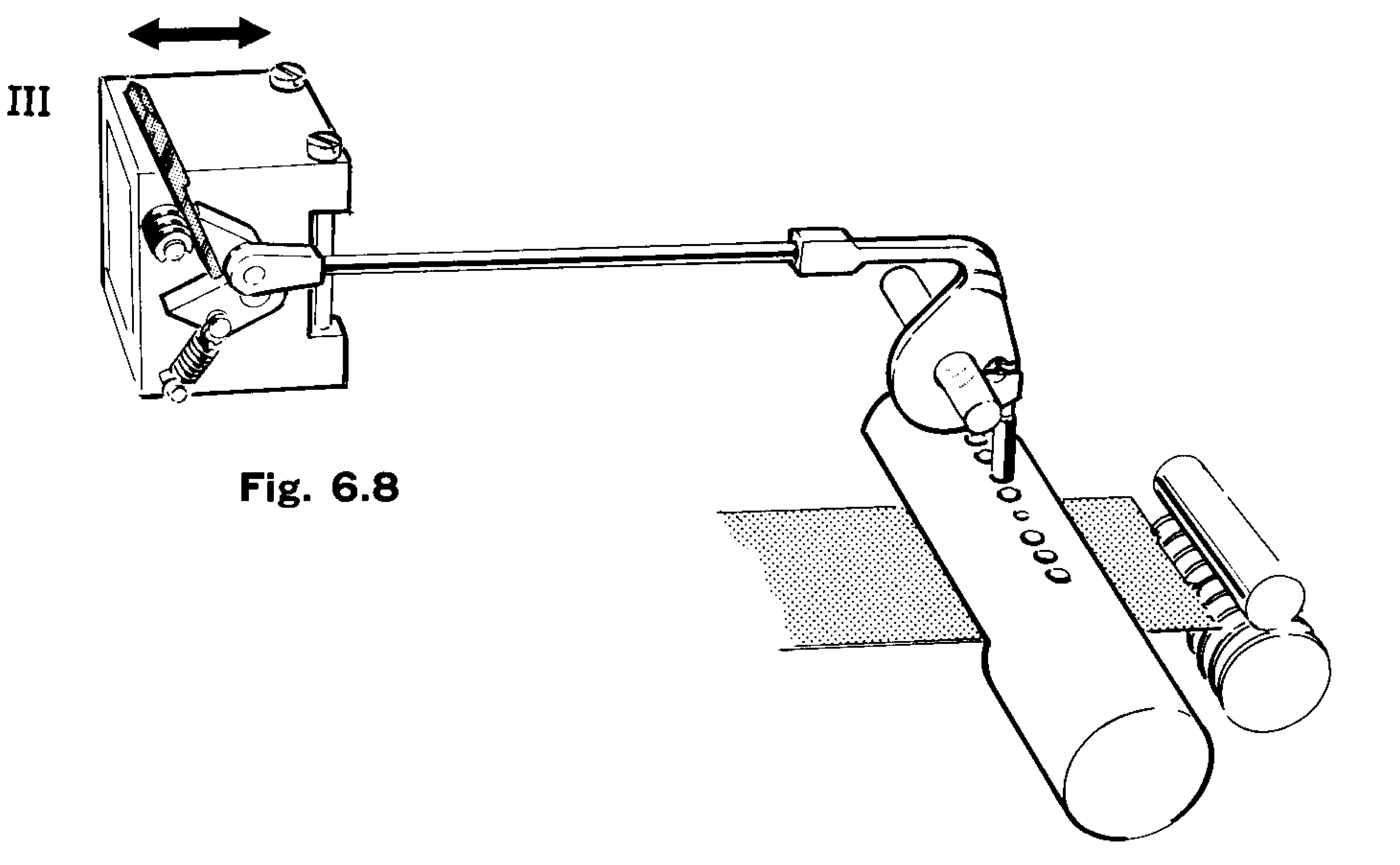


Fig. 6.8

F. Fitting and adjusting punch solenoid

1. Screw the punch solenoid onto the punch/feed unit. Make sure that the pin on the actuator fits into punch pin driver J.
2. Adjust the solenoid armature axially in the solenoid until there is a clearance of 0.05–0.1 mm between the punch pin driver and the adjacent actuator.
3. Fig 6.6 — Connect a DC voltage to the solenoid coil and adjust so that a current of 1.0 A ± 5% runs through the coil.
4. Turn the solenoid core using a screwdriver until the actuator just leaves its resting position on the O-rings.
5. Tighten screws I.
6. Fig 6.7 — Adjust the DC voltage connected to the solenoid coil so that a current of 2 A ± 5% runs through the coil.
7. Check that the actuator turns through its full stroke and contacts the O-rings. (A very small clearance between actuator and O-rings is permissible.)
8. Use your finger to press the actuator back from the O-rings. If properly adjusted you should feel an abrupt reduction in force as the actuator is pressed back to its initial position.
   Remedy: Loosen screws I and repeat from step F3 with the adjustment position slightly changed.
   NOTE: When testing with current flowing as in steps F3 and F6, the current shall only be allowed to flow for short intervals so that the coil will not overheat.
   A stabilized DC power supply that provides 0 - +6 V and 2 A is recommended.
9. Check the axial play as instructed in F2. If adjustment is necessary, F3 to F8 must be re-checked.
10. Tighten screws I.
11. Fig 6.8 — Insert a piece of 0.1 mm paper tape between the punch pin guide and the die.
12. Insert feeler gauge III between the actuator and the O-rings. Use the 1.85 mm end of the gauge for data tracks and the 2.0 mm end for the feed hole track.
13. Adjust the longitudinal position of the solenoid until punch pin presses the tape lightly against the die without cutting into the tape. Move feeler gauge III lightly back and forth as adjustment proceeds, to achieve a stabel position against the O-rings. Lift the pinch roller and check by moving the tape back and forth.
14. Tighten the punch solenoid retaining screw.
15. Re- check the adjustment as instructed in step F7.
16. Remove the feeler gauge.

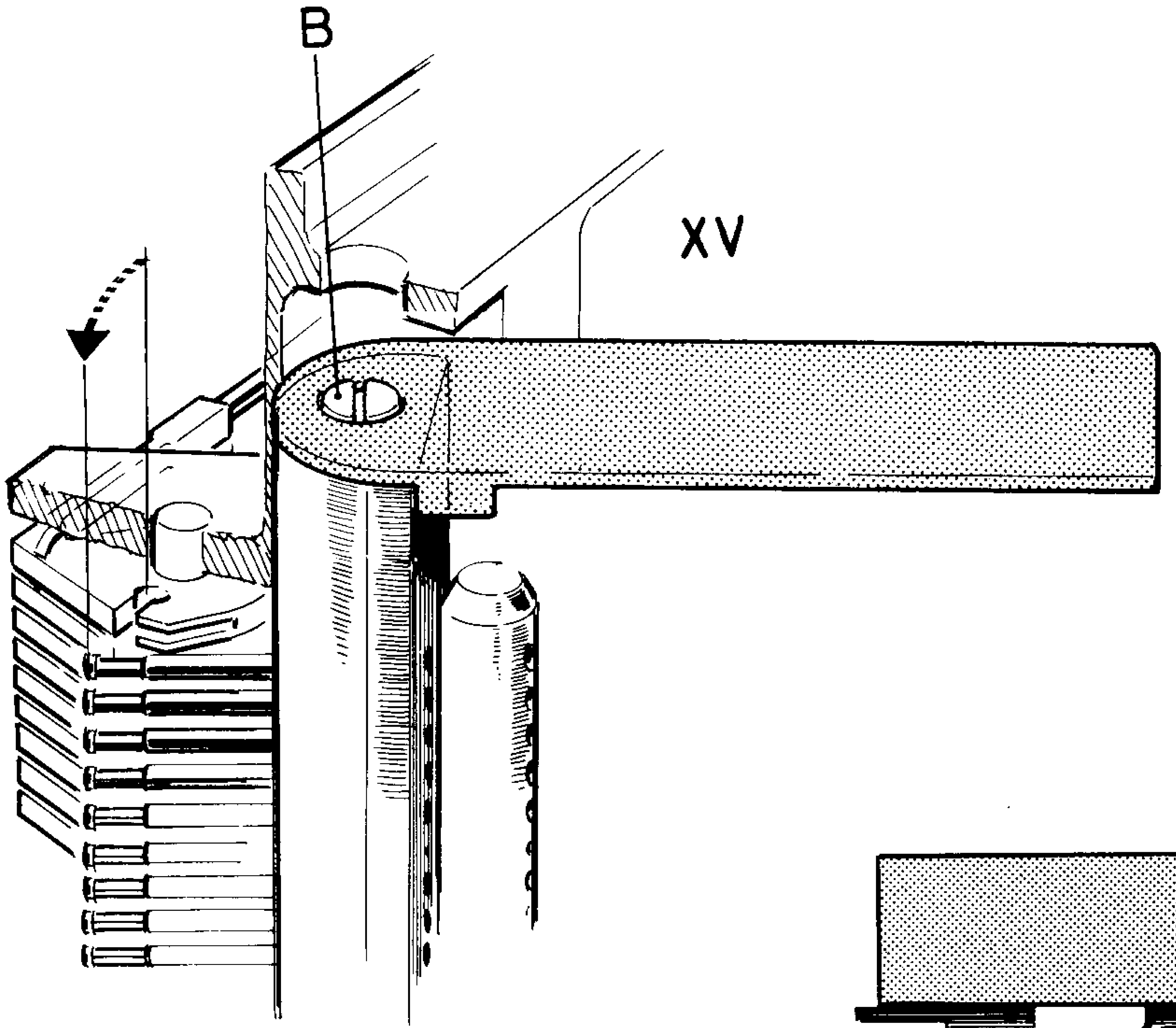


Fig. 6.9

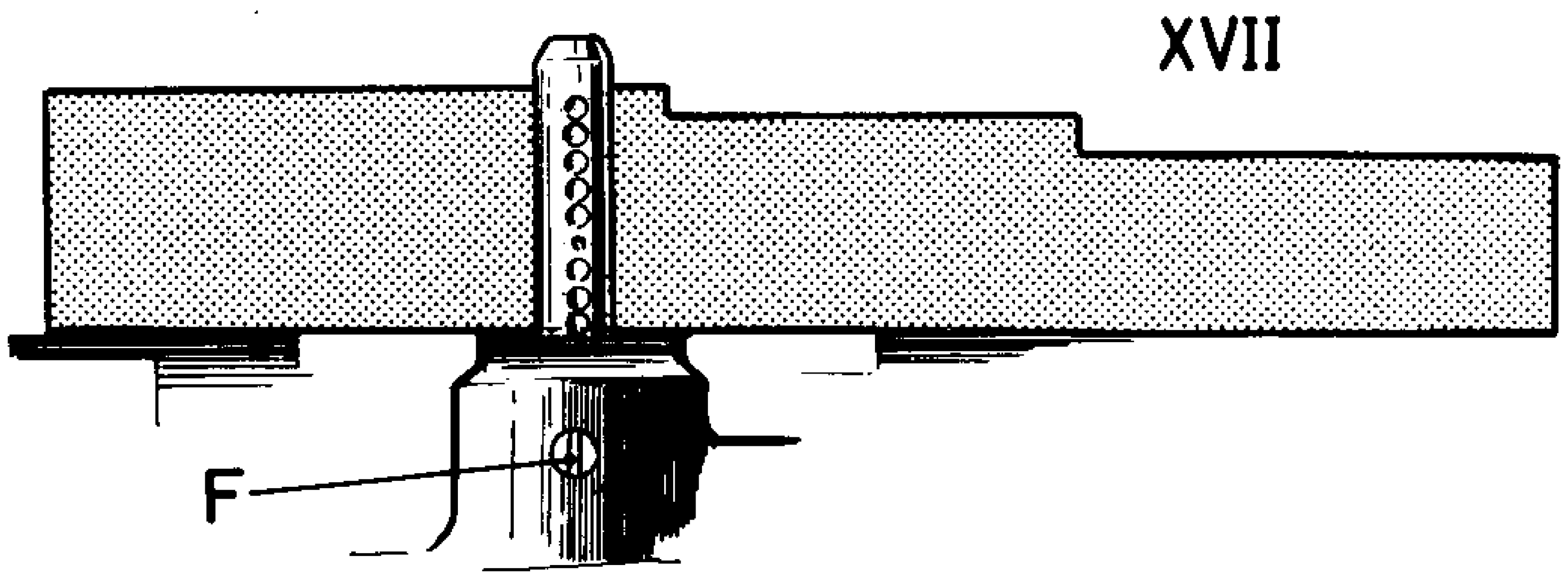


Fig. 6.10

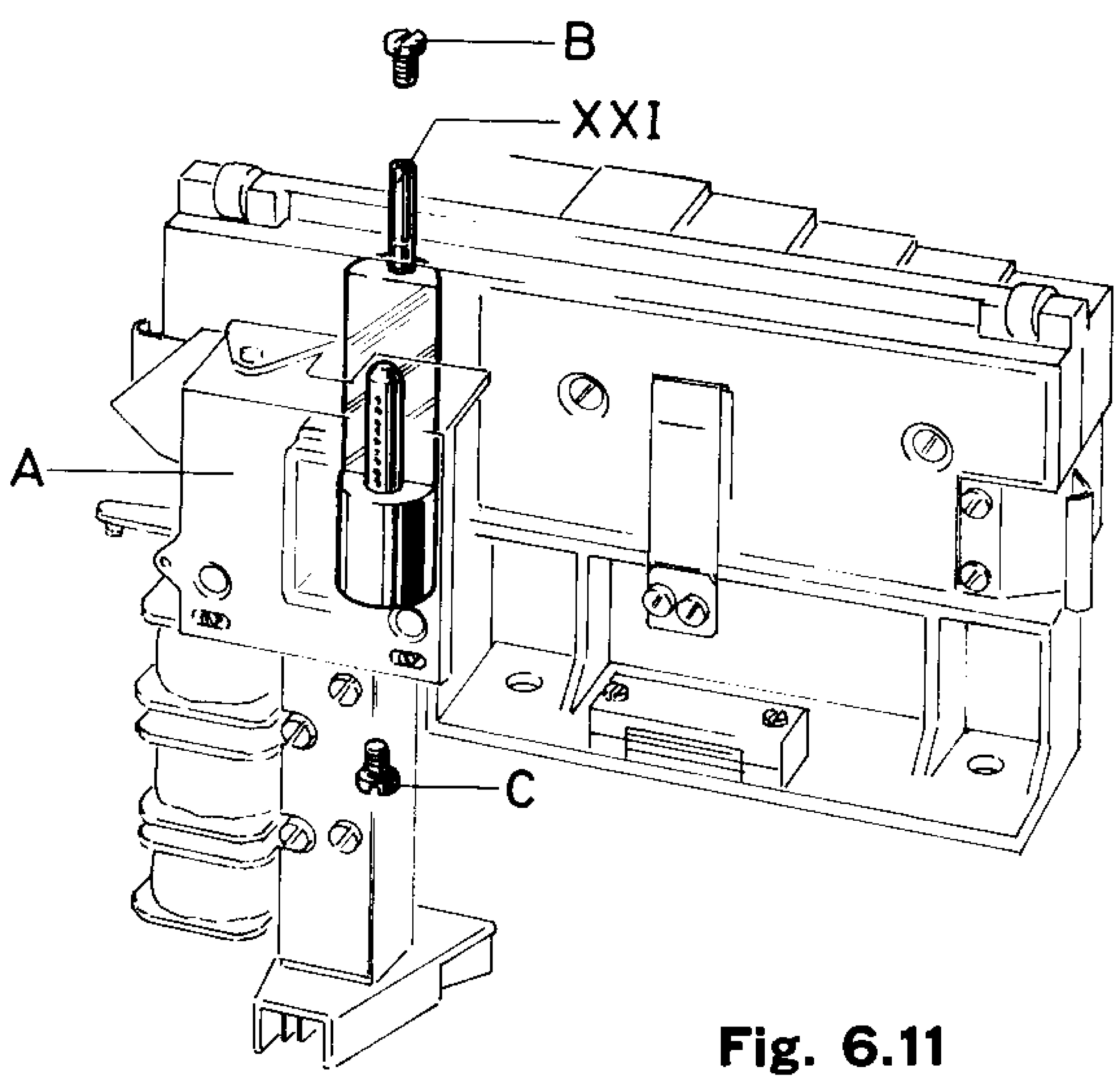


Fig. 6.11

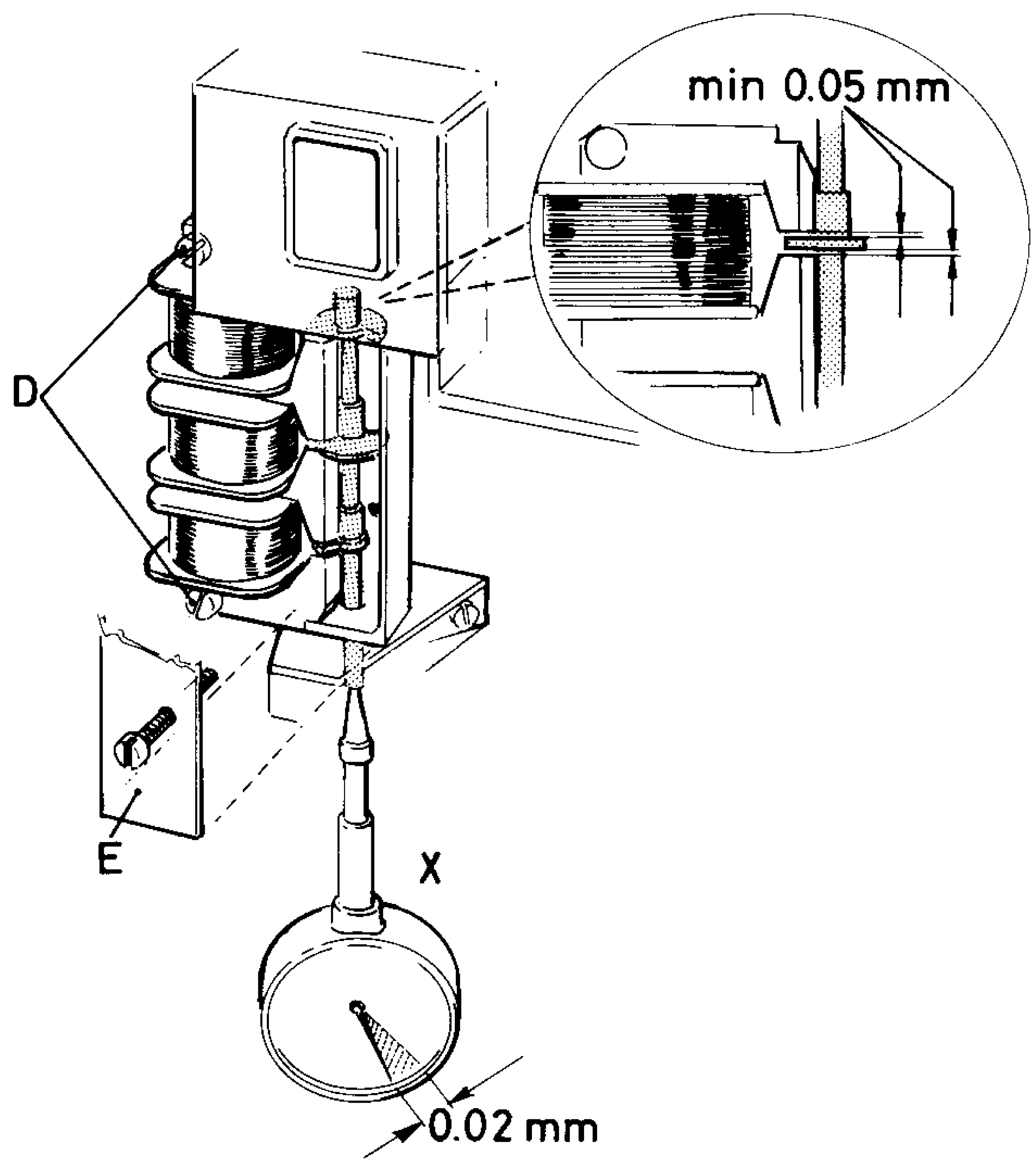


Fig. 6.12

G. Replacing punch head

1. Unscrew and remove the incremental motor and cover A as shown in Fig 6.11. See that the chad exhaust is not pulled along when cover A is removed.
2. Loosen lock screw F. See Fig 6.10.

Fig 6.9
3. Position special tool XV on the punch pin guide and loosen screw B about 1 mm to provide guidance for the tool.
4. Turn the punch head with tool XV until the punch pins disengage the punch pin guides.
5. Remove the punch pins. NOTE: Be sure to remember their track sequence if they are to be used again in the old punch head.
6. Press out the old punch head and insert a new one.
7. Turn the punch head and insert the pinswitch accompaning it (note that the pins are matched with the holes in the punch head).
8. Turn the punch head until the punch pins engage their punch pin drivers.

Fig 6.10
9. Align the reference surfaces of the punch pin guide and the punch/feed unit using tool XVII.
10. Lock the punch head using lock screw F.

Fig 6.11
11. Screw out and remove screws B and C on the punch head and check that there is grease - Rocol MT 320 - in the punch pin guide.
    Lubrication: Position grease nipple XXI as in Fig 6.11. Insert grease tube in nipple and pinch tube to press in grease. Continue pressing until all old grease is forced out on the other side. Remove excess grease and replace screws B and C.
12. Repeat steps F11 through F16.
13. Punch a bit of tape by turning the solenoid armatures manually. Check that the feed hole is 9.96 $\pm$ 0.1 mm from the reference edge.

H. Checking incremental motor

Fig 6.12
1. Remove protective plate E.
2. Check that the axial play of the motor shaft does not exceed 0.02 mm.
   Remedy: Replace the motor mount.
3. Supply approx 1 A to each individual motor winding in sequence.
4. While the current is flowing, check that the clearance between the individual vanes and the stator is not less than 0.05 mm.
   Adjustment: Loosen screws D. Then make a rough adjustment by inserting two feeler gauges having sequential thickenesses (0.07 and 0.08 mm for example) on each side of the vane closest to the punch/feed unit so that play between stator and vane is entirely taken up. Press the stator and motor mount together and tighten screws D. Repeat steps H3 and H4. Try to have the two air gaps between stator and vane as equal as possible.

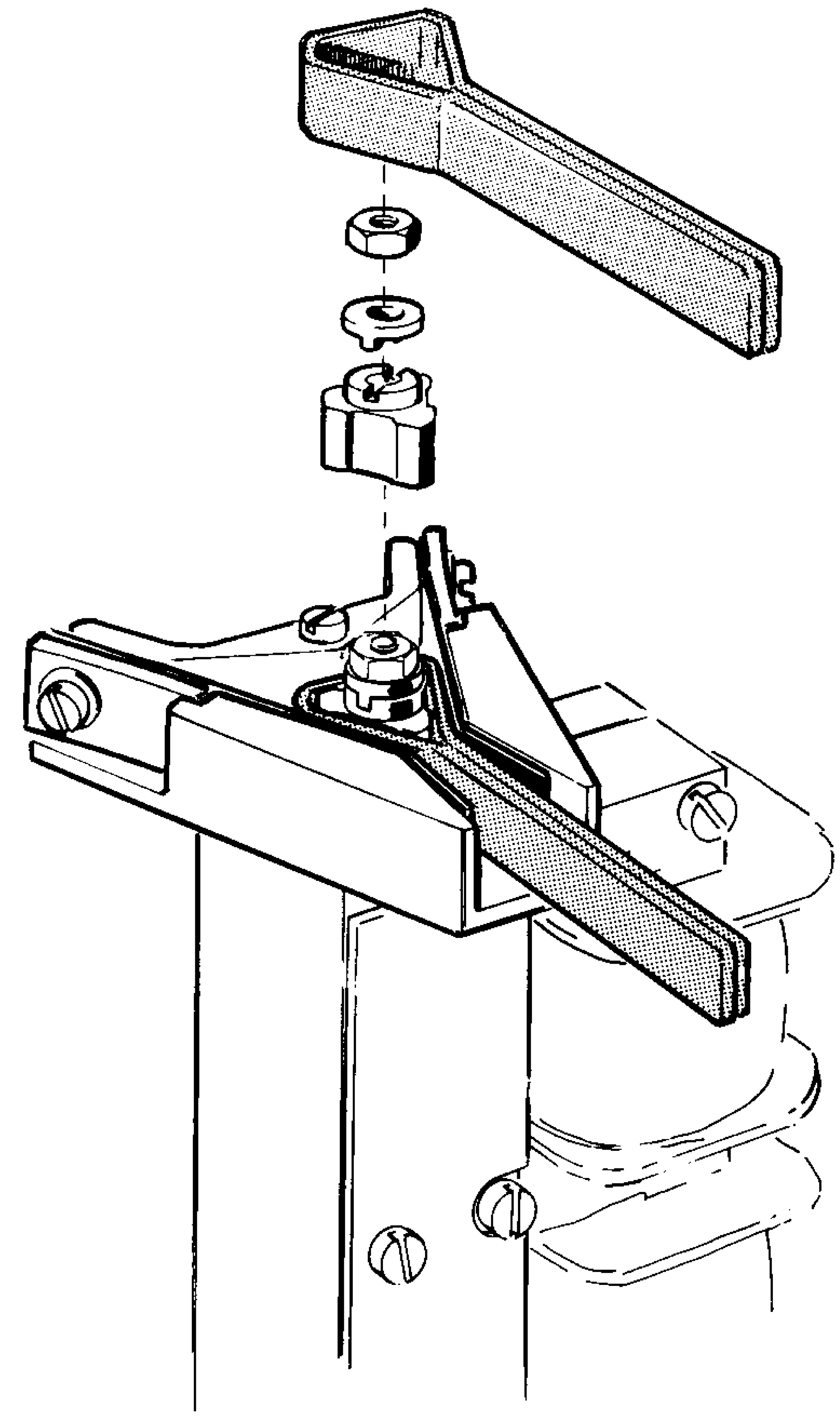


Fig. 6.13

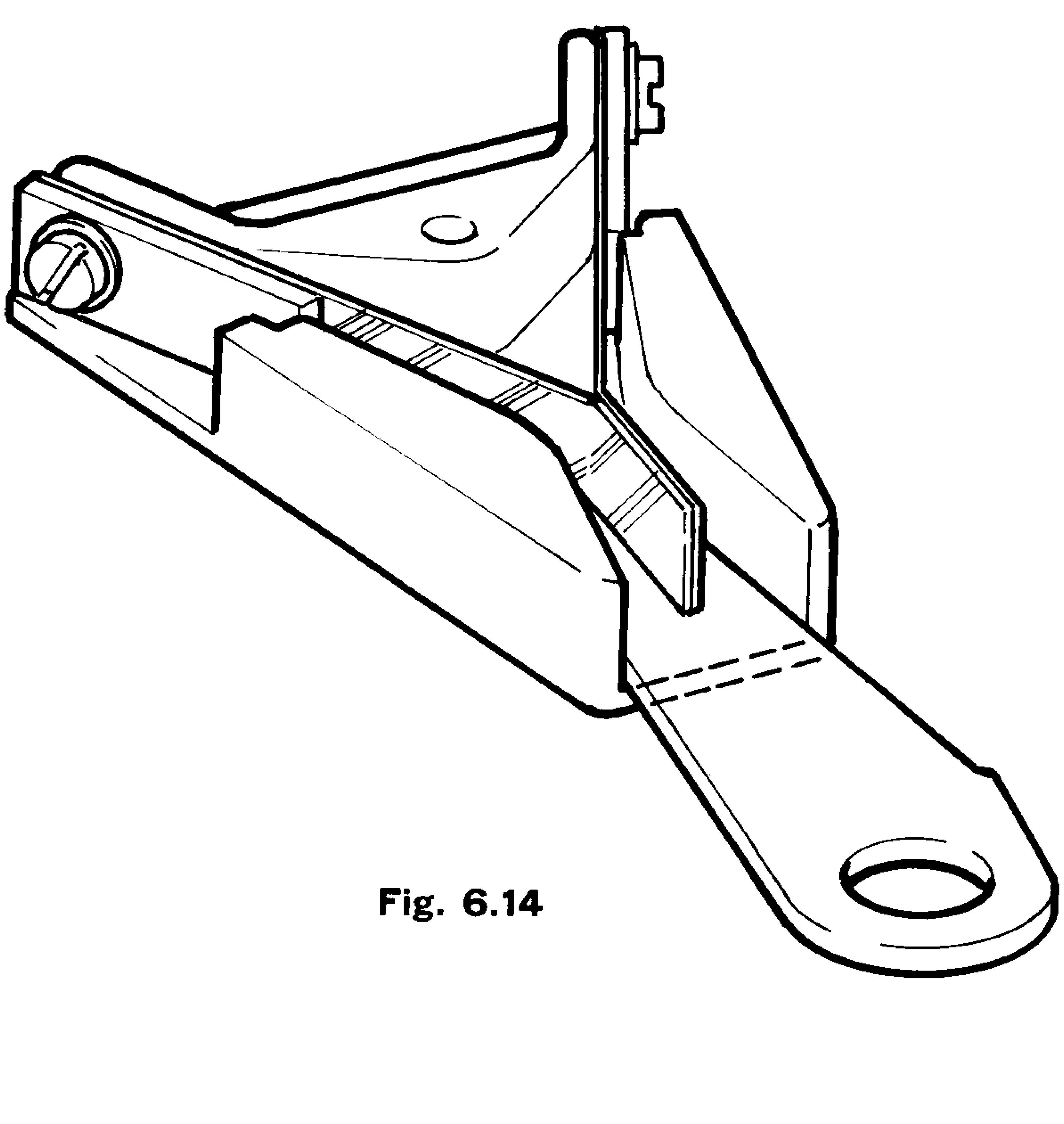


Fig. 6.14

5. Check that the pinwheel, brake shoe and vanes have not turned relative to each other.
   Remedy: Replace motor mount.

Fig 6.13

6. Check that feeding accuracy between adjacent rows is better than 3%.
   Remedy: Replace brake shoe S as instructed below.

   Replacement procedures:

   1. Fit the holding tool on the brake shoe as indicated in the figure.
   2. Unscrew nut 10.110.309.00 carefully. Remove locating washer 11.491.890.00 and brake shoe 15.035.901.10.
   3. Mount the new brake shoe. Kindly observe that it fits only in one position due to the fact that the locating slot is placed unsymmetrically.
   4. Fit the locating washer observing the same as in point three (3).
   5. Fit the nut and tighten it carefully.
   6. Remove the holding tool and check and adjust as described in "Checking motor brake".

I. Checking motor brake

Fig 6.14

1. Turn brake shoe A and check that springs B do not touch the brake housing at point C.
2. Check that springs B do not contact the dust washer inside the brake shoe.
   Adjustment: Insert a feeler gauge 11.587.440.00 (1.1 $\pm$ 0.1 mm) as to Fig 6.14. Loosen the retaining screws holding the brake springs and adjust the springs. Tighten the retaining screws and remove feeler gauge and repeat checks 1 and 2.

   If the brake housing has been removed from the motor mount or the brake shoe has been replaced, the brake housing must be positioned correctly relative to the electrical zero position of the motor shaft. Supply approx. 1A to the motor winding L-10 and tighten the brake at the position assumed bu the brake shoe.

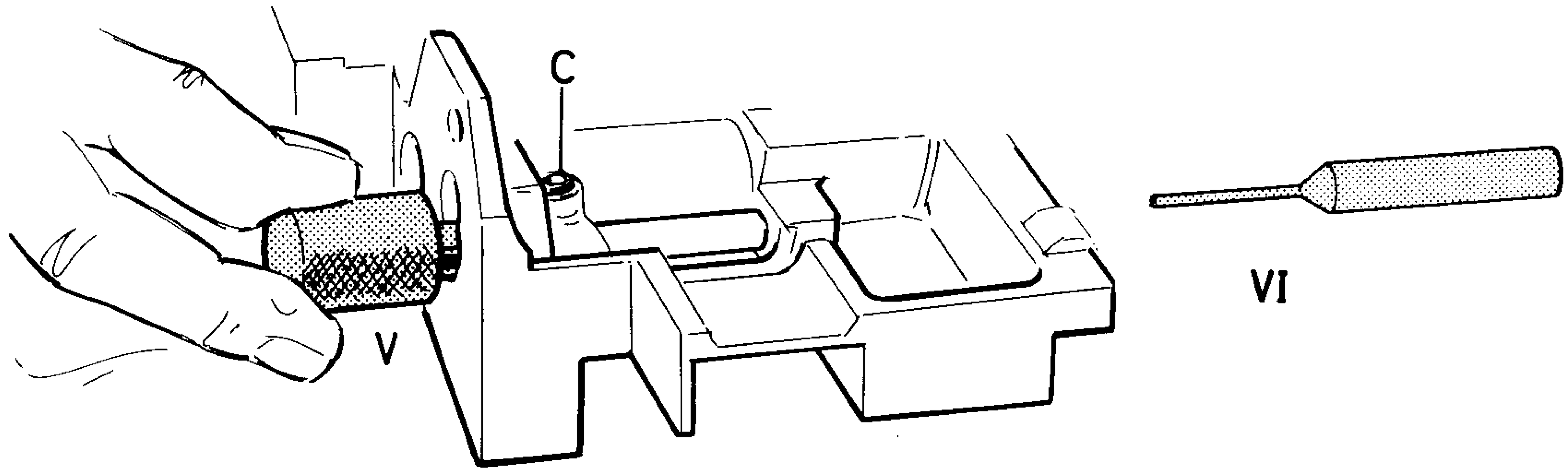
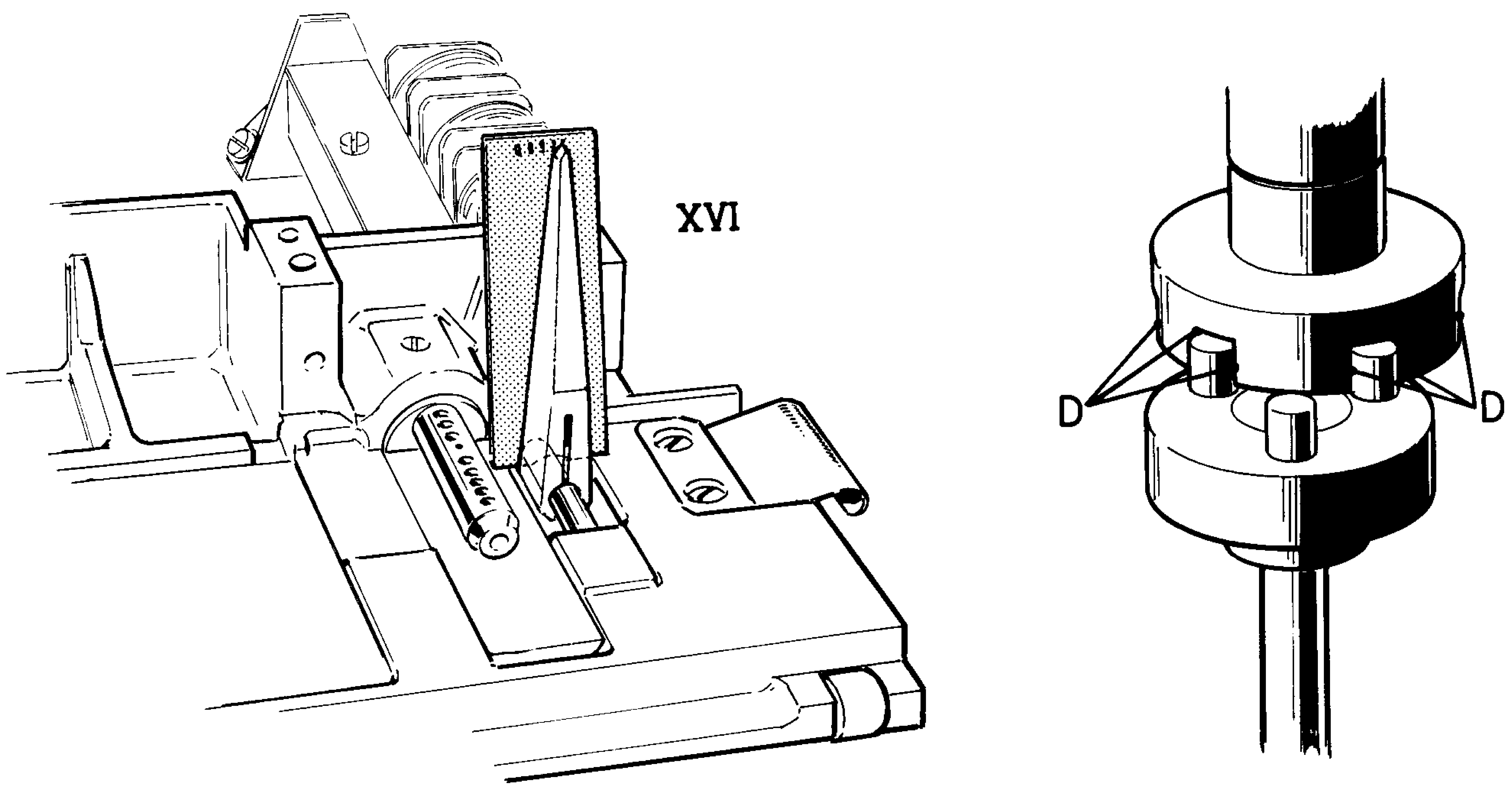


Fig. 6.15



a b

Fig. 6.16

J. Checking and replacing capstan

1. Remove the incremental motor and cover A (Fig 6.11) and check that the capstan rotates easily. See that the chad exhaust is not pulled out when cover A is removed.
   Remedy: Replace capstan as instructed below.

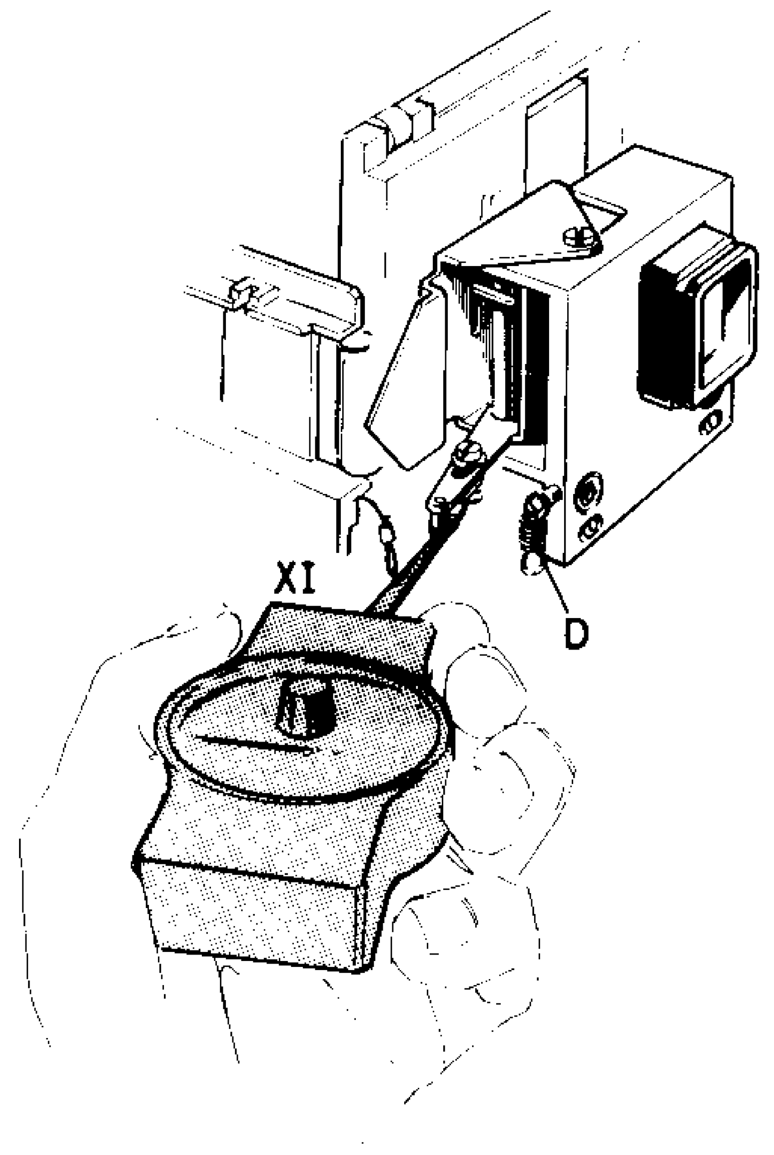
Fig 6.15

2. Loosen lock screw C.
3. Press capstan out carefully using mandrel VI.
4. Press in the new capstan manually.
5. Press in the capstan to its correct position using mandrel V.
6. Tighten lock screw C.
7. Check that the capstan rotates freely.

K. Checking transmission between incremental motor and capstan

Fig 6.16

1. Using gauge XVI, check that the radial play of the capstan does not exceed 2°. Check at all 6 positions.
   Explanation: This check is important to assure correct inter-row spacing. If play is present the reason can be
   a. the pinwheel and brake shoe have turned relative to each other
   b. the motor brake is incorrectly positioned relative to the electrical zero position of the motor shaft
   c. the slotted wheel on the capstan is worn.
   Adjustment: a. replace motor mount, b. see last sentence under adjustment in section I above or c. repalce capstan.
2. Unscrew and remove the motor brake.
3. Lift the pinch roller away from the capstan.
4. Turn the motor shaft using a screwdriver and check that the transmission does not bind.
   Adjustment: Unscrew the motor and turn the motor shaft 120° or 240°. If it still binds, replace the capstan. When replacing capstan, check that there are no fins or mould marks at D (6 grooves). See Fig 6.16b. If binding persists after capstan is replaced, the motor mount must be replaced.



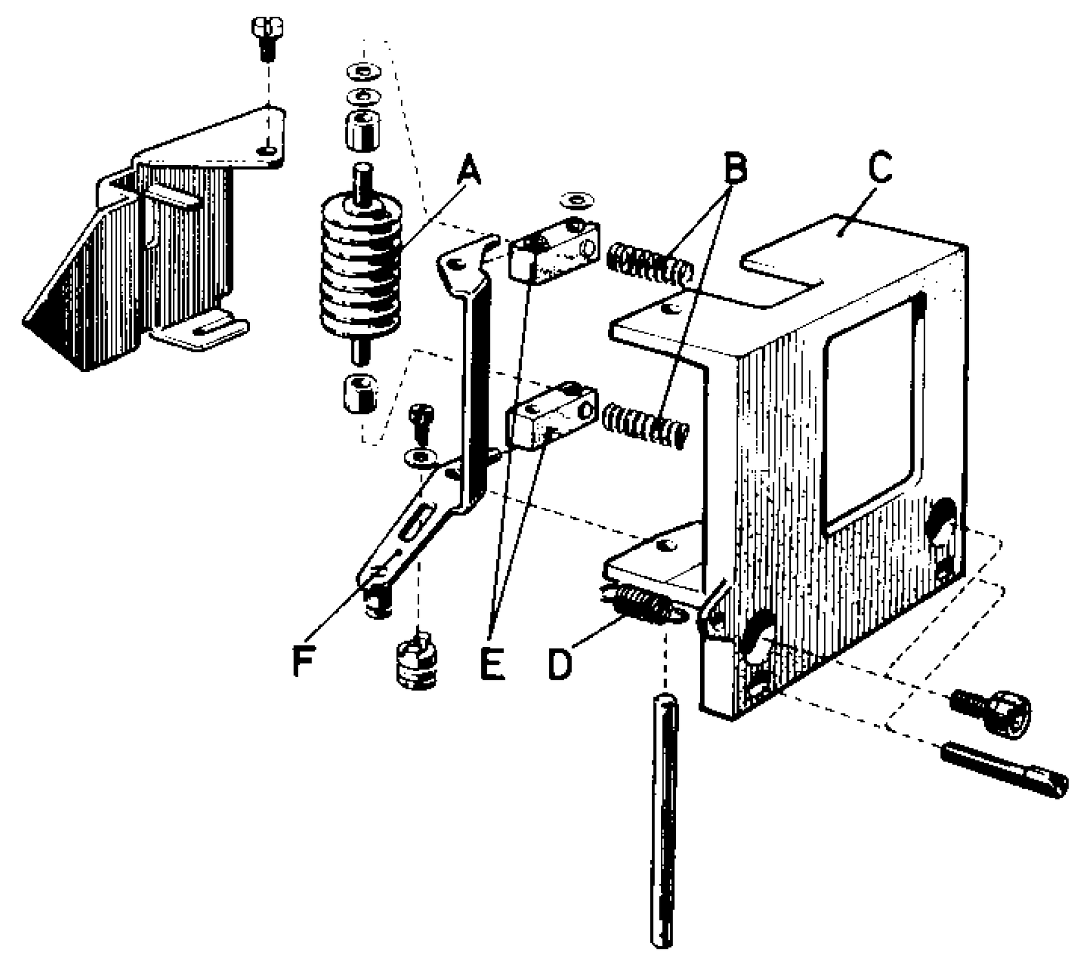


Fig. 6.17

b

a

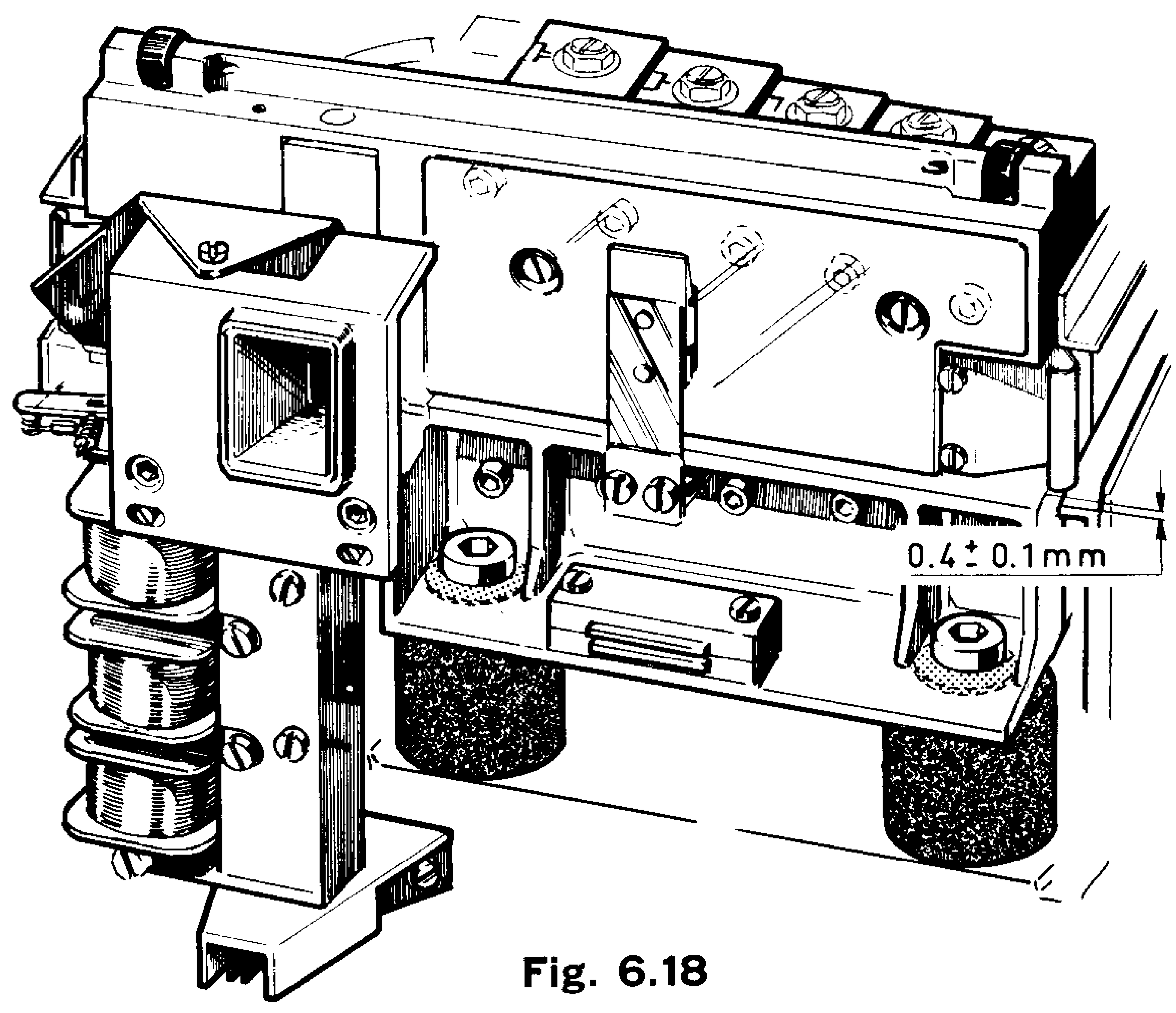


Fig. 6.18

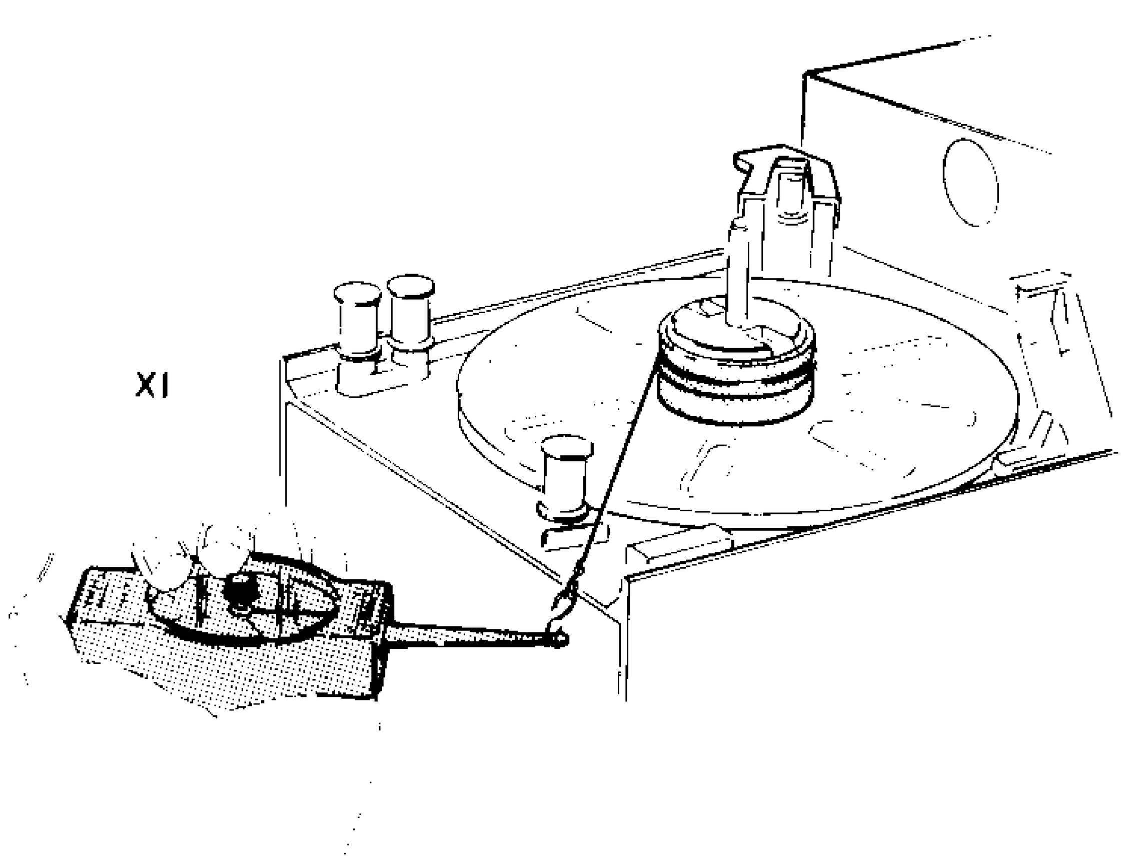


Fig. 6.19

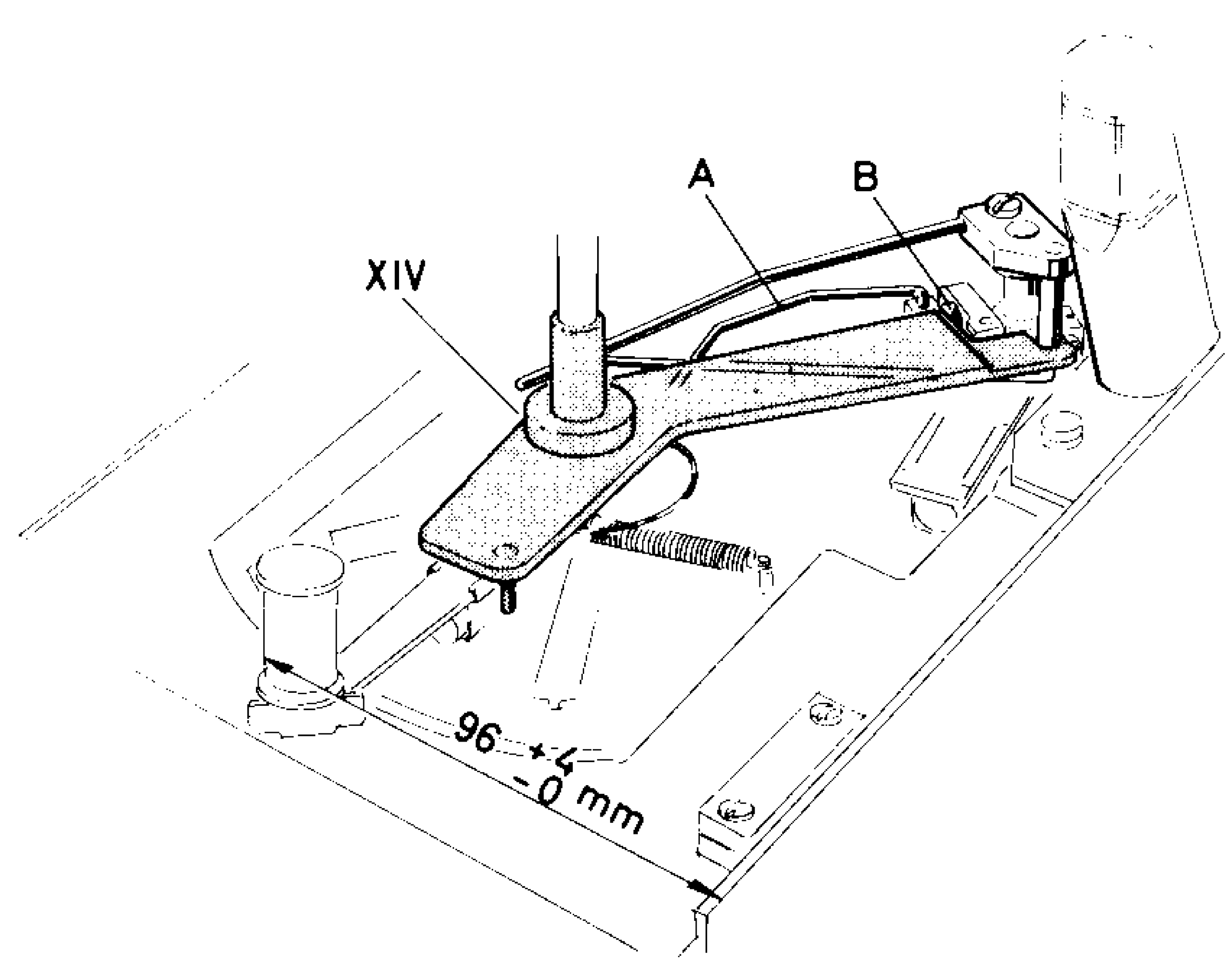


Fig. 6.20

L. Checking pinch roller

Fig 6.17

1. Unhook spring D.
2. Check as shown in Fig 6.17a that the pinch roller exerts a force of 600 $\pm$ 50 gf against the capstan.
   Remedy: Replace springs B.
3. Remove cover C.
4. Check that pinch roller A rotates easily.
   Remedy: Replace pinch roller.
5. Check that there are no defects on the periphery of the pinch roller.
   Remedy: Replace pinch roller.
6. Check that the pinch roller flanges do not run in any of the tracks on the tape.
   Adjustment: Insert washers between arms E and yoke F.

M. Fitting punch/feed unit

Fig 6.18

1. When fitting the punch/feed unit, check that its reference edge is 0.4 $\pm$ 0.1 mm above the reference edges of the tape slots in the right-hand and left-hand sidewalls.
   Adjustment: Adjust by inserting washers between the rubber anti-vibration mountings and the punch/feed unit.

N. Checking braking force on supply flange

Fig 6.19

1. Loosen the surge takeup arm and check the braking force on the supply flange as shown in Fig 6.19. The braking force shall be 400 $\pm$ 150 gf.
   Explanation: If the braking force is too high or too low the reason can be
   a. too little torque exerted by the surge takeup arm
   b. worn or improperly mounted brake shoe.

Fig 6.20

Adjustment: a. see steps N2 and N3 below or b. replace brake shoe B. Then secure the surge takeup arm using holder XIV. Adjust the length of link A so that the brake shoe just touches the edge of the tool. When the brake shoe is adjusted correctly, the surge takeup arm is $96 \begin{smallmatrix}+4\\-0\end{smallmatrix}$ mm from the edge of the punch.

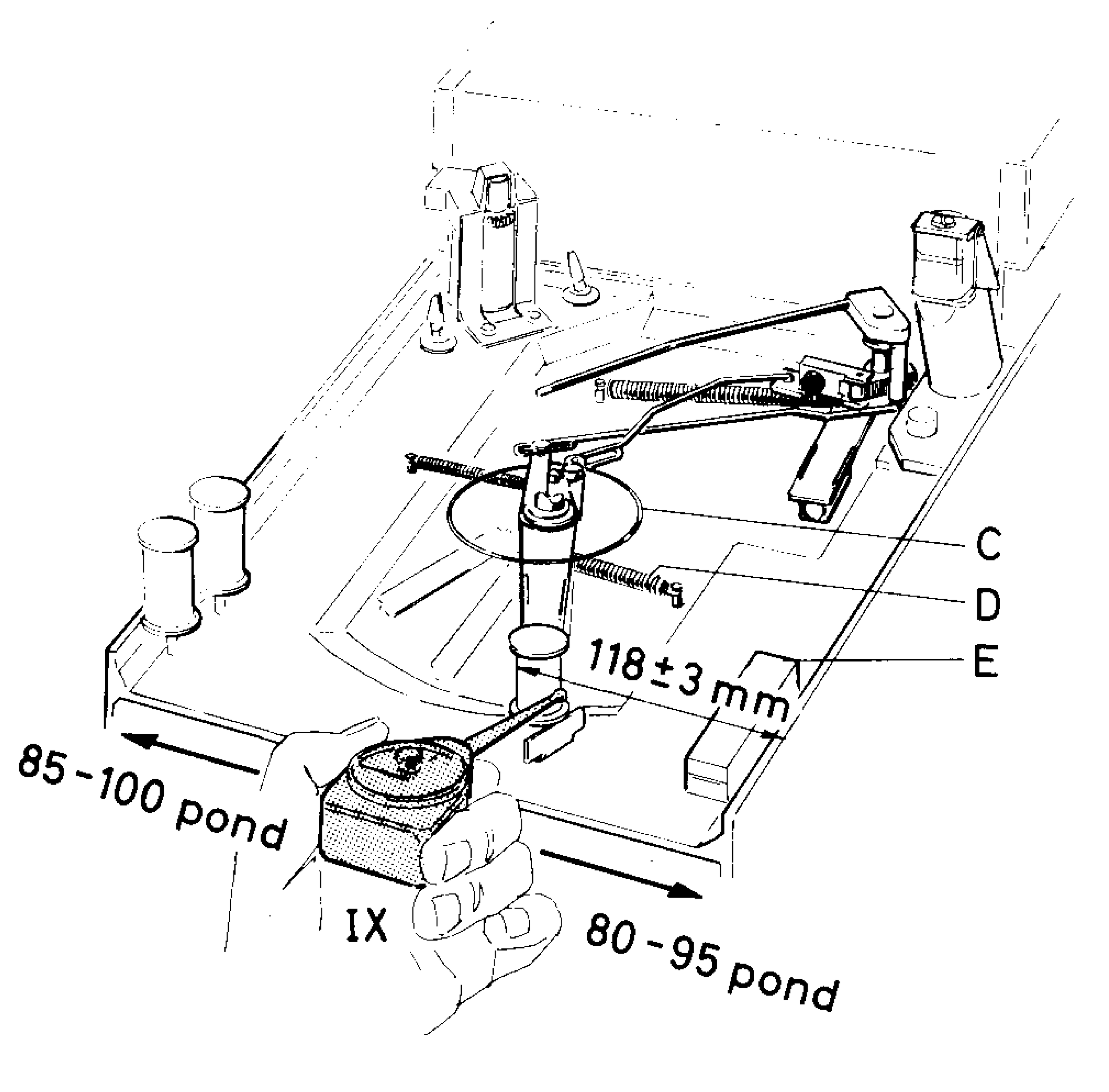


Fig. 6.21

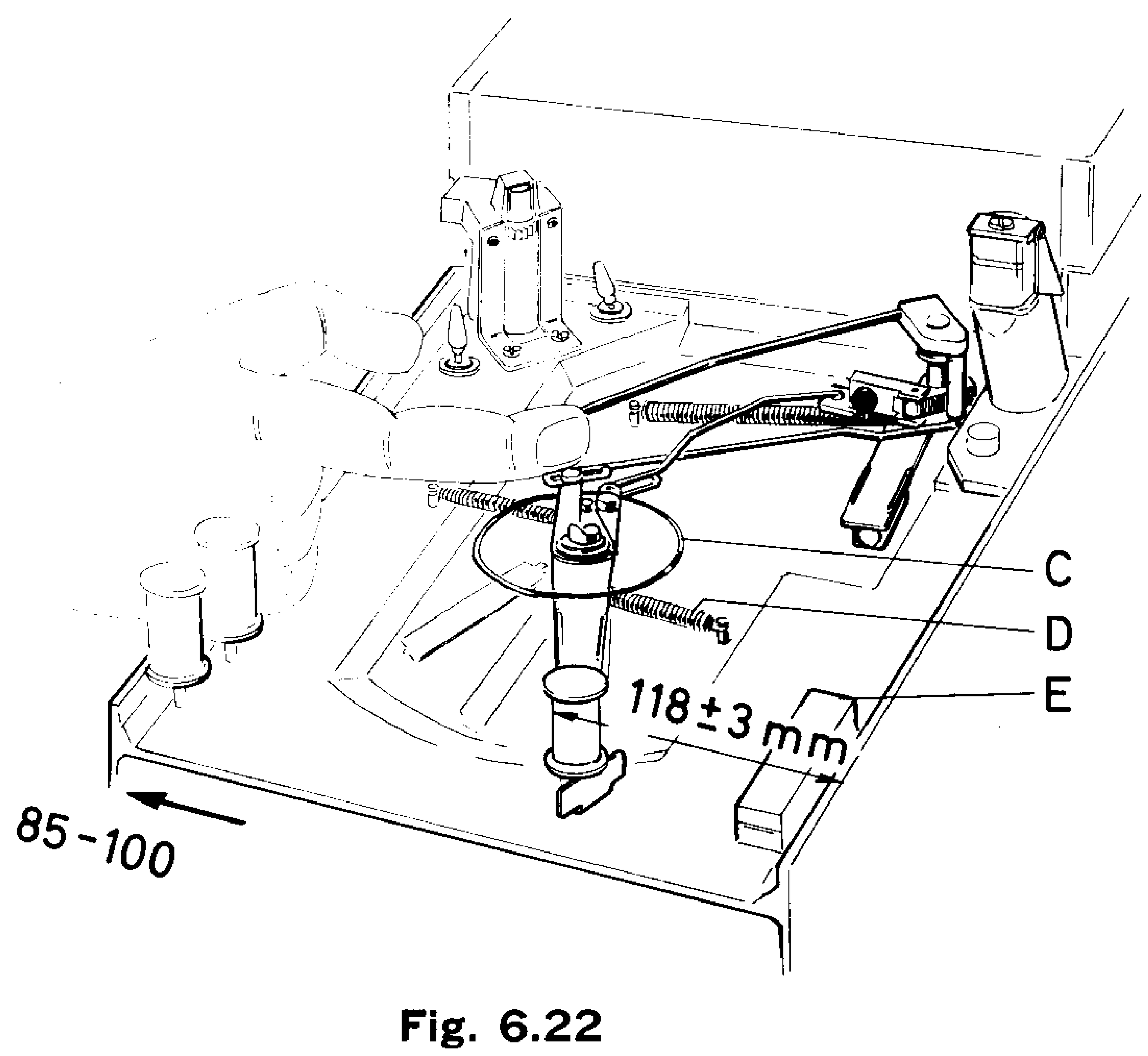


Fig. 6.22

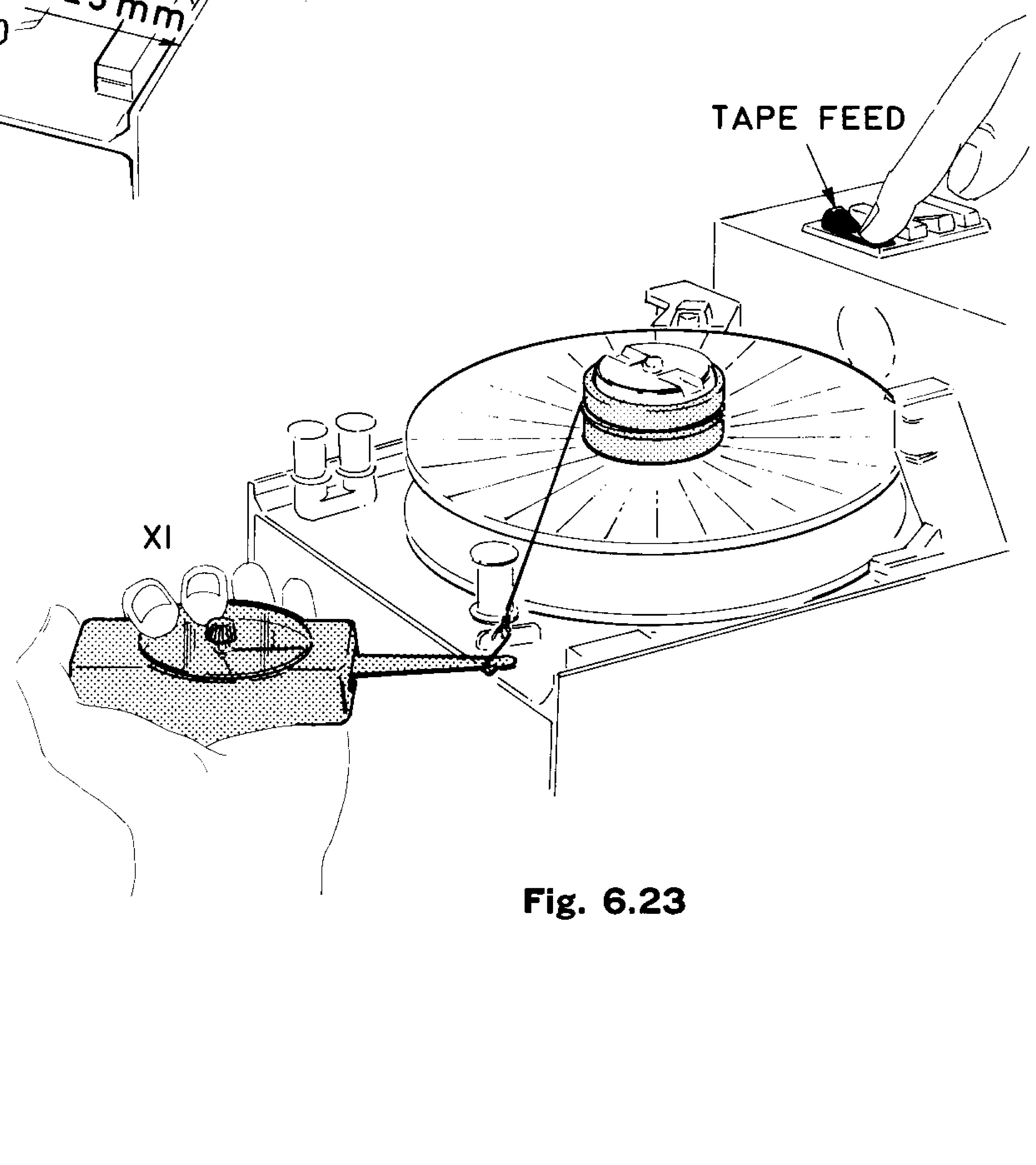


Fig. 6.23

Fig 6.21

2. Measure the torque ecert by the surge takeup arm dynamically at a point 118 $\pm$ 3 mm to the left of the sidewall. Readings shall be taken as the arm moves in both directions. The torque shall be 85 - 100 gf as spring D is tightened and 80 - 95 gf as spring D is slacked off. Note arrow and dimension in illustration.
   Adjustment: Clean the surge takeup arm shaft hole and/or replace spring D.
3. Measure the torque exerted by the surge takeup arm dynamically at a point 78 $\pm$ 3 mm to the left of the sidewall. Readings shall be taken as the arm moves in both directions. The torque shall be 55 - 60 gf as spring C is tightened and 40 - 50 gf as spring C is slacked off.
   Adjustment: Replace spring C.

O. Checking sensor arm

Fig 6.22

1. Loosen the surge takeup arm from the retainer magnet.
2. Check that sensor arm E does not bind. You should be able to move it out easily to both end positions. After moving the sensor arm to its rear end position, allow it to return carefully, while checking to see that the surge takeup arm is moved down toward the centre of the punch.
   Adjustment: Clean the sensor arm shaft hole and/or replace spring F.

P. Checking pulling force of winding motor

Fig 6.23

1. Check as shown in Fig 6.23 that the pulling force which the winding motor exerts on the takeup flange is not less than 950 gf.
   Explanation: If the pulling force is too low the reason can be
   a. that the winding motor is not pressing against the takeup flange properly
   b. that the winding motor drive wheel is worn
   c. that the transmission between drive wheel and capstan is binding or
   d. the winding motor is faulty.

   Adjustment: a. see step P2 b. replace the drive wheel c. replace the motor mount or d. replace the winding motor.

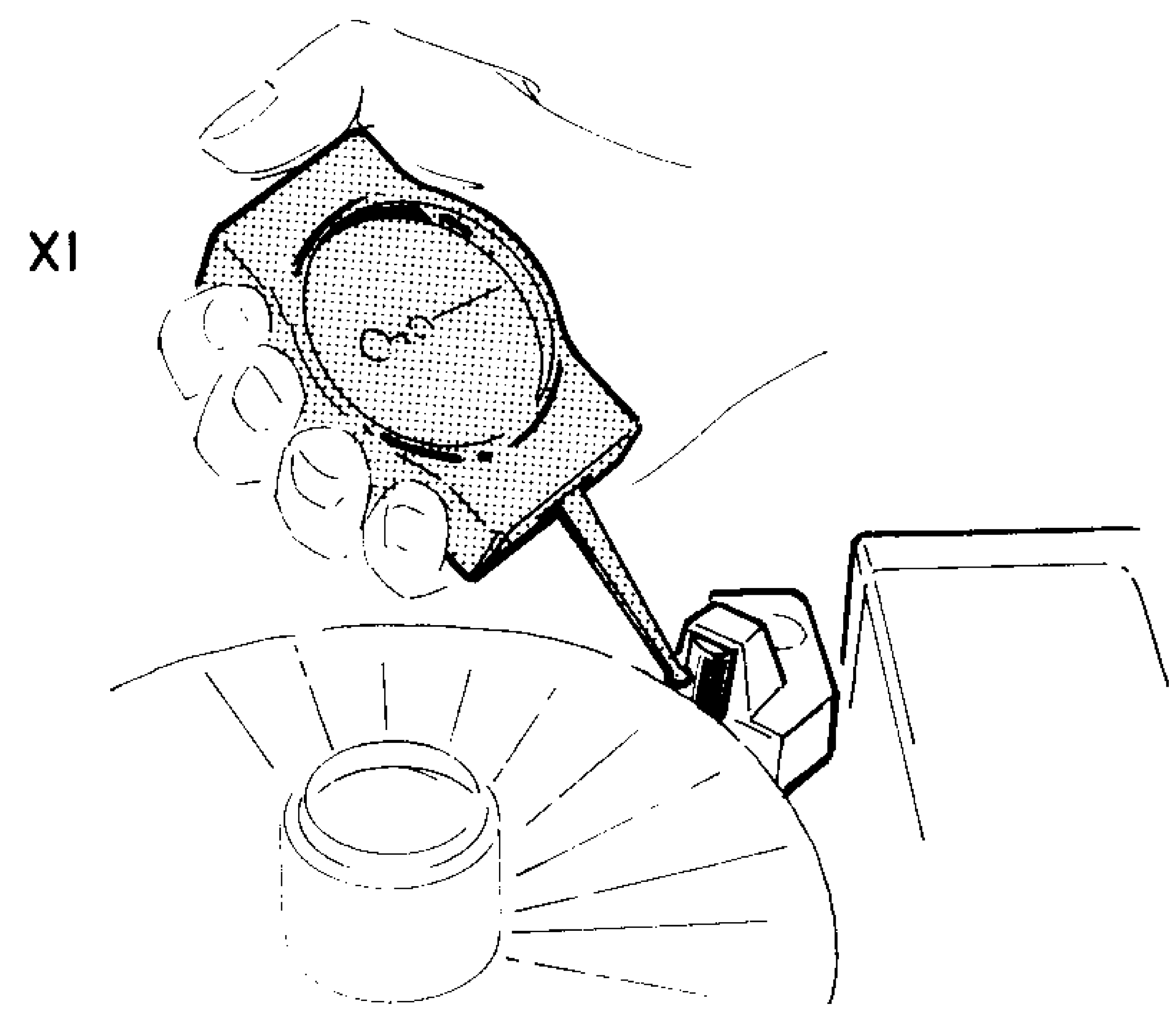


Fig. 6.24

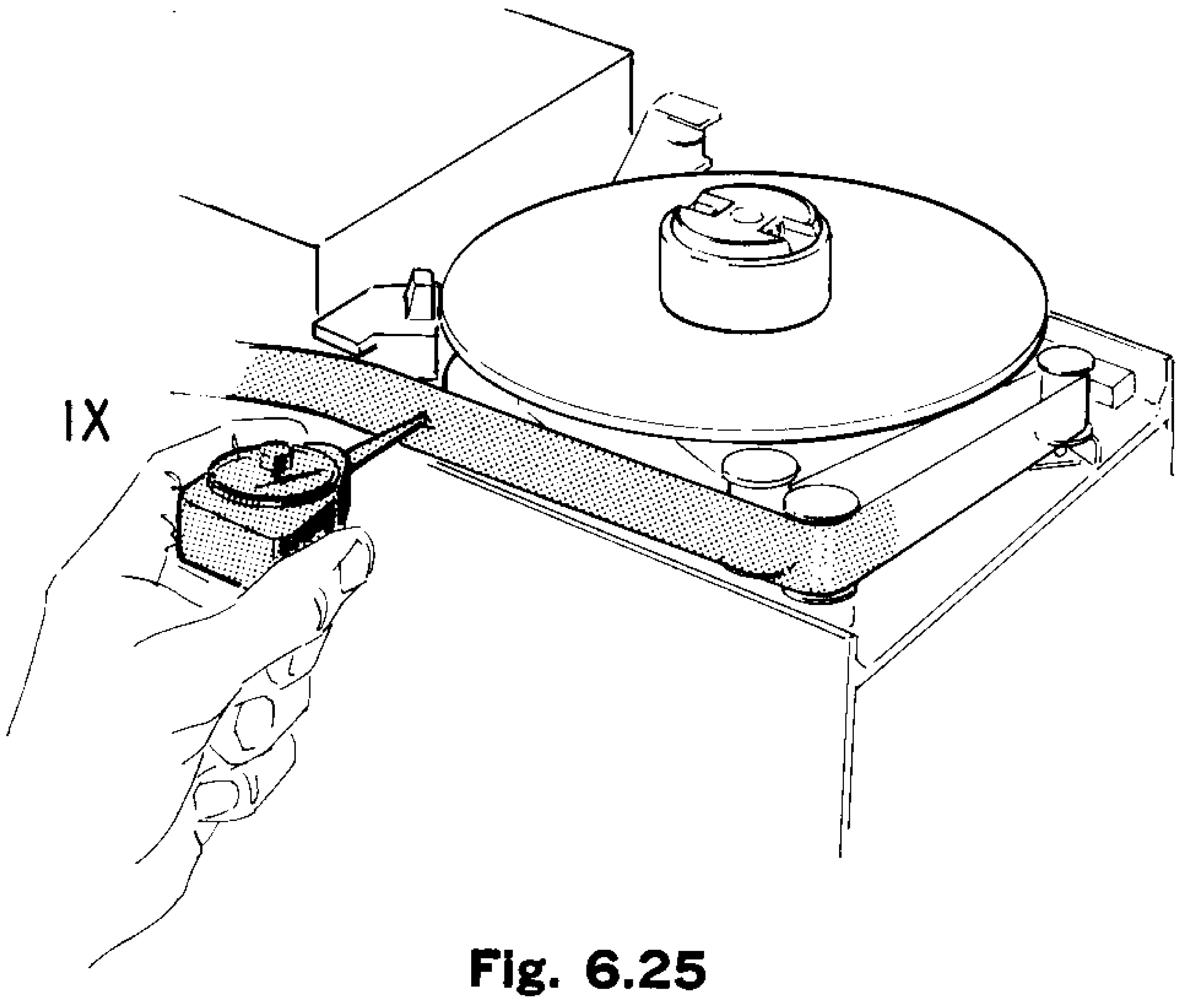


Fig. 6.25

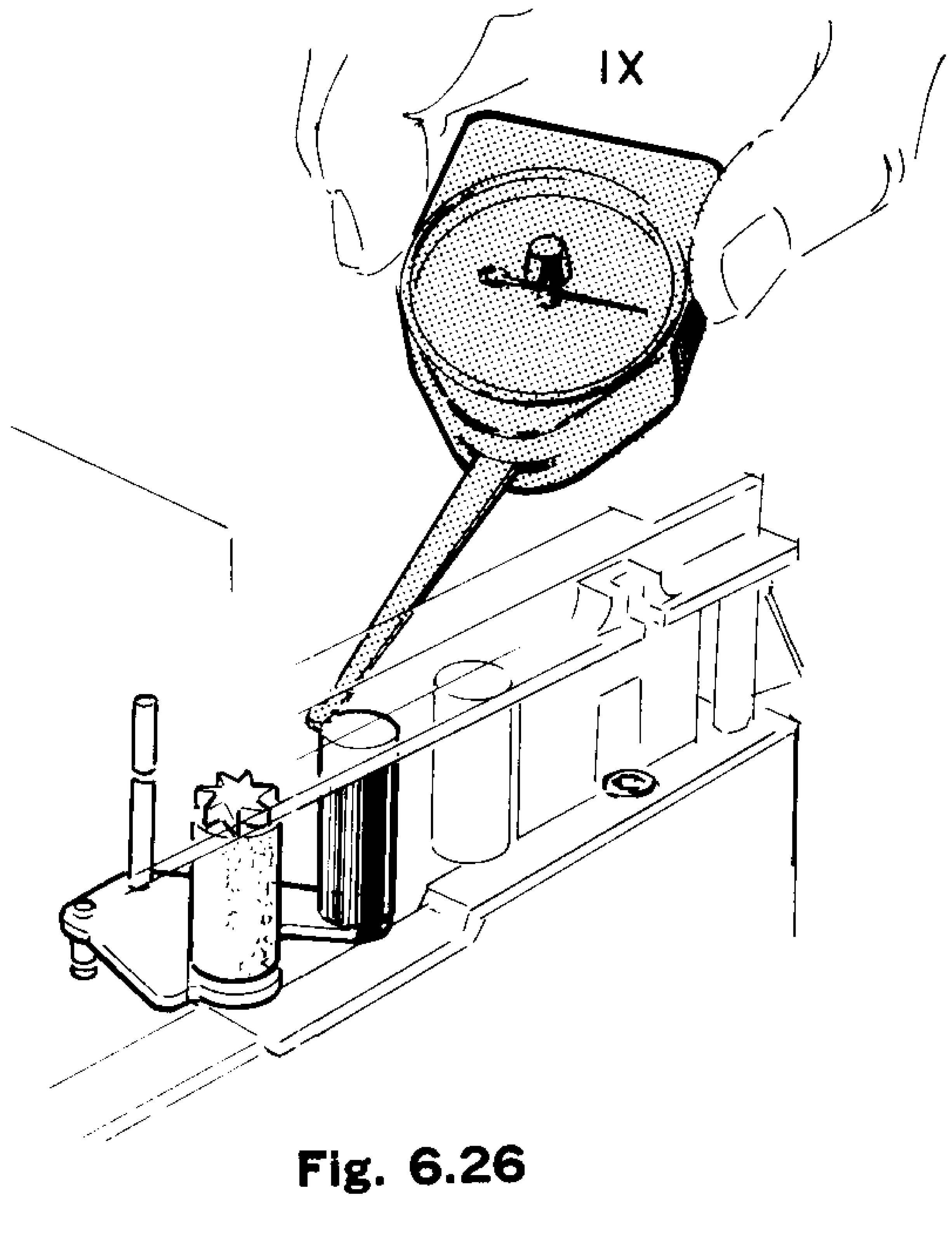


Fig. 6.26

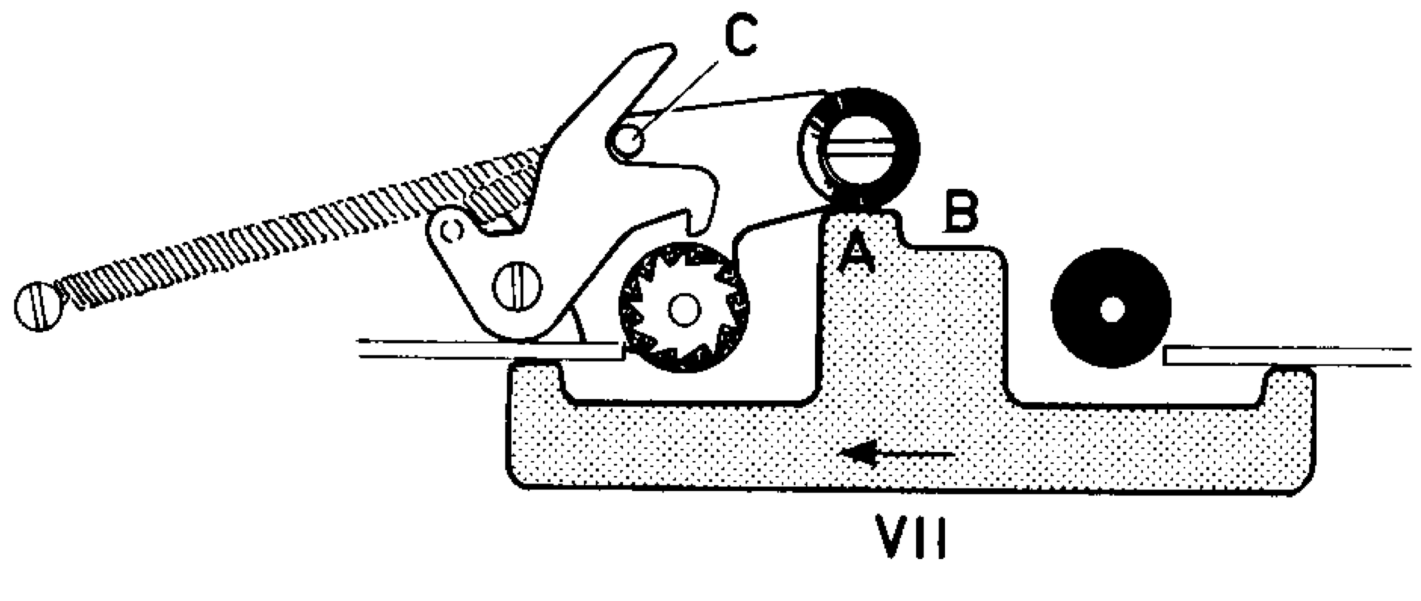


Fig. 6.27

Fig 6.24 2. Check that the winding motor drive wheel presses against the takeup flange with a force of 650 - 800 gf.
Adjustment: Adjust the position of the motor by bending the motor retaining spring.

Q. Checking unwinding force

1. Fit the supply flange and takeup flange and load the punch with a full coil of tape.

Fig 6.25 2. Loosen the surge takeup arm from the retainer magnet and check as shown in Fig 6.25 that the force exerted for unwinding the tape does not exceed 50 gf.
Explanation: This check is important to assure correct inter-row spacing. If the pulling force is too high the reason can be
   a. binding at the supply flange hub
   b. warped supply flange or
   c. binding guide rollers.

Adjustmnet: a. remove the supply flange and clean both the shaft and its hole, b. straighten the supply flange or replace it or c. clean the guide roller shafts and their holes.

R. Checking reversing buffer arm

Fig 6.26 1. Check that the torque exerted by the reversing buffer arm is 180 $\pm$ 20 gf when the guide rollers are all alingned.
Adjustment: Clean and lubricate the reversing buffer arm shaft hole, the rubber-coated roller shaft hole and the shaft.

Fig 6.27 2. Hold special tool VII as shown in Fig 6.27.

3. Check that the rubber-coated roller is not caught by the catch when the reversing buffer arm is moved out against stop A on the special tool.
4. Now move the tool in the direction shown by the arrow, move the reversing buffer arm against stop B and check that the roller is picked up and that there is ample engagement between the ratchet wheel and catch.
Adjustment: Engagement can be increased or decreased by carefully bending pin C.

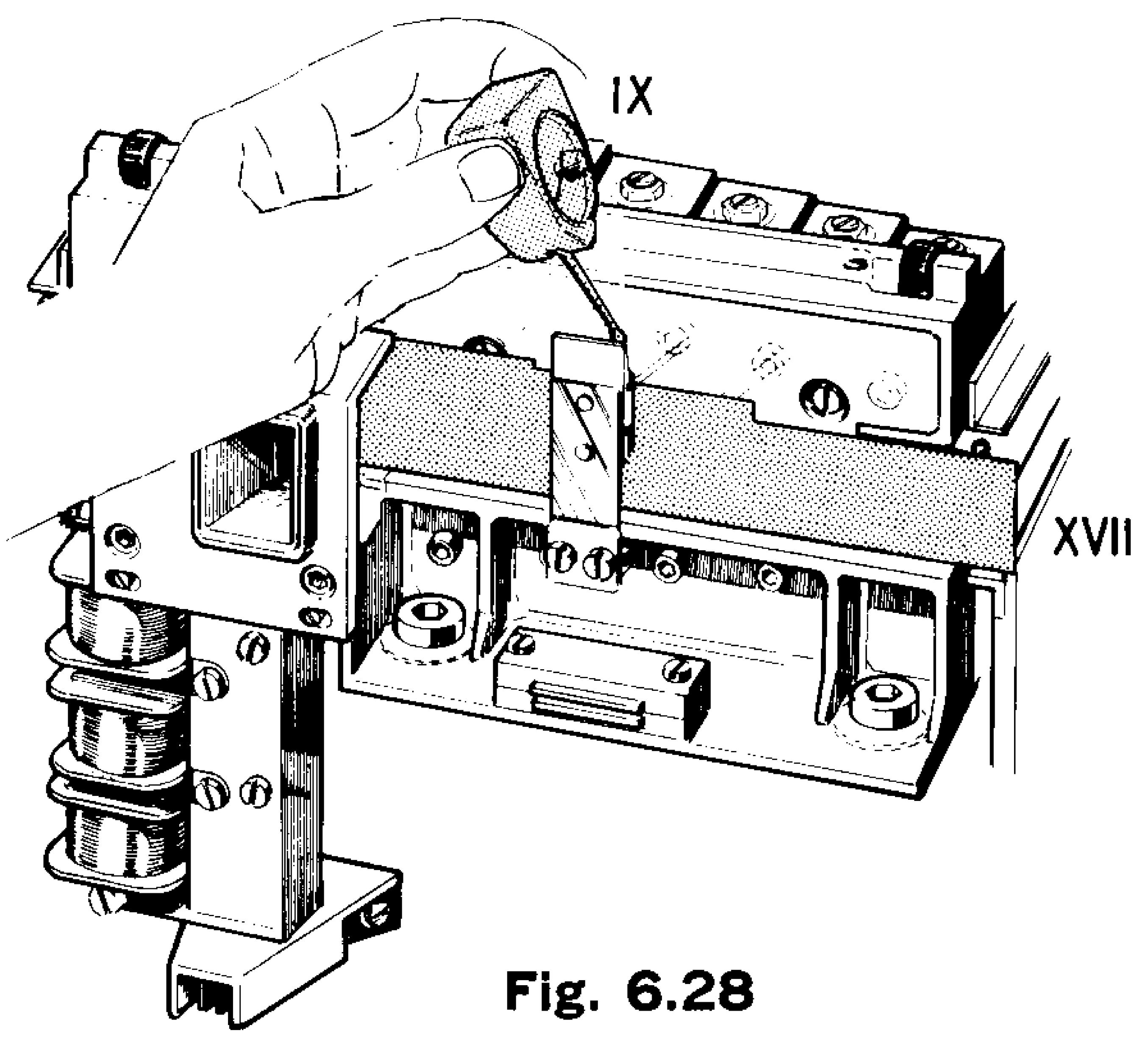


Fig. 6.28

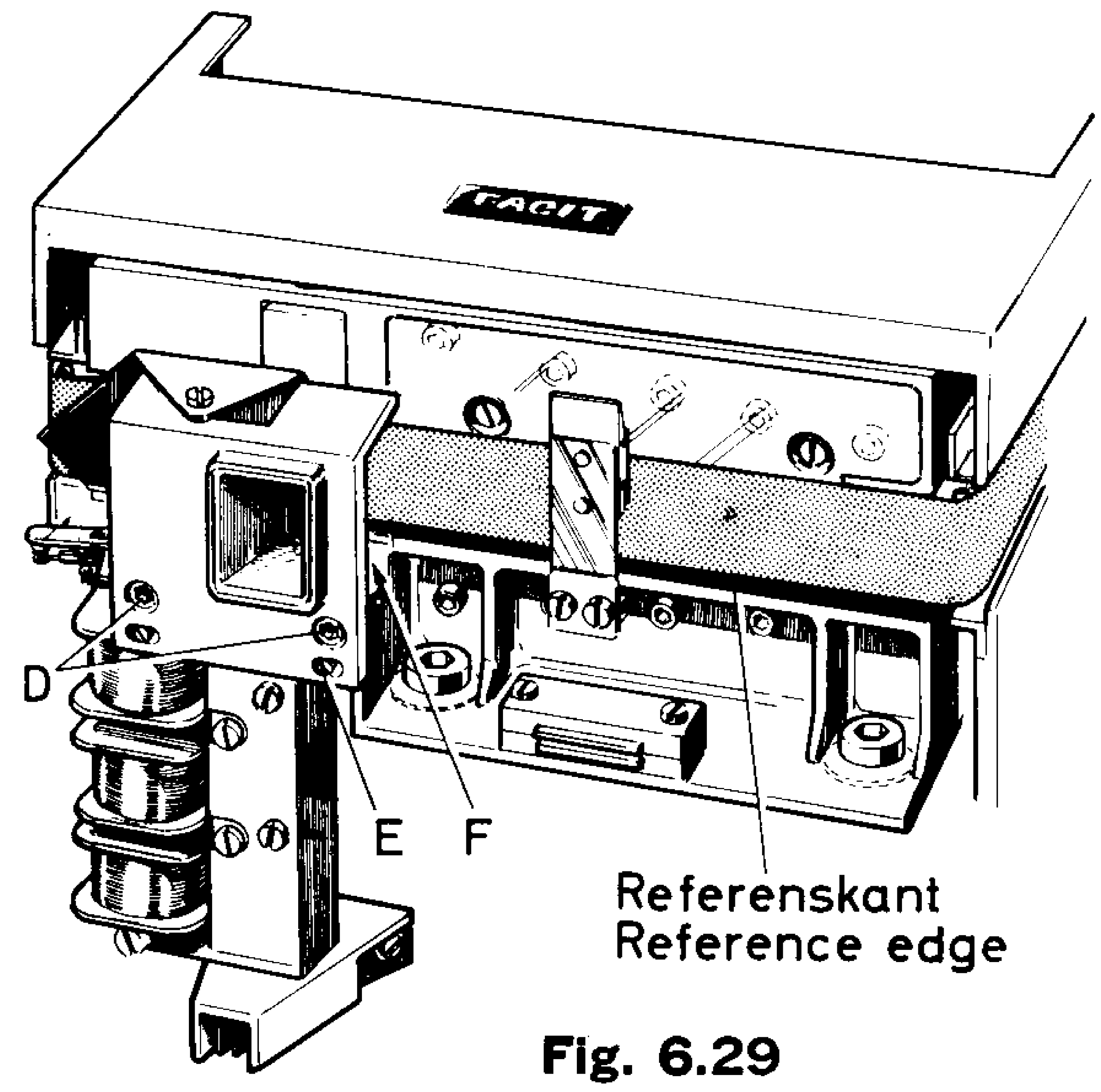


Fig. 6.29

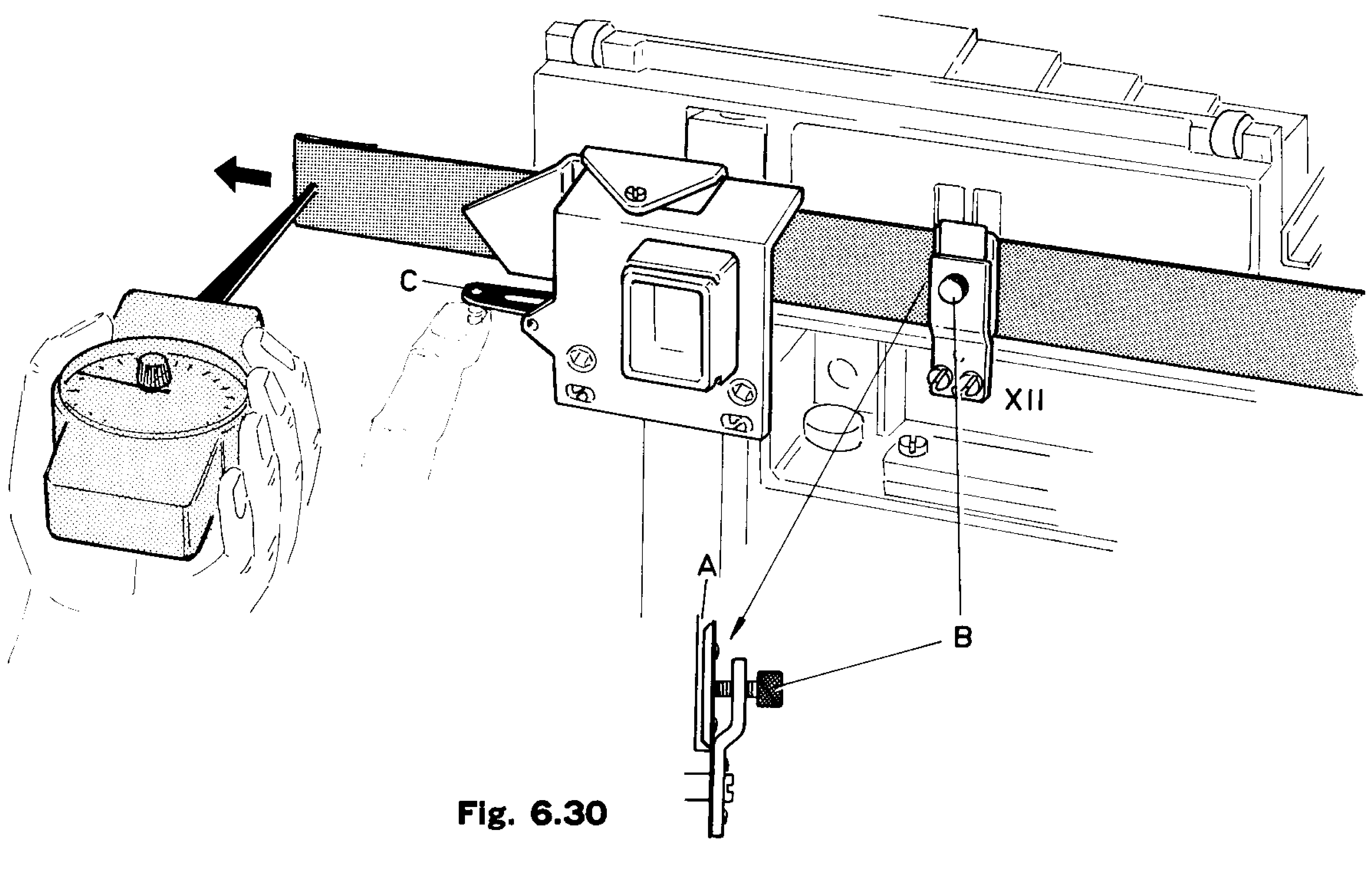


Fig. 6.30

S. Checking adjustment of spring mounted tape guide

Fig 6.28

1. Check that the spring-mounted tape guide exerts a max force of 25 gf on the tape.
   Adjustment: Unscrew and remove the spring-mounted tape guide and straighten it. When replacing with tool XVII, adjust vertical position of spring-mounted tape guide.

T. Checking tape feed

1. Load the punch with tape.
2. Fig 6.29 — Run the punch by depressing the TAPE FEED button and check that tape is fed down along the reference edge of the punch/feed unit. Note that the cover above the punch solenoids shall be in place and that the spring-mounted tape guide shall not press against the tape.
   Adjustment: Loosen lock screw F. Loosen retaining screws D slightly. Run the tape punch using the TAPE FEED button or a data generator (50 rows per second). Turn eccentric screw E slowly until the tape eases away from the reference edge. Then turn the eccentric screw back until the tape is fed down along the reference edge. Lock the eccentric screw using lock screw F and tighten retaining screws D.
3. Run the punch and check that the tape does not strike the edge of the takeup flange.
   Adjustment: Straighten the takeup flange or replace it.

U. Checking incremental motor pulling force

Fig 6.30

1. Remove spring-mounted tape guide and screw special tool XII in place as shown in Fig 6.30.
2. Load the punch with a piece of paper tape and run the tape through gap A on the special tool.
3. Depress the TAPE FEED button.
4. Increase the friction on the tape by screwing in screw B.
5. Release the TAPE FEED button when the friction becomes so high that the incremental motor is unable to feed the tape without missing an increment (row) occasionally.

XX

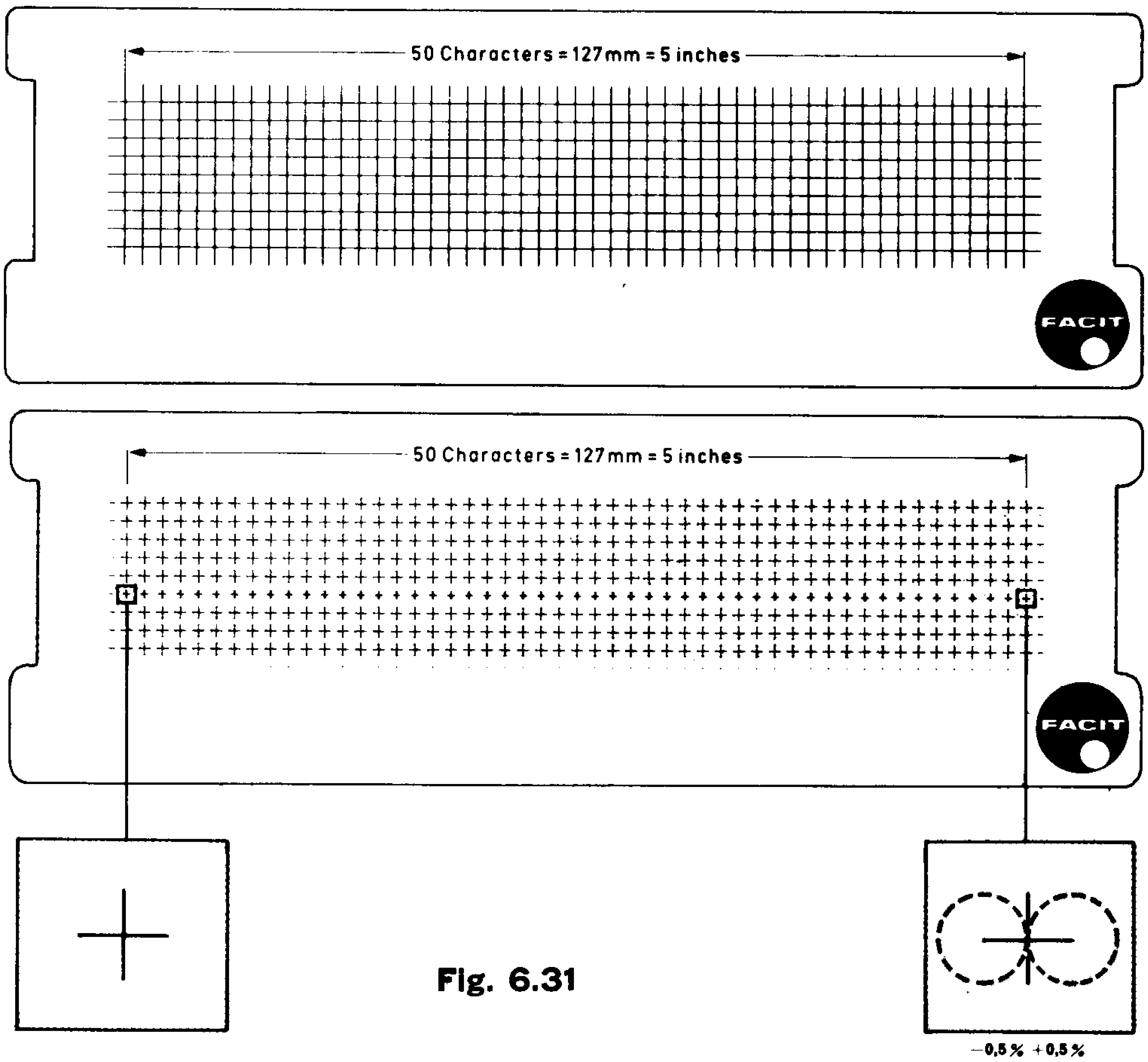

50 Characters = 127mm = 5 inches
FACIT
50 Characters = 127mm = 5 inches
FACIT
−0,5 % +0,5 %

Fig. 6.31

6. Cut off the tape at the tape lifter. Bend over the end of the tape and make a hole for the dial-type spring tension gauge.
7. Lift aside hte pinch roller by pressing arm C and insert the tip of the spring tension gauge into the hole in the folded-over tape end.
8. Move the spring tension gauge perpendicularly to the tape in the direction shown by the arrow.
9. Read the spring tension gauge when the pulling force it exerts is sufficient to just about cancel out the friction at special tool XII. The reading shall be at least 200 gf.
10. Screw the spring-mounted tape guide in place and adjust as instructed in step S1.

V. Checking inter-row spacing

Fig 6.31

1. Position a punched tape on the template so that the centre of a feed hole coincides with the leftmost vertical line on the template and one of the horizontal track lines.
2. Check that the centres of the feed track holes - from the leftmost to the rightmost vertical line - are directly above the track line. Check that one vertical line is visible in every feed hole.
3. The inter-row spacing is indicated by the rightmost vertical line. The max permissible deviation is ± 0.5%.

W. Checking punching action

1. Load the punch with a coil of tape and connect it to mains via a variable autotransformer set to the rated voltage.
2. Run the punch via a data generator (75 rows per second) so that holes are punched in all tracks.
3. Slowly lower the output voltage from the variable autotransformer until the DC voltage is shut off.
4. Check that holes are punched fully in all tracks on the tape.
   NOTE: the CODE HOLE button does not provide DC voltage shutoff.

X. Checking tape check functions

Tape low

1. Move the sensor arm (6 in Fig 4.7) toward the centre of the supply flange.
2. Check that the TAPE LOW lamp lights just before the sensor arm reaches the hub of the supply flange.
   Adjustment: The actuation point can be adjusted between 1,000 and 10,000 rows before end of tape using screw (14) as shown in Fig 4.7.

Tape ruptured/tape too tight

3. Load the punch with a coil of tape.
4. Run the punch with a data generator and move the surge takeup arm to its two end positions.
5. Check that the punch stops and that the ERROR lamp lights. See section 4.4.

Mark character

6. Depress the CODE HOLES button and check that the programmed mark character is punched into the tape. See section 5.5.

Blank tape

7. Depress the FEED HOLES button and check that blank tape (only the feed hole punched) is obtained.

Virgin tape

8. Depress the TAPE FEED button and check that virgin tape is obtained.

EXT function

9. Connect an ohmmeter to pins 19 and 25 on the signal in/output connector P1.
10. Depress the EXT button and check that the resistance shown on the ohmmeter is 0 ohm.

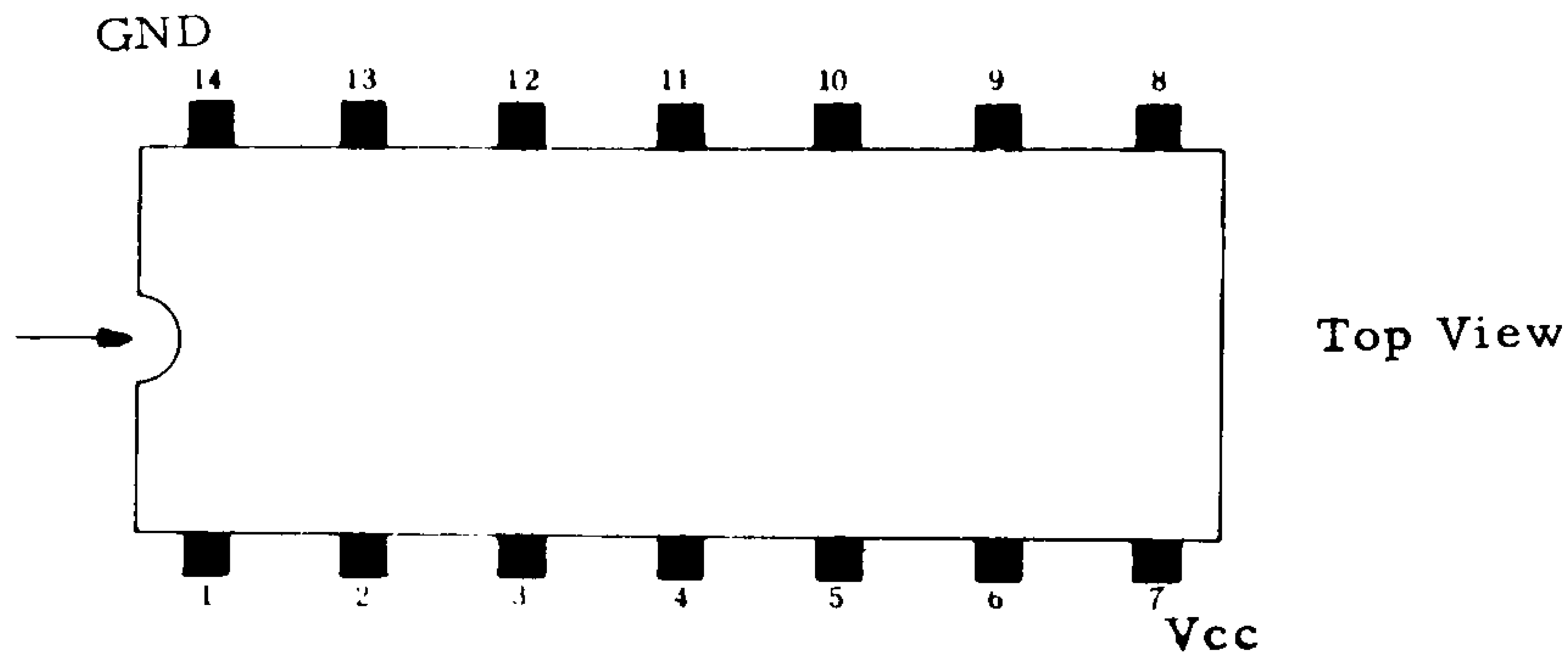


Fig 6.32 IC package pin numbering

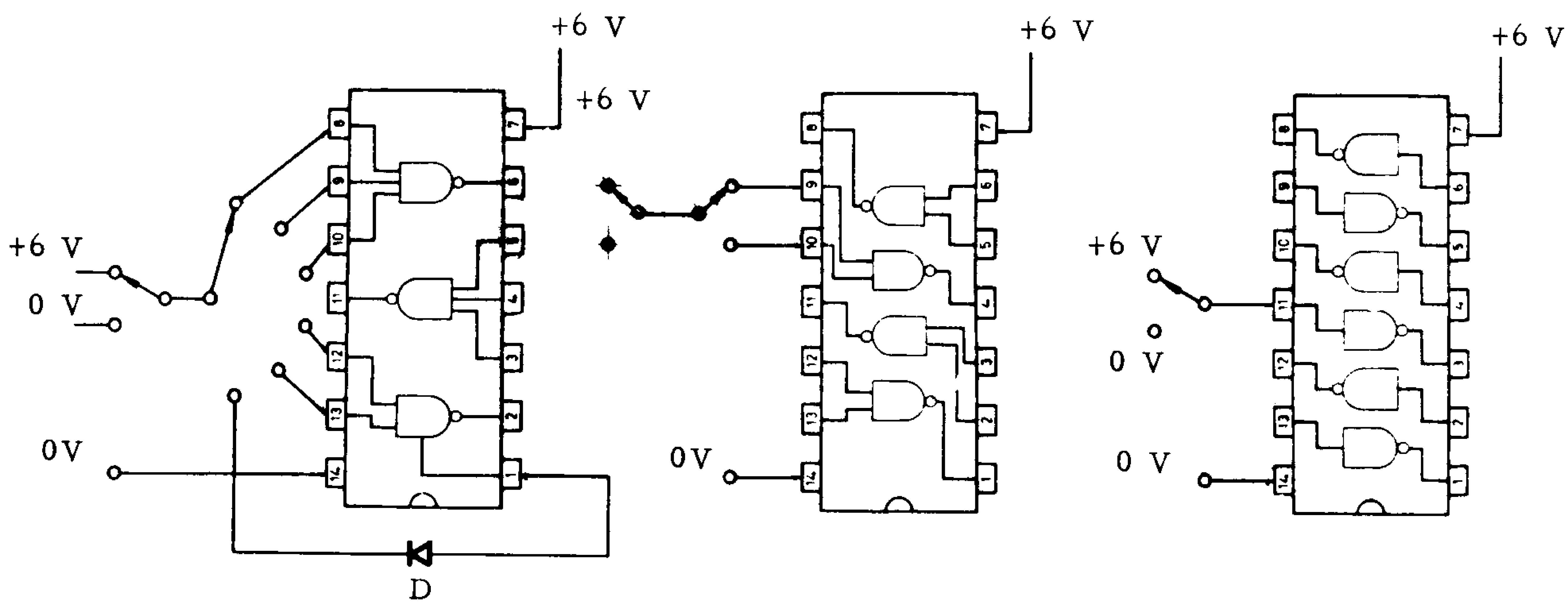


Fig 6.33 Testing IC packages - types FCH 161, FCH 191 and FCH 211.
The FCH 161 package can be provided with a number of fan-in diodes D

6.2 CHECKING PRINTED CIRCUIT BOARDS

6.2.1 General

SEE TO IT THAT THE MAINS VOLTAGE IS DISCONNECTED BEFORE REPLACING PRINTED CIRCUIT BOARDS

Check the printed circuit board connectors. If necessary, clean with trichloroethylene.

6.2.2 Handling integrated circuits

Integrated circuits must be handled very gently during fault tracing. They are easily damaged by overvoltages and short circuits. A low-voltage soldering iron shall thus be used for all soldering work.

Integrated circuits must be removed from printed circuit boards to test their logical functions. They shall be tested using the hookups shown in Figs 6.33, 6.34 and 6.35.

Since the IC package is built up symmetrically, care must be taken to see that +6 V is connected to the correct pin. The semi-circular cutout on

Fig 6.32 the package (see arrow in Fig 6.32) indicates the end at which pins 1 and 14 are located. +6 V (± 5%) shall be connected to pin 7 and 0 V (ground) to pin 14.

NOTE: +6 V shall not be connected directly to any output. Moreover, integrated circuits shall not be tested using an ohmmeter because of the overvoltage risk.

6.2.3 Testing integrated circuits

The five different IC packages used in the 4070 have been grouped into three classes for testing purposes:

Fig 6.33 Class A - types FCH 161, 191 and 211 - see Fig 6.33
Connect +6 V to pin 7 and 0 V to pin 14. If all inputs to a gate are floating (not connected to anything), its output shall be 0 V (from 0 to +0.4 V). If all inputs to a gate are connected to +6 V its output shall be 0 V. If 0 V is connected to any of the inputs, the corresponding output shall be +6 V.

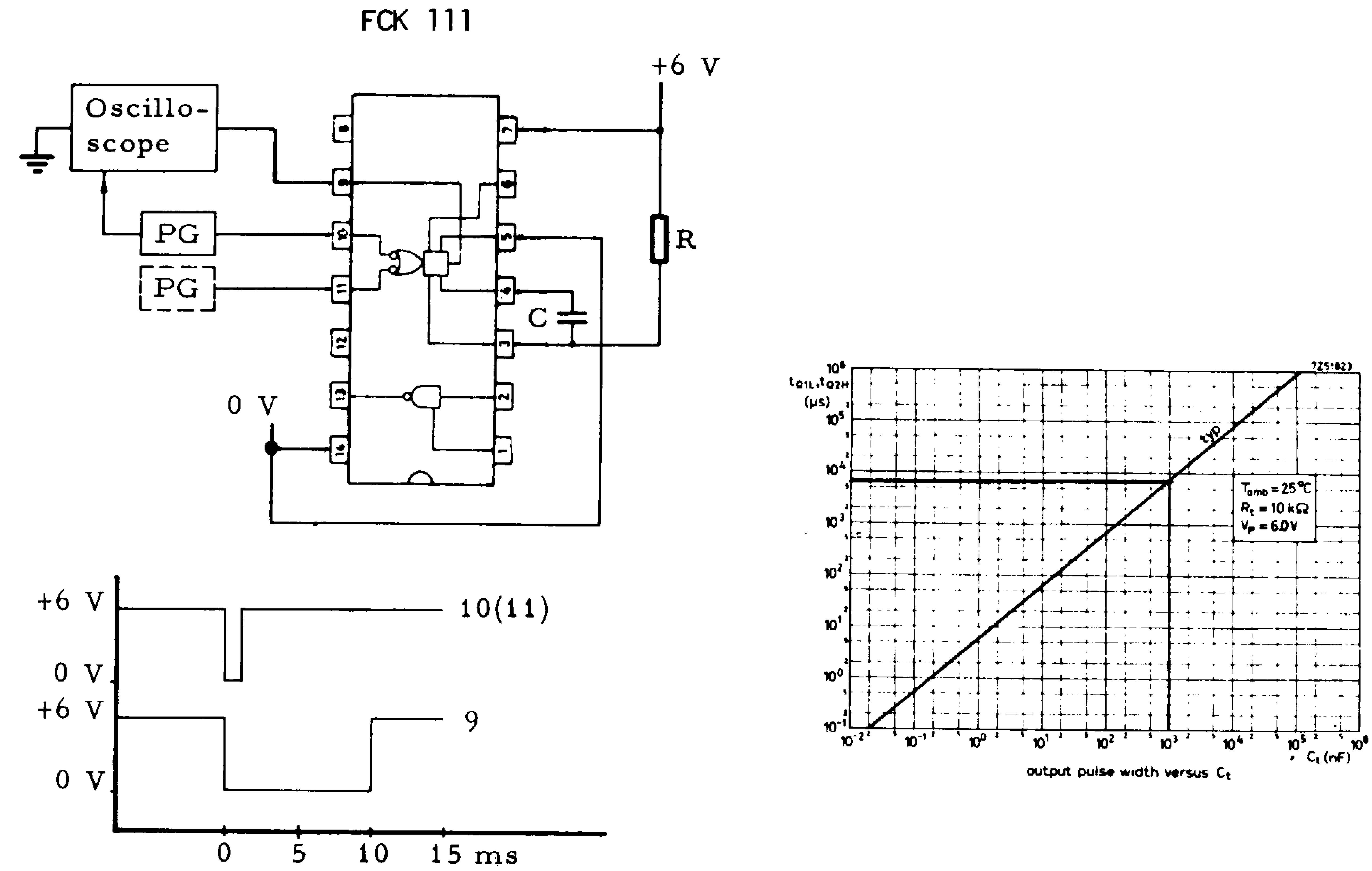


Fig 6.34 Testing IC package - type FCK 111, monostable flip-flop

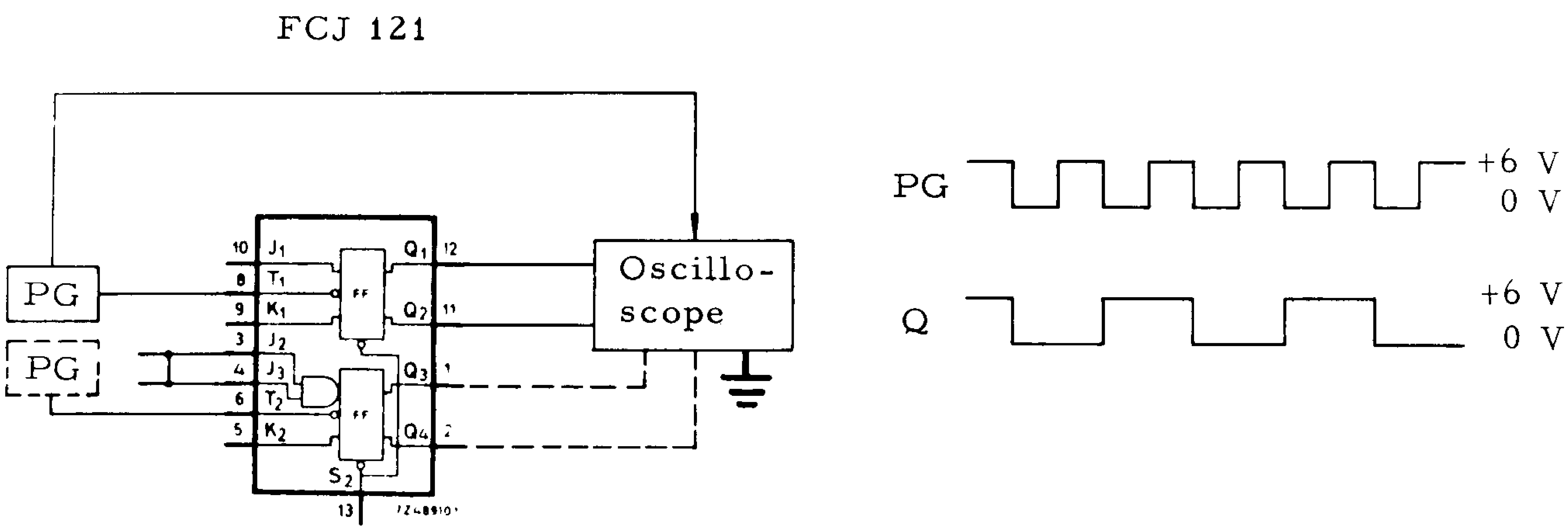


Fig 6.35 Testing IC package - type FCJ 121, JK flip-flop
Oscillograms (punching speed, 50 rows/second)

Class B - type FCK 111

Fig 6.34 Connect as shown in Fig 6.34. When R is 10 kilohms and C is 1 μF, the pulse duration shall be about 10 ms.
NOTE: The trigger pulse from the pulse generator must be shorter than the output pulse from the flip-flop.

Class C - type FCJ 121

Fig 6.35 Fig 6.35 shows the hookup for testing this type of package. Table 1 is the truth table for a flip-flop triggered via its T input. The flip-flop having 2 J inputs shall be tested with pins 3 and 4 joined together. Table 2 is the truth table for a flip-flop triggered via its S input.

Table 1 - triggering via T input (both flip-flops)

T=HIGH		T=LOW	
J1 J2	K1 K2	Q1 Q3	Q2 Q4
H	H	Change of state	
L	H	L	H
H	L	H	L
L	L	No change of state	

Information at the J and K inputs is transferred to the master flip-flop when T becomes HIGH. When T subsequently goes LOW, the outputs assume the levels appearing in the table. Input S2 must be HIGH or floating.

Table 2 - 0-setting via input S2 (both flip-flops)

S2	Q1 Q3	Q2 Q4
L	L	H
H	No change of state	

A signal at input S2 overrides the signals at other inputs, thus determining the levels at the outputs of both flip-flops.

H= HIGH (the more positive voltage)
L= LOW (the less positive voltage)

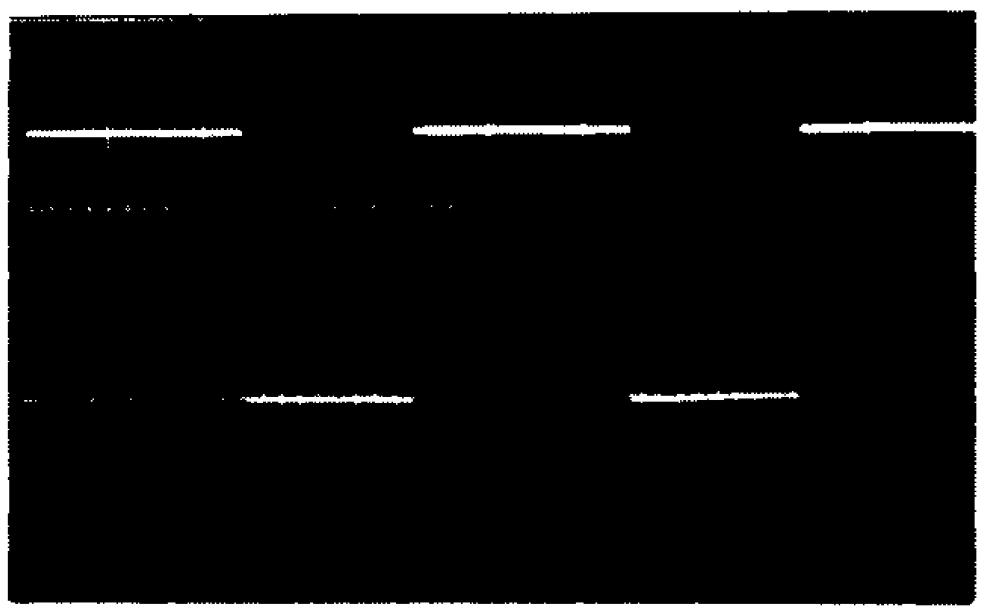
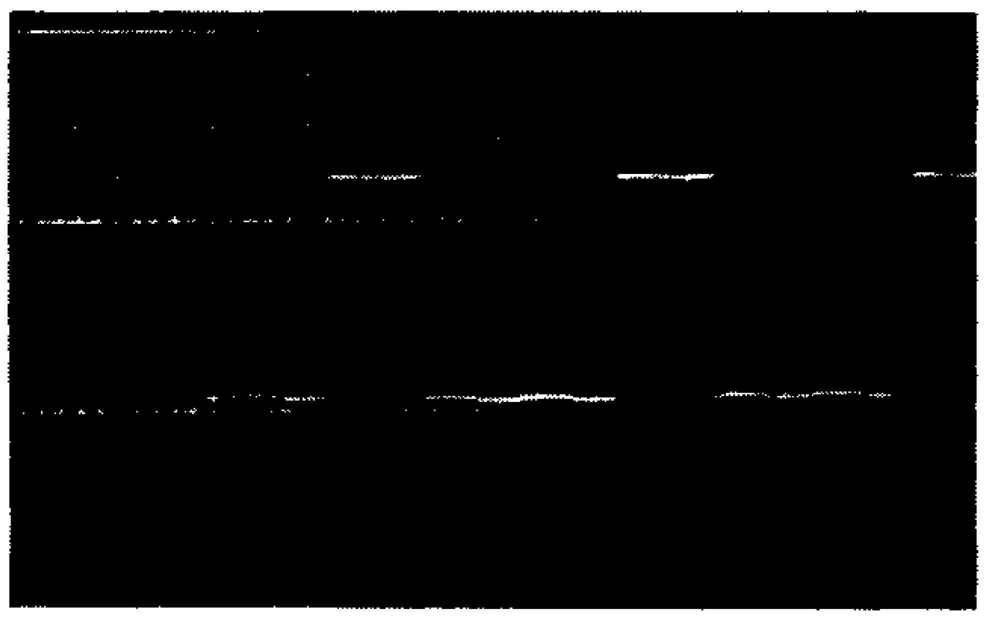
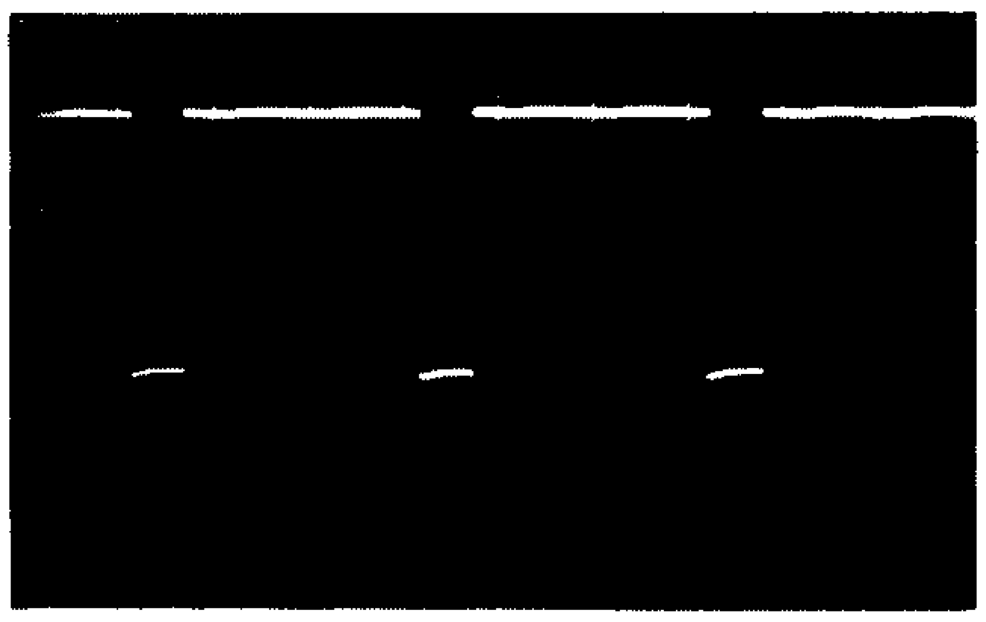
6.3 FAULT TRACING

These fault tracing routines are based on the instrumentation normally available in two types of workshops - central workshops and local workshops. They are therefore presented on two levels.

Commonly encountered mechanical faults, their probable causes and remedies recommended for central workshops and local workshops are presented in Appendix 1. The following oscillograms can be of some assistance for fault tracing on the circuit boards. In addition, waveforms are shown for all the points on the logic diagram.

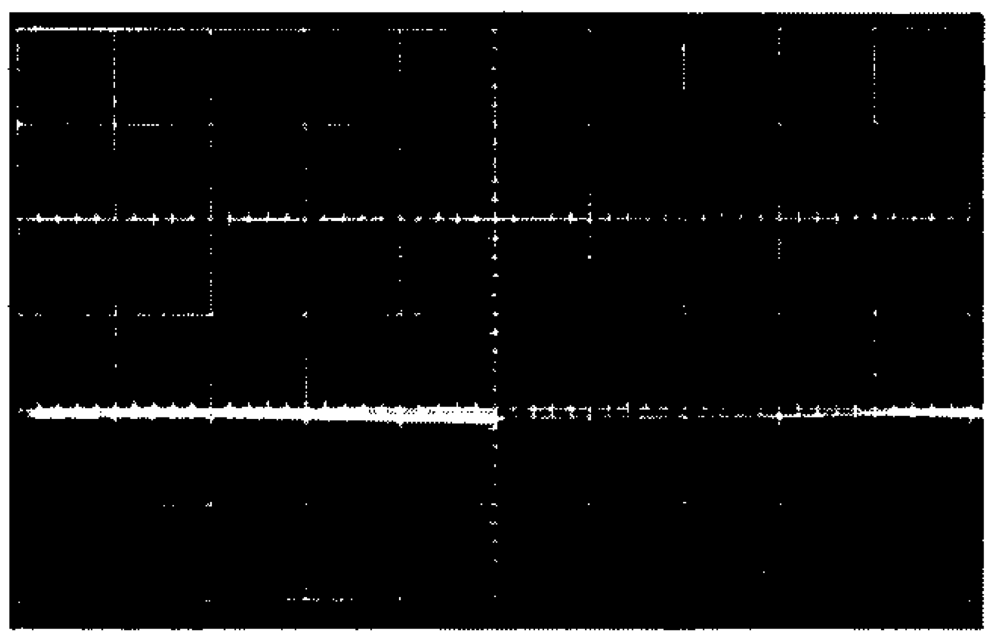
A checklist appears on page 6.17. It shall always be run through step by step when the punch has undergone mechanical fault tracing or any sort of adjustment.

Oscillograms (punching speed, 50 rows/second)

Test points A - I	Trigg	Scale
	PI	2 V/cm 5 ms/cm
Test points J and L 	PI	2 V/cm 20 ms/cm
Test points K, M and N 	PI	2 V/cm 20 ms/cm

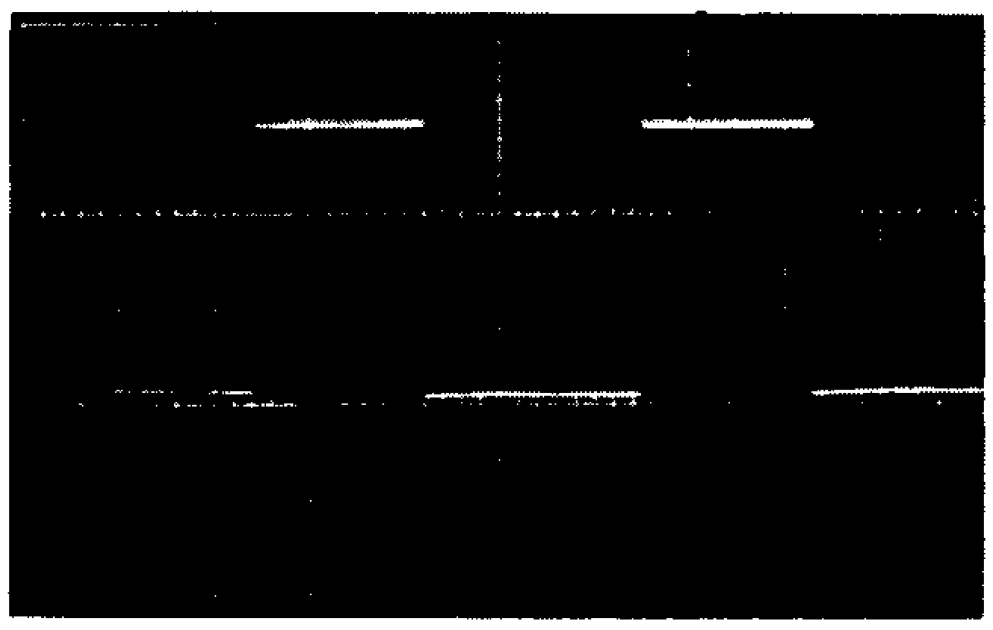
	Trigg	Scale

Test point P



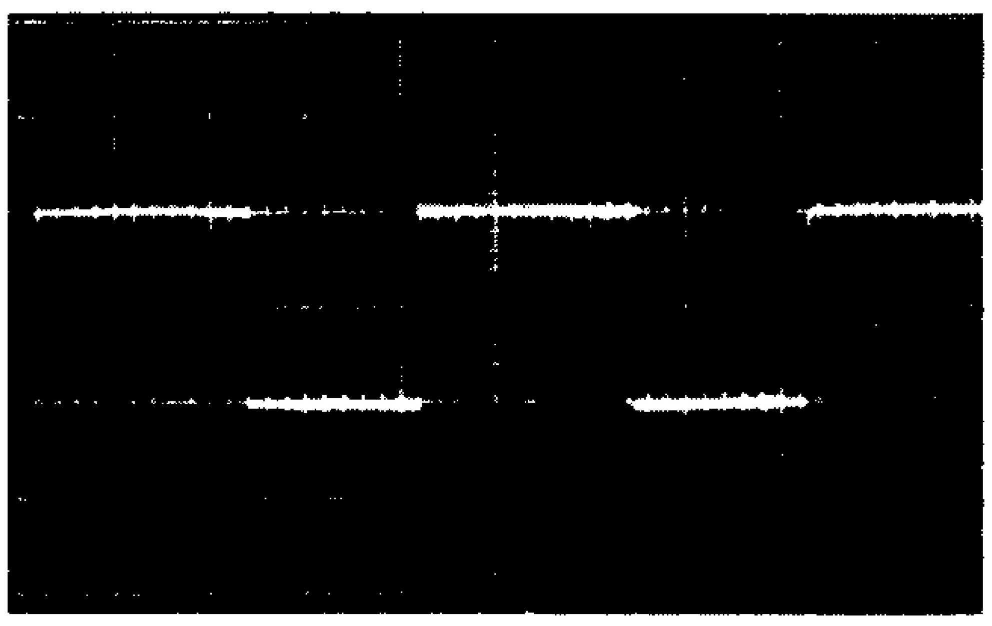
Trigg	Scale
PI	5 V/cm 5 ms/cm

Test point R



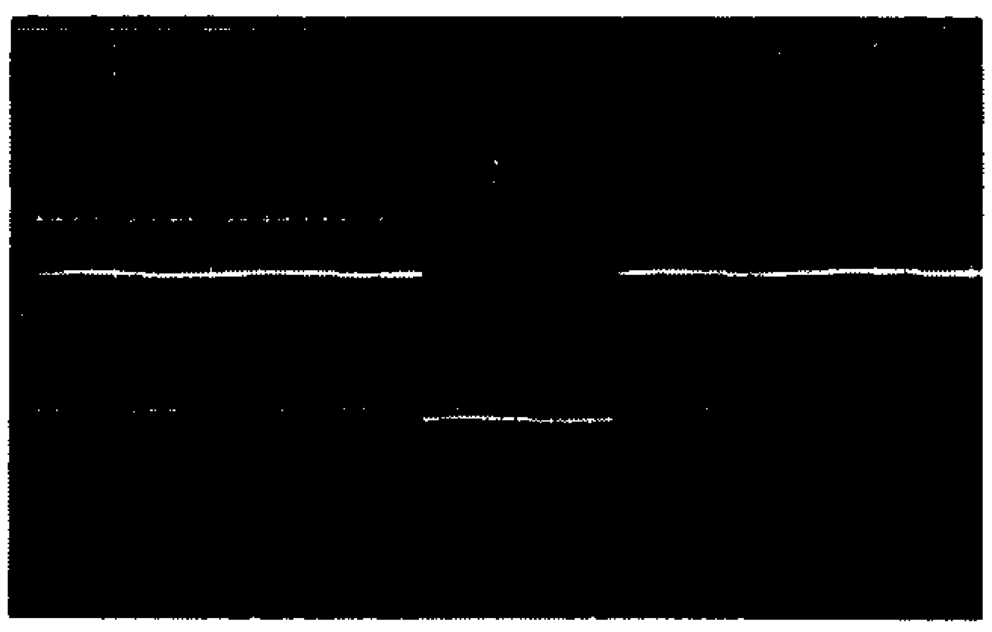
Trigg	Scale
PI	2 V/cm 5 ms/cm

Test point S



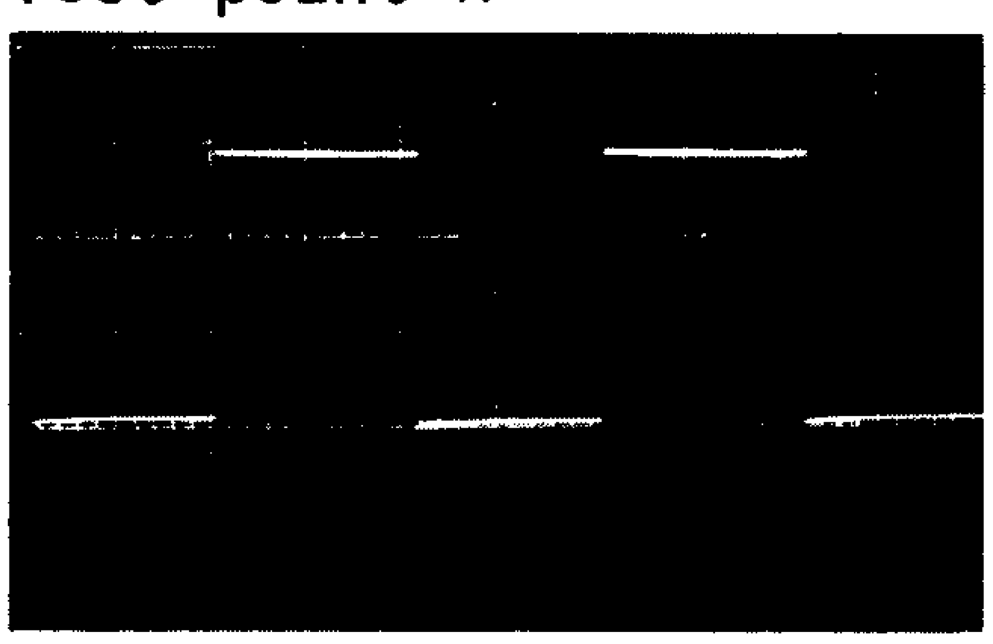
Trigg	Scale
PI	2 V/cm 5 ms/cm

Test point U



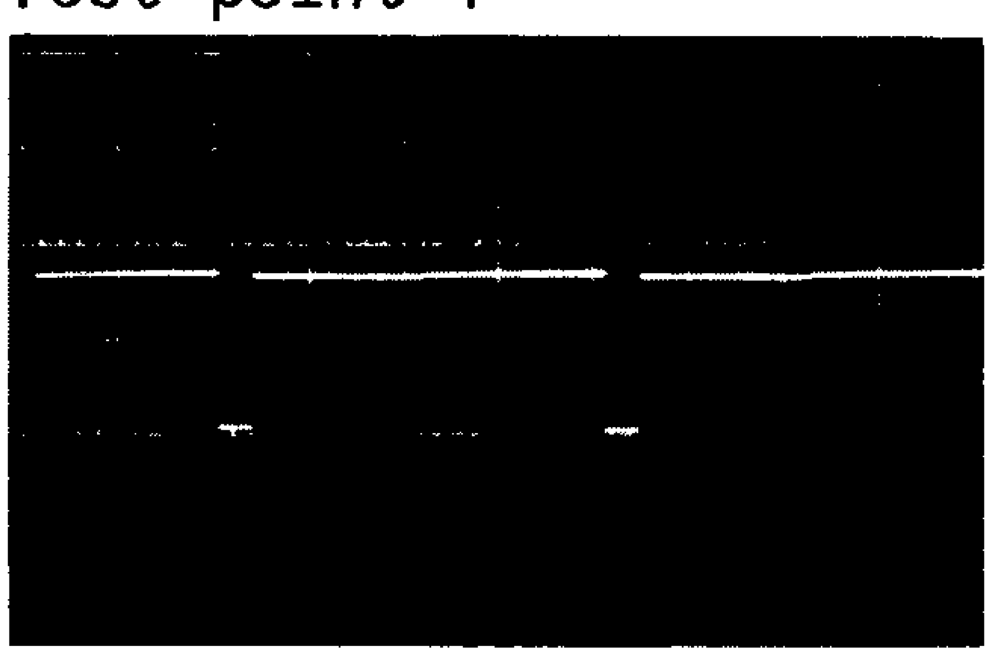
Trigg	Scale
PI	2 V/cm 10 ms/cm

Test point X



Trigg	Scale
PI	2 V/cm 5 ms/cm

Test point Y



Trigg	Scale
PI	2 V/cm 5 ms/cm

6.4 PERIODIC SERVICING

Periodic servicing shall be undertaken at intervals determined by the number of reels punched, namely 50, 500, 1,000, and 2,000-reels intervals.

50-reel service is carried out by the customer. It entails dust removal and a check to see that the data fed to the punch is, in fact, punched out on the tape.

The remaining service should be carried out by a suitable trained serviceman as indicated below.

With respect to certain operating conditions such as -
irregular duty cycles with very long stop periods
characteristics of the tape being used
a lubrication of the tape punch head as per section G 11 might be required between each 500-reel service.

500-reel service	Section
1. = Lubricate the punch head	G 11
Check wear on	
2. Winding up motor drive	P
3. Supply flange brake	N
4. Rubber ring on core catch	
5. Spring attachment on punch solenoids	
6. Brake triangle of incremental motor (feeding accuracy adjacent rows, 3%)	H 6
7. Punch pin driver	D
Check bearings on	
8. Supply and takeup flanges	
9. Surge takeup arm	N
10. Tape low sensor arm	O
11. Guide rollers	
12. Reversing buffer arm	R
13. Pinch roller	L
14. Motor shaft	H
15. Capstan	J
16. Punch solenoids	B

Run through list on page 6.19

1,000-reel service

Replace	Section
1. Punch head and punch pins	G
2. Punch solenoids	B
3. Incremental motor mount	H
4. = 500-reel service, when applicable	

2,000-reel service

1. = 1,000-reel service

Remove, clean and check

2. Movable parts
3. Shafts
4. Bearing sleeves

Check and if necessary replace

5. Winding motor	
6. Fan motor	
7. Capstan	J
8. Pinch roller	L
9. Supply and takeup flanges	
10. Supply flange brake	N
11. Springs	

Checklist

Check:	Limits:	Section/step:
1. Unactuated position of surge takeup arm	96 $^{+4}_{-0}$ mm edge of punch	N1
2. Torque exerted by surge takeup arm	80 - 100 gf	N2
	40 - 60 gf	N3
3. Braking force on supply flange	400 ± 150 gf	N1
4. Unwinding force	max 50 gf	Q
5. Force exerted against takeup flange by winding motor	650 - 800 gf	P
6. That sensor arm moves easily		O
7. Torque exerted by reversing buffer arm	180 ± 20 gf	R1
8. Fan motor blows air out through side crevices		
9. Force exerted against tape by spring-mounted tape guide	max 25 gf	S
10. Force exerted by pinch roller against capstan	600 ± 50 gf	L1
11. Pulling force of winding motor	min 950 gf	P
12. Pulling force of incremental motor	min 200 gf	U
13. Inter-row spacing		V
14. Punching action		W
15. Tape check functions		X

6.5 LUBRICATION INSTRUCTIONS

1. Plastic parts
   Clean shafts and shaft holes for all plastic rollers carefully with methylated spirits or equivalent.
   NOTE: Never permit oil or grease to contact plastic parts.

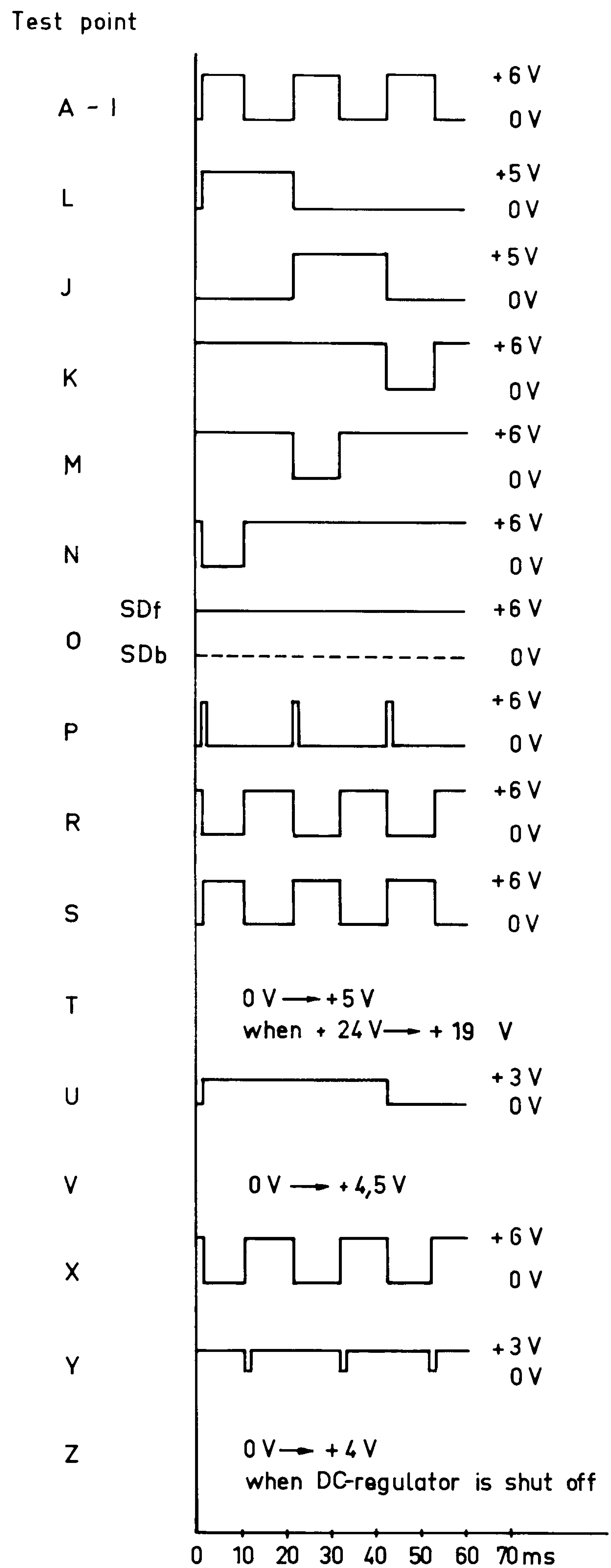
2. Punch/feed unit
   Lubricate with - Rocol MT 320 - the punch head as instructed in step G 11.

3. Surge takeup arm
   Clean the surge takeup arm shaft and its hole and the bearing sleeves of the two arms located above the surge takeup arm. Lubricate all these parts with a thin coat of oil.

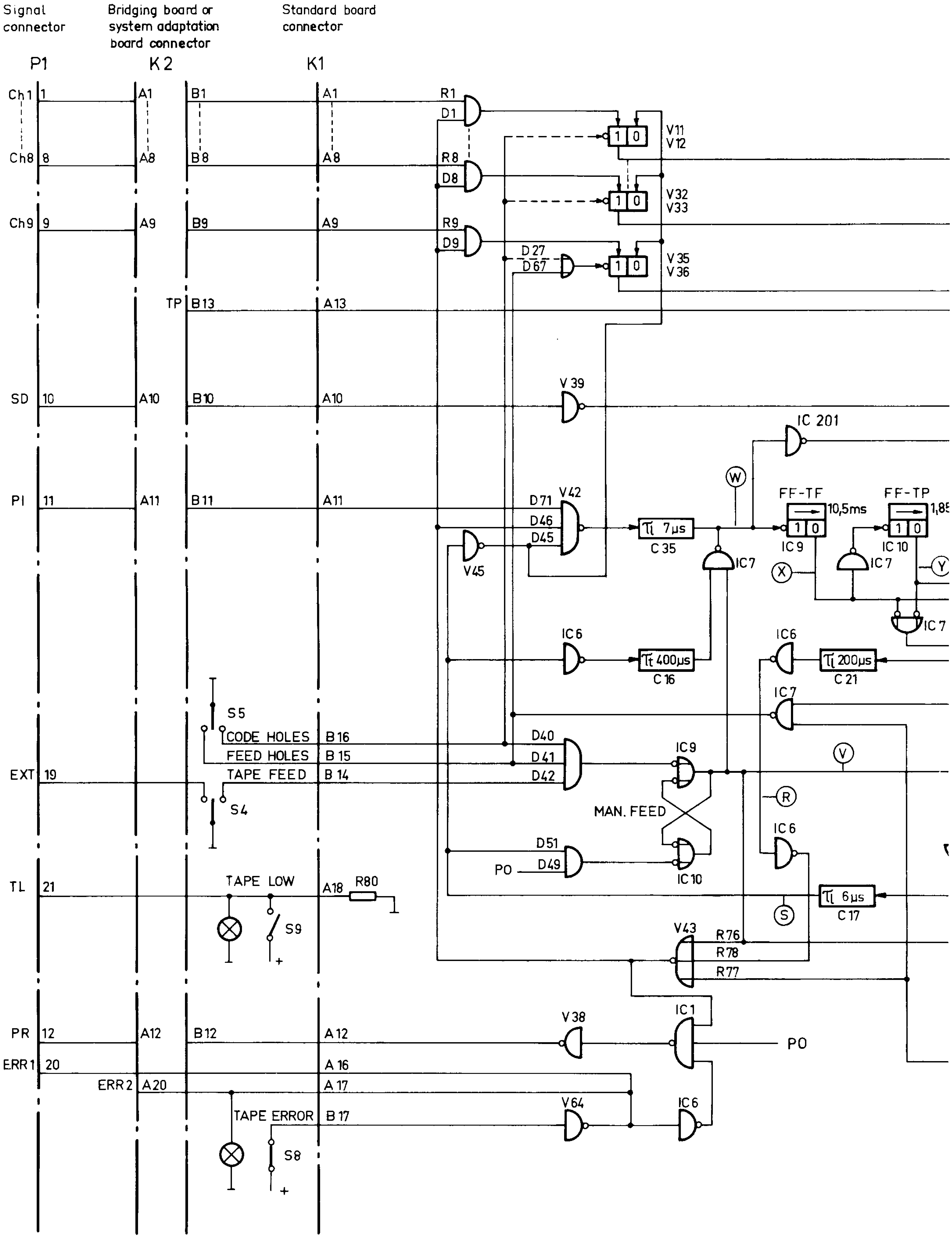
4. Reversing buffer arm
   Lubricate the reversing buffer arm with grease Esso P 290 or equivalent.

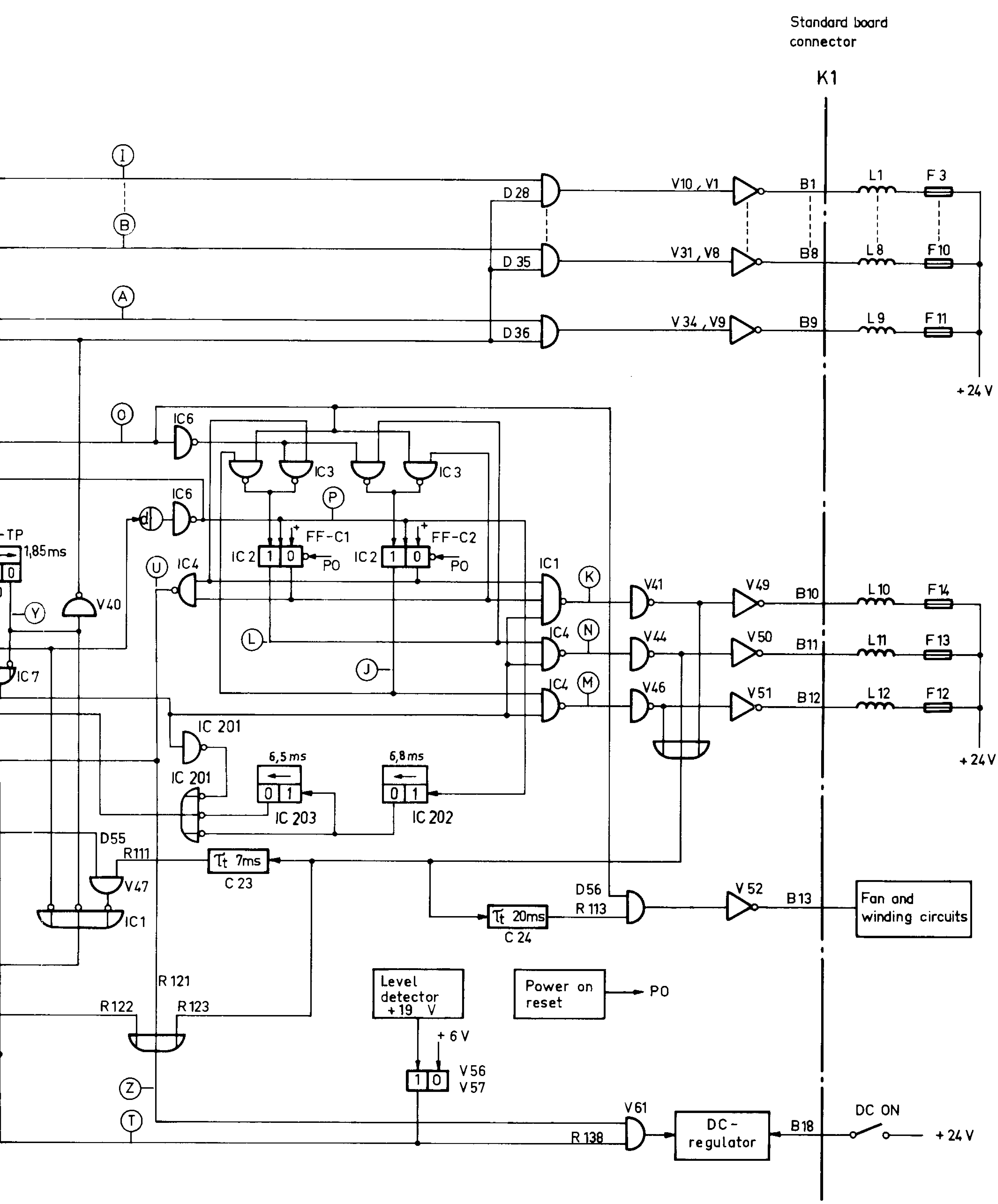
FAULT	PROBABLE CAUSE
1. Faulty inter-row spacing	1. Incorrect pulling 2. Transmission betw and capstan bindi 3. Motor or brake bi 4. Pinch roller bind 5. Unwinding mechani 6. Flanges on pinch code-hole tracks
2. Skipped track (no mark on tape)	1. Faulty printed ci 2. Faulty cabling 3. Broken punch pin 4. Faulty punch sole 5. Punch solenoid lo punch/feed unit c 6. Punch solenoid co solenoid frame
3. Unsatisfactory readability	1. Worn or damaged p
4. Sporadically skipped track (mark on tape)	1. Incorrect punch p adjustment 2. Improperly adjust solenoid 3. Play in punch pin 4. Punch pins bindin 5. Chads jammed in d 6. Faulty printed ci
5. Faulty tape feed indication (rupture tape)	1. Supply reel core or faulty core la 2. Supply flange bra adjusted or worn
6. Faulty tape feed indication (tape too tight)	1. Supply flange bin 2. Surge takeup arm 3. Supply flange war 4. Sticky tape
7. Unsatisfactory winding	1. Winding motor pul low 2. Takeup flange war 3. Punch pins worn 4. Reversing buffer 5. Reversing buffer

	REMEDY Central workshop	Local workshop
force	1. Section V	1. Replace punch/feed unit
en motor shaft g	2. Section K	2. Replace punch/feed unit
ding	3. Section H and I	3. Replace punch/feed unit
ng	4. Section L	4. Replace punch/feed unit
m	5. Section Q	5. Replace punch/feed unit
oller run in n tape	6. Section L	6. Replace punch/feed unit
cuit board	1. Section 5	1. Replace printed circuit board
	2. Section 5	2. Replace punch
river	3. Section E	3. Replace punch/feed unit
oid	4. Sections B, C and F	4. Replace punch/feed unit
se on assis	5. Sections B, C and F	5. Replace punch/feed unit
l loose in	6. Sections B, C and F	6. Replace punch/feed unit
nch pins	1. Section G	1. Replace punch/feed unit
n vertical	1. Steps F11 through F16	1. Replace punch/feed unit
d punch	2. Section C and steps F11 through F16	2. Replace punch/feed unit
driver	3. Sections D and E	3. Replace punch/feed unit
	4. Step G11	4. Step G11 or replace punch/feed unit
e	5. Clean carefully	5. Clean carefully
cuit board	6. Section 5	6. Replace printed circuit board
ot secured ch	1. Secure core or repair latch	1. Secure core or replace supply flange
e improperly	2. Section N	2. Replace punch
ing	1. Clean	1. Clean
inding	2. Steps N2 and N3	2. Replace punch
ed	3. Replace or straighten supply flange	3. Replace supply flange
	4. Replace tape	4. Replace tape
ing force too	1. Section P	1. Section P
ed	2. Replace or straighten	2. Replace takeup flange
	3. Section G	3. Replace punch/feed unit
ollers binding	4. Clean	4. Clean
rm twisted	5. Replace or straighten	5. Straighten reversing buffer arm



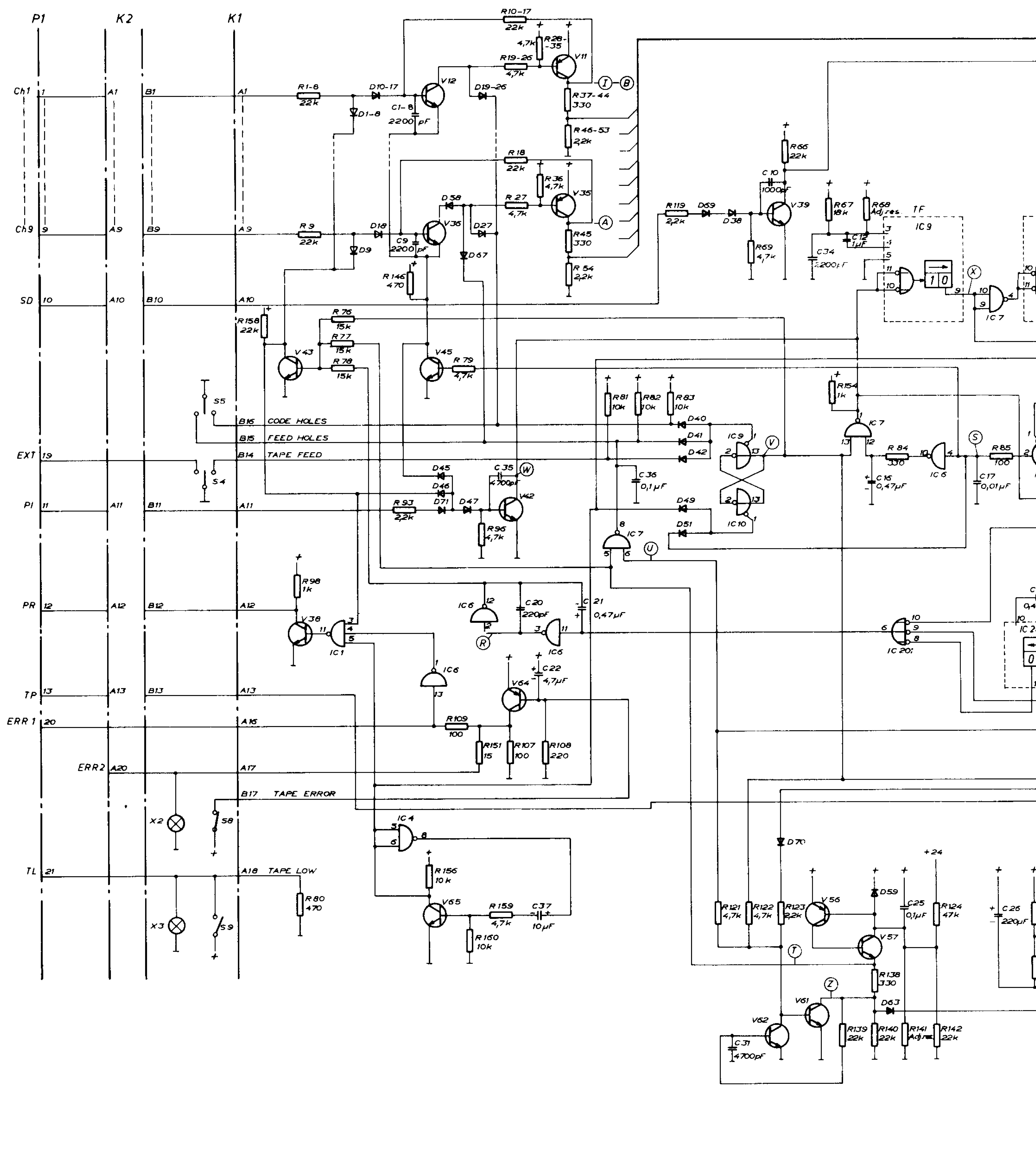
Test point
A - I
+6 V
0 V
L
+5 V
0 V
J
+5 V
0V
K
+6 V
0 V
M
+6 V
0 V
N
+6 V
0 V
O
SDf
+6 V
SDb
0V
P
+6 V
0 V
R
+6 V
0 V
S
+6 V
0 V
T
0 V → +5 V
when + 24 V → + 19 V
U
+3 V
0 V
V
0 V → + 4,5 V
X
+6 V
0 V
Y
+3 V
0 V
Z
0 V → +4 V
when DC-regulator is shut off
0
10
20
30
40
50
60
70 ms


Signal connector
Bridging board or system adaptation board connector
Standard board connector
P1
K2
K1
Ch1
Ch8
Ch9
TP
SD
PI
EXT
TL
PR
ERR1
ERR2
V11 V12
V32 V33
V35 V36
V39
IC 201
FF-TF
FF-TP
10,5ms
V42
C 35
IC 9
IC 10
IC7
V45
IC6
C 16
C 21
C 17
S5
S4
S9
S8
CODE HOLES
FEED HOLES
TAPE FEED
MAN. FEED
TAPE LOW
TAPE ERROR
R80
V43
V38
V64
IC1
PO

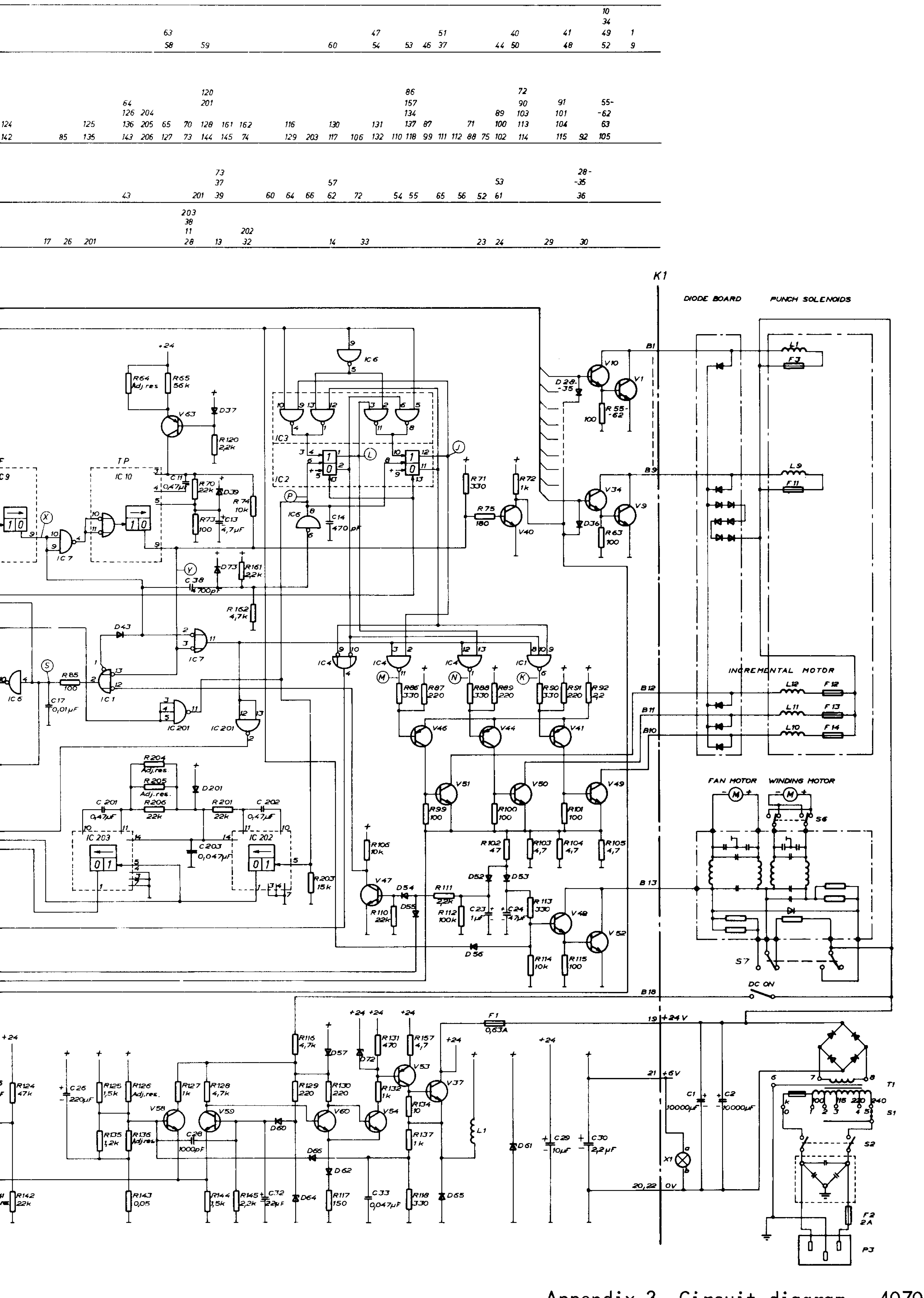

Standard board connector
K1
D 28
D 35
D 36
V10 , V1
V31 , V8
V 34 , V9
B1
B8
B9
L1
L8
L9
F 3
F 10
F 11
+ 24 V
IC6
IC3
IC 3
FF-C1
FF-C2
IC 2
PO
IC4
IC1
V41
V44
V46
V49
V50
V51
B10
B11
B12
L 10
L 11
L 12
F 14
F 13
F 12
-TP
1,85 ms
V40
IC 7
IC 201
6,5 ms
6,8 ms
IC 203
IC 202
D55
R111
V47
Tt 7ms
C 23
D56
R 113
Tt 20ms
C 24
V 52
B 13
Fan and winding circuits
R 121
R122
R123
Level detector +19 V
+ 6 V
V 56
V 57
Power on reset
PO
V61
R 138
DC - regulator
B18
DC ON
+ 24 V

Ch.	V	D	R
1	1 10 11 12	1 10 19 28	1 10 19 28 37 46 55
2	2 13 14 15	2 11 20 29	2 11 20 29 38 47 56
3	3 16 17 18	3 12 21 30	3 12 21 30 39 48 57
4	4 19 20 21	4 13 22 31	4 13 22 31 40 49 58
5	5 22 23 24	5 14 23 32	5 14 23 32 41 50 59
6	6 25 26 27	6 15 24 33	6 15 24 33 42 51 60
7	7 28 29 30	7 16 25 34	7 16 25 34 43 52 61
8	8 31 32 33	8 17 26 35	8 17 26 35 44 53 62
9	9 34 35 36	9 18 27 36 58 67	9 18 27 36 45 54 63

V	43 38 · 65 12 36 45 · 42 64 · 11 35 · 39 62 · 56 61 · 57
R	158 · 1- -8 9 98 80 · 76 77 78 · 146 93 · 156 · 160 79 109 · 159 96 151 · 10- -17 19- -26 18 27 107 · 28- -35 36 108 · 37- -44 46- -53 45 54 · 81 · 82 · 119 83 · 121 · 69 122 · 123 · 66 · 67 154 139 · 68 138 140 · 84 141 · 124 142 · 85 · 125 135
D	1- -8 9 · 10- -17 18 · 58 45 46 71 · 67 47 · 19- -26 27 · 40 41 42 49 51 · 69 · 38 · 70 · 59 · 63
C	1- -8 9 · 35 · 20 · 37 22 · 21 · 36 · 31 · 10 · 34 · 12 · 16 · 25 · 17 · 26 · 201



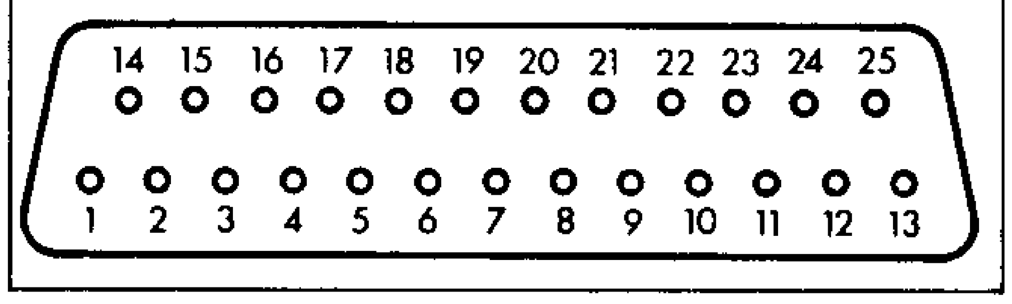
FACIT 4070



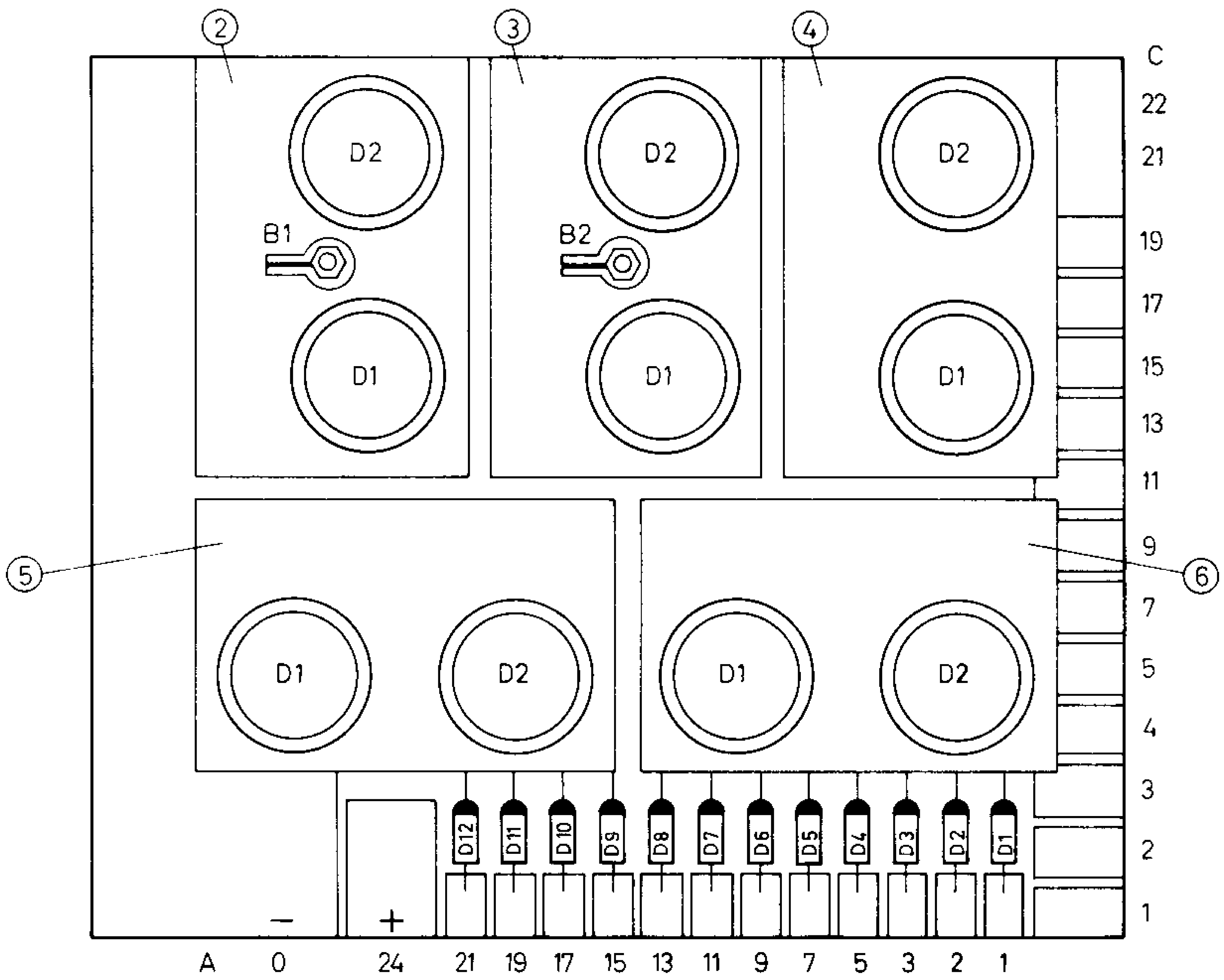
Appendix 3 Circuit diagram - 4070

Signal connector P1

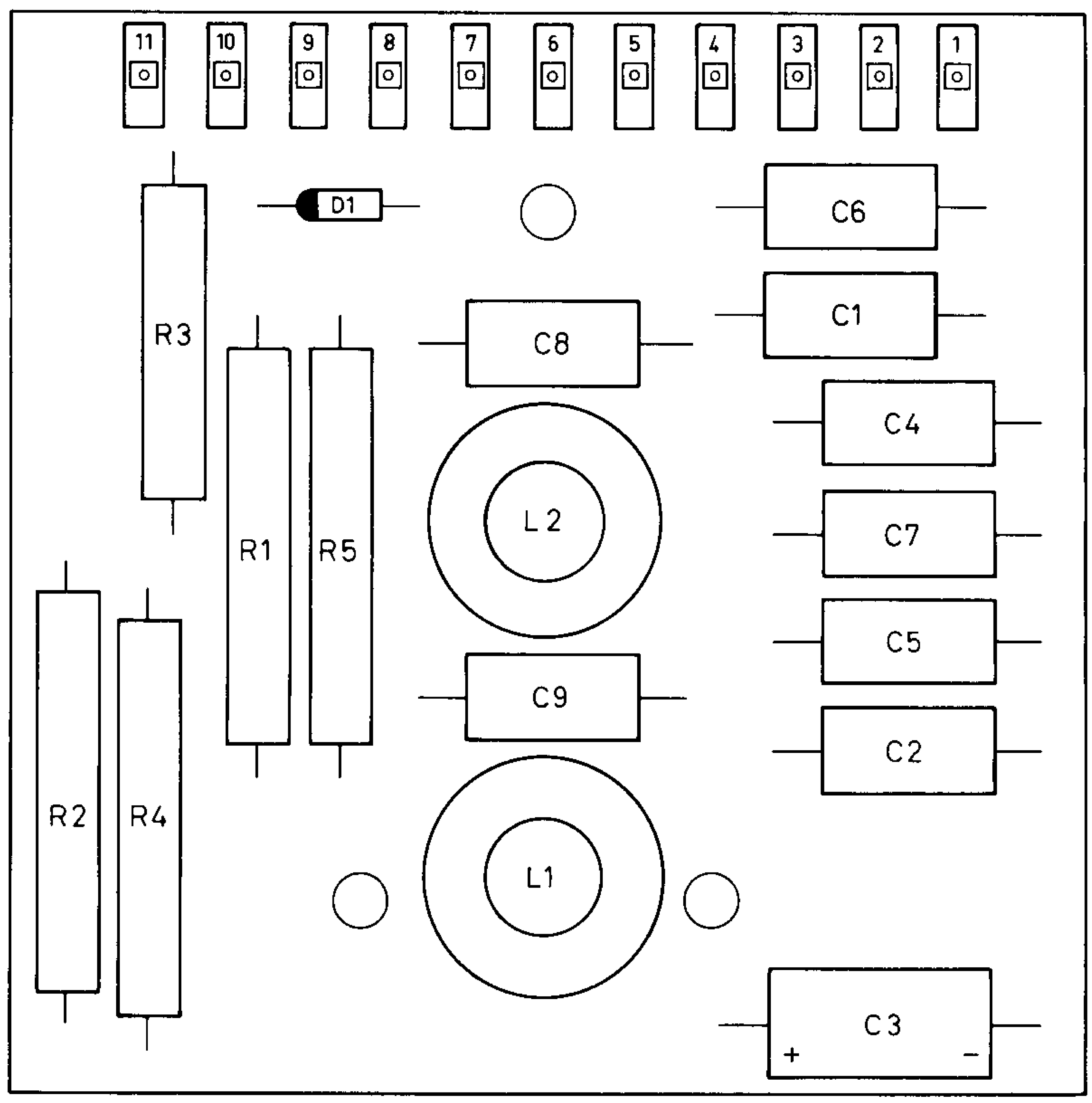
Pin	Signal	Pin	Signal
1	Ch1	14	–
2	Ch2	15	–
3	Ch3	16	–
4	Ch4	17	–
5	Ch5	18	–
6	Ch6	19	Ext
7	Ch7	20	Err. 1
8	Ch8	21	TL
9	Ch9	22	+ 24 V
10	SD	23	–
11	PI	24	+ 6 V
12	PR	25	0 V
13	–		

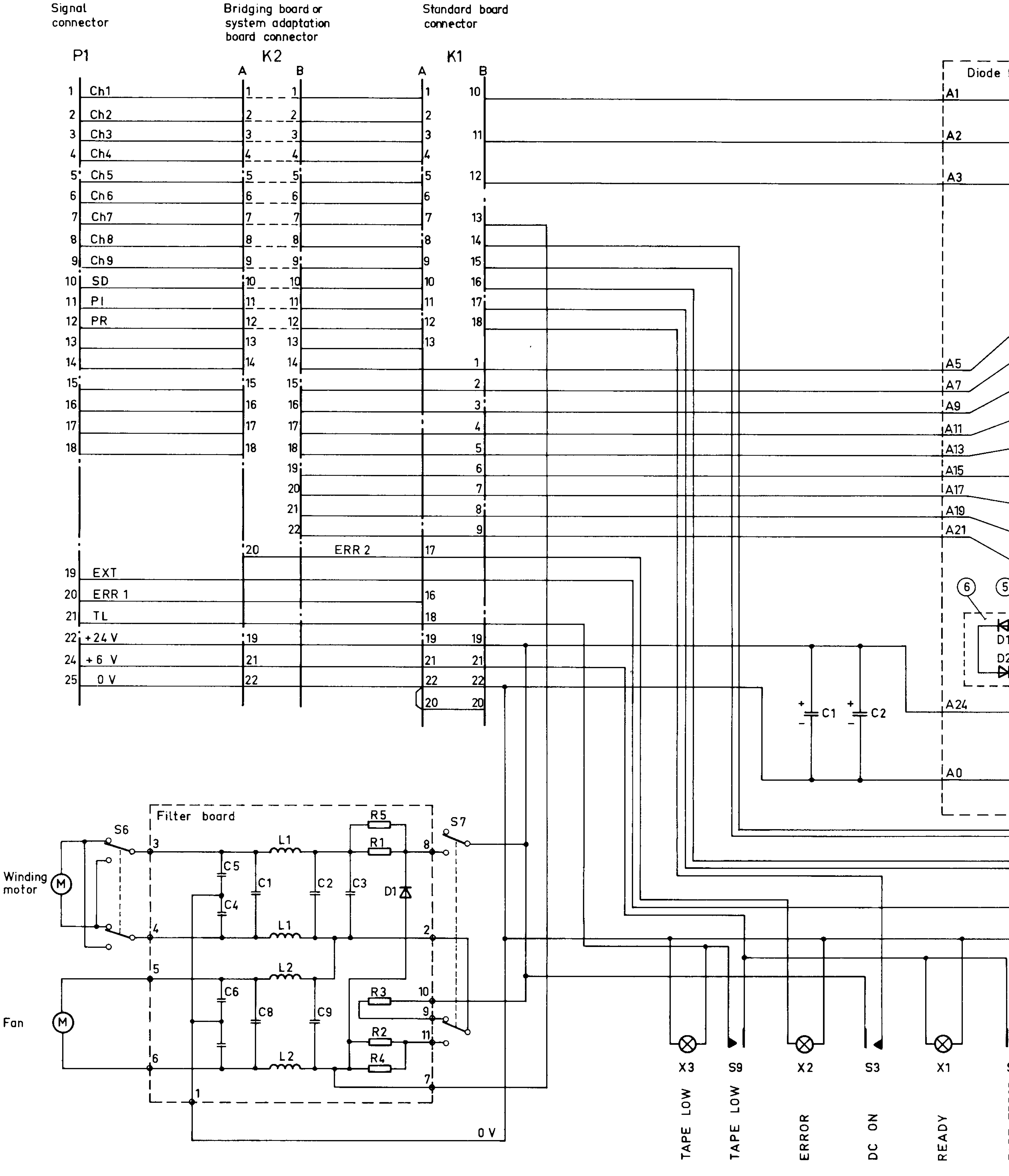


Diode board

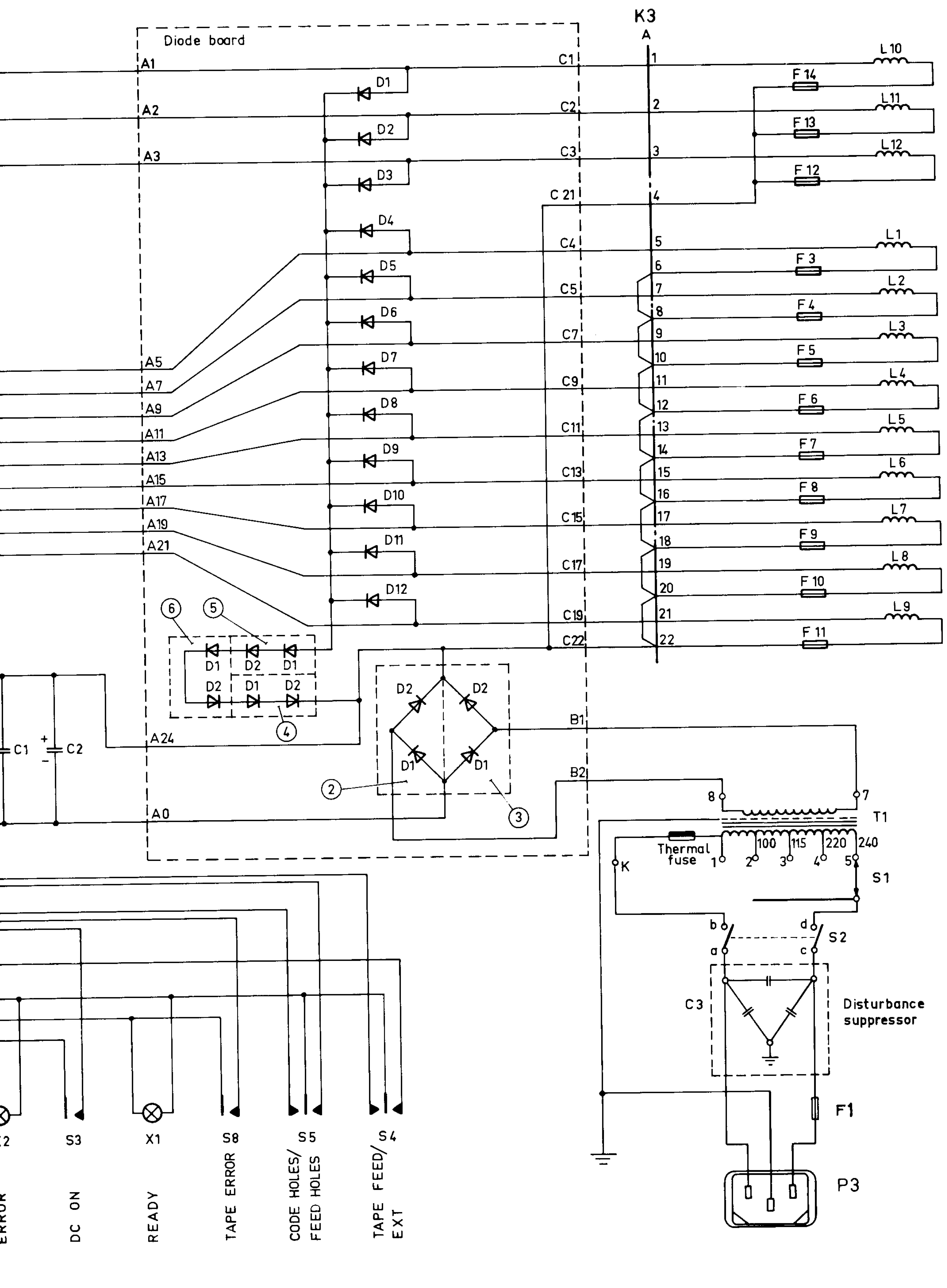


Filter circuit board




Signal connector
P1
Bridging board or system adaptation board connector
K2
Standard board connector
K1
Diode
Ch1
Ch2
Ch3
Ch4
Ch5
Ch6
Ch7
Ch8
Ch9
SD
PI
PR
ERR 2
EXT
ERR 1
TL
+24 V
+6 V
0 V
C1
C2
Filter board
S6
S7
Winding motor
Fan
L1
L2
R1
R2
R3
R4
R5
C1
C2
C3
C4
C5
C6
C8
C9
D1
0 V
X3
S9
X2
S3
X1
TAPE LOW
TAPE LOW
ERROR
DC ON
READY

Punch/feed unit connector

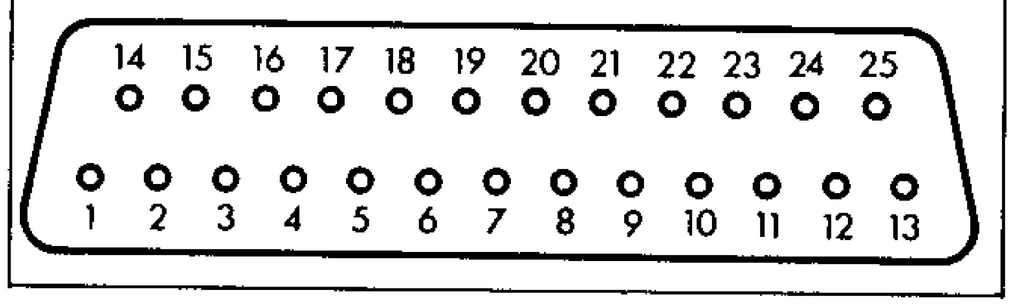


Appendix 4 Mains operated FACIT 4070

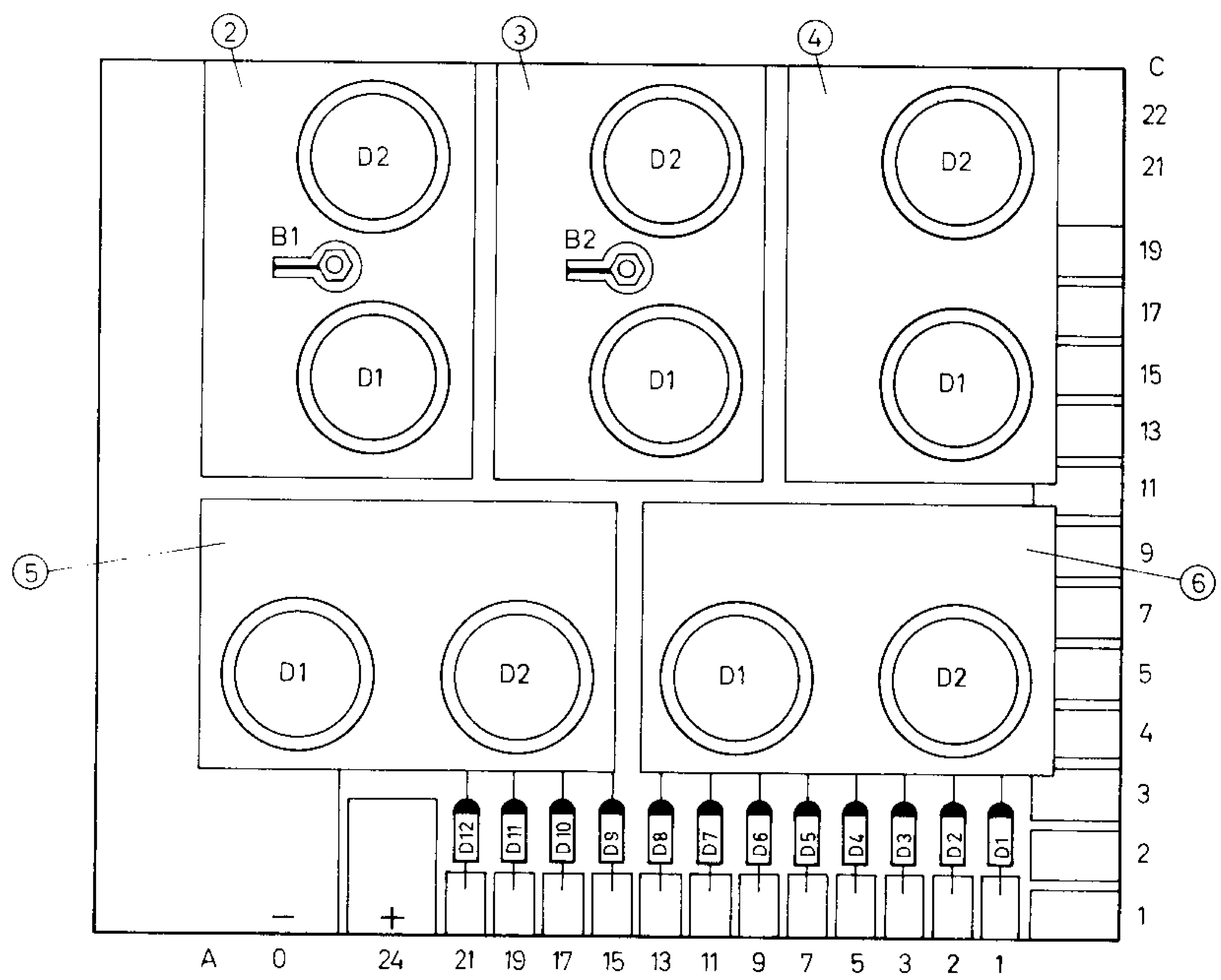
Interconnection diagram with diode board and filter board

Signal connector P1

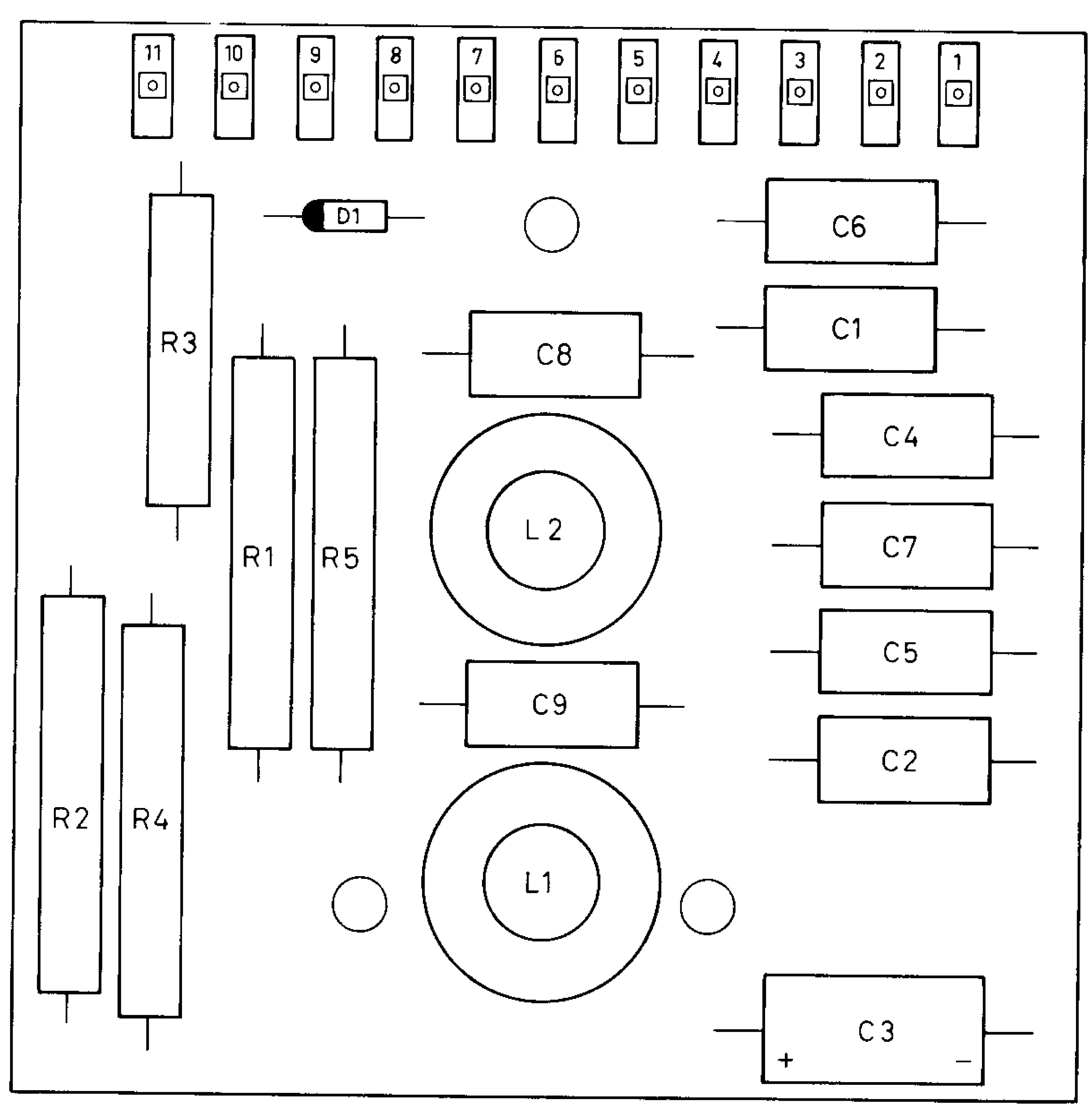
Pin	Signal	Pin	Signal
1	Ch1	14	–
2	Ch2	15	–
3	Ch3	16	–
4	Ch4	17	–
5	Ch5	18	–
6	Ch6	19	Ext
7	Ch7	20	Err. 1
8	Ch8	21	TL
9	Ch9	22	+ 24 V
10	SD	23	–
11	PI	24	+ 6 V
12	PR	25	0 V
13	–		

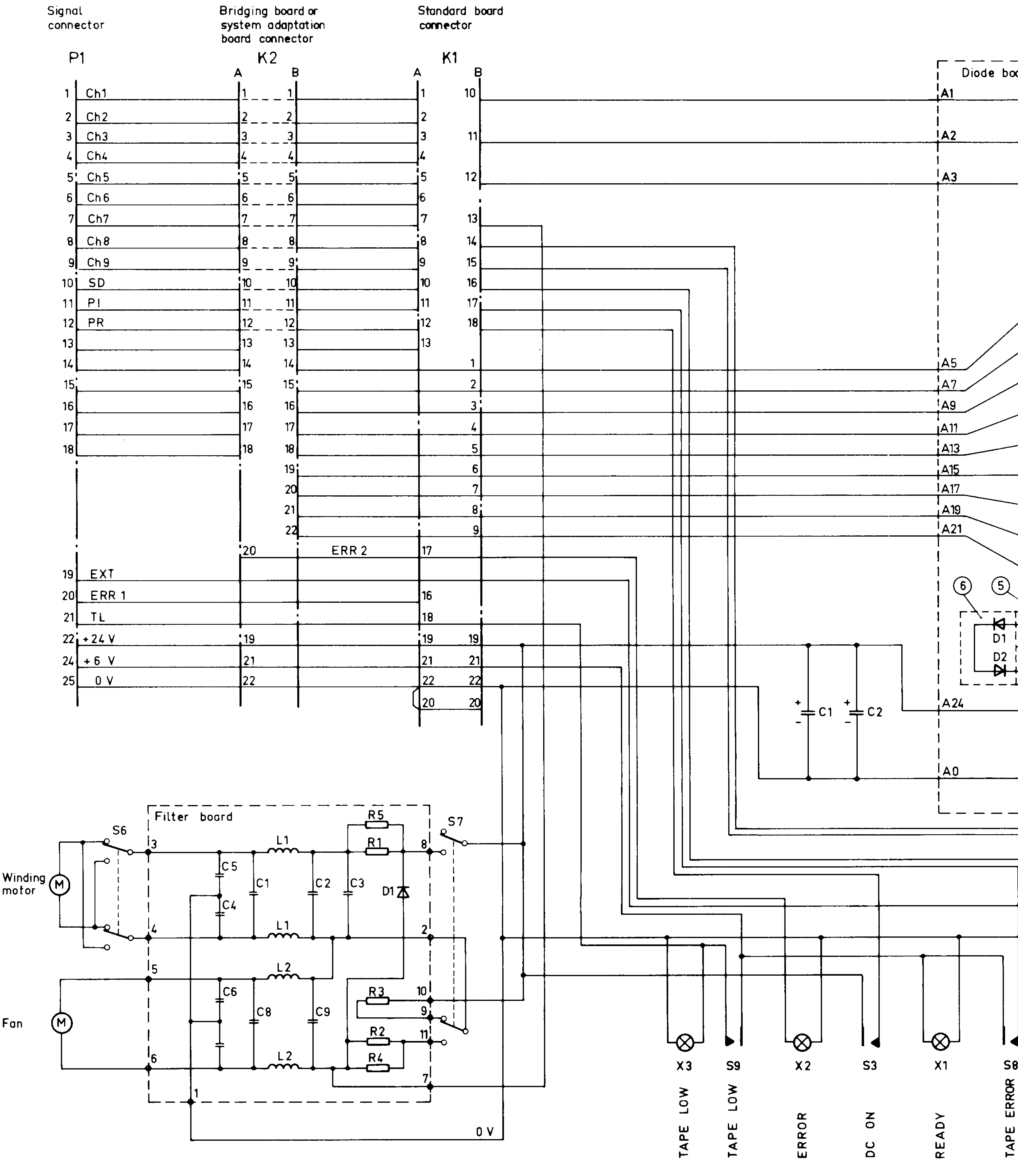


Diode board

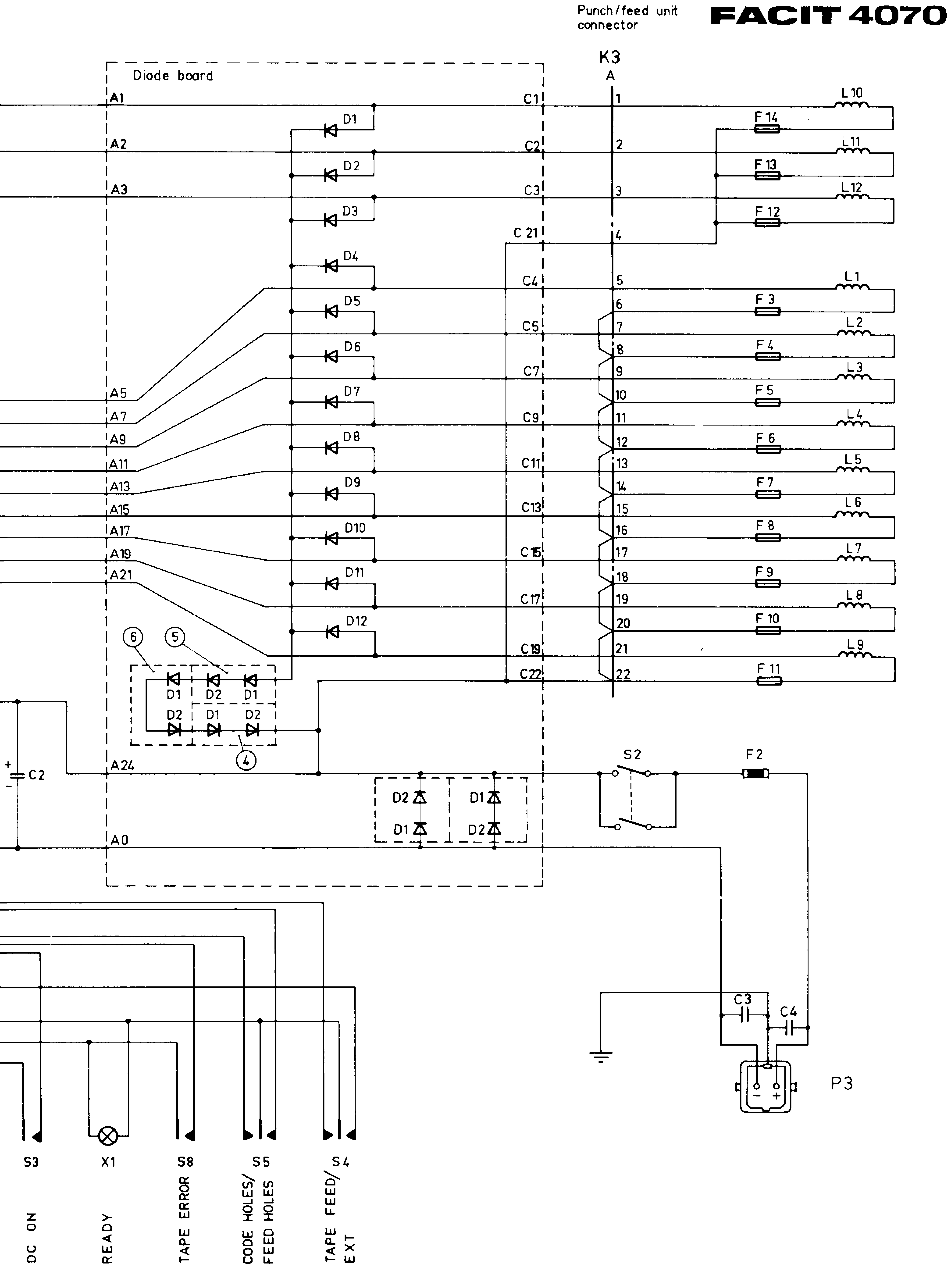


Filter circuit board




Signal connector
Bridging board or system adaptation board connector
Standard board connector
P1
K2
K1
Diode board
Ch1
Ch2
Ch3
Ch4
Ch5
Ch6
Ch7
Ch8
Ch9
SD
PI
PR
ERR 2
EXT
ERR 1
TL
+24 V
+6 V
0 V
C1
C2
Filter board
S6
S7
Winding motor
Fan
R5
R1
R3
R2
R4
L1
L2
C5
C4
C3
C6
C8
C9
D1
X3
S9
X2
S3
X1
S8
TAPE LOW
TAPE LOW
ERROR
DC ON
READY
TAPE ERROR

FACIT 4070



Appendix 5 Battery operated FACIT 4070

Interconnection diagram with diode board and filter board