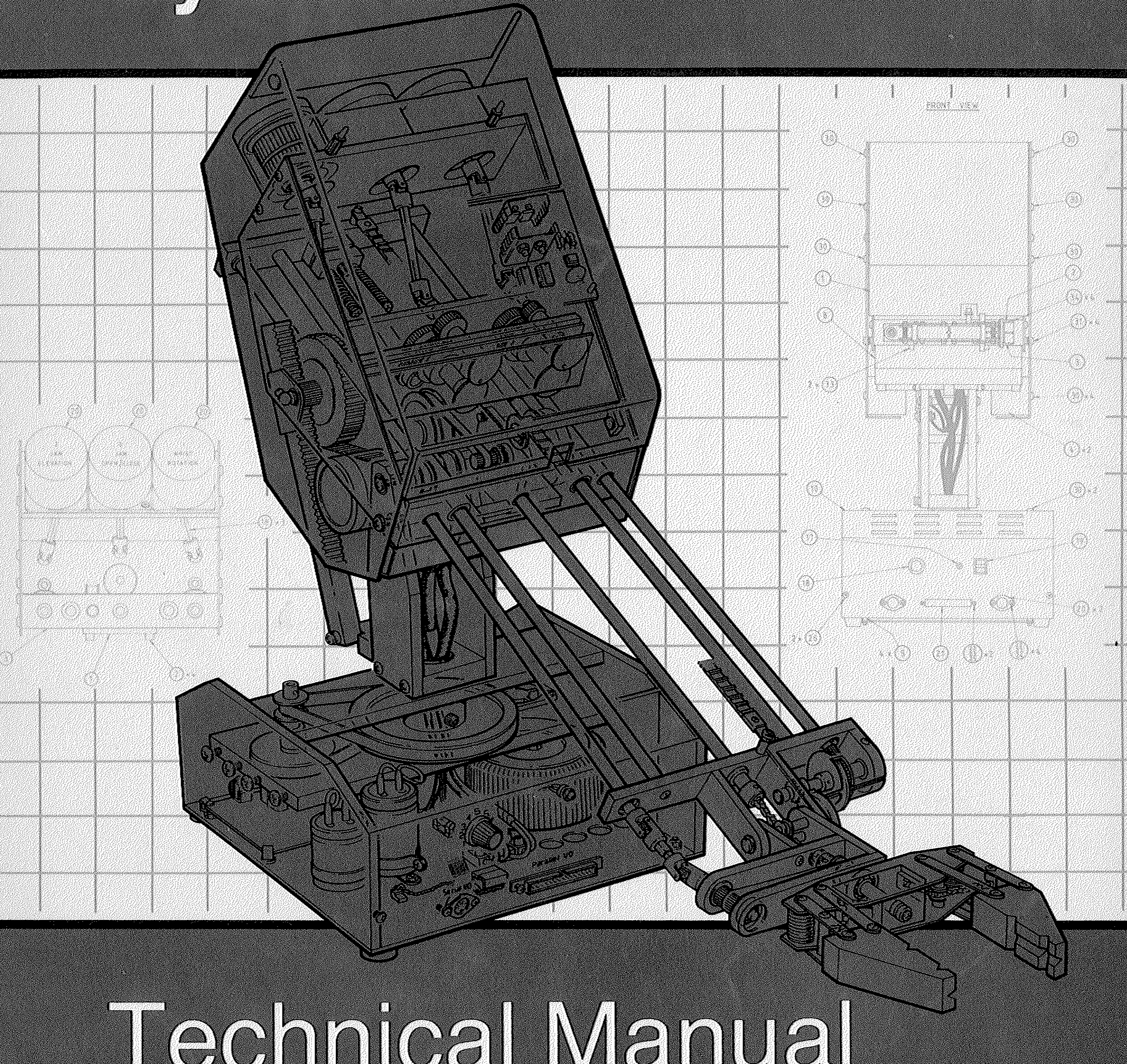
L.J. Electronics

ATLAS II Robotic System



Technical Manual

L.J. Electronics

ATLAS II Robotic System

Technical Manual

Written by LJ Technical Dept. LJ Technical Dept.

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Introduction

ATLAS Technical Manual

Introduction

This manual has been written to provide the user with all the technical information they will need when working with the LJ ATLAS Robotic Teaching System.

It accompanies the ATLAS User Manual which gives full details on how to operate the system in its various control modes.

The technical manual is divided into two sections Section 1 Electrical and Section 2 Mechanical sections are broken down into sub-sections each of which covers a part or operation of the system in detail.

Work covered in these sections includes maintenance, assembly/disassembly, test information, data and setting up procedures.

The manual also covers trouble-shooting and fault finding together with hints on repairing a non-working system.

Note: some of the electrical drawings have 'sheet' reference numbers. These numbers are referred to when a connection is made between one drawing and another. Refer to Section K for drawings in order of sheet reference.

110V 60Hz

WARNING: THIS APPARATUS MUST BE EARTHED

As the colours of the wires in the mains lead supplied with this apparatus may not correspond with the coloured markings identifying the terminals in your plug proceed as follows:

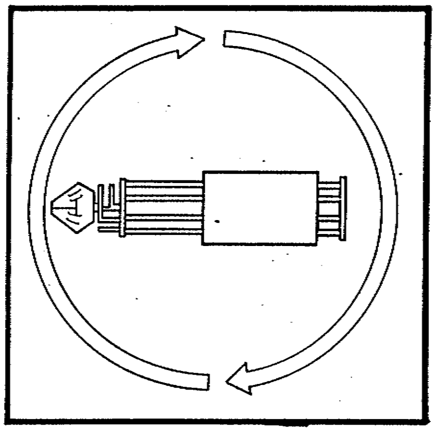
- The wire which is coloured green must be connected to the terminal plug which is marked by the letter E or by the safety earth symbol ⏚ or coloured green or green-yellow.
- The wire which is coloured white must be connected to the neutral terminal.
- The wire which is coloured black must be connected to the live terminal.

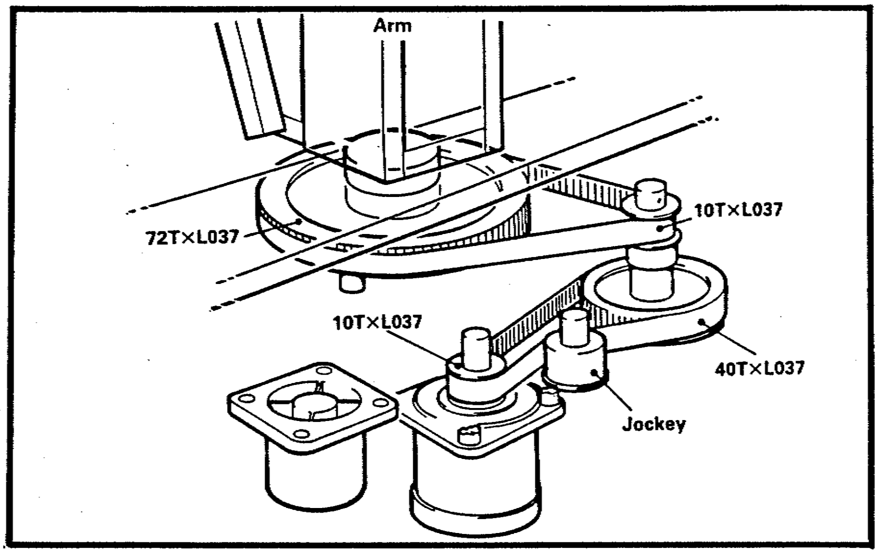
The ATLAS Robotic System

Mechanical Drive

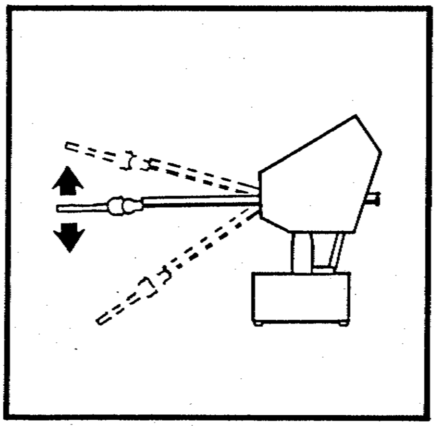
The ATLAS is a robotic system with five degrees of movement and one supplementary function.

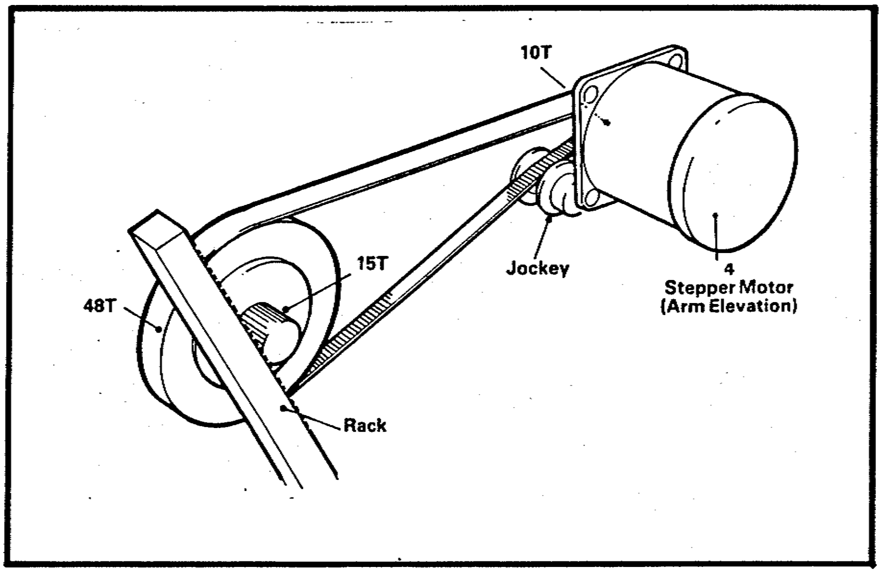
1. **Arm rotation.** The arm can rotate through 370°. This function is driven by stepper motor. Toothed belts over cog wheels are used for this drive, with the motor output geared down by the ratio 28.8:1. The drive mechanism is shown in the diagram.



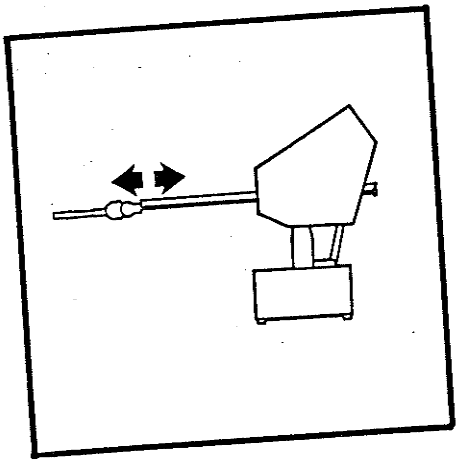


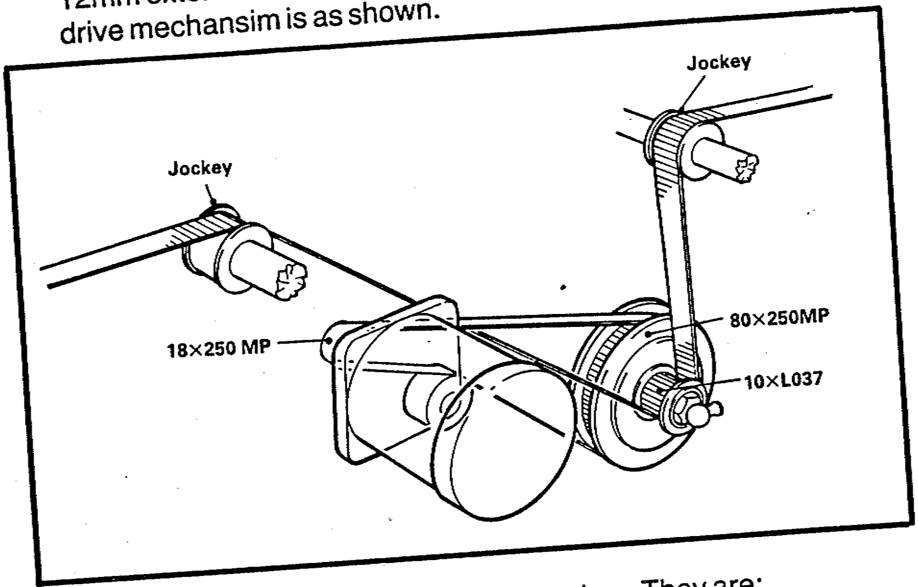
2. **Arm elevation.** The arm can be elevated through 80°. This is from 60° below to 20° above the horizontal. Drive is again provided by stepper motor, with toothed belt leading to a final rack and pinion drive mechanism. Approximately 14 rotations of the motor are required to give the 80° movement. The elevation mechanism is illustrated in the diagram.





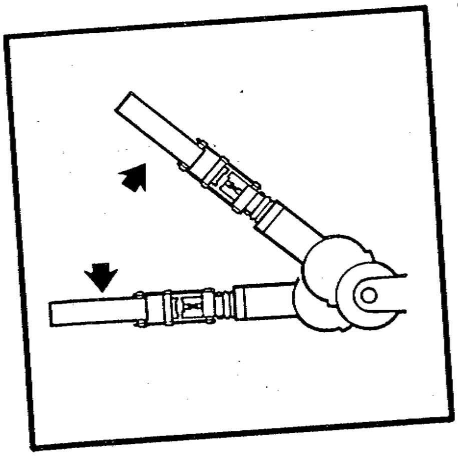
3. **Arm extension.** The arm can be extended by 320mm. Stepper motor driving a toothed belt to a final linear belt drive is used for this mechanism. Reduction gearing gives approximately 12mm extension for 360° motor rotation. The arm extension drive mechansim is as shown.

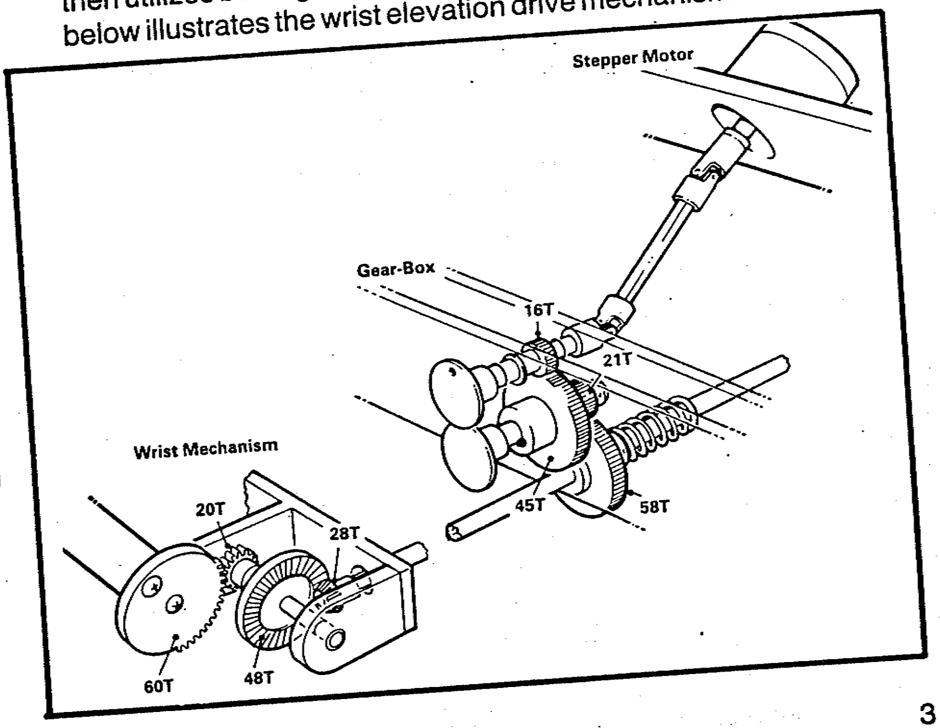




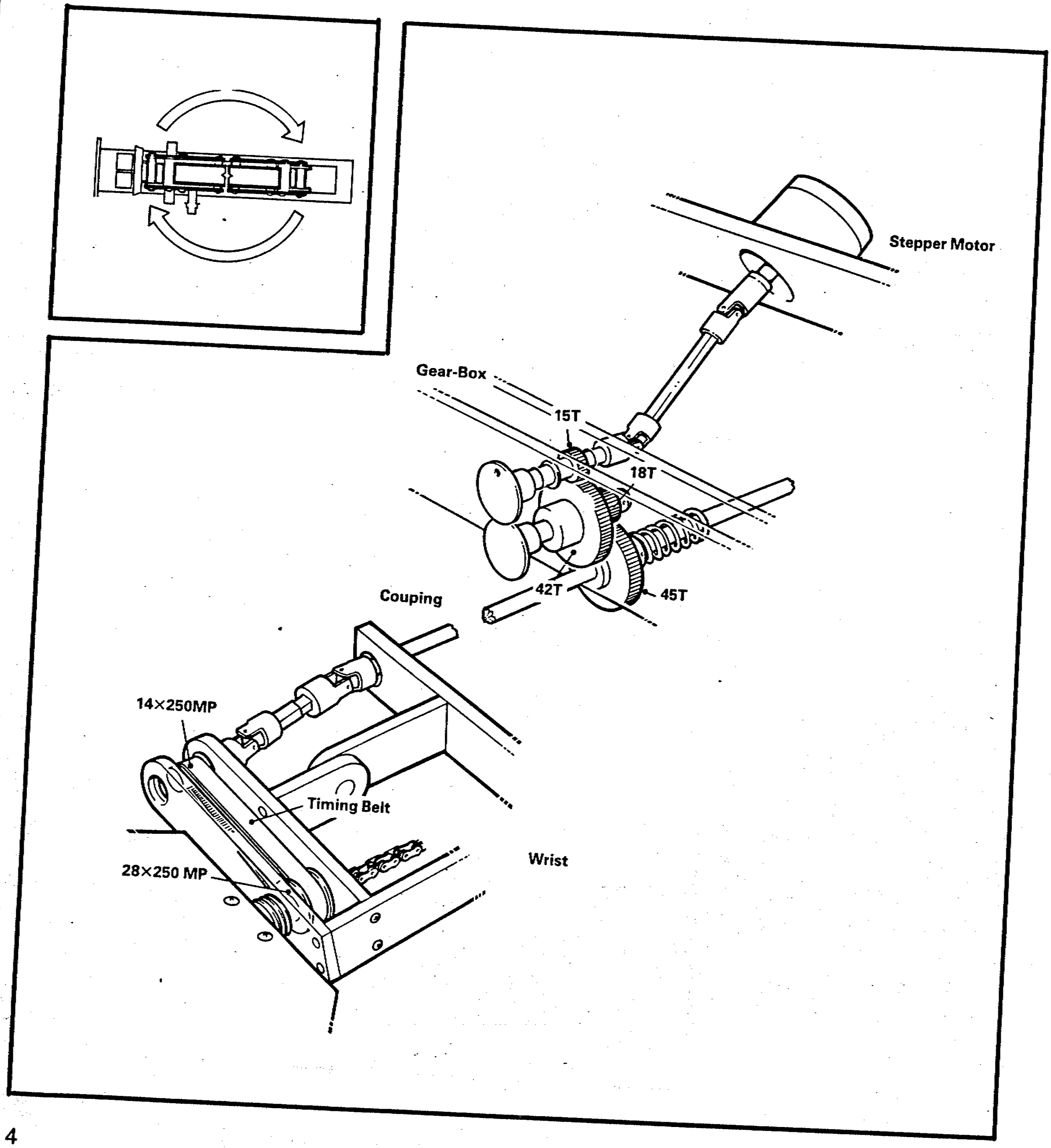
At the 'wrist' there are two degrees of freedom. They are:

1. **Wrist elevation.** The wrist may be elevated through 140°, from 70° below to 70° above the arm elevation axis. Drive is by stepper motor, with a reduction gearbox rotating a shaft which then utilizes bevel gearing to elevate the wrist. The diagram below illustrates the wrist elevation drive mechanism.



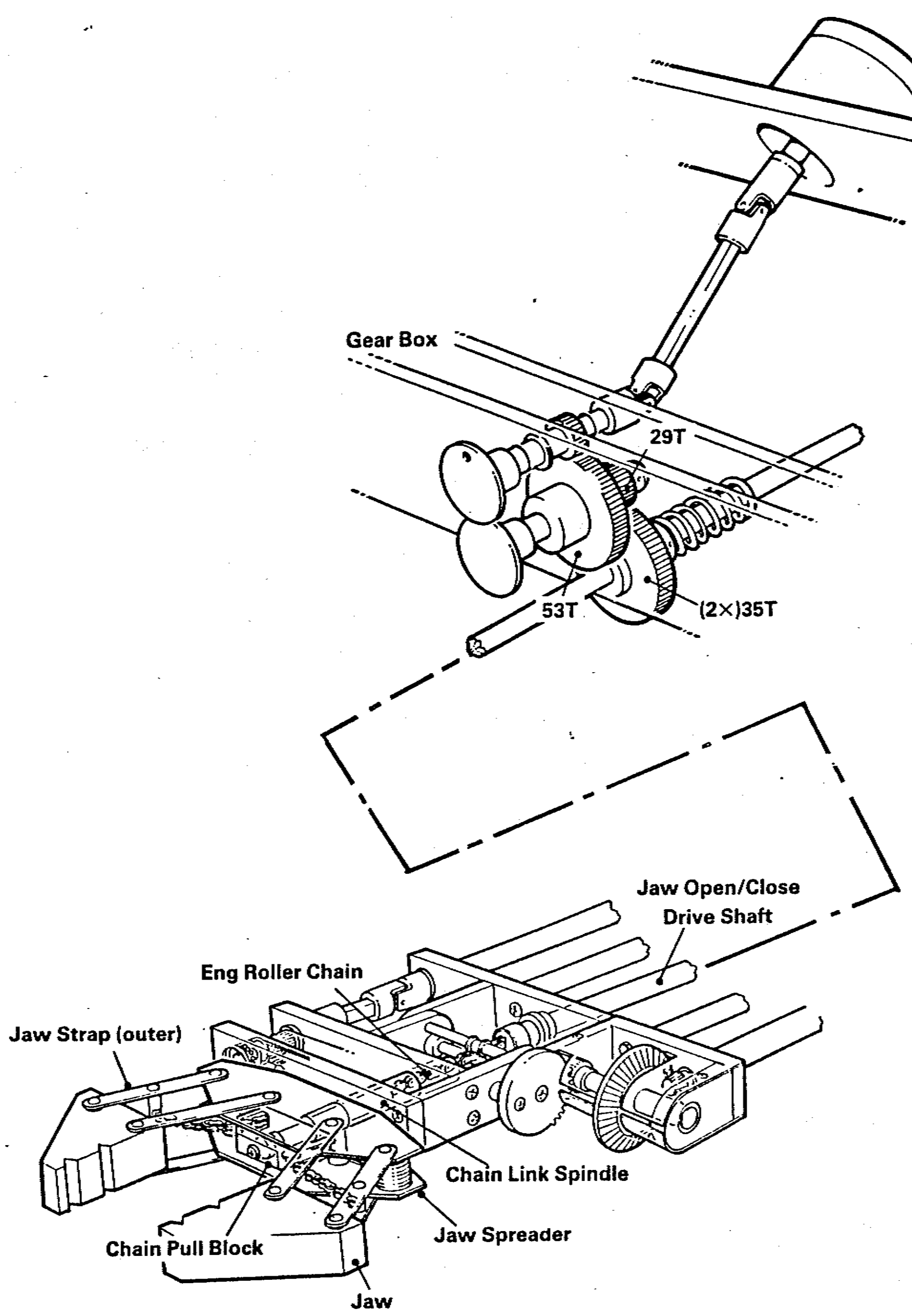


2. **Wrist rotation.** Continuous rotation of the wrist is provided by stepper motor, through a gearbox, to a rotating shaft, with final toothed belt drive. This rotation mechanism is shown in the diagram.



The supplementary function is a two jaw parallel motion gripper.

This is stepper motor driven, with a rotating shaft opening and closing the jaws through a twin chain linkage. Maximum jaw aperture is 50mm. The diagram below illustrates this mechanism.



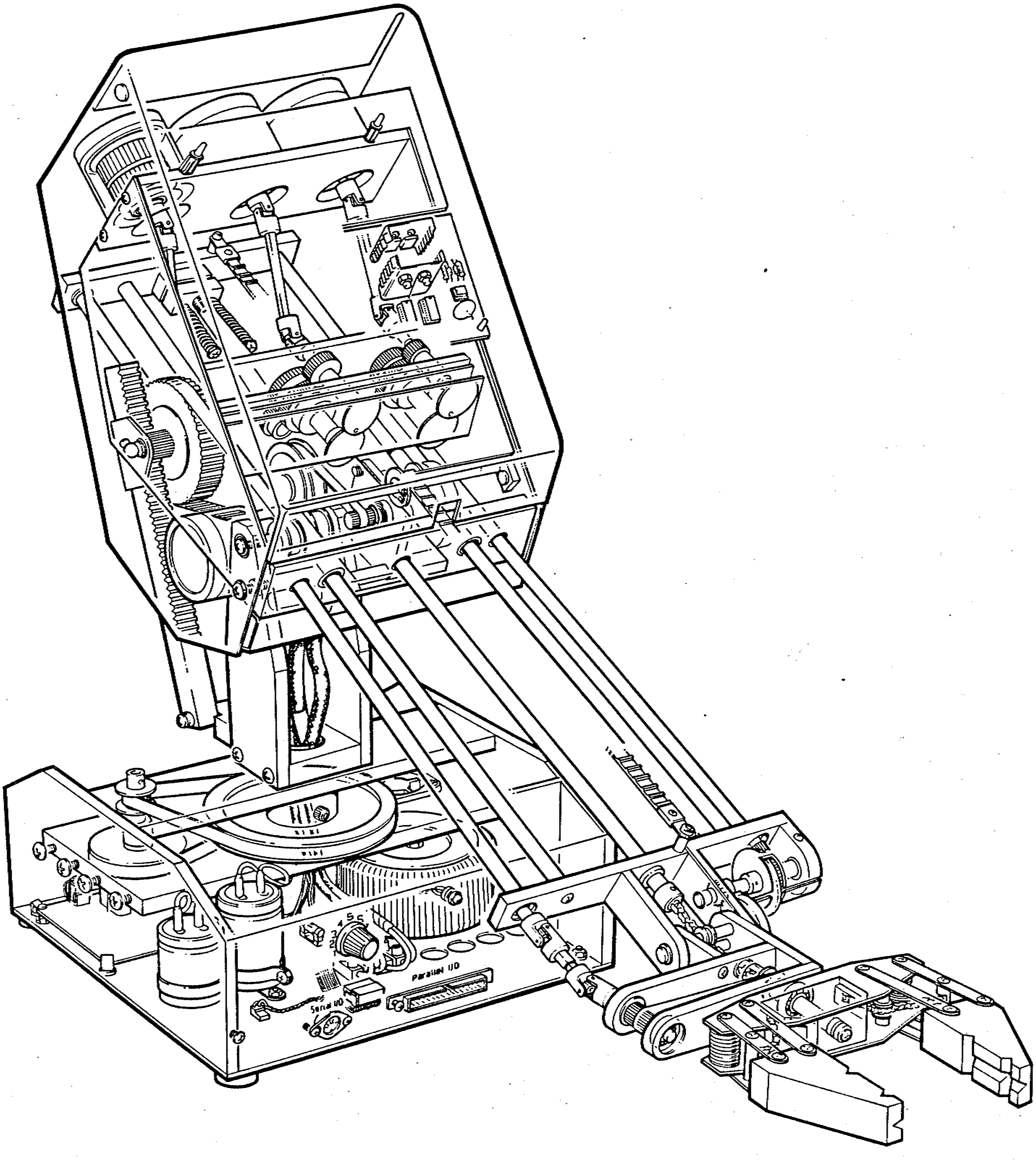
Electrical system

The ATLAS has the complete electrical control system integral to the arm. This system comprises:

- **A power supply unit:** providing 24V d.c., unregulated at 10A.
  5V d.c., regulated at 1A.
  from an input of 240V a.c. at 1A max.
  or 110V a.c. at 2A max.

- **Stepper motor drive amplifiers:** Six independent chopper drive amplifier circuits provide the power required for the four windings of each stepper motor. The use of the chopper amplifier enables each motor to be stepped at a maximum rate of 2,000 steps/second.

- **Control microcomputer:** This is based on the 6502 microprocessor and has 6k of EPROM capacity for the control programs and 8k of battery-backed RAM for sequence data storage. The battery support facility enables sequencs to be retained when a.c. power is removed from the unit. The microcomputer also contains a cassette interface for storage and recall of sequences using a standard cassette recorder. For control from an external computer, the microcomputer provides parallel and serial input/output communication channels.


Parallel I/O
Serial I/O

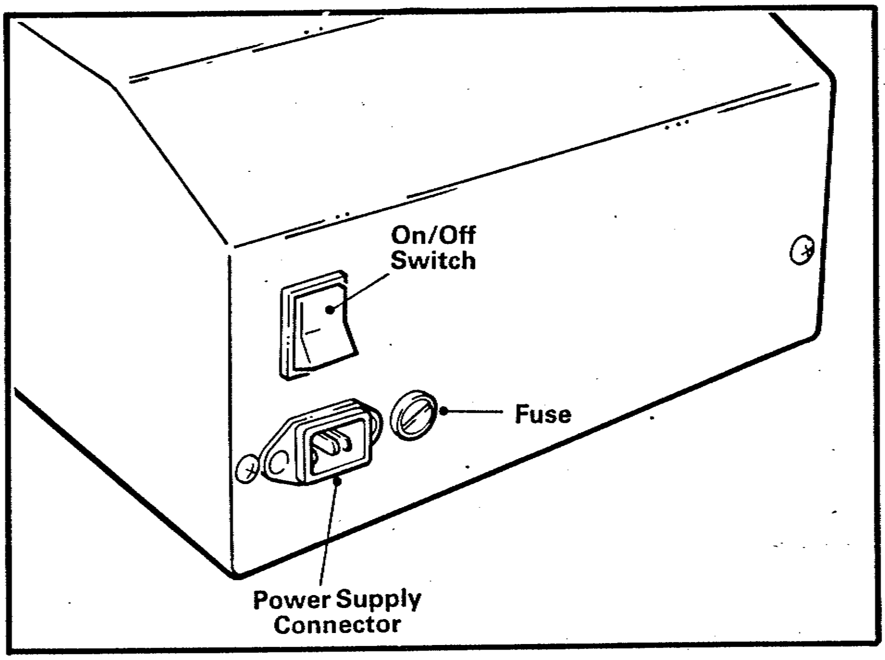
Section A Power Supply

The ATLAS has two d.c. supply voltages derived from 240V/220V, 50Hz (or 110V a.c. 60Hz). These supplies are:

24V d.c., unregulated at 10A maximum.
5V d.c., regulated at 1A maximum.

AC Input

AC power enters the ATLAS through the base back panel either via a grommet or a filter/socket. The line then passes through a 3.15A anti-surge fuse (5A for 110V), through a double pole switch and then connects into terminal block 1. The a.c. voltage then passes through a filter or is connected directly to the primary of the transformer depending on the age of the ATLAS. The transformer has two primaries so that they can either be connected in series for 240V operation or in parallel for 110V operation. See diagram for connections.



24V Supply

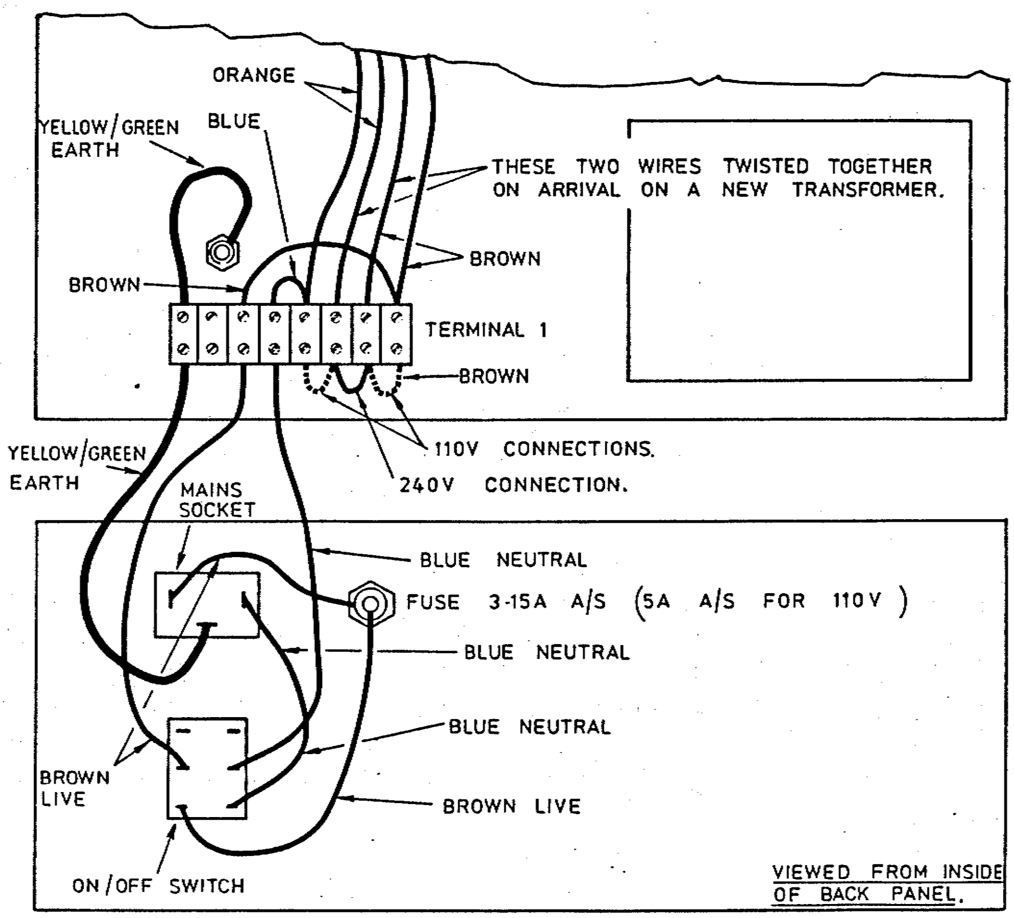
There are two 0-18V a.c. 5A secondary windings on the ATLAS transformer; these are connected in parallel to give 18V a.c. at 10A. These windings are connected to a 20A bridge rectifier which full wave rectifies the a.c. to give 24V d.c. A 10,000μF, 35V electrolytic capacitor provides the smoothing for this supply. This supply provides the 24V required for the stepper motors.

5V Supply

There is one 0-9V, 2A a.c. secondary winding on the transformer. This winding is connected to a 2A bridge rectifier which rectifies the a.c to give approximately 13V d.c which is smoothed by a 10,000μF 25V electrolytic capacitor. The unregulated supply is used to power the small d.c fan which is used for cooling the ATLAS base. The regulated 5V supply is used to power the microprocessor control board, and the integrated circuits on all the other boards.

Testing the System Power Supply

Warning - Dangerous voltages are present in the base. It is advised that an isolation transformer should be used to reduce the risk of electrical shock. Connect the a.c. power input lead to the base terminal block as shown below: Check that the link is secured in the terminal block. Switch on the power supply. Work through the sequence of checks detailed, referring to the diagram.



Using the digital multimeter, carry out the following checks:

1. Measure the a.c voltage outputs from the transformer secondaries. These can be measured at terminal block 2 as voltage 1 to 2 (18V-20V r.m.s.).

2. Measure the unregulated d.c voltage across capacitor C_1. This should be in the range of 26V-27.5V.

3. Measure the unregulated d.c voltage across capacitor C_2. This should be in the range of 11V-12.5V.

4. Measure the unregulated d.c voltage from 3 to 4 on terminal block 3. This should be the same as at the terminal of C_1 (test 2).

5. Measure the regulated d.c voltage from 1 to 2 on terminal block 3. This should be in the range of 4.9V-5.1V.

6. Connect the 2 red leads from the Resistive Load Module (supplied with the test and diagnostic set HS1A) to connector 3 and 4 of terminal block 3. This load will draw 1A approximately and the voltage from 3 to 4 should not fall below 24.5V.

7. Connect the 2 black leads from the Resistive Load Module to connector 1 and 2 of terminal block 3. This 5V load will draw 1A, and the output voltage with this load applied should not fall by more than 50mV. Measure the voltage from 1 and 2 and confirm this regulation.

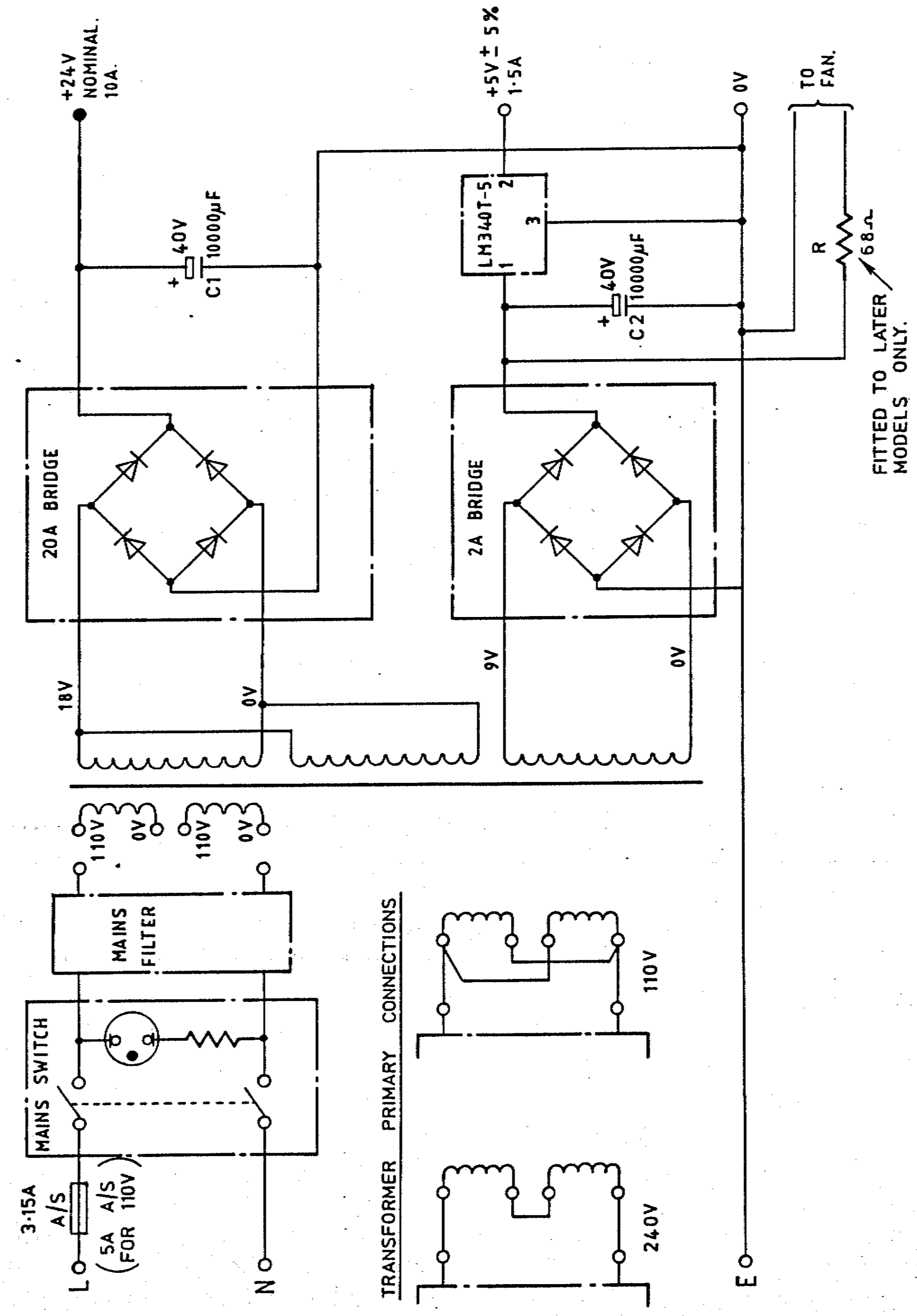
8. Briefly* connect the 5V load across the 24V unregulated output (black leads to connectors 3 and 4). Check that the output voltage does not fall below 22.5V.

   ** The heat sink used for the resistive load module will get excessively hot if the 5V load is connected to the 24V output for long periods.*

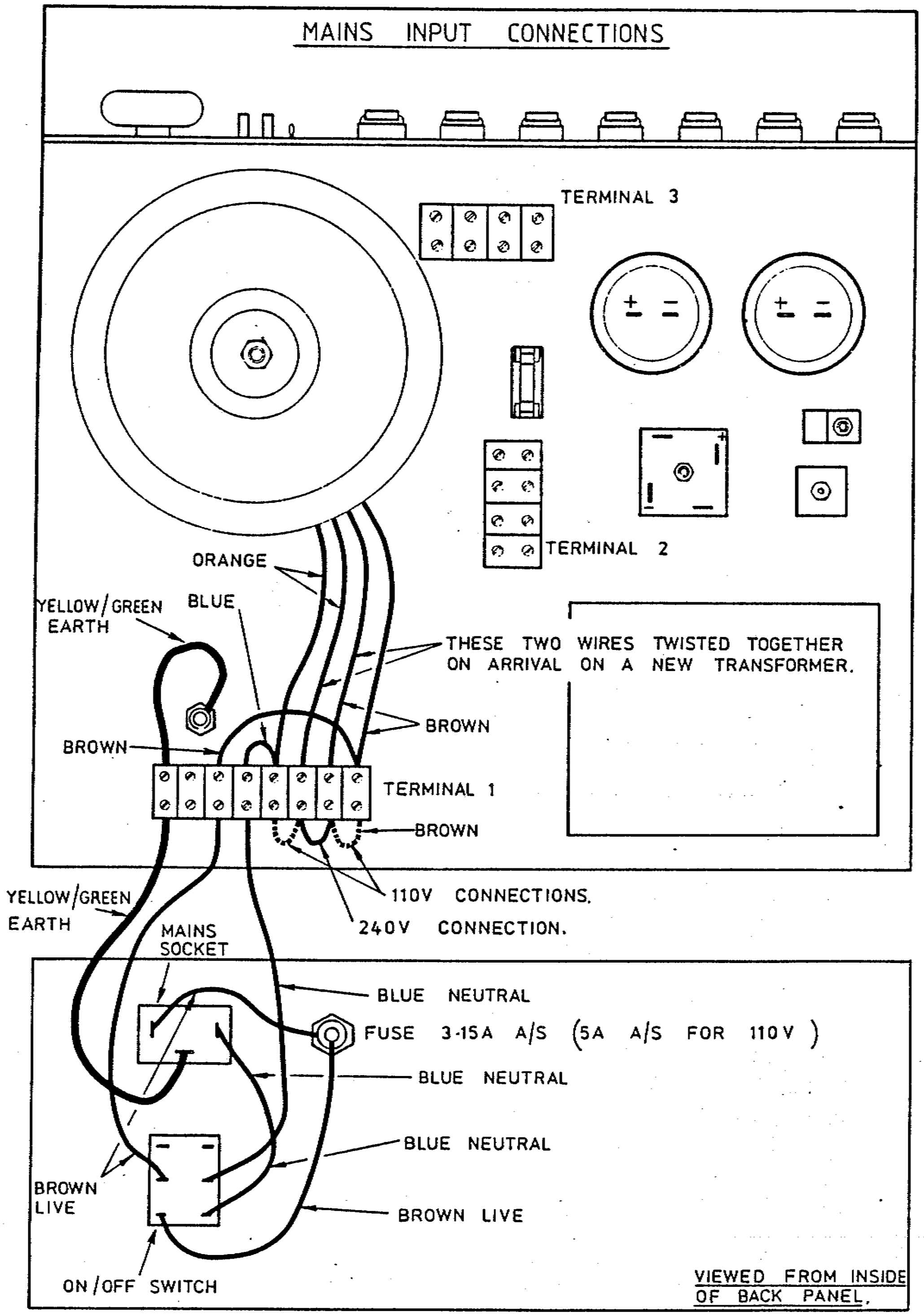
Use an oscilloscope to confirm the following measurements:

	No Load	5Ω Load Applied
5V regulated supply; noise	10mV	10mV
24V unregulated supply; noise	100mV	5V approx ripple

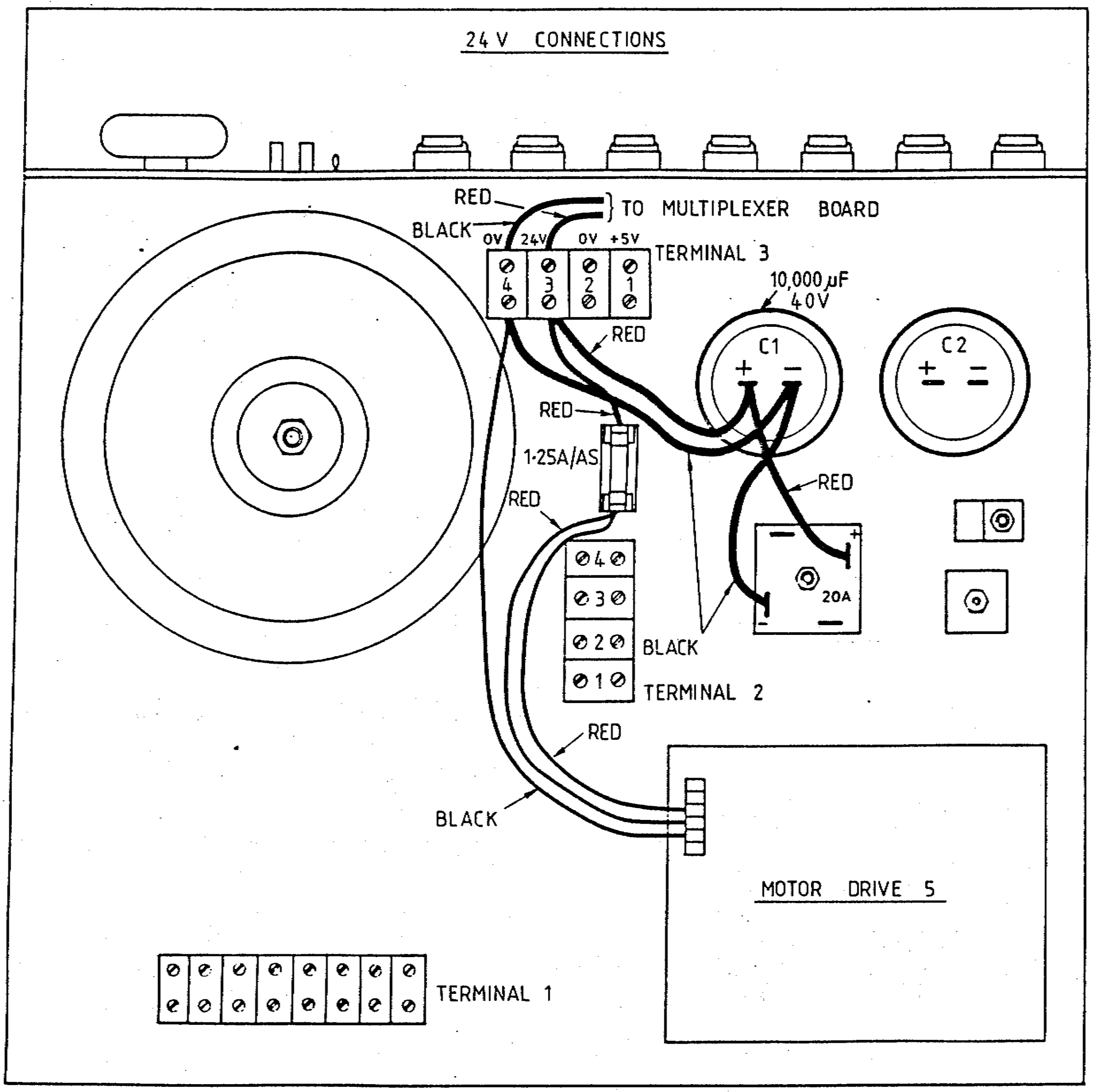
Switch OFF the a.c. input. Disconnect the base from the a.c. supply. Check continuity from the positive terminal of C2 to connector 7 of terminal block 1. This connection is for 12V unregulated to the cooling fan. By performing a continuity check with a.c. power disconnected, the hazard of measuring close to the high voltage power input is avoided.



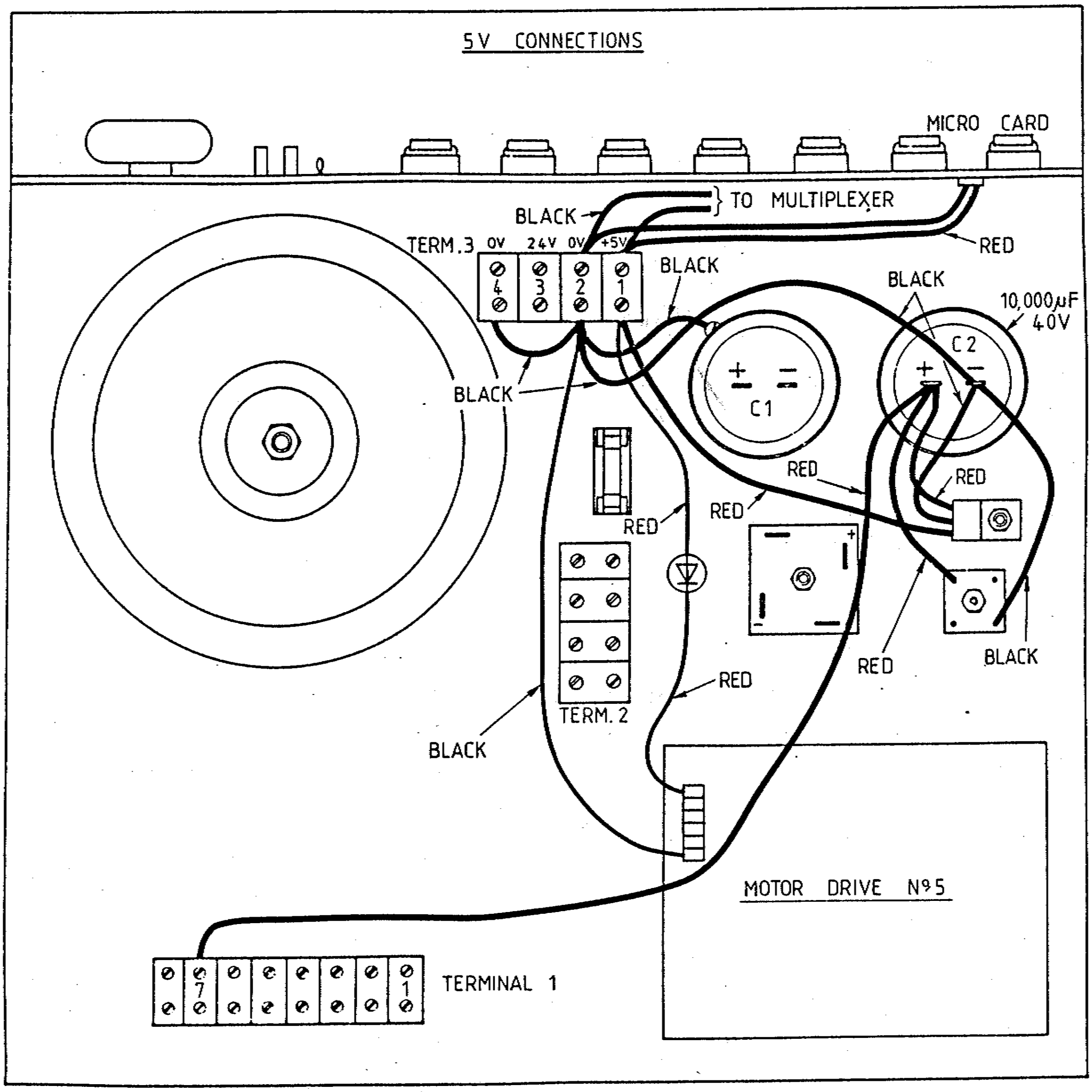
ATLAS Base Circuit Diagram



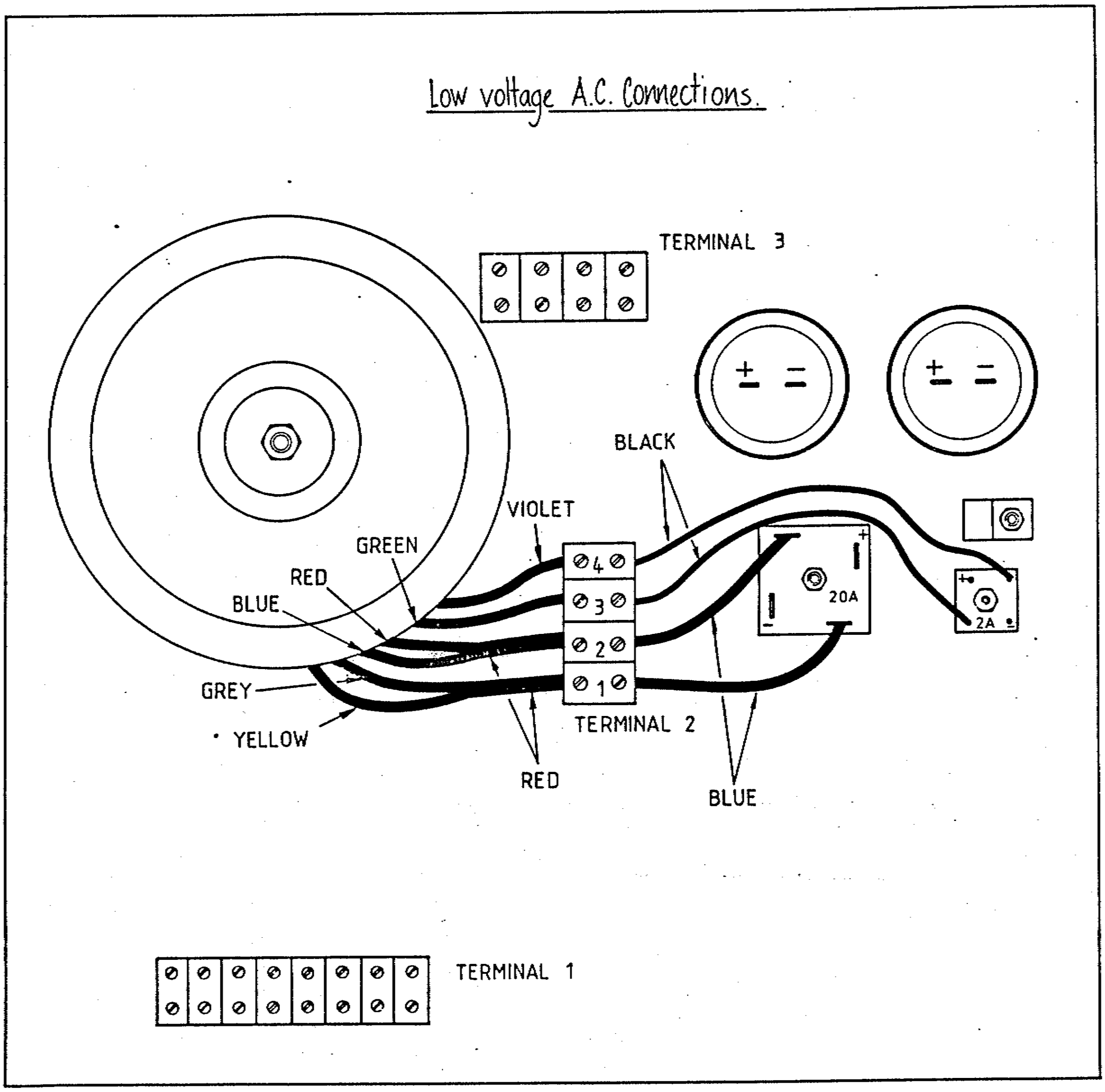
Input Connections



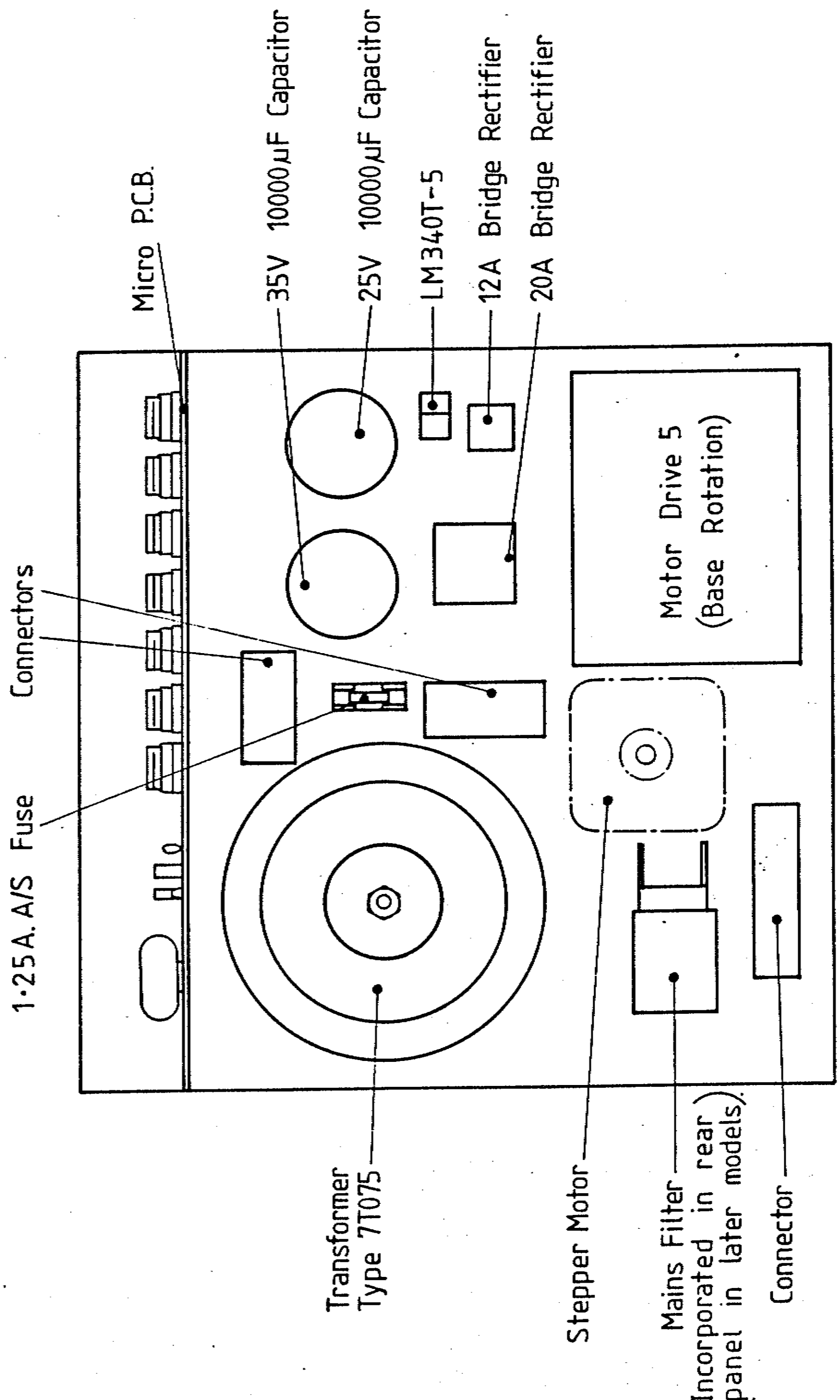
24V Connections



5V Connections



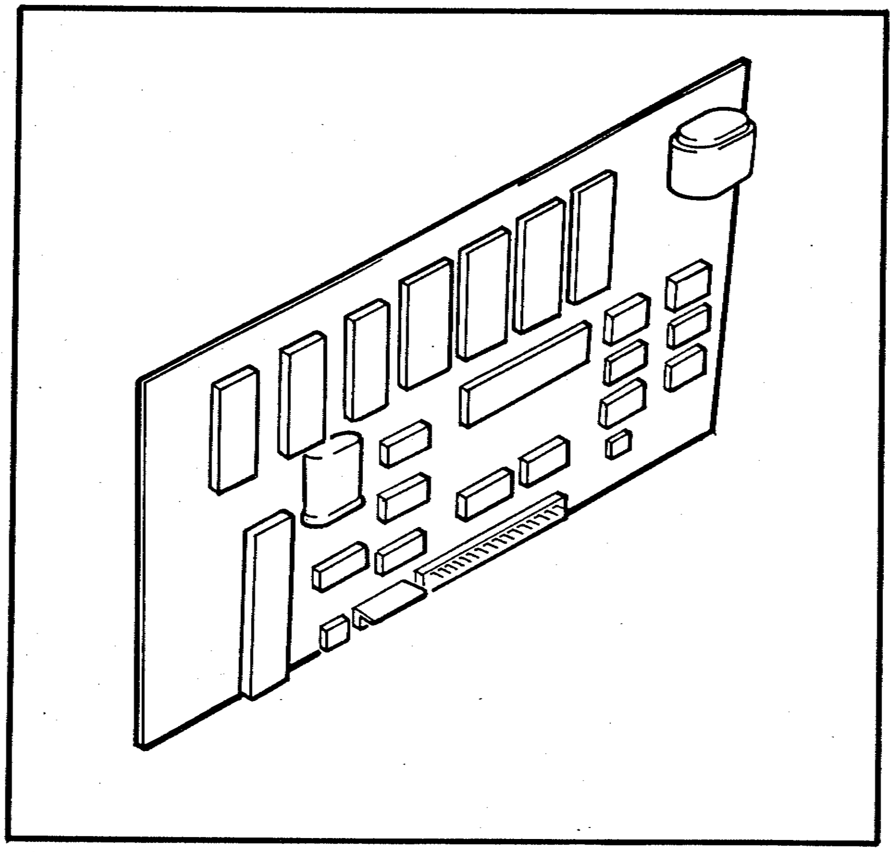
Low Voltage AC Connections



ATLAS Base Layout

The ATLAS Micro Card

In common with other microcomputer control systems the ATLAS Micro Card contains the following circuit blocks.



1. **Microprocessor or MPU**
The ATLAS micro card uses the popular 6502 microprocessor (as used in the PET, APPLE, BBC MICRO etc., as well as in the EMMA and other equipment produced by L.J. Electronics).

2. **Read/Write Memory**
This is usually known as Random Access Memory or 'RAM'. The MPU can read data from or write to this type of memory. The ATLAS micro card holds 8192 (written 8k) bytes of RAM. When the ATLAS is switched OFF a small battery supplies the RAM with enough power for it to retain its information.

3. **Read only Memory or 'ROM'**
As its name suggests, this type of memory can only be read by the MPU. The ROM on the ATLAS micro card can be erased with short-wave ultraviolet light and re-programmed, and is known as 'EPROM'. There are 6144 (6k) bytes of EPROM on the card.

4. **Input/Output Ports (I/O)**
I/O ports provide the interface between the micro card and the other boards in ATLAS, as well as the outside world via the connection sockets. There are sixteen bits of I/O on the micro card which are arranged into two 8-bit registers known as Port A and Port B. Two other registers, known as DDR A and DDR B, define whether each individual bit of Port A and Port B is to be an input or output.

5. **Control Lines**
This is a general term covering the following:

a) $\overline{\textbf{RESET}}$
This signal forces the MPU to a specific address in memory. From this address, and the next in sequence, it receives information which tells it where to go next. This process is known as vectoring. $\overline{\text{RESET}}$ is generated automatically when the ATLAS is switched ON, and by pressing the $\overline{\text{RESET}}$/INITIATE switch down.

b) $\overline{\textbf{NMI}}$, $\overline{\textbf{IRQ}}$
These signals operate in a similar manner to $\overline{\text{RESET}}$, but direct the MPU to different memory locations.

c) **Ø2**
This is the clock signal, generated by the MPU and some external logic, which synchronises the flow of data between the MPU and the rest of the system. The clock frequency is accurately fixed at 1MHz by a Quartz Crystal.

d) **Read/Write** This signal, generated by the MPU, governs the direction of data transfers between the MPU and the rest of the system.

e) **CA1, CB1 (Inputs) CA2, CB2 (Outputs)**
These fulfil various tasks in the ATLAS system, e.g. CA2 is used to flash the indicator LED on the front panel. These lines are detailed in the section on the 6522 I/O Chip.

6. **Cassette Interface**
A **CUTS** (computer users tape standard) cassette interface is provided to enable data to be transferred between the micro card and a cassette recorder.

7. **Address Decoding**
This is a small block of logic which decides where the other circuit blocks are to live within the area of memory addressable by the MPU. The way this is done determines the **Memory Map** for the system. The memory map for the ATLAS micro card is as given.

ATLAS I Memory Map

This is the complete memory map for the ATLAS micro card. All addresses are in Hexadecimal.

0000-00FF	Zero page RAM. This page is used for temporary data storage, calculations and indirect addressing.
0100-01FF	Stack RAM. This page holds subroutine and interrupt return addresses and the editor buffer.
0200-1FFF	RAM. This, the main data storage area, holds the information which controls the actions of the ATLAS.
2000-DFFF	This area is uncommitted.
E000-E7FF	The I/O Port/Timer Chip (6522) occupies 16 byte blocks throughout this area. The primary addresses are E000-E00F.
E800-EFFF	This is the ATLAS editor. This piece of software, contained in a 2716 EPROM, allows the stored data sequences to be modified.
F000-F7FF	This 2716 EPROM contains the test routines for the micro card when used in conjunction with the micro card test module.
F800-FFFF	This 2716 EPROM contains the main operating programs for the ATLAS system. After RESET the MPU is sent to address F800 which is the starting point for the system software.

ATLAS II Memory Map

This is the complete memory map for the ATLAS II microcard. All addresses are in hexadecimal.

0000-00FF Zero Page RAM. This is used for temporary data storage, calculations and indirect addressing.

0100-01FF Stack RAM. This page holds subroutine and interrupt return addresses.

0200-07FF This area is Operating System work space.

0800-1FFF Main Data Storage area.

2000-DFFF This area is uncommitted

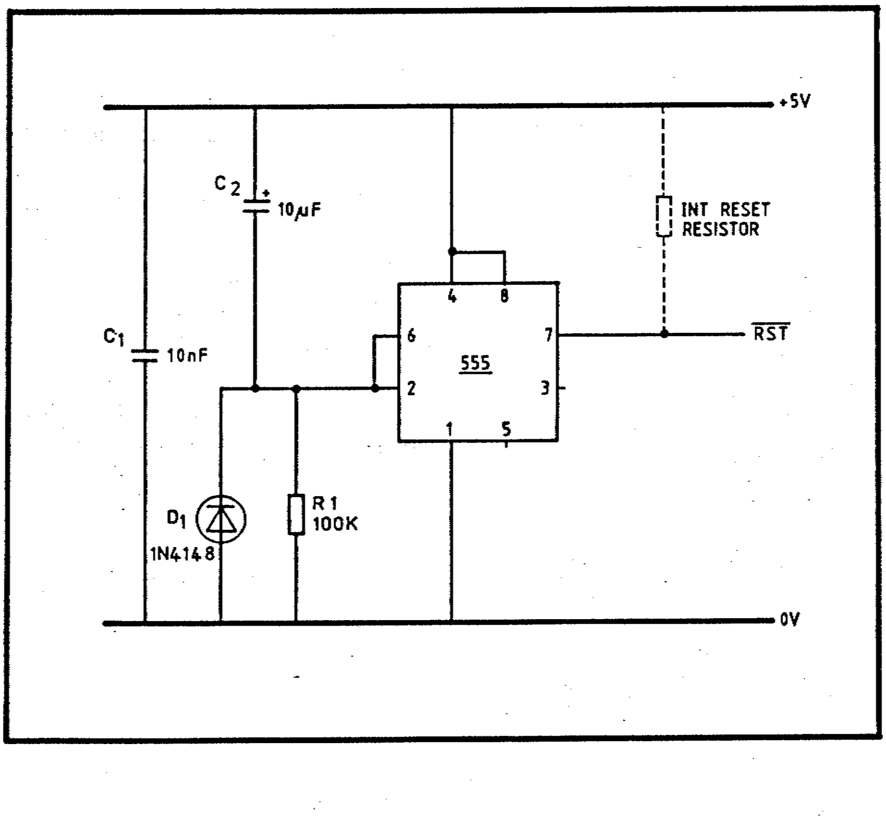
E000-E7FF The I/O Port/Timer 6522 VIA occupies 16-byte blocks throughout this area of memory.

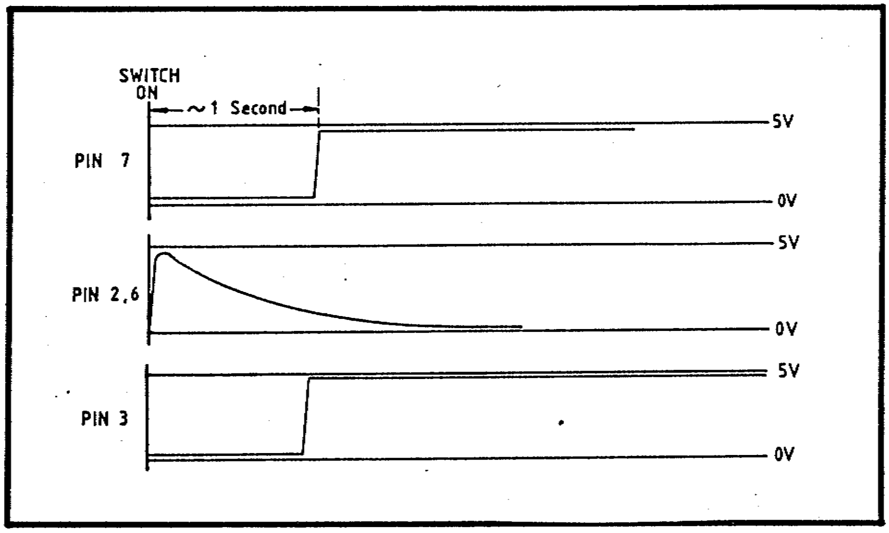
E800-FFFF ATLAS Operating System (EPROMS).

Circuit Description

Power On Reset

The $\overline{RST}$ signal is generated by a 555 timer circuit on applying 5V to the circuit.





When 5V is applied to the circuit, pin 6 and pin 2 will initially be at 5V and pin 7 at 0V. As C2 charges via R1 the voltage on pin 6 and pin 2 will fall exponentially to 0V. When the voltage on pin 6 and pin 2 reaches approximately 2V the output voltage on pin 7 rises to approximately 5V.

Battery Back-up

The Battery Back-up circuit is shown. The circuit description is as follows. With 5V present,

i) TR3 is biased **On** by R3, D1 and R2 taking its collector to approximately 0V and therefore the RAM CS to 0V, thus enabling the RAM.

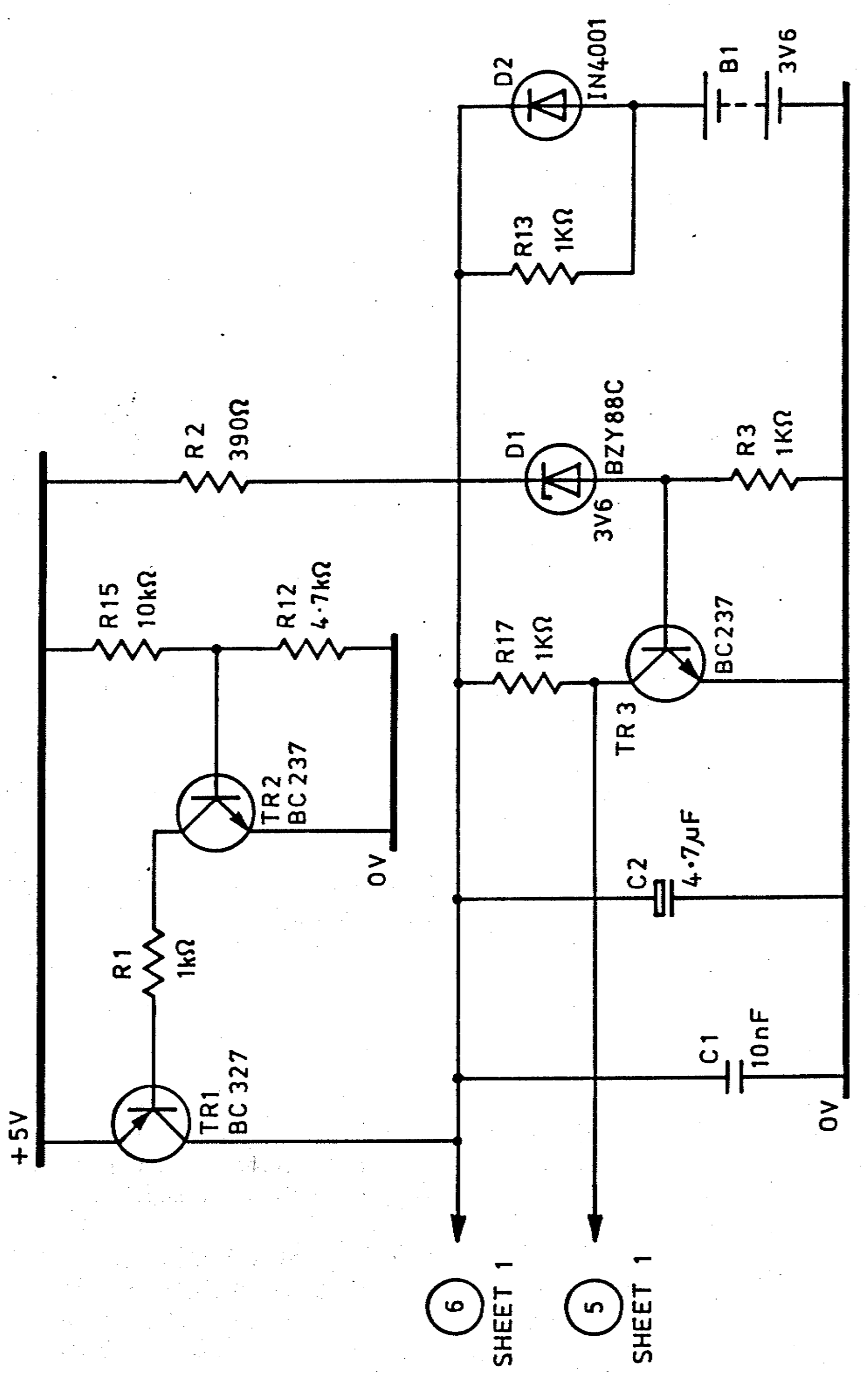
ii) TR2 is biased **On** by R15 and R12 which in turn holds TR1 **On** via R1 giving 5V which is connected to the Vcc pin on the RAM, thus powering the RAM.

iii) The battery is charged by R13 when TR1 is **On**.

With 5V absent:

i) TR3 turns **Off** when the supply drops to below approximately 4.3V. The CS line to the RAM is then pulled up to the voltage on the collector of TR3 by R17, thus disabling the RAM.

ii) TR2 turns **Off** which turns TR1 **Off**. Diode D1 now becomes forward biased and Vcc to the RAM is held at approximately 3V, thus ensuring that the contents of the RAM are not lost. C1 and C2 are for smoothing/decoupling purposes only.



ATLAS Micro Card Battery Back-up Sheet 4

Cassette Interface

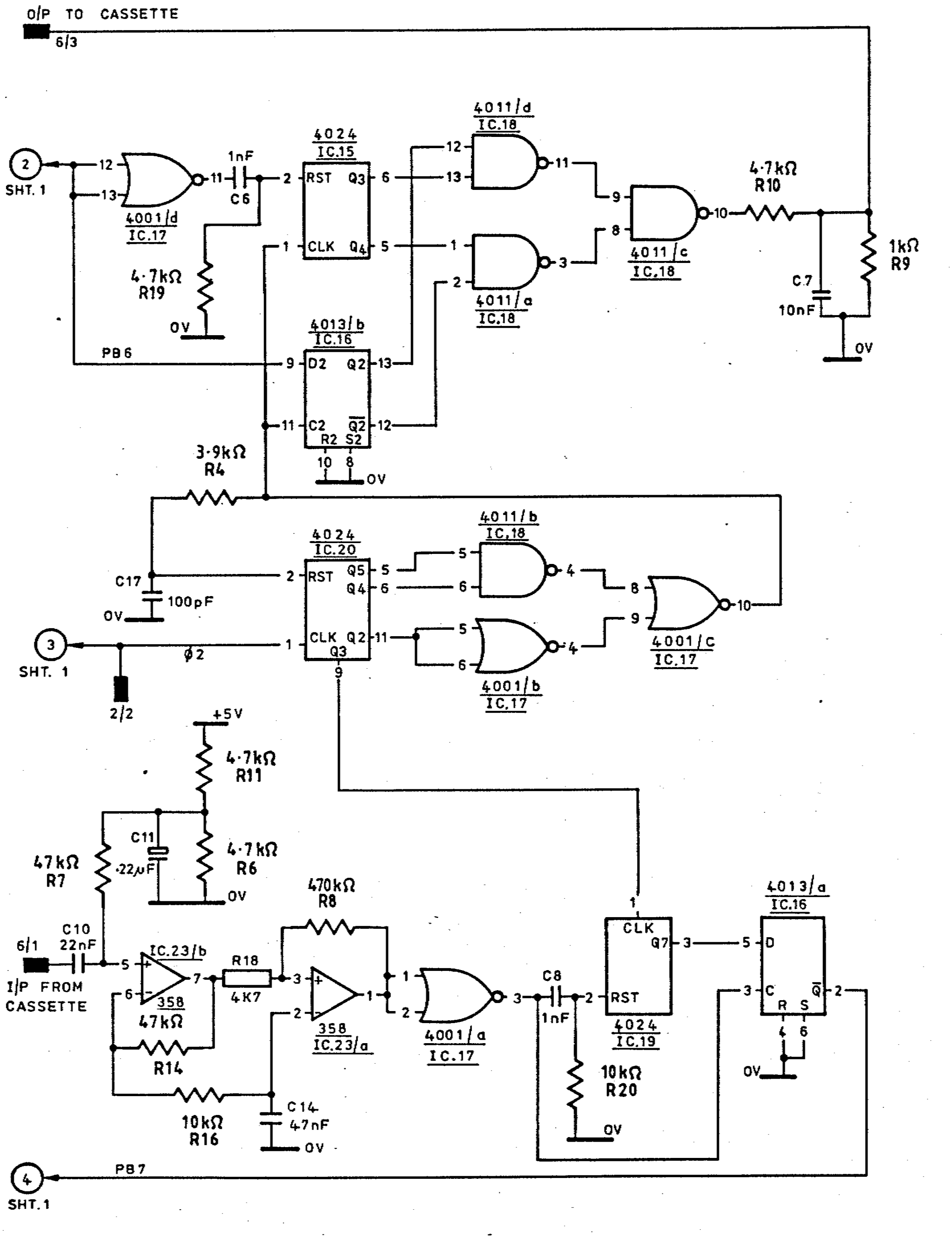
A 7-bit binary counter (4024), IC20, counts $\emptyset_2$ clock pulses. A reset to this counter is generated by the logic gates connected to output pins 5, 6 and 11 when the 4024 has counted 26 clock pulses. Thus a short duration pulse is generated every 26 microseconds. A second counter, IC15, counts the reset pulses; pin 6 of IC15 will go high after 8 pulses and then low after a further 8, producing a square wave on pin 6, with a periodic time of 16 x 26 microseconds (416μsec) giving a frequency of 2.4kHz. Similarly, a square wave with a frequency of 1.2kHz will be produced on pin 5 of IC15.

The two frequencies generated, 2.4kHz and 1.2kHz, are applied to selection logic where the frequency gated out to the cassette is dependent upon the logic level on PB_6 of the 6522.

The input from the cassette is firstly amplified by the 358, dual operational amplifier. The potential divider to pin 5 of the 358 ensures that both input and the output to the first stage will be d.c biased at the midpoint of the supply voltage (2.5V with 5V supply).

The 7-bit counter, IC19, counts the pulses generated from pin 9 of IC20.

The reset signals will occur at IC19 pin 2 at either 1.2kHz or 2.4kHz. This frequency will determine whether IC19 pin 3 is '1' or '0' when the reset occurs. This '1' or '0' is loaded into the IC16 and passed to PB_7 of the 6522.



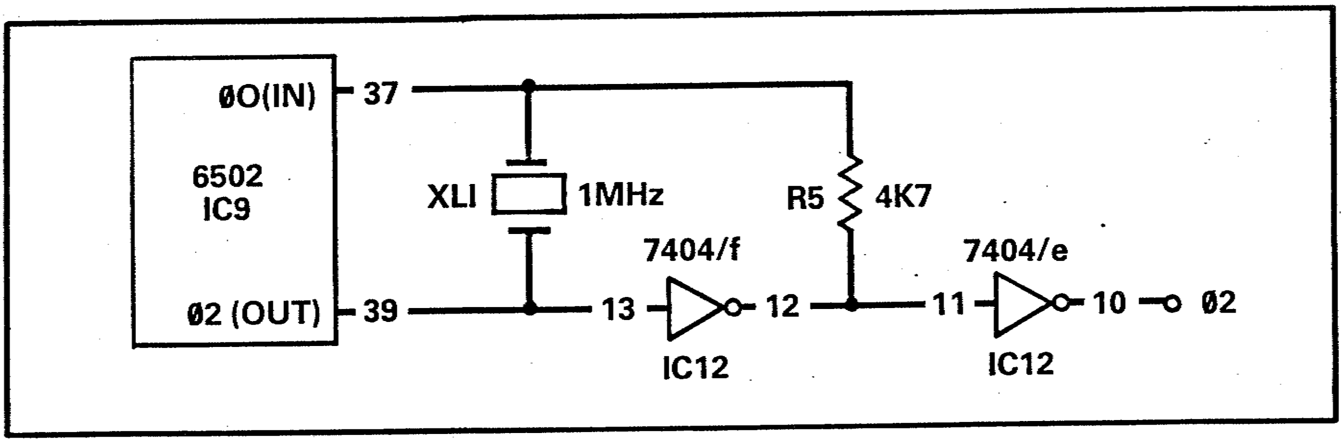
ATLAS Cassette Interface

RAM Circuit Description

The RAM on the micro card is provided by four 16384 bit static RAM integrated circuits, type 6116, giving a total capacity of 8192 bytes (8k). The positive supply to the 6116s (pin 24) is provided by the +5V supply via the battery back-up circuit or by the battery when the +5V supply is removed. The CS signal (pin 18) to the 6116s is provided by the battery back-up circuit. This ensures that, as the +5V supply collapses, the 6116s are de-selected before the address lines, data lines or WE line cause corruption of stored data. The WE line is set low by the microprocessor, when writing data to a respective memory location in RAM. The RAM memory locations are accessed by the address lines A0-A10. The OE inputs to the RAM ICs are the chip select active low input. This signal is provided by the address decoding circuitry.

Microprocessor and Clock Generation

The microprocessor used, is the 6502. The 6502 is a 40 pin IC providing Address, Data and various Control lines. These are outlined in the following description.



Clock (Ø0, Ø1, Ø2) The 6502 clock inputs can be driven from a TTL level square wave. The ATLAS micro card clock circuit is as shown.

Address Bus (A0-A15) The 16-bit address bus is used to transfer the address generated by the processor to the address inputs of all memory and peripheral interface devices. The address is always provided by the 6502, thus the address bus is unidirectional. The bus lines are TTL compatible, capable of driving one standard TTL load and 130pF.

Data Bus (D0-D7) The 8-bit data bus is bi-directional, providing a two-way transfer path between the microprocessor and the memory and interface circuits. The data bus is tri-state and is capable of driving one standard TTL load and 130pF.

Ready (RDY) This input signal is provided to allow the user to halt the 6502 on all cycles except write cycles. This feature is of use when fast direct memory access (DMA) transfers are to be performed.

Interrupt Request ($\overline{IRQ}$) When this input is in the low state (logic '0'), the microprocessor is requested to begin an interrupt sequence. The microprocessor will not acknowledge this request until it has completed the current instruction being executed. Then, provided the interrupt mask bit (interrupt disable, within the status register), is not set, the microprocessor will begin an interrupt sequence.

The interrupt sequence is:

(i) Store Program Counter high byte (PCH) on the stack
(ii) Store Program Counter low byte (PCL) on the stack
(iii) Store Status Register Contents on the stack
(iv) Load PCL from address FFFE
(v) Load PCH from address FFFF
(vi) Normal program execution sequences now continue from the memory vector held at FFFF and FFFE.

On the ATLAS board, the $\overline{IRQ}$ input is returned to +5V through a 4.7kΩ resistor to facilitate wired - OR operation.

Non-Maskable Interrupt ($\overline{NMI}$)
A negative going transition on this input requests that a non-maskable interrupt sequence is begun by the microprocessor. This interrupt is not conditional and will always be actioned following completion of the current instruction. The sequence of steps for an $\overline{NMI}$ is the same as for $\overline{IRQ}$, except that the vector address will be loaded to PCL and PCH from locations FFFA and FFFB respectively.

The 6502 has an internal latch which is set by a '1' to '0' transition on the $\overline{NMI}$ input. Thus a single, short duration, negative going pulse may be used to provide an $\overline{NMI}$, unlike $\overline{IRQ}$, which has no latch and requires $\overline{IRQ}$ to remain low until the interrupt is actioned. $\overline{NMI}$ will take priority over $\overline{IRQ}$.

Wired-OR inputs to the $\overline{NMI}$ are facilitated by a 4.7kΩ resistor returned to 5V.

Set Overflow Flag (SO)
A negative going edge on this input sets the overflow flag within the status register. This facility is not required for any of the current 6500 family circuits and the SO input is returned to 5V on the ATLAS board.

Sync
This output line identifies those cycles in which the microprocessor is doing a fetch instruction operation. The SYNC line goes high during Ø1 of a fetch operation and stays high for the remainder of that cycle.

Reset ($\overline{RES}$)
This input is used to reset or start the microprocessor from a power down condition. During the time that this line is held low, writing to or from the microprocessor is inhibited. When a positive edge occurs on the input the microprocessor will immediately begin the reset sequence. After a system initialization time of six clock cycles, the mask interrupt flag will be set and the microprocessor will load the program counter from the memory vector locations FFFC and FFFD. This is the start location for program control.

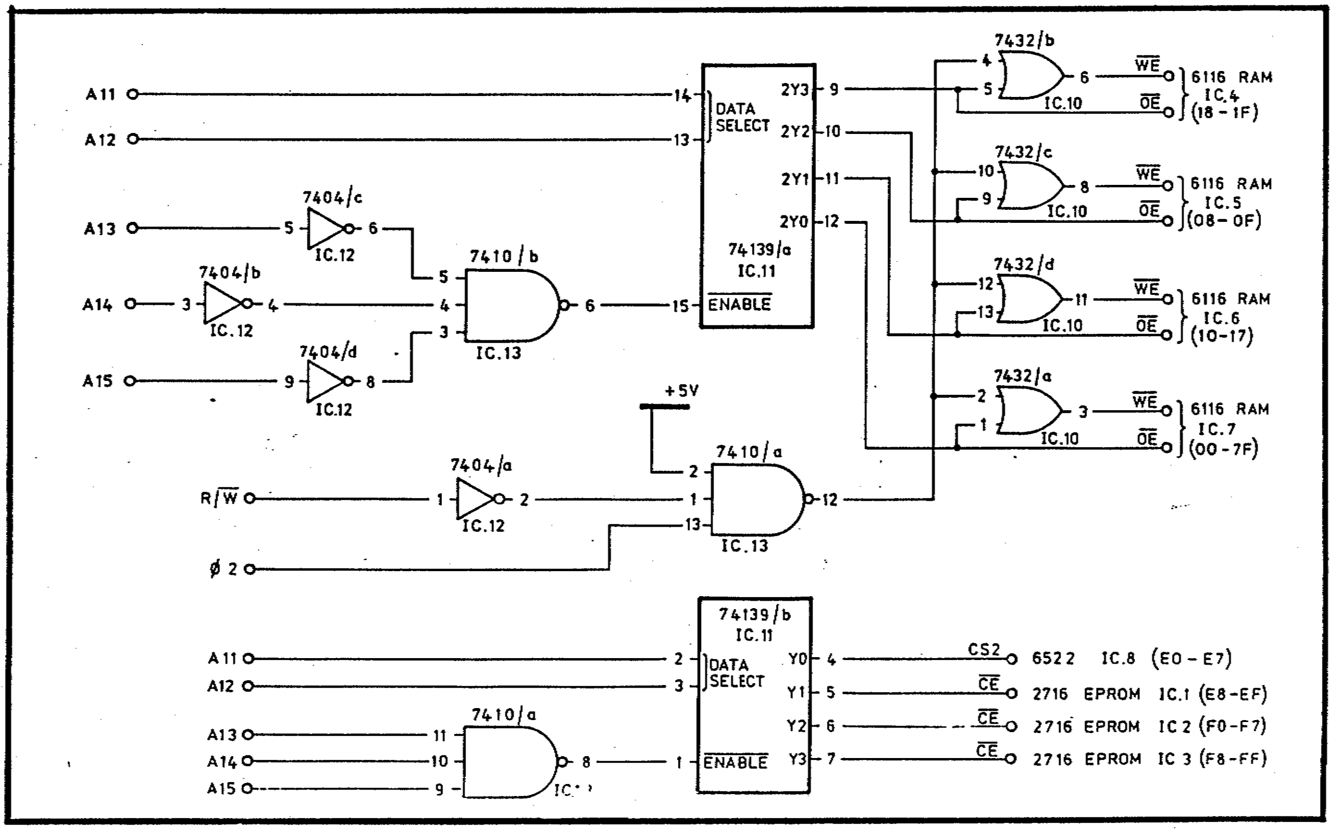
On the ATLAS board, $\overline{RES}$ is held high through a 4.7kΩ resistor.

Read/Write (R/$\overline{W}$)
This output signal is used to control the direction of data transfers between the processor and other memory circuits on the data bus. R/$\overline{W}$ high signifies data transfer into the 6502; R/$\overline{W}$ low signifies data transfer out of the 6502.

Supply Voltages The 6502 requires a 5V regulated supply, the maximum Vcc rating is +7V.

Address Decoding

The circuit diagram of the address decoding is shown below.



As shown above the address decoding provides the chip selects, OE for the RAM cicuits, CE for the EPROMS and CS2 for the 6522.

The circuit is split into two sections, RAM decoding and EPROM decoding. The OE enable signals for the RAMs are decoded as follows.

A11, A12 are connected to the data select input of a '1 of 4' decoder. The decoder is itself enabled when A13, A14 and A15 are low via the three inverters and NAND gate of the enable input. By this configuration the following areas of memory are selected.

IC7	0000	
	07FF	
IC5	0800	
	0FFF	RAM
IC6	1000	
	17FF	
IC4	1800	
	1FFF	

The OE outputs for the RAM circuits perform an **OR** function with the R/$\overline{W}$ and Ø2 expression shown to provide a write enable signal (WE). For WE to be low (active) the R/$\overline{W}$ must be low, Ø2 must be high and OE must be low.

The EPROM decoding uses another '1 of 4' decoder with A11 and A12 connected to the 'data select' inputs. An enable is provided by a NAND function of A13, A14 and A15.

This configuration decodes the EPROMs and the 6522 to the areas of memory as shown below.

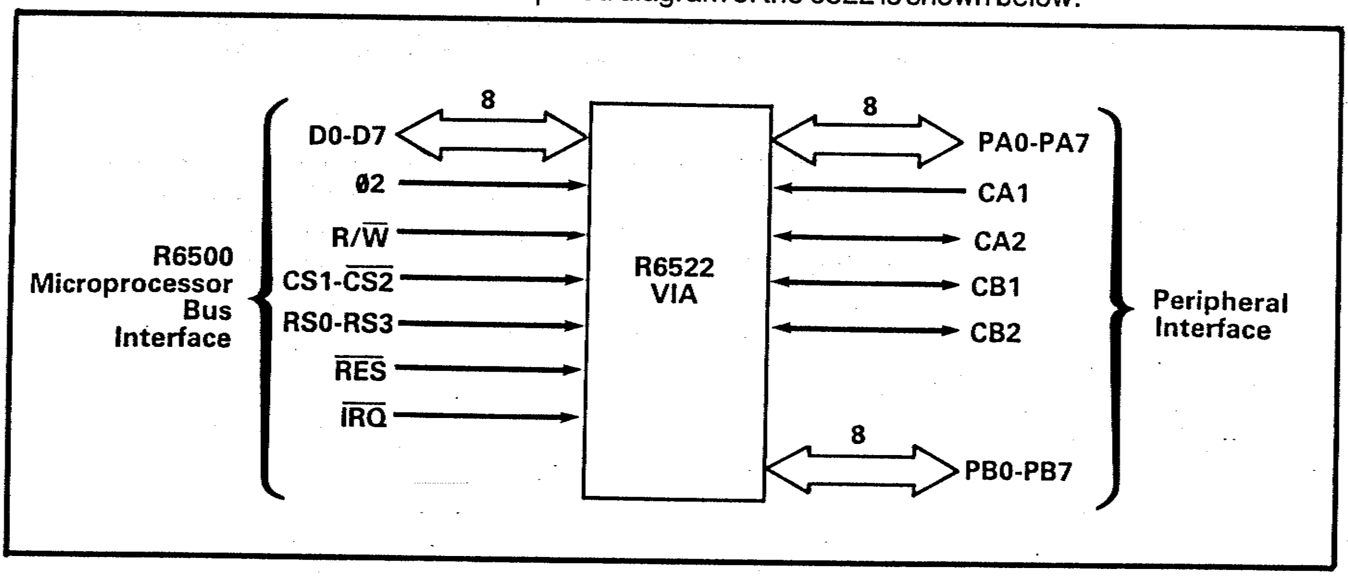
6522	E000	
VIA	E7FF	
IC1	E800	
	EFFF	
IC2	F000	EPROM
	F700	
IC3	F800	
	FFFF	

System Input/Output

The input/output controller on the ATLAS micro card is the 6522. This 40 pin IC contains:

a) Two 8-bit programmable input/output ports.
b) two 16-bit programmable timer/counters.
c) one 8-bit serial transfer register.

A simplified diagram of the 6522 is shown below:



A description of the 6522 pin functions is as given

$\overline{RES}$ Reset
The reset input clears all internal registers to logic 0 (except T1 and T2 latches and counters and the Shift Register). This places all peripheral interface lines in the input state, disables the timers, shift register, etc., and disables interrupting from the chip.

Ø2 (Input Clock)
The input clock is the system Ø2 clock and is used to trigger all data transfers between the system processor and the 6522.

R/$\overline{W}$ (Read/Write)
The direction of the data transfers between the 6522 and the system processor is controlled by the R/$\overline{W}$ line. If R/$\overline{W}$ is low, data will be transferred out of the processor into the selected 6522 register (write operation). If R/W is high and the chip is selected, data will be transferred out of the 6522 (read operation).

D0-D7 (Data Bus)
The eight bi-directional data bus lines are used to transfer data between the 6522 and the system processor. During read cycles, the contents of the selected 6522 register are placed on the data bus lines and transferred into the processor. During write cycles, these lines are high-impedance inputs and data is transferred from the processor into the selected register. When the 6522 is unselected, the data bus lines are high impedance.

CS1, CS2 (Chip Select)
The two chip select inputs are normally connected to processor address lines either directly or through decoding. The selected 6522 register will be accessed when CS1 is high and CS2 is low.

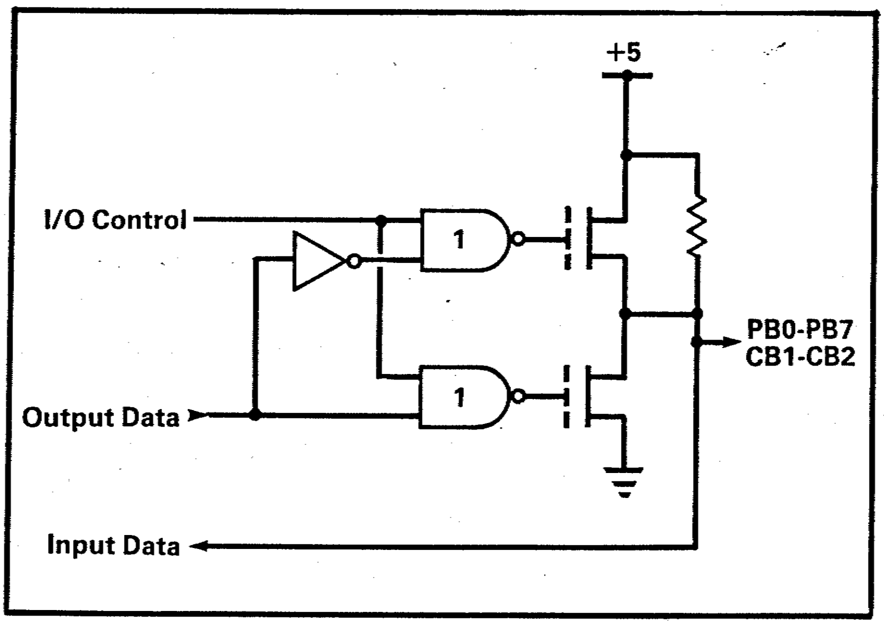
RS0-RS3 (Register Selects)
The four Register Select inputs permit the system processor to select one of the 16 internal registers of the 6522. The ATLAS micro card has the lines RS0-RS3 connected to address lines A0-A3 respectively. Thus, the memory locations for the 6522 registers are as given in the table.

Address	Register Designation	Description Write	Read
E0×0	ORB/IRB	Output Register 'B'	Input Register 'B'
E0×1	ORA/IRA	Output Register 'A'	Input Register 'A'
E0×2	DDRB	Data Direction Register 'B'	
E0×3	DDRA	Data Direction Register 'A'	
E0×4	T1C-L	T1 Low-Order Latches	T1 Low-Order Counter
E0×5	T1C-H	T1 High-Order Counter	
E0×6	T1L-L	T1 Low-Order Latches	
E0×7	T1L-H	T1 High-Order Latches	
E0×8	T2C-L	T2 Low-Order Latches	T2 Low-Order Counter
E0×9	T2C-L	High-Order Counter	
E0×A	SR	Shift Register	
E0×B	ACR	Auxiliary Control Register	
E0×C	PCR	Peripheral Control Register	
E0×D	IFR	Interrupt Flag Register	
E0×E	IER	Interrupt Enable Register	
E0×F	ORA/IRA	Same as E0×1 Except no 'Handshake'	

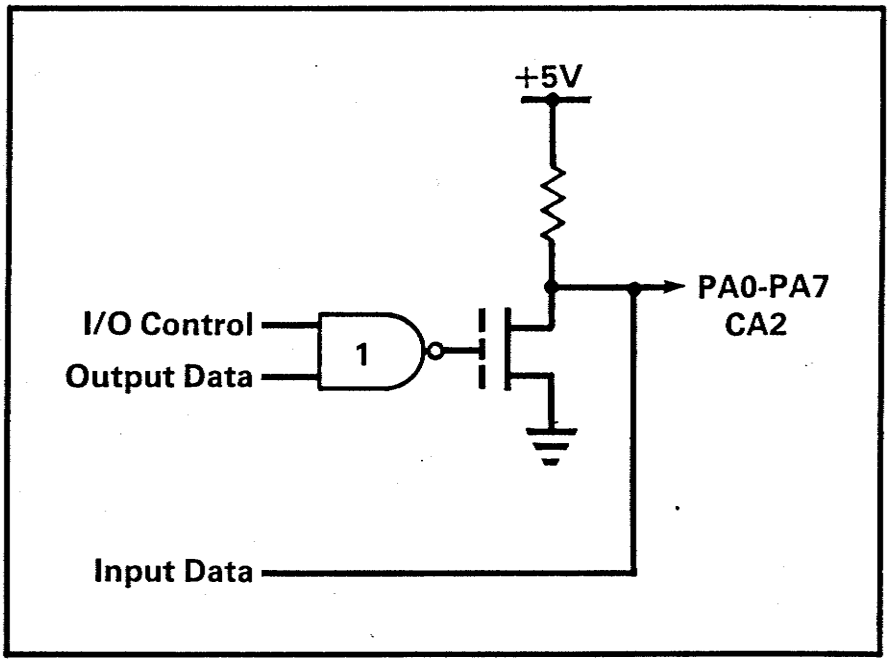
The fact that the register select lines are activated by address lines A0-A3, regardless of the state of address lines A4-A7, means that the hexadecimal code used for X, is unimportant.

$\overline{IRQ}$ (Interrupt Request)
The Interrupt Request output goes low whenever an internal interrupt flag is set and the corresponding interrupt enable bit is a logic 1. This output is 'open-drain' to allow the interrupt request signal to be 'wire-or -ed' with other equivalent signals in the system.

PA0-PA7 (Peripheral Port A)
The Peripheral port A consists of 8 lines which can be individually programmed to act as inputs or outputs under control of Data Direction Register. The polarity of output pins is controlled by an Output Register and input data may be latched into an internal register under control of the CA1 line. All of these modes of operation are controlled by the system processor through the internal control registers. These lines represent one standard TTL load in the input mode and will drive one standard TTL load in the output mode. The diagram below illustrates the output circuit.



PB0-PB7 (Peripheral Port B)
The Peripheral B port consists of eight bi-directional lines which are controlled by an output register and a data direction register in much the same manner as the PA port. In addition, the polarity of the PB7 output signal can be controlled by one of the interval timers while the second timer can be programmed to count pulses on the PB6 pin. Peripheral B lines represent one standard TTL load in the input mode and will drive one standard TTL load in the output mode. In addition, they are capable of sourcing 1.0mA at 1.5VDC in the output mode to allow the outputs to directly drive Darlington transistor circuits. Figure shown is the circuit diagram.



CA1, CA2 (Peripheral A Control Lines)
The two Peripheral A control lines act as interrupt inputs or as handshake outputs. Each line controls an internal interrupt flag with a corresponding interrupt enable bit. In addition, CA1 controls the latching of data on Peripheral A port input lines. CA1 is a high impedance input only while CA2 represents one standard TTL load in the input mode. CA2 will drive one standard TTL load in the output mode.

CB1, CB2 (Peripheral B Control Lines)
The Peripheral B control lines act as interrupt inputs or as handshake outputs. As with CA1 and CA2, each line controls an interrupt flag with a corresponding interrupt enable bit. In addition, these lines act as a serial port under control of the Shift Register. These lines represent one standard TTL load in the input mode and will drive one standard TTL load in the output mode. Unlike PB0-PB7, CB1 and CB2 cannot drive Darlington transistor circuits.

EPROM IC1, IC2 and IC3 on the control card are 2716 EPROMs. These provide 6144 byte (6k) of read only memory which contain the system control program. CE is the chip enable input for each EPROM. When this input is low the memory contents at the particular address supplied by A0-A10 are passed onto the data bus. The CE input is enabled from the address decoding.

ATLAS I Micro Test Schedule

1. Inspect underside of board for short or open circuits and solder splashes.

2. Inspect top of board for incorrect components. Ensure that I.Cs are correctly inserted - pay special attention to bent pins.

3. Hold board over light box and check for hair line p.c.b. shorts.

4. Insert the three EPROMs if this has not already been done. Starting from the socket nearest the RAM, the order is: F8-FF, FØ-F7, E8-EF.

5. Using the ATLAS Micro Test Module, connect the 2-way polarised socket to the 2-pin power plug under the micro card, ensuring correct polarity. Install the micro card so that the 34-way connector faces the test card. Plug the three sockets onto the corresponding board pins on the micro card.

6. Connect a power supply providing 5V at 500mA (minimum) to the test card. Switch on for about 5 seconds then switch off. Check that I.Cs are cool; if not, check orientation.

7. The switches and LEDs on the test card will be referred to by the I/O bit to which they correspond. Set all port A switches to '0'.

8. Turn power ON. All port A LEDs should light for about a second, then change to the pattern below:

● ● ● ○ ● ○ ○ ○

PA_7 … PA_0

If this pattern does not occur, check the following control lines:

6502 Pin 39, Ø2 clock at 1MHz.
6502 Pin 7, Sync waveform. Complex waveform, with low going pulses every few microseconds, indicating that a program is running. 6502 Pin 40, Reset line, must be at logic '1' continuously for the micro to run.
6502 Pin 4 and Pin 6, $\overline{IRQ}$ and $\overline{NMI}$ respectively, must both be high continuously for micro to operate correctly. If these checks show that the microprocessor is running, then use a logic analyzer to confirm that it is running the following:

Reset vectors: FFFC ØØ
FFFD F8

The vectored address leads to the program:

```
F800  78  SEI                    Disable interrupts
F801  D8  CLD                    Clear decimal mode flag
F802  A2  LDX#FF
F804  86  STX  09                (0009)=FF for later use
F806  9A  TXS                    Stack pointer = 01FF
F807  A9  LDA#08
F809  8D  STA  E001              Set bit 3 of output reg.A
F80C  A9  LDA#1F
F80E  8D  STA  E003              Initialize DDR.A
F811  A9  LDA#44
F813  8D  STA  E000              Set bit 6, 2 of output reg.B
F816  8D  STA  E002              Initialize Port B
F819  A2  LDX#1B                 Copy some data to zero page
F813  8D  LDA  FF02,X
F81E  95  STA  82 ,X
F820  CA  DEX
F821  D0  BNE  F81B (F8)
F823  86  STX  23                (0023) = 0 for later use
F825  A9  LDA#EC
F827  8D  STA  E00C              Reset CA2
F82A  AD  LDA  E00D              Read interrupt flag reg.
F82D  29  AND#02                 Mask off CA1 flag
F82F  D0  BNE  F83E (00)         Flag set
F831  88  DEY
F832  D0  BNE  F82A  (F6)
F834  CA  DEX
F835  D0  BNE  F82A  (F3)        After approx 1 second
F837  AD  LDA  E00C
F83C  D0  BNE  F825  (E9)
```

If the micro is found to be running an incorrect start-up program, then the fault is almost certainly an IC failure. This is best diagnosed by IC replacement with known operating items.

When the sequence required occurs, continue with the test.

9. Press the $\overline{\text{NMI}}$ button on the test card. If the LEDs on Port A sequence, one LED on at a time, the check on Port A is successful; if not then:
   Assuming that the micro has found the $\overline{\text{NMI}}$ vectors (FFFA, FFFB) and the data contained within (00,F0) the program will be directed to F000.

(a) The first check is to shift a logic '1' through data direction register A (Addr.E003) from LSB to MSB. The result is read back and compared with data sent. If they differ, the program stays in a loop.

```
F00A  LDA  E003
F00D  STA  E003
F010  JMP  F00A
```

The instructions to read and write DDRA should result in pulses on read/write (pin 22) and double pulses on chip select (pin 23) of the 6522. Data present on the data bus when chip select is low should give an indication of the fault.

(b) If the first test was successful an identical test is now performed on Port A output register (E001). If it fails for any other reason the program will settle into the following loop.

```
F028  LDA  E001
F02B  STA  E001
F02E  JMP  F028
```

and the same rules as for (a) apply.

10. Set Port A switches to 00000000. Press $\overline{\text{NMI}}$, Depress R/$\overline{\text{W}}$ then release.

On port B, one LED OFF should cycle repeatedly right to left. If the LEDs do not cycle then:

A shift test on data direction register B (E002) has failed but in this test the data which failed to be read properly is stored on Port A and so is visible on Port A LEDs.

11. Press RESET on Test Module. Set Port A switches PA7-PA0 to 00000001. Press $\overline{\text{NMI}}$, depress the R/$\overline{\text{W}}$ button then release. After approximately 1 second, Port A should cycle, as in test 9. This is a RAM test.

If the LEDs do not sequence: The following sequence of 'tests' could be carried out on RAM, giving diagnostic information on the test module:

(a) Each code in turn, from 00-FF, is written to locations 0000 and 0001 at the bottom of zero page. If either location fails the incorrect data is written to the Port A LEDs. If 0000 failed, Port B LEDs show:

● ○ ○ ○ ○ ○
PB_5 PB_0

If 0001 fails, Port B led's show:

● ○ ○ ○ ○ ●
PB_5 PB_0

(b) Attempts to clear every location from 0100-1FFF. If test fails the page number (e.g. 16 if location 1678 failed to clear) is displayed on the port A LEDs and PB1 LED is lit while PB5 L.E.D flashes, i.e.

● ○ ○ ○ ● ○
PB_5 PB_0

(c) Performs a checksum test on selected memory locations on each page of RAM. Failure indication is as for (b), except that PB2 LED is lit:

● ○ ○ ● ○ ○
PB_5 PB_0

(d) Finally, a shift test is performed on every location from 0002-1FFF. Fault indication is as for (b) and (c) except that PB3 LED is lit:

● ○ ● ○ ○ ●
PB_5 PB_0

12. After previously running test (11), switch power OFF. Check pin 24 of each RAM. It should be between 3 and 4 volts. Check pin 24 of an EPROM - it must be at 0V. (Allow time for smoothing capacitors to discharge!) If not, check the battery backup circuitry, especially the orientation and type numbers of transistors and diodes. If there were any faults switch ON, press $\overline{NMI}$ and proceed from (11). If not, switch ON, press $\overline{NMI}$ and set Port A switches to 00000010. Depress R/$\overline{W}$, then release. If battery backup has worked, port A LEDs should be cycling. If not, Port A will indicate which page of RAM has not been retained while PB6 LED will be flashing.

13. Press $\overline{\text{RESET}}$. Set Port A switches to 00000011. Press $\overline{\text{NMI}}$. Depress R/$\overline{\text{W}}$ then release. The decoder LEDs D15-D10 and D27-D20 should be lit in turn. Port A LEDs will be counting down from 7 to 1.

14. Press $\overline{\text{RESET}}$. Set Port A switches to 00000100. Press $\overline{\text{NMI}}$. Depress the R/$\overline{\text{W}}$ then release. Immediately after press CA1 button and after a few seconds PA7 LED should light. Press $\overline{\text{NMI}}$ and switch to **Write** then **Read,** this time pressing CA2 button. PA6 LED should light. Repeat with CB1 and CB2, PA5 and PB4 LEDs should light respectively.

15. Press $\overline{\text{RESET}}$. Set Port A switches to 00000101. Press $\overline{\text{NMI}}$. Depress R/$\overline{\text{W}}$ then release. This tests Timer 1. Port A will be incrementing and decoder outputs will be cycling from right to left, taking about ½ second.

16. Press $\overline{\text{RESET}}$. Set Port A switches to 00000110. Press $\overline{\text{NMI}}$. Depress R/$\overline{\text{W}}$ then release. This test Timer 2. Port A will be decrementing and decoder outputs will be cycling from left to right, taking about ½ second.

17. Press $\overline{\text{RESET}}$. Set Port A switches to 00000111. Press $\overline{\text{NMI}}$. Depress R/$\overline{\text{W}}$ then release. A checksum will be carried out on the EPROM in E8-EF. Port A should read.

    ○ ○ ○ ● ● ● ●

18. Repeat (17), with Port A set to;

    a) ○ ○ ○ ○ ● ○ ○ ○
    b) ○ ○ ○ ○ ● ○ ○ ●

    Checksum should be;

    a) ○ ● ● ● ● ● ○ ○
    b) ● ○ ● ○ ● ○ ● ○

    An incorrect checksum can indicate.

    a) EPROM checksum has changed (i.e. later edition)
    b) Bent pin on EPROM
    c) Open circuit on bus line to EPROM
    d) Chip select fault
    e) Faulty EPROM If the checksum seems to fluctuate the EPROM is badly programmed and should be replaced.

19. Press $\overline{\text{RESET}}$. Set Port A switches to 00001010. Press $\overline{\text{NMI}}$. Depress R/$\overline{\text{W}}$ then release. This test outputs to code #0F continuously in serial mode to PB6. It uses the cassette dump routine at FE1C.

    Check that the pattern 0111100001 is produced repeatedly on PB6 (pin 16 of the 6522). If so, plug the 3-way shorting link on the cassette I/O pins and check that the same waveform is now present on PB7 (pin 17). If not, read the description of the cassette interface and follow the signals through the circuit with the aid of the diagram.

20. Connect a cassette recorder to the I/O plug with the white spot facing the 34-way connector. Set port A switches to 00001011. Start recording. Press $\overline{\text{NMI}}$. Depress R/$\overline{\text{W}}$ then release. This routine writes the code #AA 256 times. When it is finished port A LEDs will be cycling.

21. Play back the recording and check the sound quality.

22. Set port A switches to 00001100. Play back again. Press $\overline{\text{RST}}$ followed by $\overline{\text{NMI}}$. When header tone sounds, depress the R/$\overline{\text{W}}$ then release. If a byte is read in error it will be displayed on port A LEDs and PB5 LED will be flashing. If there are no errors port A LEDs will be cycling when header tone returns.

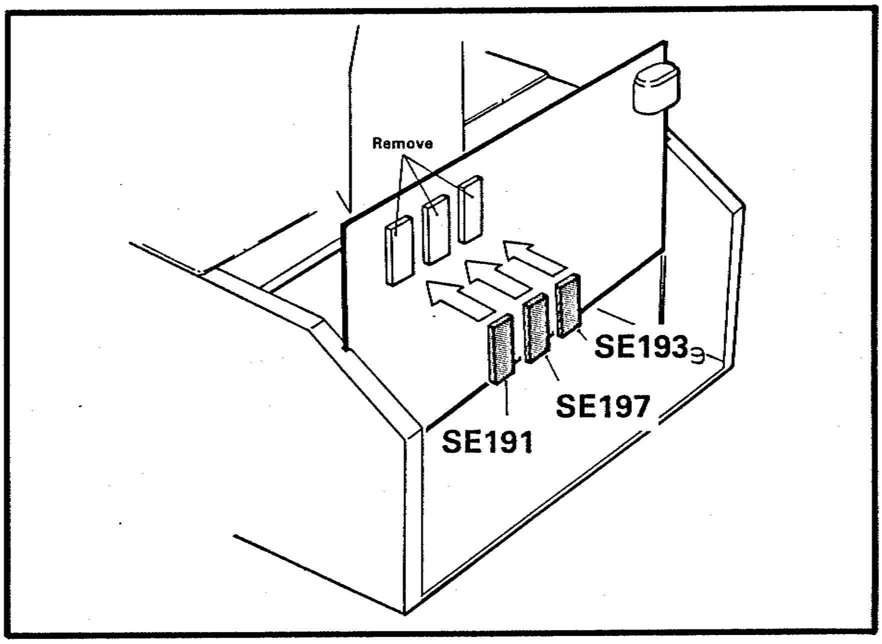
ATLAS II Micro Test Schedule

1. Inspect underside of board for short or open circuits and solder splashes.

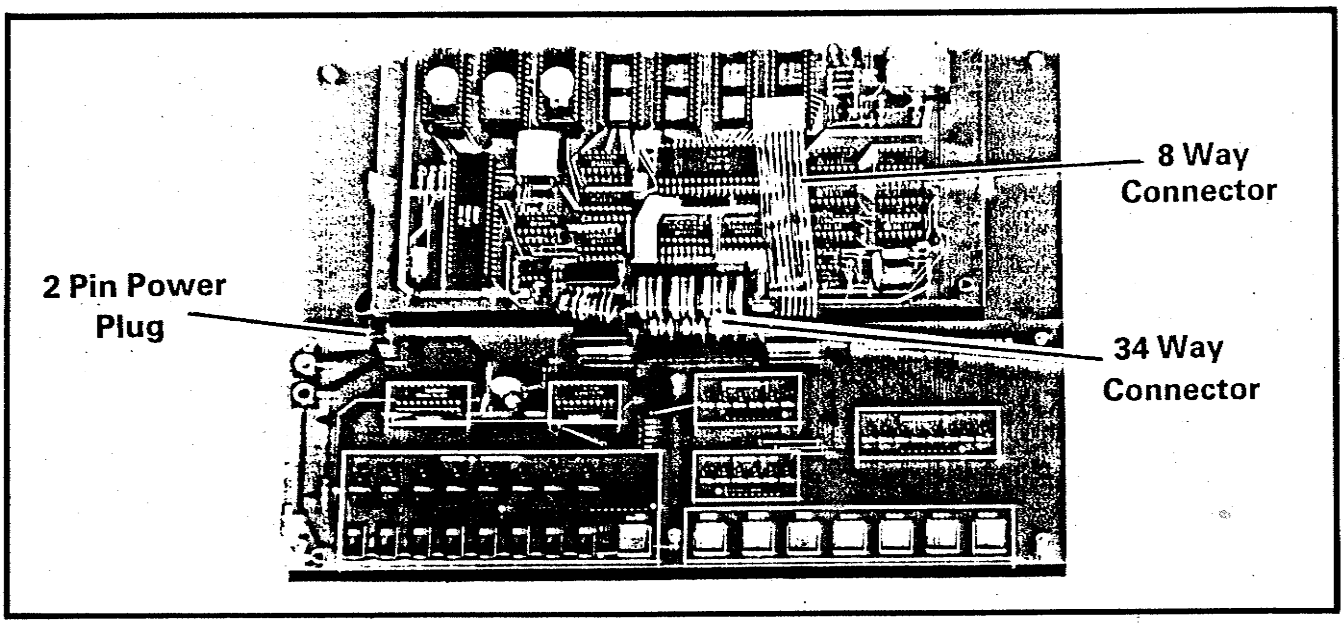
2. Inspect top of board for incorrect components. Ensure that I.Cs are correctly inserted - pay special attention to bent pins.

3. Hold board over light box and check for hair line p.c.b. shorts.

4. **Insert the ATLAS II test EPROM (SE197) into location F0-F7 replacing EPROM SE192.** Ensure that EPROM SE191 is in location E8-EF and SE193 is in F8-FF



5. Using the ATLAS Micro Test Module, connect the 2-way polarised socket to the 2-pin power plug under the micro card, ensuring correct polarity. Install the micro card so that the 34-way connector faces the test card. Plug the three sockets onto the corresponding board pins on the micro card.



6. Connect a power supply providing 5V at 500mA (minimum) to the test card. Switch on for about 5 seconds then switch off. Check that I.Cs are cool; if not, check orientation.

7. The switches and LEDs on the test card will be referred to by the I/O bit to which they correspond. Set all port A switches to '0'

8. Turn power ON. All port A LEDs should light for about a second, then change to the pattern below:

● ● ● ○ ● ● ● ●

PA_7 PA_0

If this pattern does not occur, check the following control lines:

6502 Pin 39, Ø2 clock at 1MHz.
6502 Pin 7, Sync waveform. Complex waveform, with low going pulses every few microseconds, indicating that a program is running. 6502 Pin 40, Reset line, must be at logic '1' continuously for the micro to run.
6502 Pin 4 and Pin 6, $\overline{IRQ}$ and $\overline{NMI}$ respectively, must both be high continuously for micro to operate correctly. If these checks show that the microprocessor is running, then use a logic analyzer to confirm that it is running the following:

Reset vectors: FFFC 00
FFFD F8

The vectored address leads to the program:

F800	START:SEI	:Begin
F801	CLD	:Operate in Hex
F802	LDX#FFH	
F804	TXS	
F805	STX 1FH	:Disable 'Serial Initiate'
F807	STX 41H	:Ensure pass 1 runs to completion
F809	JSR FC23	:Initiate Port B and DDR
F80C	STA E002H	
F80F	STA 38H	:Disable Single Step
F811	STA 39H	:Assume push button not pressed
F813	JSR FD75	:Enable Serial I/P make PA0-3 high
F816	LDA#1FH	:Initiate DDR A
F818	STA E003H	
F81B	LDA#7FH	:Disable 6522 Interrupts
F81D	STA E00EH	

If the micro is found to be running an incorrect start-up program, then the fault is almost certainly an IC failure. This is best diagnosed by IC replacement with known operating items.

When the sequence required occurs, continue with the test.

9. Press the $\overline{\text{NMI}}$ button on the test card. If the LEDs on Port A sequence, one LED on at a time, the check on Port A is successful; if not then:
   Assuming that the micro has found the $\overline{\text{NMI}}$ vectors (FFFA, FFFB) and the data contained within (00,F0) the program will be directed to F000.

   (a) The first check is to shift A '1' through data direction register A (Addr.E003) from LSB to MSB. The result is read back and compared with data sent. If they differ, the program stays in a loop.

   ```
   F00A  LDA  E003
   F00D  STA  E003
   F010  JMP  F00A
   ```

   The instructions to read and write DDRA should result in pulses on read/write (pin 22) and double pulses on chip select (pin 23) of the 6522. Data present on the data bus when chip select is low should give an indication of the fault.

   (b) If the first test was successful an identical test is now performed on Port A output register (E001). If it fails for any other reason the program will settle into the following loop.

   ```
   F028  LDA  E001
   F02B  STA  E001
   F02E  JMP  F028
   ```

   and the same rules as for (a) apply.

10. Set Port A switches to 00000000. Press $\overline{\text{NMI}}$, Depress R/$\overline{\text{W}}$ then release.

    On port B, one LED OFF should cycle repeatedly left to right. If the LEDs do not cycle then:

A shift test on data direction register B (E002) has failed but in this test the data which failed to be read properly is stored on Port A and so is visible on Port A LEDs.

11. Press $\overline{\text{RESET}}$ on Test Module. Set Port A switches to 00000001. Press NMI, depress the R/$\overline{\text{W}}$ button then release. After approximately 1 second, Port A should cycle, as in test 9. This is a RAM test.

If the LEDs do not sequence: The following sequence of 'tests' could be carried out on RAM, giving diagnostic information on the test module:

(a) Test locations 0000 and 0001 at the bottom of zero page. Every code from 00-FF is written in turn. If either location fails the incorrect data is written to the Port A LEDs. If 0000 failed, Port B LEDs show:

● ○ ○ ○ ○ ○
PB_5 PB_0

If 0001 fails, Port B led's show:

● ○ ○ ○ ○ ●
PB_5 PB_0

(b) Attempts to clear every location from 0100-1FFF. If test fails the page number (e.g. 16 if location 1678 failed to clear) is displayed on the port A LEDs and PB1 LED is lit while PB5 L.E.D flashes, i.e.

(c) Performs a checksum test on selected memory locations on each page of RAM. Failure indication is as for (b), except that PB2 LED is lit:

● ○ ○ ● ○ ○
PB_5 PB_0

(d) Finally, a shift test is performed on every location from 0002-FFF. Fault indication is as for (b) and (c) except that PB3 LED is lit:

● ○ ● ○ ○ ○
PB_5 PB_0

12. After previously running test (11), switch power OFF. Check pin 24 of each RAM. It should be between 3 and 4 volts. Check pin 24 of an EPROM - it must be at 0V. (Allow time for smoothing capacitors to discharge!) If not, check the battery back-up circuitry, especially the orientation and type numbers of transistors and diodes. If there were any faults switch ON, press $\overline{\text{NMI}}$ and proceed from (11). If not, switch ON, press $\overline{\text{NMI}}$ and set Port A switches to 00000010. Depress R/$\overline{\text{W}}$, then release. If battery back-up has worked, port A LEDs should be cycling. If not, Port A will indicate which page of RAM has not been retained while PB5 LED will be flashing.

13. Press $\overline{\text{RESET}}$. Set Port A switches to 00000011. Press $\overline{\text{NMI}}$. Depress R/$\overline{\text{W}}$ then release. The decoder LEDs D15-D10 and D27-D20 should be lit in turn. Port A LEDs will be counting down from 7 to 1.

14. Press $\overline{\text{RESET}}$. Set Port A switches to 00000100. Press $\overline{\text{NMI}}$. Depress the R/$\overline{\text{W}}$ then release. Immediately after press CA1 button and after a few seconds PA7 LED should light. Press $\overline{\text{NMI}}$ and switch to **Write** then **Read,** this time pressing CA2 button. PA6 LED should light. Repeat with CB1 and CB2, PA5 and PB4 LEDs should light respectively.

15. Press $\overline{\text{RESET}}$. Set Port A switches to 00000101. Press $\overline{\text{NMI}}$. Depress R/$\overline{\text{W}}$ then release. This tests Timer 1. Port A will be incrementing and decoder outputs will be cycling from right to left, taking about ½ second.

16. Press $\overline{\text{RESET}}$. Set Port A switches to 00000110. Press $\overline{\text{NMI}}$. Depress R/$\overline{\text{W}}$ then release. This test Timer 2. Port A will be decrementing and decoder outputs will be cycling from left to right, taking about ½ second.

17. Press $\overline{\text{RESET}}$. Set Port A switches to 00000111. Press $\overline{\text{NMI}}$. Depress R/$\overline{\text{W}}$ then release. A checksum will be carried out on the EPROM in E8-EF. Port A should read.

    ○ ○ ○ ○ ○ ○ ● ●

18. Repeat (17), with Port A set to;

    a) ○ ○ ○ ○ ● ○ ○ ○
    b) ○ ○ ○ ○ ● ○ ○ ●

Checksum should be;

a) ○ ● ● ● ● ● ● ●
b) ○ ○ ○ ● ● ● ● ○

An incorrect checksum can indicate.

a) EPROM checksum has changed (i.e. later edition)
b) Bent pin on EPROM
c) Open circuit on bus line to EPROM
d) Chip select fault
e) Faulty EPROM If the checksum seems to fluctuate the EPROM is badly programmed and should be replaced.

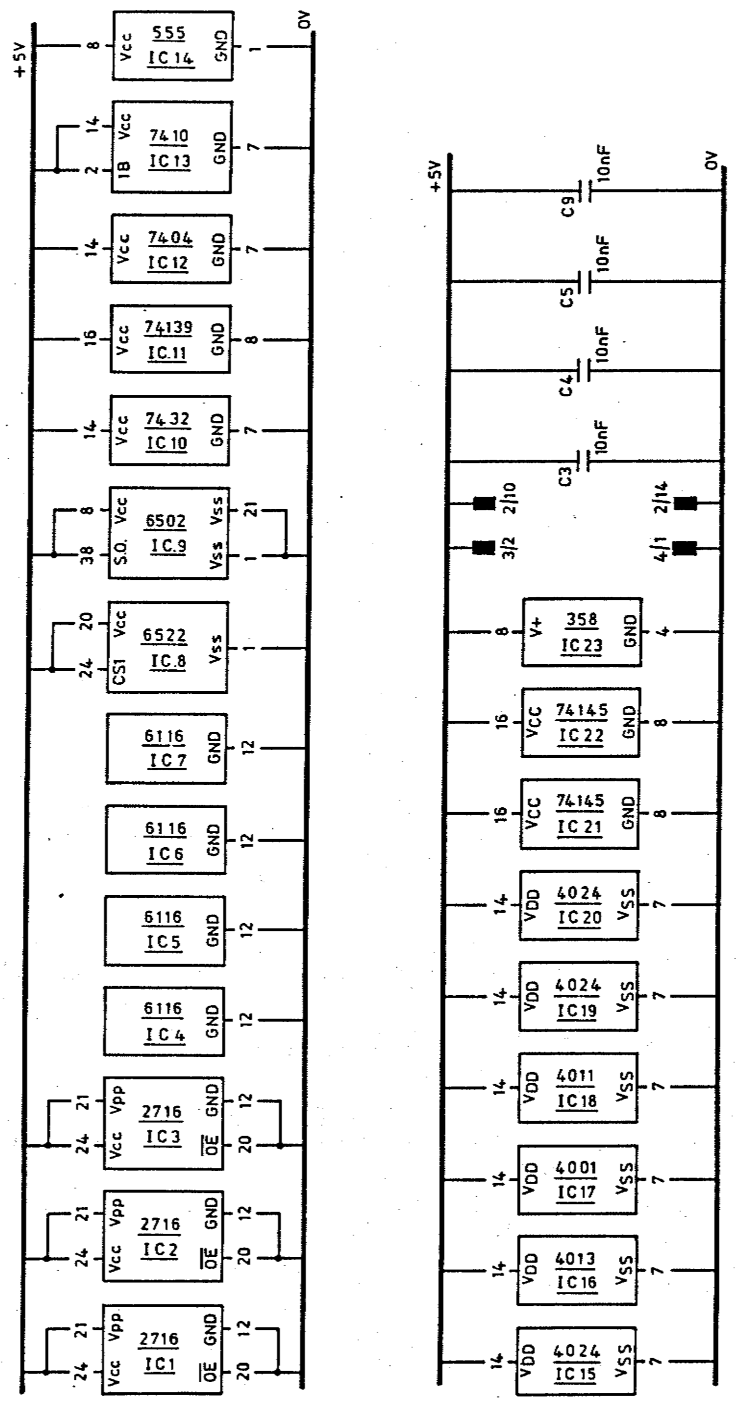
19. Press RESET. Set Port A switches to 00001010. Press $\overline{NMI}$. Depress R/$\overline{W}$ then release. This test outputs to code #0F continuously in serial mode to PB6. It uses the cassette dump routine at FE1C.

    Check that the pattern 0111100001 is produced repeatedly on PB6 (pin 16 of the 6522). If so, plug the 3-way shorting link on the cassette I/O pins and check that the same waveform is now present on PB7 (pin 17). If not, read the description of the cassette interface and follow the signals through the circuit with the aid of the diagram.

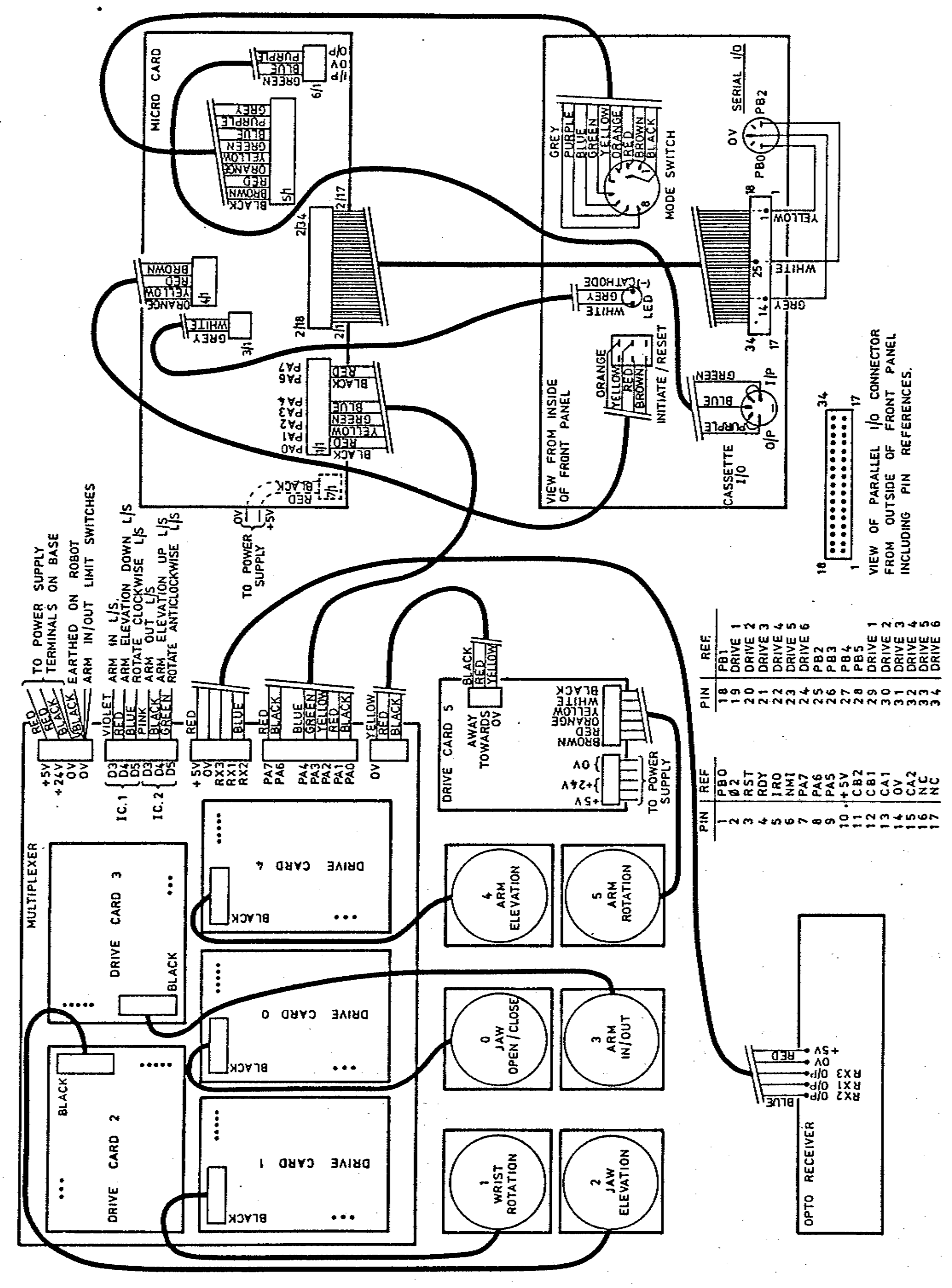
20. Connect a cassette recorder to the I/O plug with the white spot facing the 34-way connector. Set port A switches to 00001011. Start recording. Depress R/$\overline{W}$ then release. This routine writes the code #AA 256 times. When it is finished port A LEDs will be cycling.

21. Play back the recording and check the sound quality.

22. Set port A switches to 00001100. Play back again. When header tone sounds, depress the R/W then release. If a byte is read in error it will be displayed on port A LEDs and PB5 LED will be flashing. If there are no errors port A LEDs will be cycling when header tone returns.



ATLAS Micro Card Supply Rail Connections



PCB Interconnection Diagram

The stepper motors used on the ATLAS have 4 field windings. To step a motor these windings must be energised in a particular sequence, as illustrated below:-

Windings
'1' indicates winding ON
'0' indicates winding OFF

A	B	C	D
1	1	0	0
0	1	0	0
0	1	1	0
0	0	1	0
0	0	1	1
0	0	0	1
1	0	0	1
1	0	0	0
1	1	0	0
0	1	0	0
etc			

This sequence will cause the motor to 'half step'; for the ATLAS motors this means stepping 0.9°. The motor moves 0.9° on each of the steps given above. Moving through the sequence in one direction steps the motor clockwise; moving through in the reverse direction steps the motor counter clockwise. Moving in 'half step', rather than 'full step', lessens the problem of stepper motor resonances.

In order that current may be switched quickly in the windings, a higher voltage than the winding rating is used and the current through the winding is then 'chopped' to give an average winding current of less than the maximum rating. By using this chopper amplifier arrangement, the motor can be stepped at up to 2,000 steps/second. Simple winding switching only gives a step rate of 400-500 steps/second.

The energising sequence can be generated by using either an SDB 520 i.c. or a 7602 i.c. (on post March 1986 ATLAS robots). We will firstly examine the operation of the circuit which uses the SDB 520 ie. referring to Stepper Motor Drive Card Circuit diagram 1 the operation of the circuit is as follows:

ATLAS Chopper Drive Amplifier Circuit 1 Description (for pre March 1986 ATLAS robots)

IC3 is a 555 timer circuit, connected as a free-running oscillator, to operate at a frequency of 25kHz approx. Variable resistor VR1 will adjust the mark:space ratio of the output frequency. The output from pin 7 of the 555 can be observed at test point 1 (TP 1). This output switches the junction of R_6 and R_7 between 12V and 0V approximately. This signal is fed to each of the 4 driver circuits and will be considered later.

The signals for the 4 windings are generated by the SDB 520 i.c. This circuit has the following inputs fed from the microcomputer, via the multiplexer board;

positive rotation (CW)
negative rotation (CCW)

The 520 i.c. also has facility for an excitation input, but this is not used on the drive amplifier board. Four outputs are provided by the 520 i.c., one for each motor phase. These outputs are latched internally and will be held until a further positive or negative rotation pulse is received.

The four outputs from the 520 are fed to 4 inputs of the 7407 non-inverting buffer i.c. The outputs from these buffers are fed to 4 identical chopper driver circuits.

Consider chopper driver 2. The VMOS FET, TR4, is normally OFF, since its gate is at approximately 0V while its source is at 0V. When the output at pin 4 of the 7407 goes high, it pulls TR4 gate high, switching TR4 ON. Current is pulled through the brown field winding of the stepper motor. This current, flowing through TR4 also flows through R29, which is a 0.47Ω resistor. When the voltage across R29 reaches 0.6V approximately, the thyristor SCR4 is switched ON. This thyristor switching ON, pulls TR8 source low, to 0V approximately. This allows TR8 to conduct while the output from the 555 timer is high. When TR8 conducts, its drain is pulled low, switching OFF TR4. Thus, when the current through the brown winding has reached 1A. approximately, TR_4 is then chopped ON and OFF at the oscillation frequency of the 555 timer. The conducting period of TR4 during each cycle of oscillation is determined by the mark:space ratio of IC3 output. Diode D6, in conjunction with zener ZD1, prevent TR4 from being damaged by excess voltage rise at its drain when TR4 is switched OFF at the end of a step. Diode D10 prevents a negative ring at TR4 drain, when current is induced in the brown windings.

ATLAS Chopper Drive Amplifier Circuit 2 Description (for post March 1986 ATLAS robots)

We will now examine the operation of the circuit which uses the 7602 i.c. Refer to Stepper Motor Drive Card Circuit Diagram 2. The operation of this circuit is the same as that for the circuit based on the 520 i.c. However, the 7602 i.c. is a PROM which has been programmed with stepper motor sequence required and employs the use of a 4-bit up/down which addresses it cyclically to output output the correct stepping sequence.

Each of the four chopper drive amplifiers are driven by one of the outputs of IC2 and 'chopped' by the output of the 555 timer IC1.

Consider chopper driver 2. The VMOS FET TR4 is controlled by the output of IC2 pin 3 and when this goes high TR4 is switched on. This causes a current to flow through the motor winding, TR4 and resistor R29. When the voltage across R29 reaches approximately 0.6V the thyristor SCR4 will be switched on. SCR4 switching on pulls the source of TR8 low allowing it to conduct, while the output of timer IC1 is high. The conduction of TR8 pulls its drain low and hence switches off TR4.

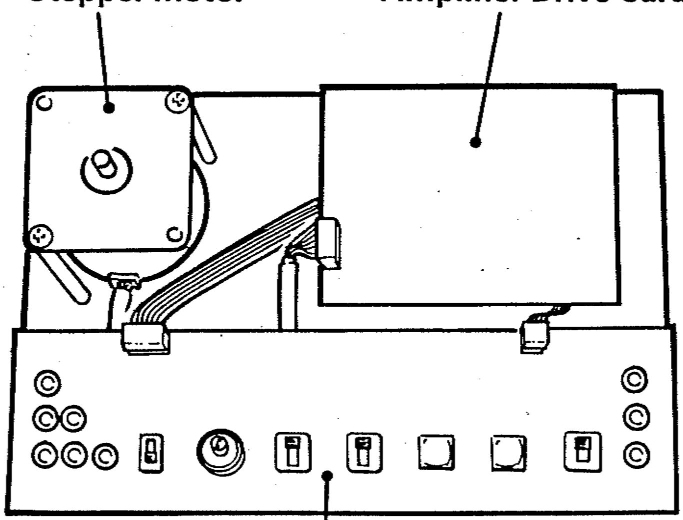
Thus when current through the motor winding reaches approx 1A, TR4 is switched on and off (chopped) at the frequency of IC1. The average current flowing through the winding is dependent on the mark:space ratio of the output of IC1 and is thus adjustable by means of VR1.

Diode D6, in conjunction with zener ZD1, prevents TR4 from being damaged by excess voltage rise at its drain when TR4 is switched off at the end of a step. Diode D10 prevents a negative ring at TR4 drain, when current is induced in the windings.

The circuit comprising TR9 and TR10 switches off all four windings, preventing damage to the chopper/drive amplifiers, when the +5V supply is removed.

Testing the Stepper Motor Drive Amplifier

The test schedule given refers to Stepper Motor Drive Card Circuit Diagram 1. Where the test schedule for circuit diagram 2 differs, indication will be made.



Remove one of the amplifier drive cards from the ATLAS and place it in the Stepper Motor Interface Module. Using an oscilloscope and a multimeter, follow the test schedule below:-

1. Ensure that all components are correctly positioned, especially i.c.s, VMOS, SCRs and diodes; the shorting link should not be fitted at this stage.

2. Check that all i.c. pins are in the sockets.

3. Inspect the pcb for short circuits, breaks in tracks, solder splashes etc.

4. Check that the IRF512 FET tabs are insulated from the heatsinks.

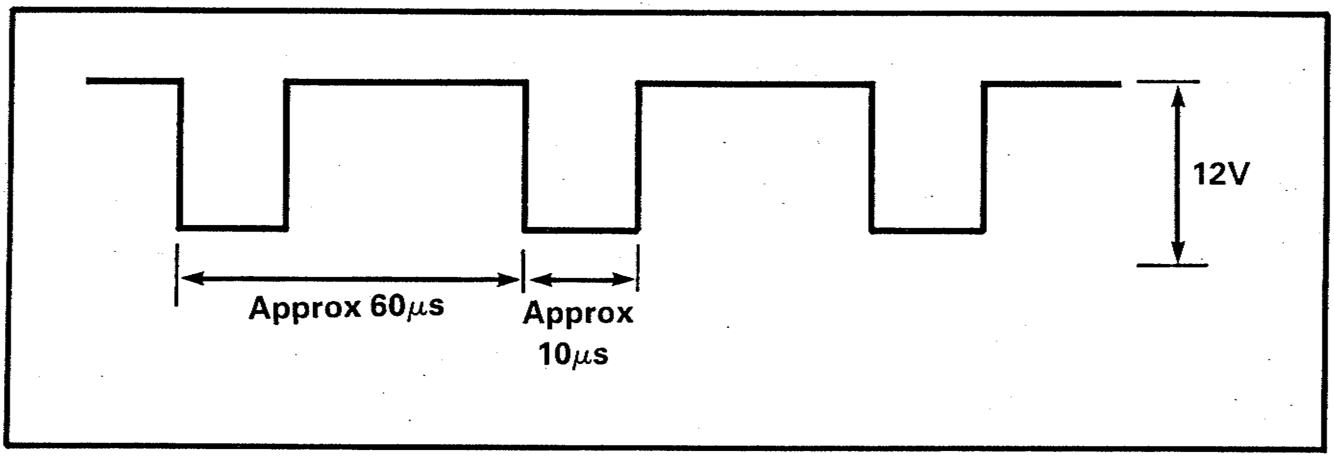
5. Connect 0V/5V/24V connector and drive signal connector - leave motor disconnected.

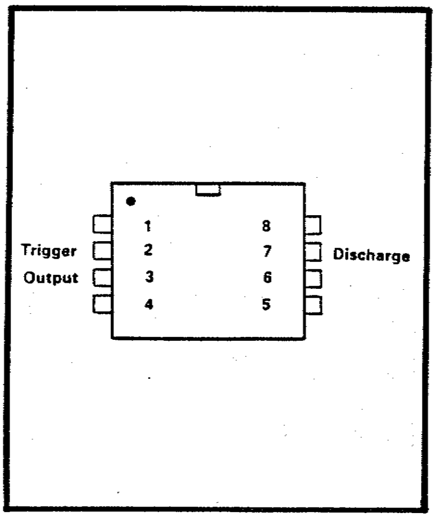
6. Turn ON the 5V supply and check that none of the i.c.s run hot. If any of them do, switch OFF the supply and check for solder shorts, i.c.s inserted the wrong way round etc.

7. Turn VR1 to full counter clockwise position.

8. Connect meter in series with 24V supply, fit the shorting link, turn ON supply. Current from 24V supply should not exceed 60mA. If it does, switch OFF immediately and check the diodes and capacitors for short circuits, or being fitted the wrong way round.

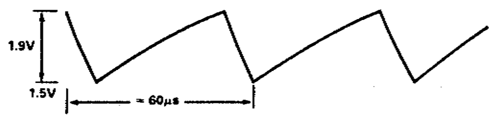
9. With the supply turned ON and monitoring the current from the 24V supply, use an oscilloscope to monitor TP1:-



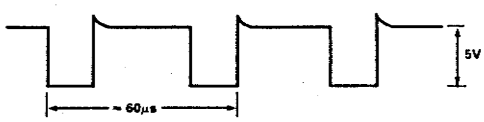


If this waveform is not present, check:

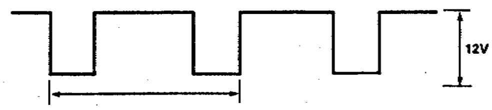
pin 2 and pin 6 on the 555 timer



pin 3 of the 555 timer

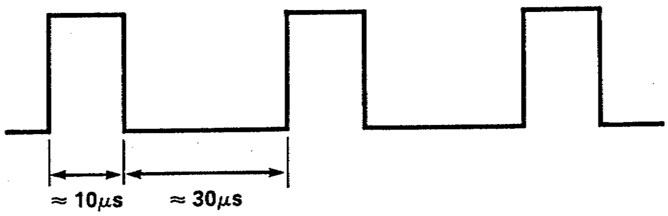


pin 7 of the 555 timer



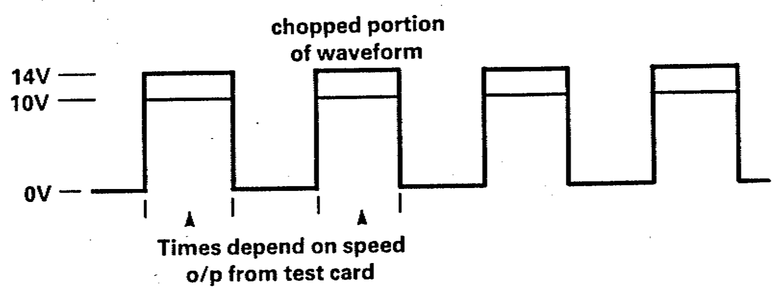
Pin 1 of the 555 timer   0V
Pin 4 & pin 8   5V plus or minus ±.25V
Left hand end of R6 +24V
Left hand end of R7   0V

10. Adjust VR1 to give waveform shown on TP1:



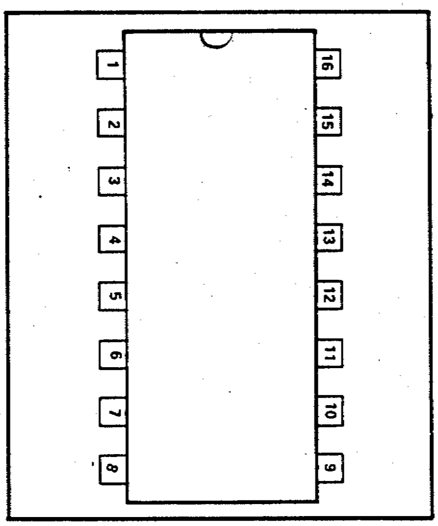
With the test rig switched to the RUN position, INT/EXT switch to INT.

11(i) Use an oscilloscope to monitor the drain of each VN10LM (metal tab):-
Expected signal



If no signal is present:

For Circuit 1:



Check o/p of the 7407, i/p to the 7407 o/p of the SDB520, i/p to the SDB520.

Phase	Pin on 7407		VN10	SCR	IRF 512	SDB520 o/p
	In	Out				
Red	9	8	TR7	SCR3	TR3	11
Yellow	3	4	TR6	SCR2	TR2	12
Brown	5	6	TR8	SCR4	TR4	13
Orange	1	2	TR5	SCR1	TR1	14

SDB520 +ve step i/p Pin 2
SDB520 −ve step i/p Pin 2

For circuit 2

The procedure for tracing a fault is basically the same for both circuits. However, with the circuit based on the 7602 it is also necessary to know what data is generated for the varying conditions on the address lines.

The coding table shown below illustrates this. Note that address line 4 is used as an excitation line.

Hex	Address					Data			
	A_4	A_3	A_2	A_1	A_0	O_7	O_5	O_3	O_1
18	1	1	0	0	0	1	1	0	1
19	1	1	0	0	1	0	0	0	1
1A	1	1	0	1	0	0	0	1	1
1B	1	1	0	1	1	0	0	1	0
1C	1	1	1	0	0	0	1	1	0
1D	1	1	1	0	1	0	1	0	0
1E	1	1	1	1	0	1	1	0	0
1F	1	1	1	1	1	1	0	0	0

Check: o/p of the 7407, i/p to the 7407
o/p of the 7602, i/p to the 7602
o/p of the 74193, i/p to the 74193
o/p of IC5/a and IC5/b, i/p to IC5/a and IC5/b

Phase	Pin on 7407 In	Out	VN10	SCR	IRF 512	SDB520 o/p
Red	9	8	TR7	SCR3	TR3	11
Yellow	3	4	TR6	SCR2	TR2	12
Brown	5	6	TR8	SCR4	TR4	13
Orange	1	2	TR5	SCR1	TR1	14

11(ii) The chopped portion of the waveform should go from approximately 14V to 10V. If it goes to 0V, either the source of the VN10 is shorted to 0V, or the SCR is faulty or possibly permanently turned on (gate above 0.7V).

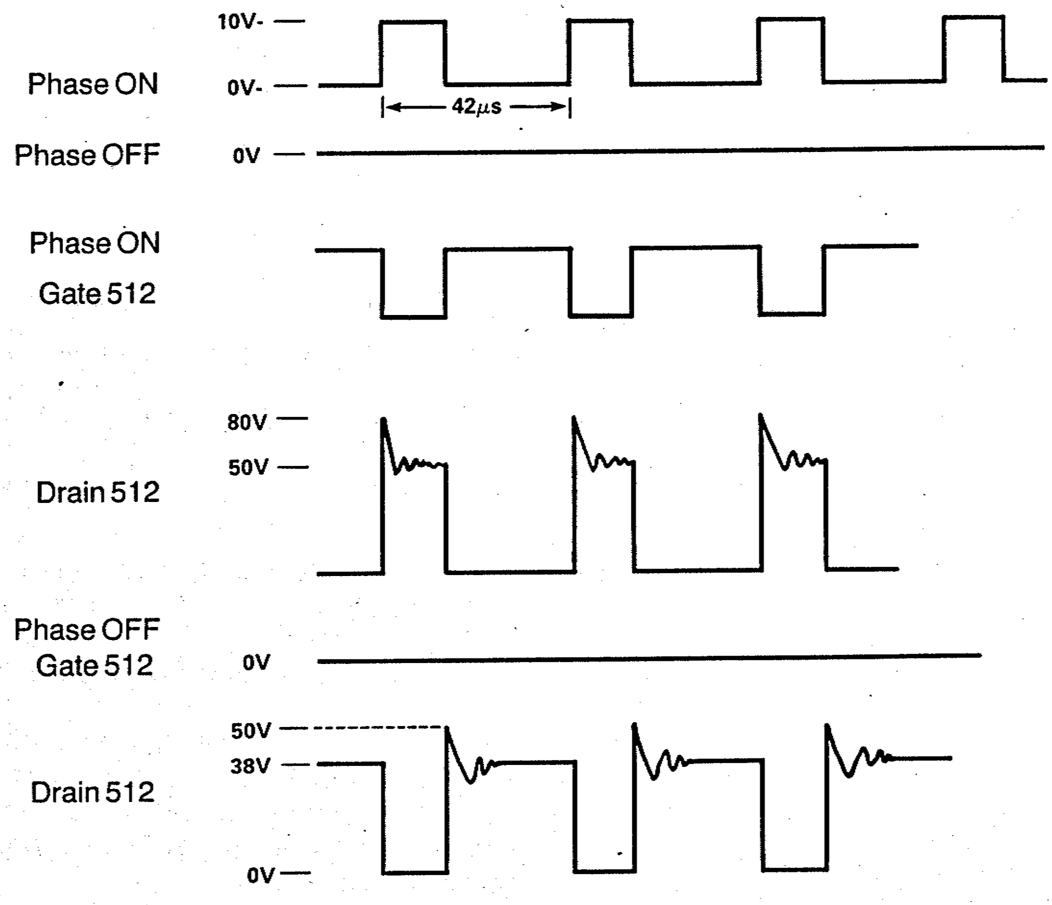
12(i) Switch OFF the power supply, connect the motor to the pcb.
(ii) Switch the test rig to the single step position.
(iii) Switch the supply ON. Meter should read approximately 400mA if one phase is on, or 750mA if two phases are on. Adjust VR1 if necessary.

12(iv) Single step the motor, observe the meter and, run a sequence of one phase on, two phases on, one phase on, etc. At least eight steps should be observed, i.e. one complete sequence. Check both forward and reverse. If when stepping through the single step test the correct sequence is not observed, use the following table to establish which phase(s) is not working correctly:-

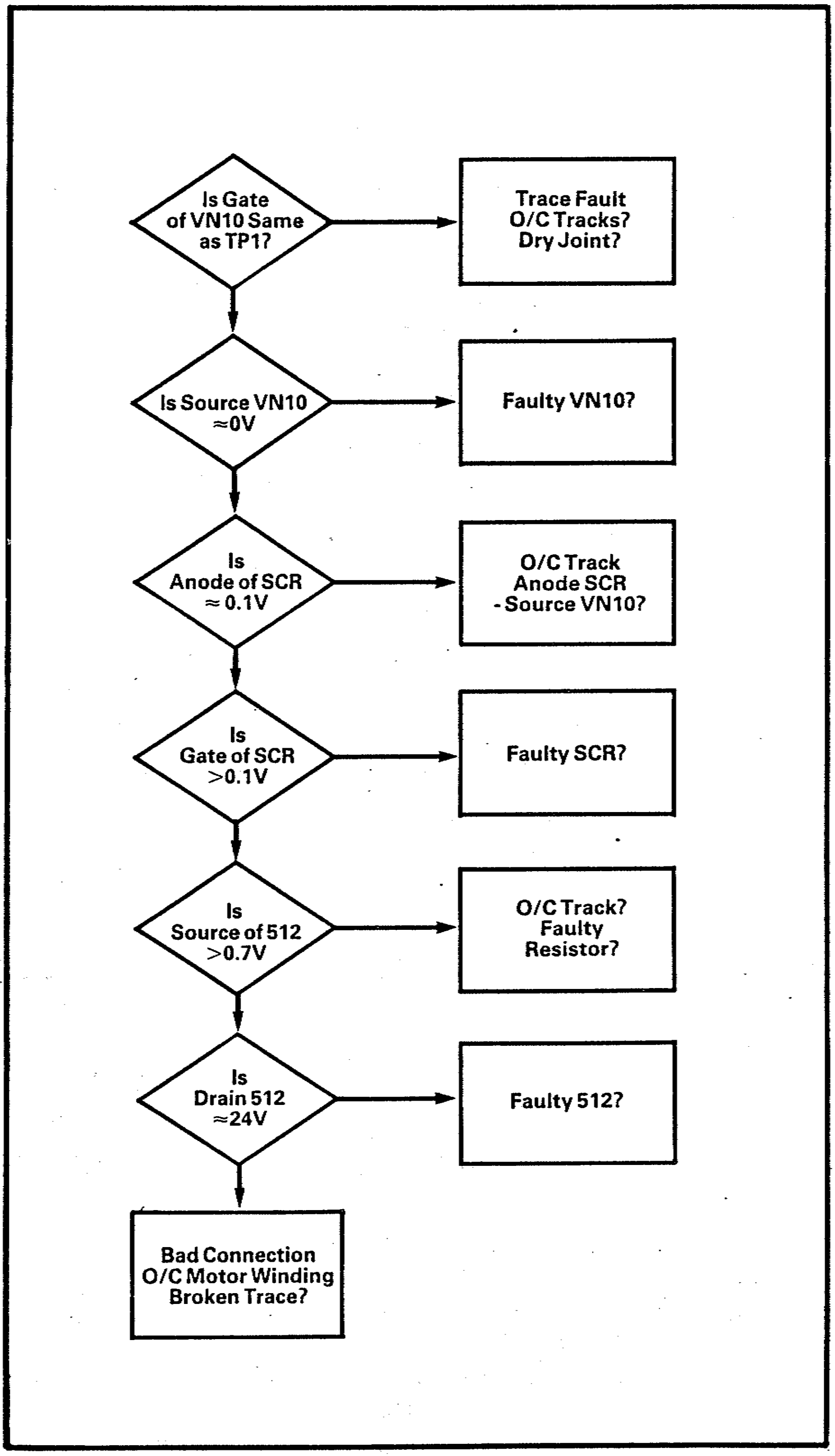
Red	1	0	0	0	0	0	1	1
Brown	1	1	1	0	0	0	0	0
Orange	0	0	1	1	1	0	0	0
Yellow	0	0	0	0	1	1	1	0

where 1 = phase ON
0 = phase OFF

Signal on tab of VN10LM



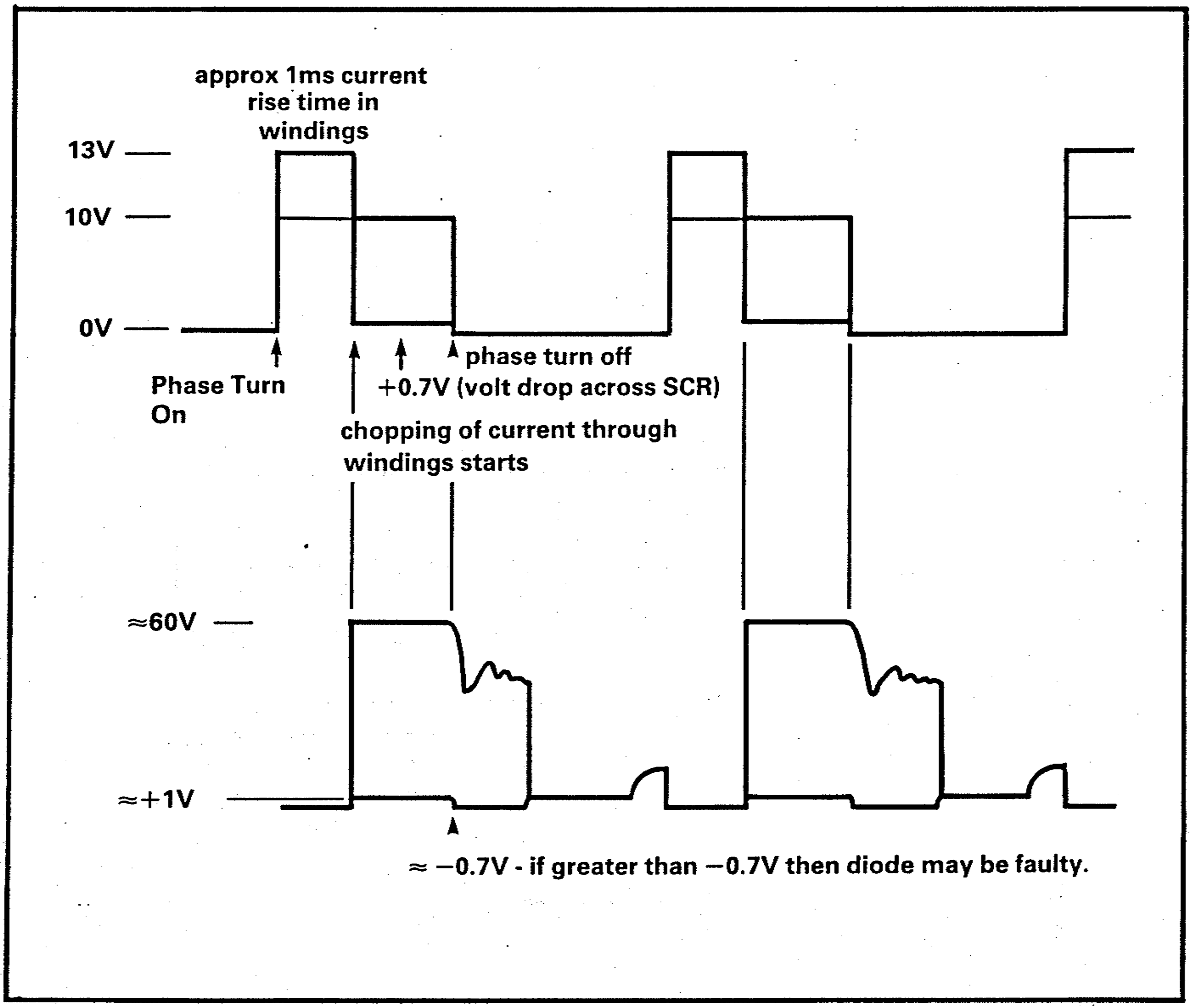
When it has been established which phases are not working, work through the following flow chart to establish the cause.



13. When it has been established that all four phases are being energised correctly:-

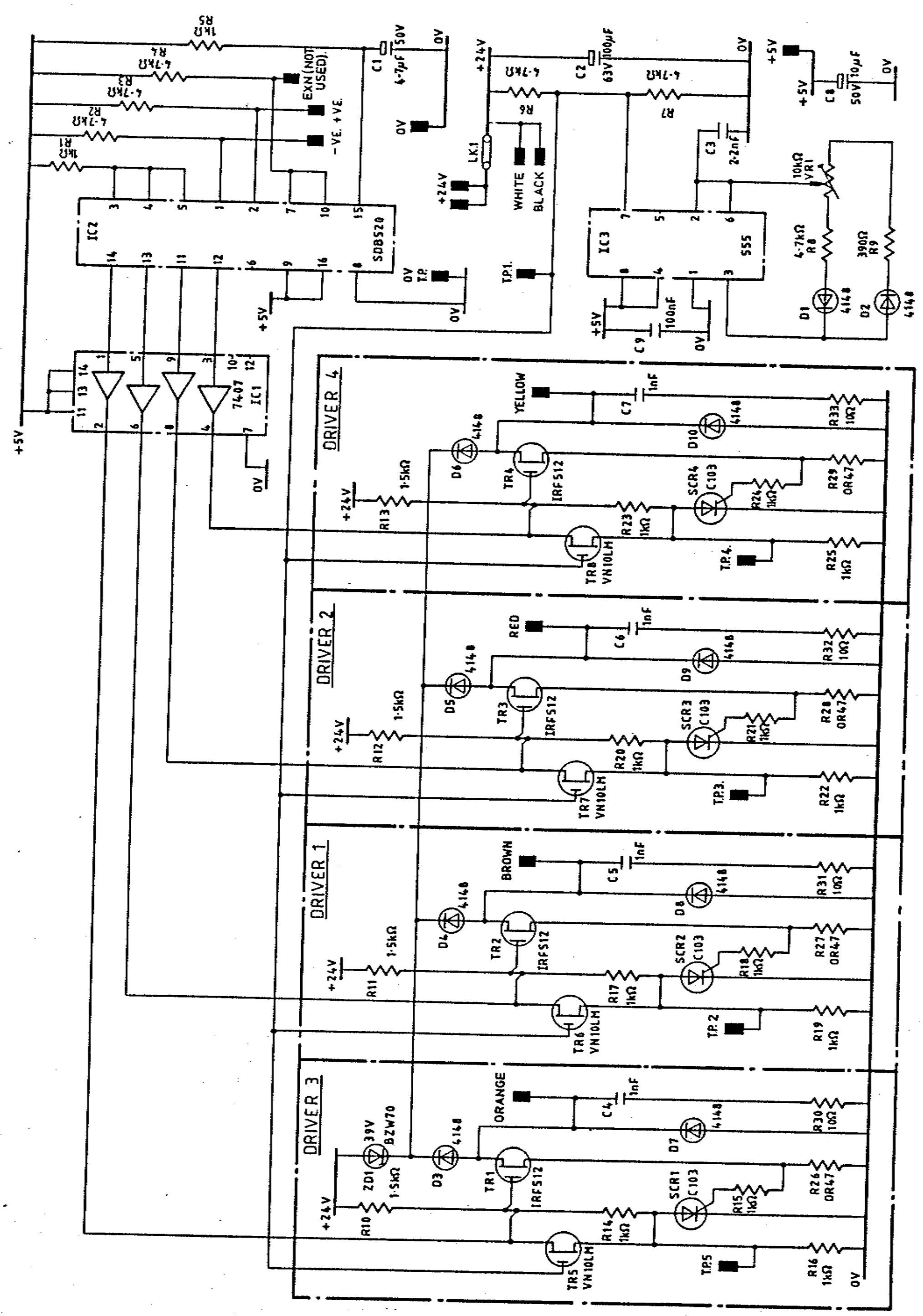
i) switch test module to RUN.
ii) adjust pot. on test module to run motor at approx. 1 kHz.
iii) check current drawn from 24V supply - should be in the range 540 mA to 775 mA.

iv) connect Channel I of scope to tab of VN10 and Channel II to the cathode of the corresponding diode (D7, D8, D9, D10) check all four phases.

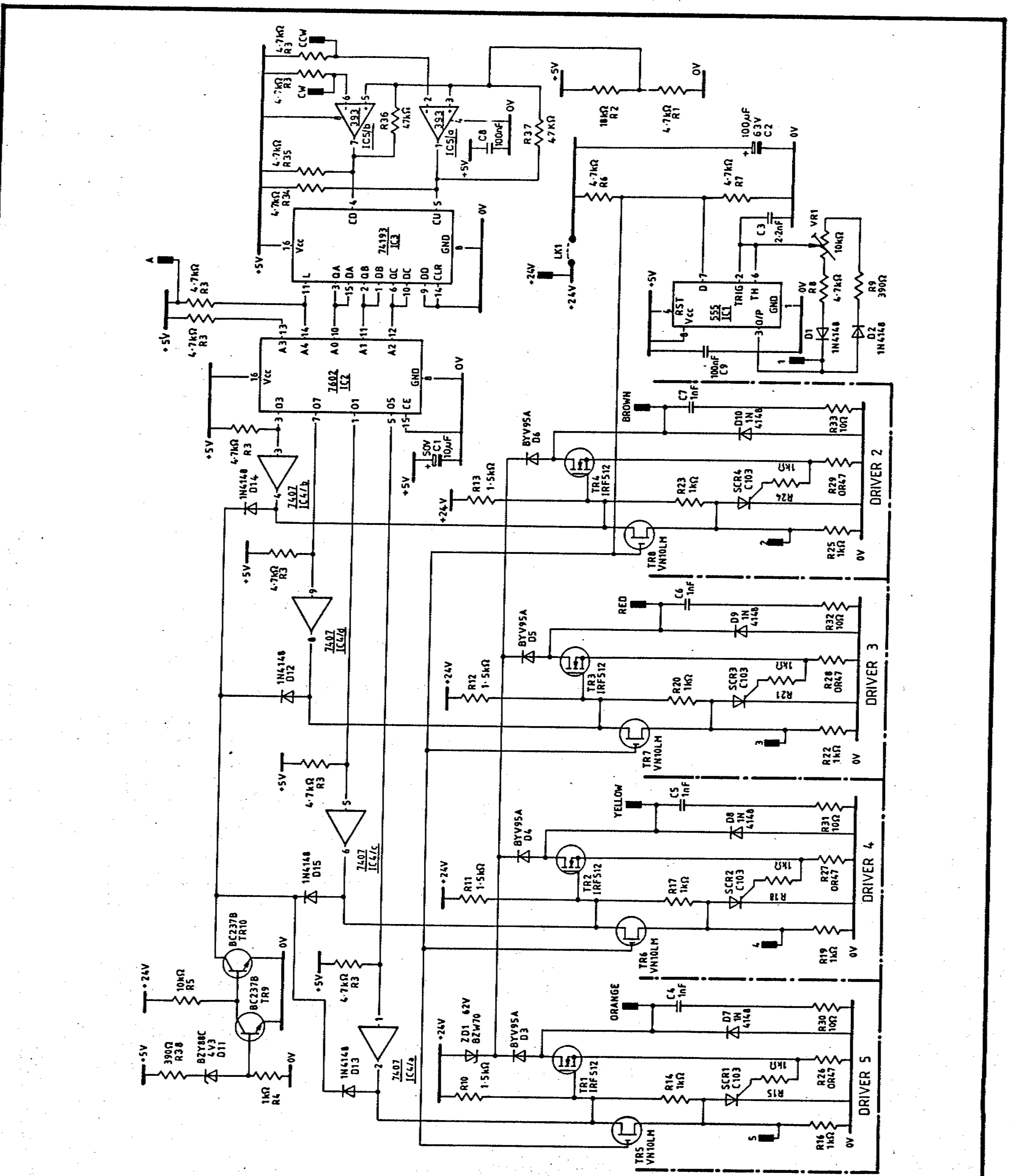


If greater than 1V, the FET may be high on resistance or the wrong resistor may have been fitted. (should be 0.47Ω).

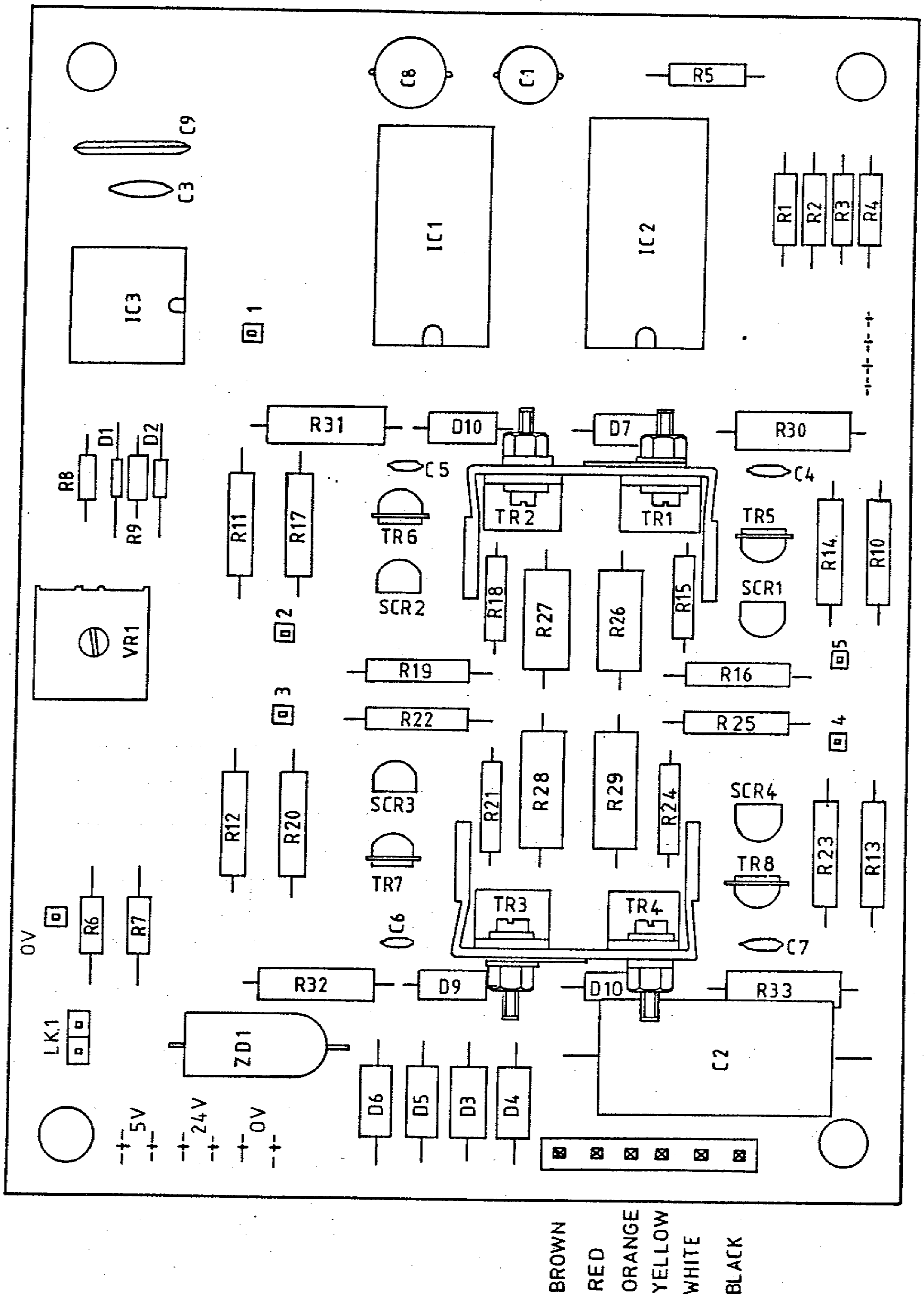
14. Test complete.



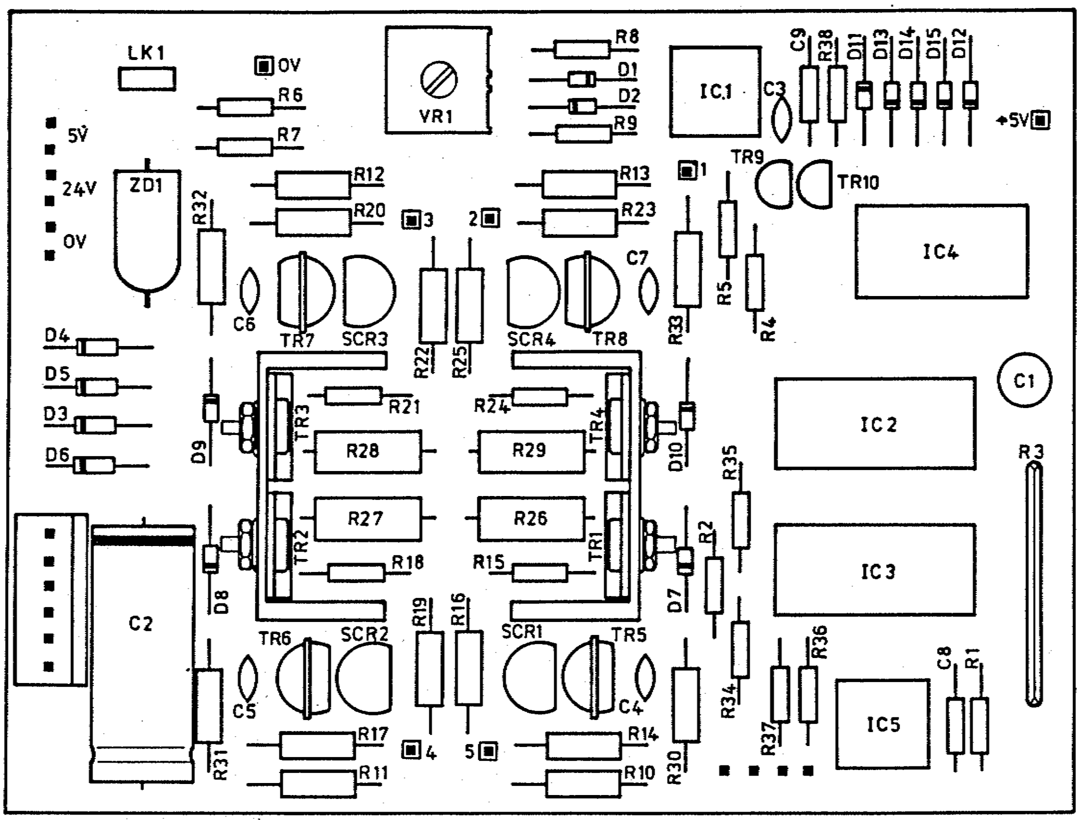
Stepper Motor Drive Card Circuit Diagram 1



Stepper Motor Drive Card Circuit Diagram 2



ATLAS Drive Card Layout 1

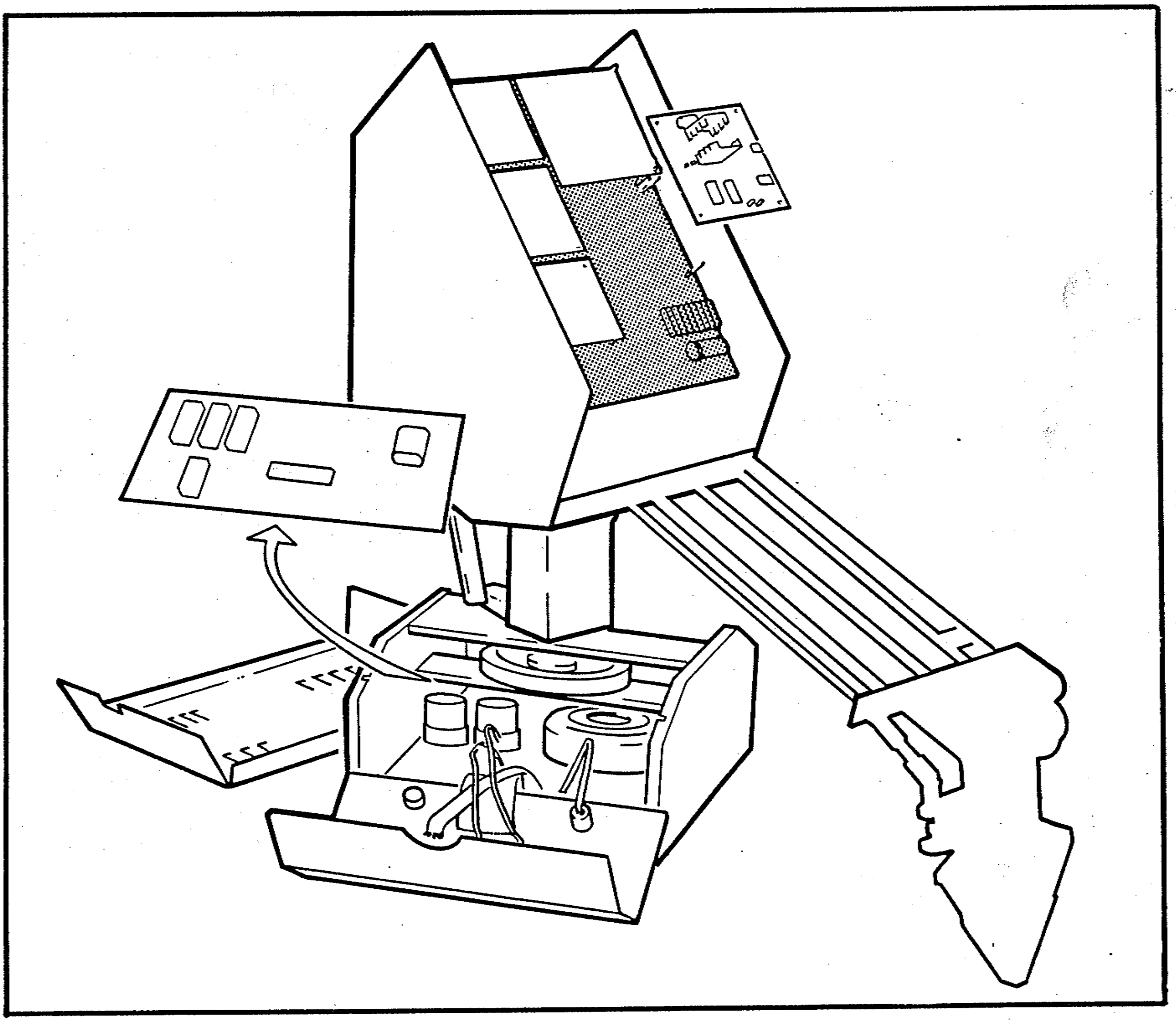


ATLAS Drive Card Layout 2

Section D Multiplexer/Demultiplexer Board

Demultiplexer Board

The 74LS138 circuits, IC3 and IC4, decode the motor select code, (PA0-PA2), the step signal (PA3) and the direction signal (PA4) to send step outputs to one of the motor drive amplifier cards. Two 7404 circuits provide inversion. The motor select signals are also used at the two 74LS151 circuits, where they multiplex any one of eight inputs (I0-I7) onto output line 2. These circuits are used to put limit switch information for the relevant motor onto lines PA6 and PA7. Diodes D1-D5 are Schottky barrier diodes (forward voltage 0.25V approx) and are used to prevent 24V being applied to the complete 5V system should a 24V to 5V short circuit occur on one of the amplifier drive cards. Fuses F1 to F5 protect the relevant stepper motor windings should there be a short circuit failure of one of the 512 F.E.Ts on the drive cards.



Using a logic probe, the following checks can be made.

1. Check that limit switch signals are received at the demultiplexer when all functions are at datum reference. Some slight adjustment of the upper optical discs may be necessary at this stage.

2. Check that the three arm functions close limit switches at the end of their travel.

3. Using the teaching console, drive each motor, in each direction in turn, and check that the correct signals are distributed at the demultiplexer.

4. Connect the motors and confirm that all functions can be driven from the teaching console. Any failures at this stage are likely to be interconnections. Check all connections if a fault occurs. Adjust the stepper winding currents if any function appears to lack power.

Multiplexer

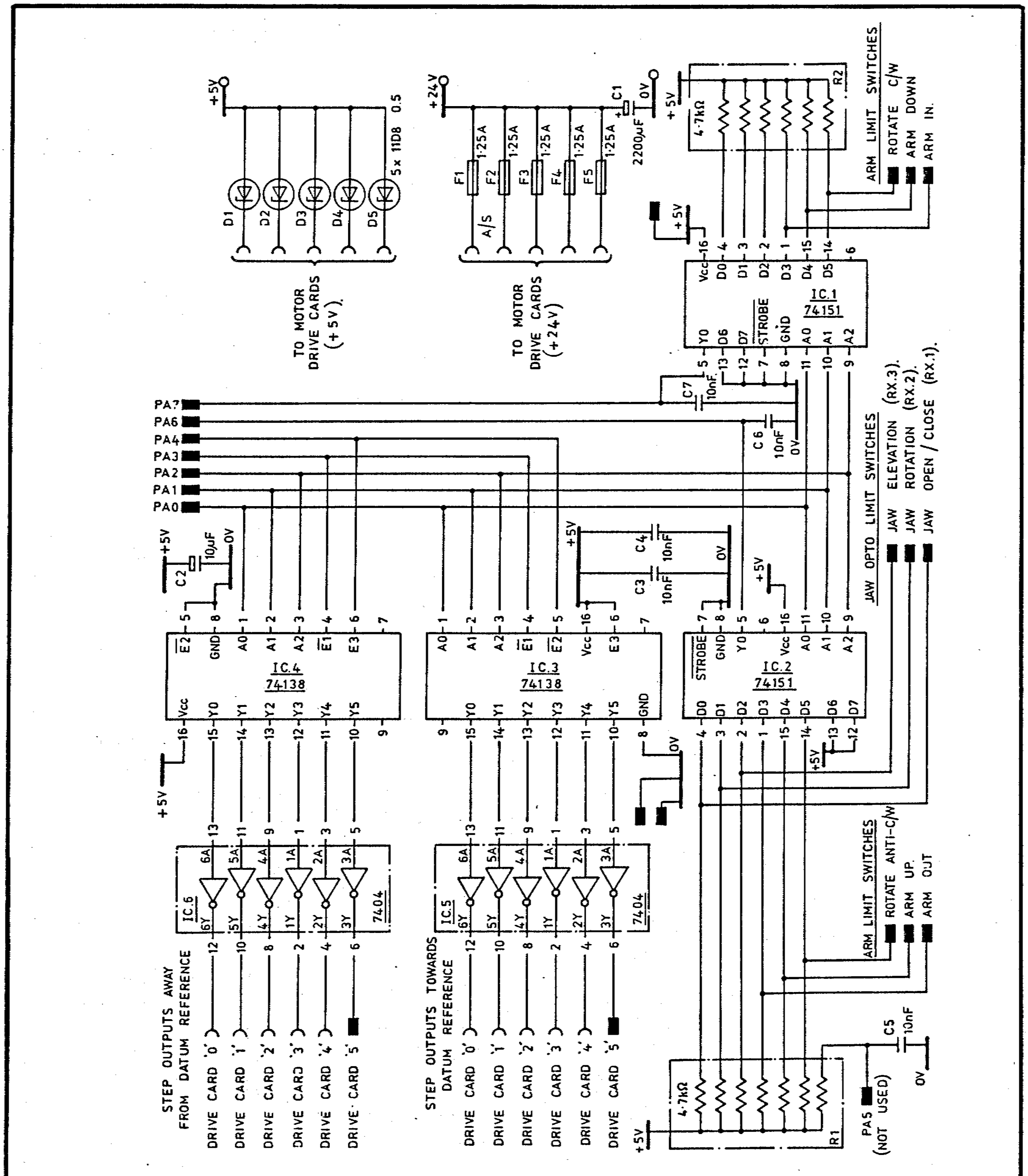
The multiplexer circuit board uses 2 ×74138, 2 × 7404 and 2 × 74151 to decode the signals from Port A on the control board to drive the motors and read the limit switches.

Motor Drive

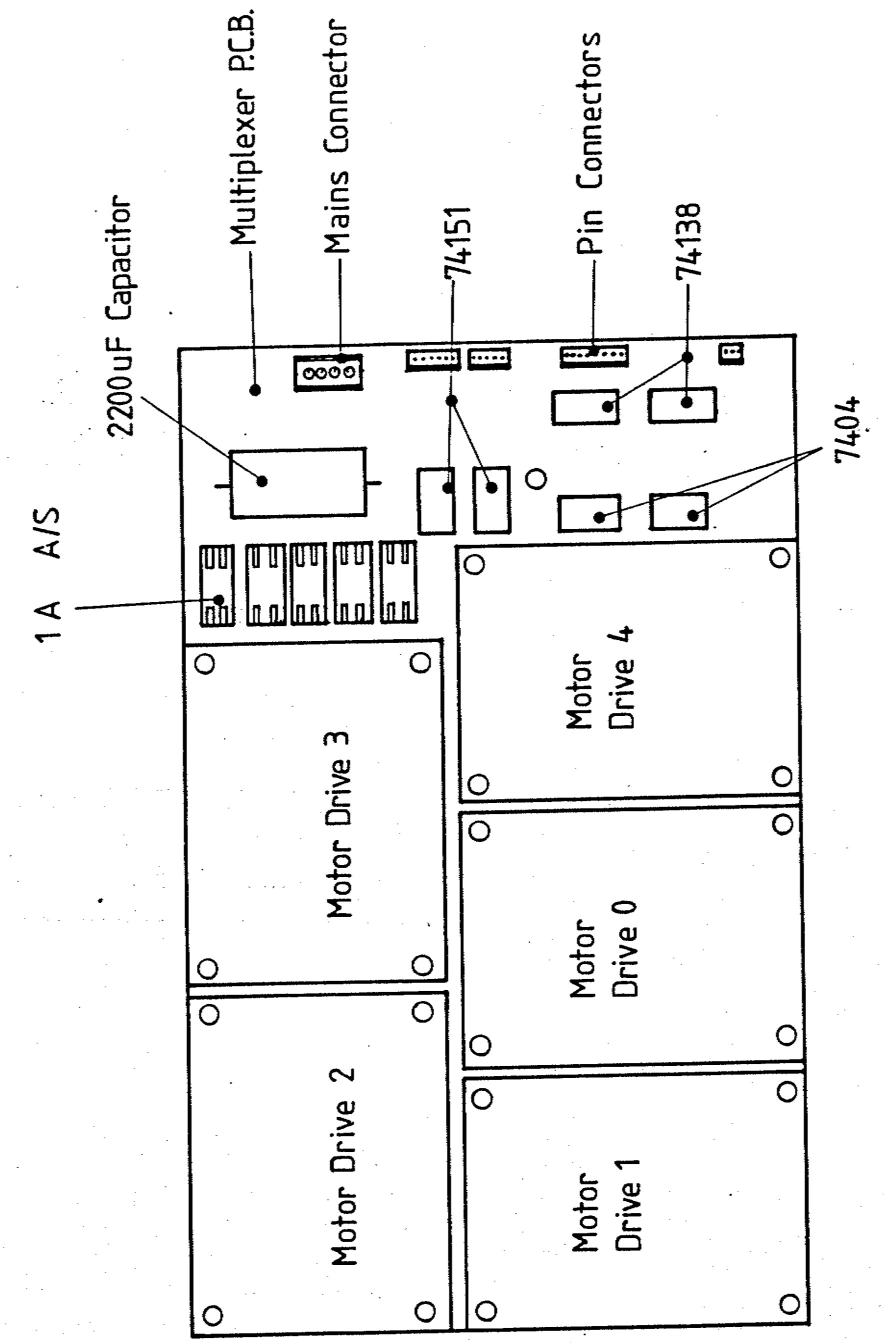
PA0, PA1 and PA2 are used to set up a code to select a motor. PA4 decides the direction, and PA3 provides the step pulse. For example, if a code 000 is set up on PA0, PA1 and PA2, motor 0 is selected. If PA4 is high, IC4 is selected, and PA3 goes low to step the motor. If PA3 goes low on pin 4 of IC4, this makes pin 15 go low, thus sending a step pulse to drive card 0. Pin 4 on IC3 also goes low but all of the outputs of IC3 stay high. Since pin 5 is connected to PA4, which is high, this disables IC3.

Reading Limit Switches

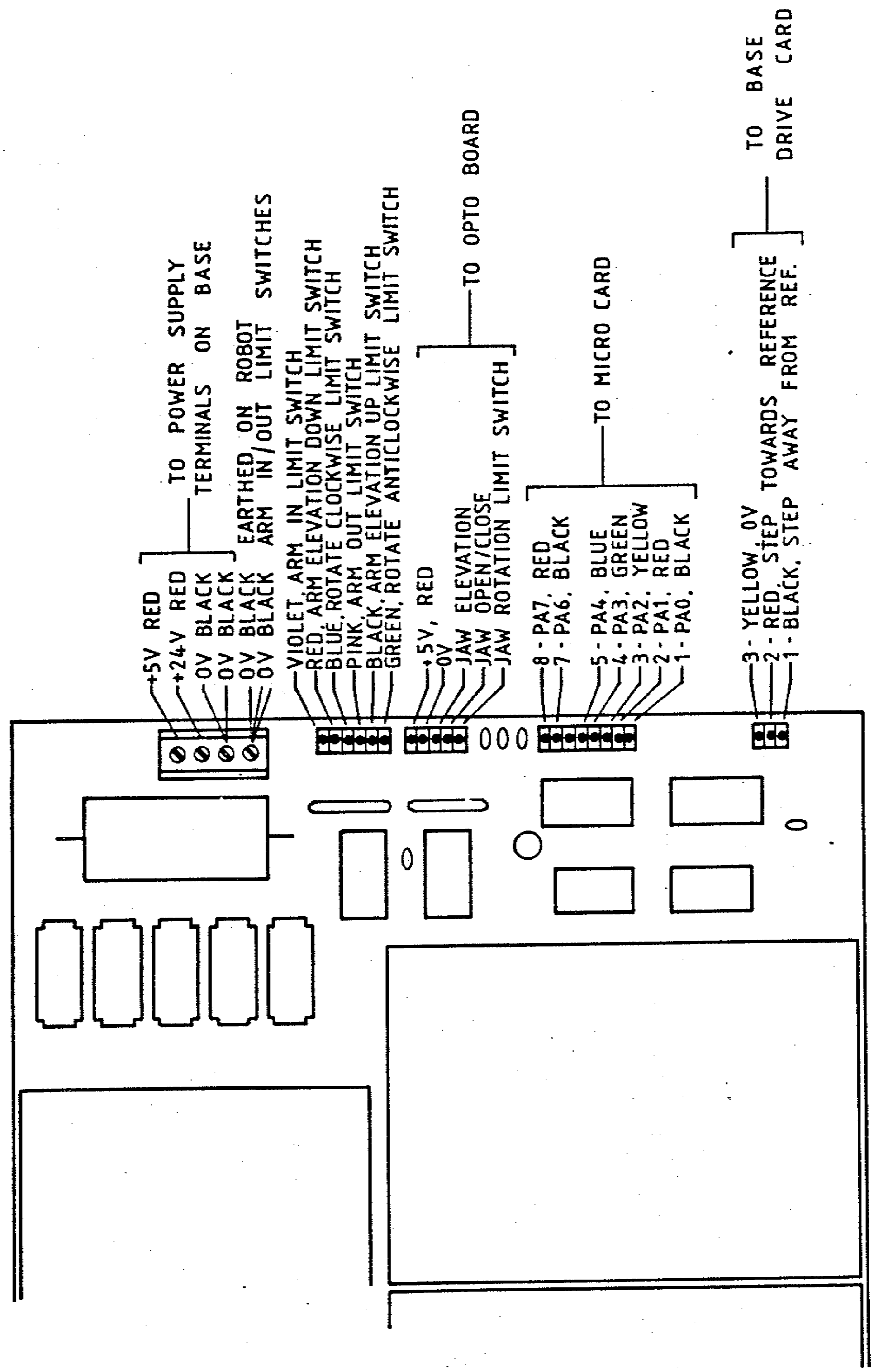
When a motor is selected using PA0, PA1 and PA2 the limit switches can also be read. The lines from the reference limit switches are taken to a 74151, IC2; the lines from the other limit switches are taken to second 74151, IC1. PA0, PA1 and PA2 are connected to both 74151s. The code on these three lines determines which of the limit switch signals is connected to the output of the 74151. The output of IC2 is connected to PA6 and the output of the other IC1 is connected to PA7.



ATLAS Multiplexer Board Circuit Diagram



Upper Electronics Layout

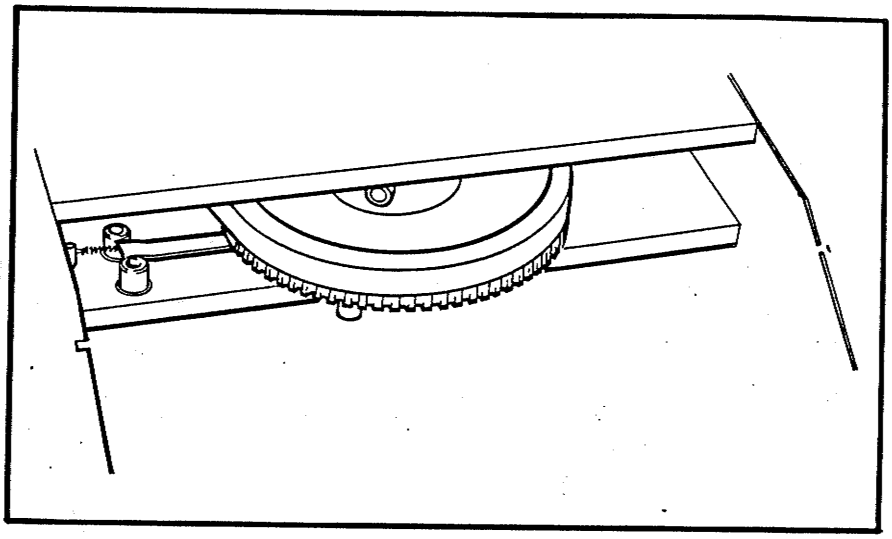


Multiplexer Pin Interconnection Diagram

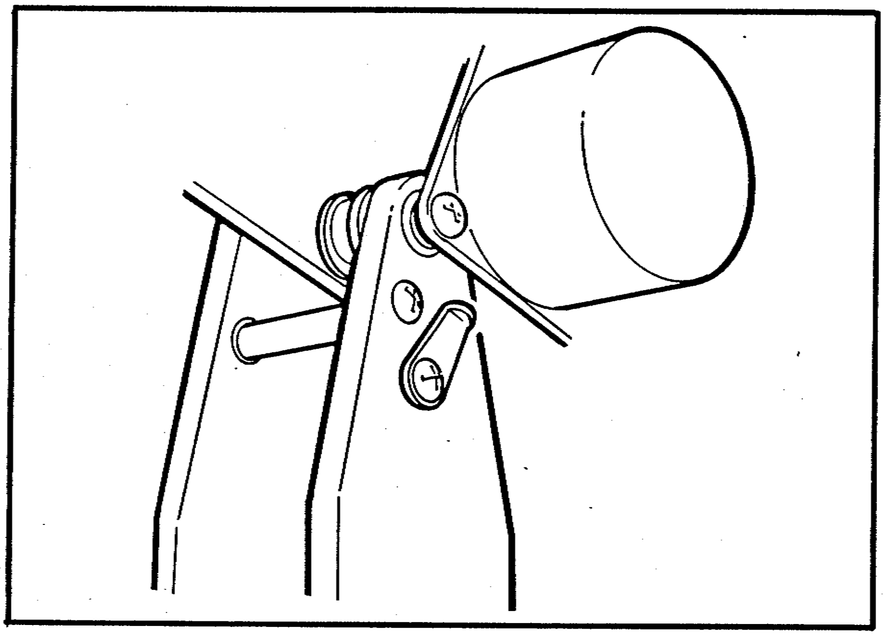
Section E ATLAS Robot Limit Switches

The ATLAS robot has limit switches associated with each of its six functions:

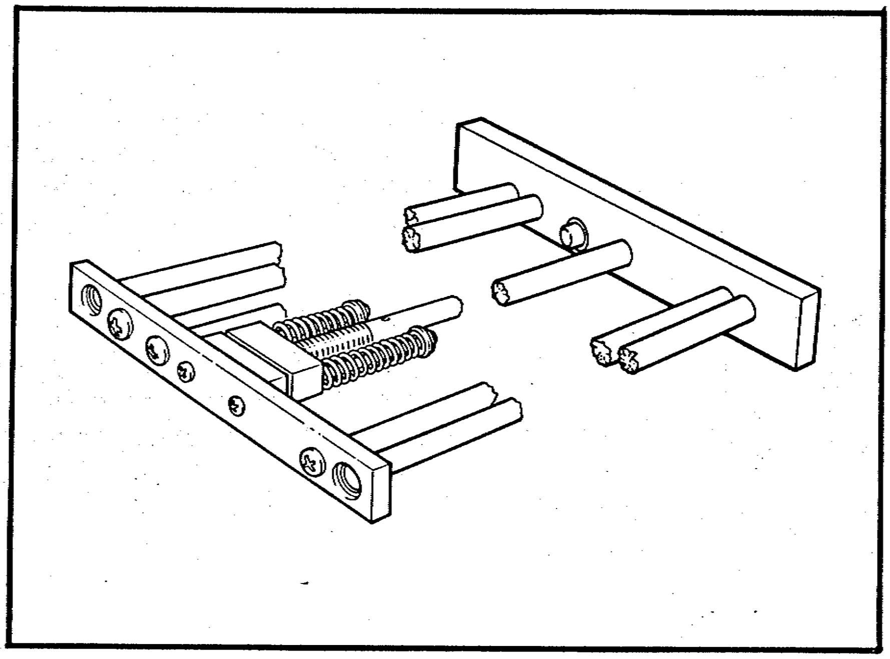
i) **Base Rotation - Two limit switches are utilised:** one for clockwise (CW) rotation and one for counter clockwise (CCW) rotation. They are operated by a lever mechanism which the large drive gear wheel in the ATLAS base moves. This lever, which is at 0V, comes into contact with one of two insulated pillars (one for CCW, the other for CW). These pillars are connected to the multiplexer pcb through the wiring harness. When the lever makes contact with the pillar, the pillar becomes 0V, the ATLAS software recognises that the rotation is at the end of its travel, and stops driving the motor.



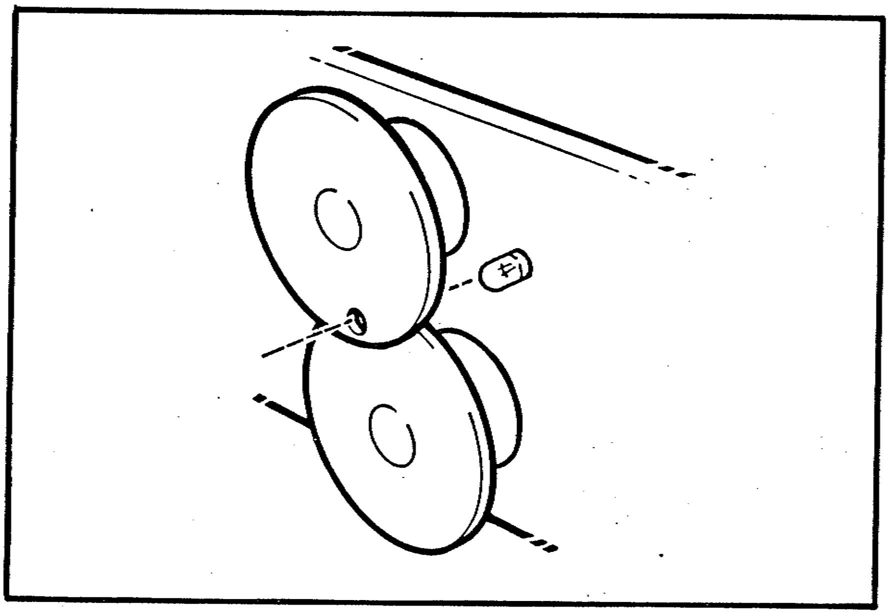
ii) **Arm Elevation** -There are two limit switches associated with the elevation function: one for arm up, and one for arm down. The arm down limit switch is an insulated shaped plate, bolted to the left-hand side of the main body support plates. When the robot reaches its maximum down position, the body of the stepper motor, which is at 0V, makes contact with the insulated pillar, which is connected to the multiplexer pcb via the wiring harness. When the ATLAS software recognises that the motor has made contact with the plate, it stops driving the arm elevation motor. The arm up limit switch works in a similar way to the down limit switch, except it uses a pillar, fixed between the two main body support plates. This is taken to 0V by the lever which connects the main body of the robot to the rack and pinion mechanism.



iii) Arm in/out - The arm in/out limit switches are push button switches which are operated by pillars attached to the front and back spreader rails of the arm assembly. The switches are mounted on the main body of the robot. The switches have normally open contacts, one side connected to 0V, the other side connected to the multiplexer pcb. The software recognises when the switch is closed and stops driving the motor which drives the arm in/out.



iv) **Jaw functions limit switches** - All three jaw functions are operated by stepper motors which drive a sliding shaft via a gearbox. Attached to the input shaft, and intermediate shaft of each function are small discs. Each of these discs has a small hole drilled in it. A printed circuit board, with infra-red light emitting diodes mounted on it, is fixed to the front of the gearbox. The discs are positioned between this board and another board, which has infra-red sensitive photo transistors mounted on it. When the ATLAS is in its reference position, the holes in the discs are aligned, the light passes through the holes onto the detector, and signals to the ATLAS software that the motors are in their reference position.



Limit Switch Adjustment

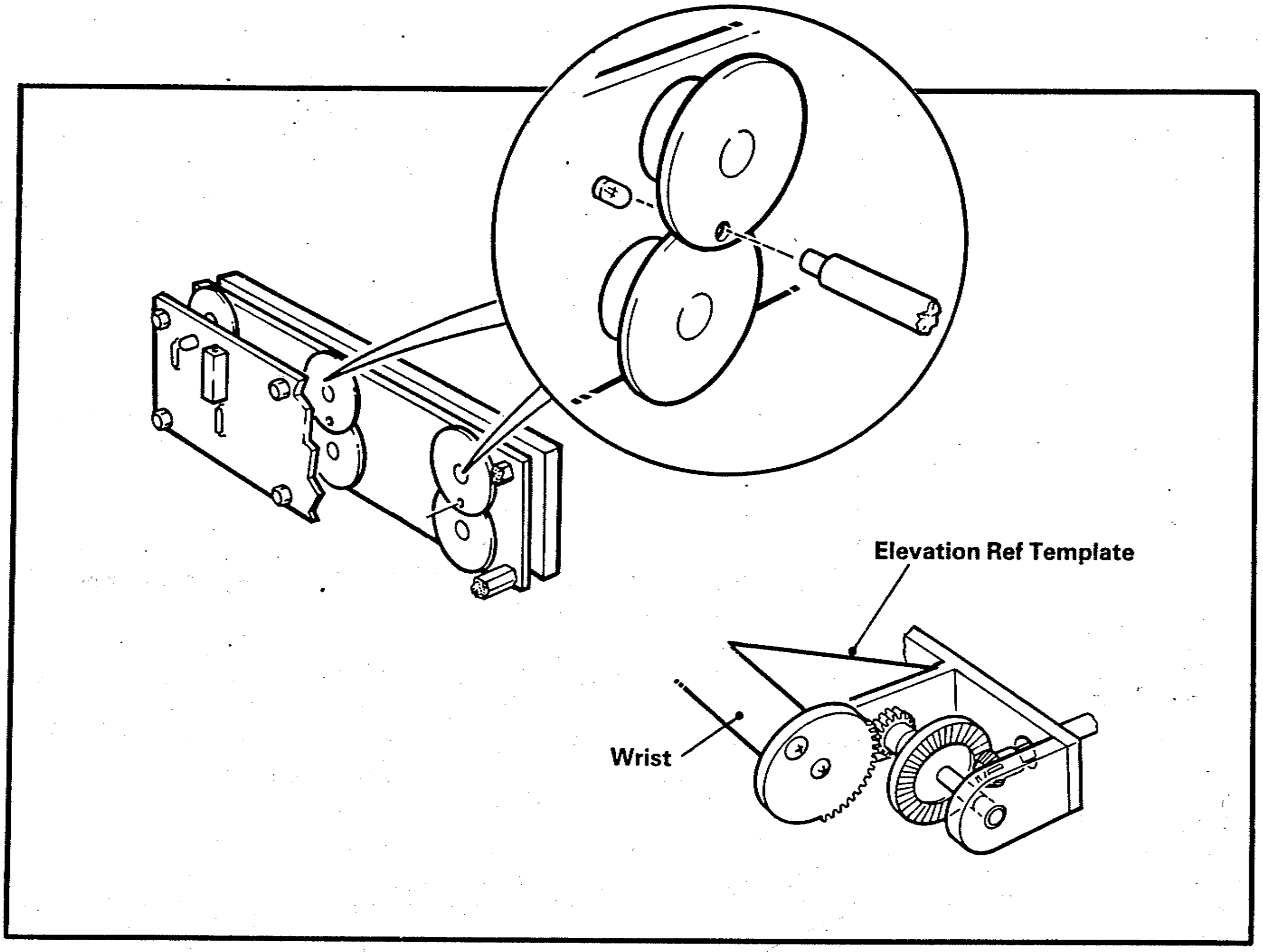
The base rotation, arm in/out and arm elevation limit switches have no adjustment. The three jaw functions have an optical limit switch arrangement, which may require adjustment from time to time. The adjustment can be split into two types - Mechanical and Electrical.

Mechanical adjustments

The mechanical alignment of the limit switch discs is carried out at the factory, and re-alignment should not be necessary at regular intervals, but adjustment may be necessary during the lifetime of the Robot. There are three pairs of discs, one pair for each function. These are stamped E, J and R, on the face of the disc.

Elevation Up Limit (E)

Fit the lower disc onto its shaft. Tighten the Allen screw sufficiently so that the disc just turns on its shaft. Using the Elevation template, turn the motor shaft until it is aligned as shown. Rotate the disc on its shaft until the hole is directly over the top of LED. Using the alignment tool (Note: if this tool is not available the shank of a 1.2mm drill bit or rod can be used), insert it through the hole, and move the disc slightly, to position the tool on the apex of the LED. Remove the tool and rotate the motor shaft until the screw is in such a position that the Allen key can be inserted into it and tightened. Reposition the hole over the LED, and fit the upper disc using the alignment tool.



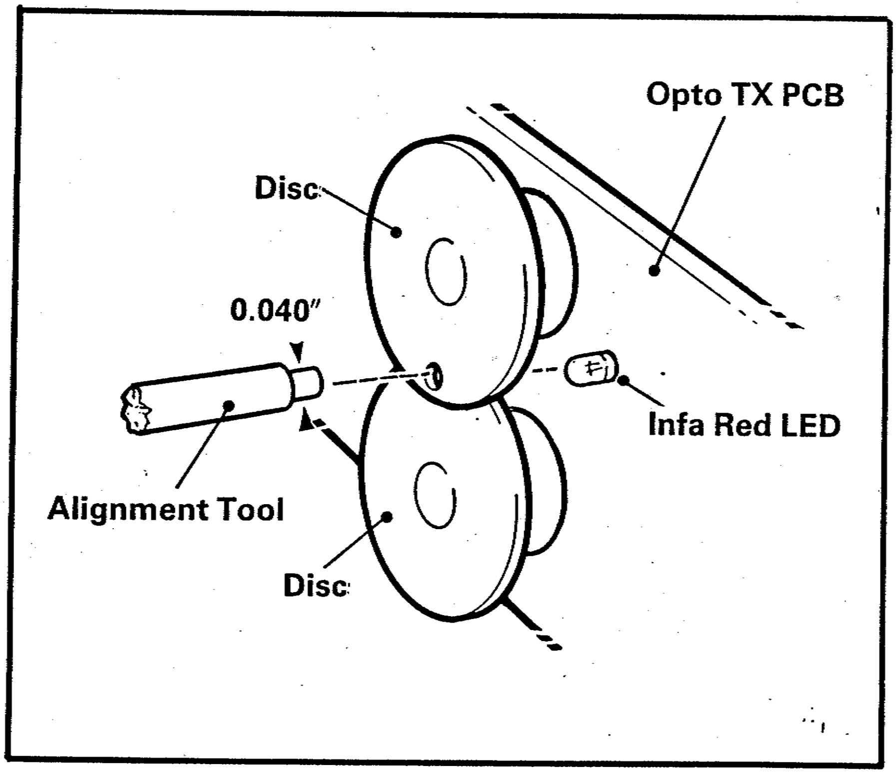
Note: At reference, the angle between the RAM and Wrist (see the diagram above) is 70°.

Jaws Open Limit (J)

Fit lower disc onto its shaft. Tighten the Allen screw sufficiently so that the disc just turns on shaft. Rotate motor shaft until jaws opening is 50mm. **Note on ATLAS II, set jaws opening to 52mm.** Rotate the disc to align the hole directly over LED using alignment tool. Turn motor shaft until the Allen screw can be tightened. Reposition disc over the LED. Fit upper disc and butt it against spacer and rotate upper disc until alignment tool can be inserted through both holes in the disc, then tighten the Allen screw.

Jaw Rotation (R)

Fit lower disc onto its shaft. Tighten the Allen screw sufficiently so that the disc just turns on its shaft. Rotate motor shaft till jaws are parallel with rotation bearing bracket. Rotate disc on shaft, using alignment tool placing hole directly over LED. Turn motor shaft until the Allen screw can be tightened. Reposition hole over LED. Fit upper disc and butt it against spacer and rotate upper disc until alignment tool can be inserted through both holes in the disc, then tighten the Allen screws.



Detector Board

The detector board can now be fitted, making sure that the pins on the LED board locate in the socket in the detector board.

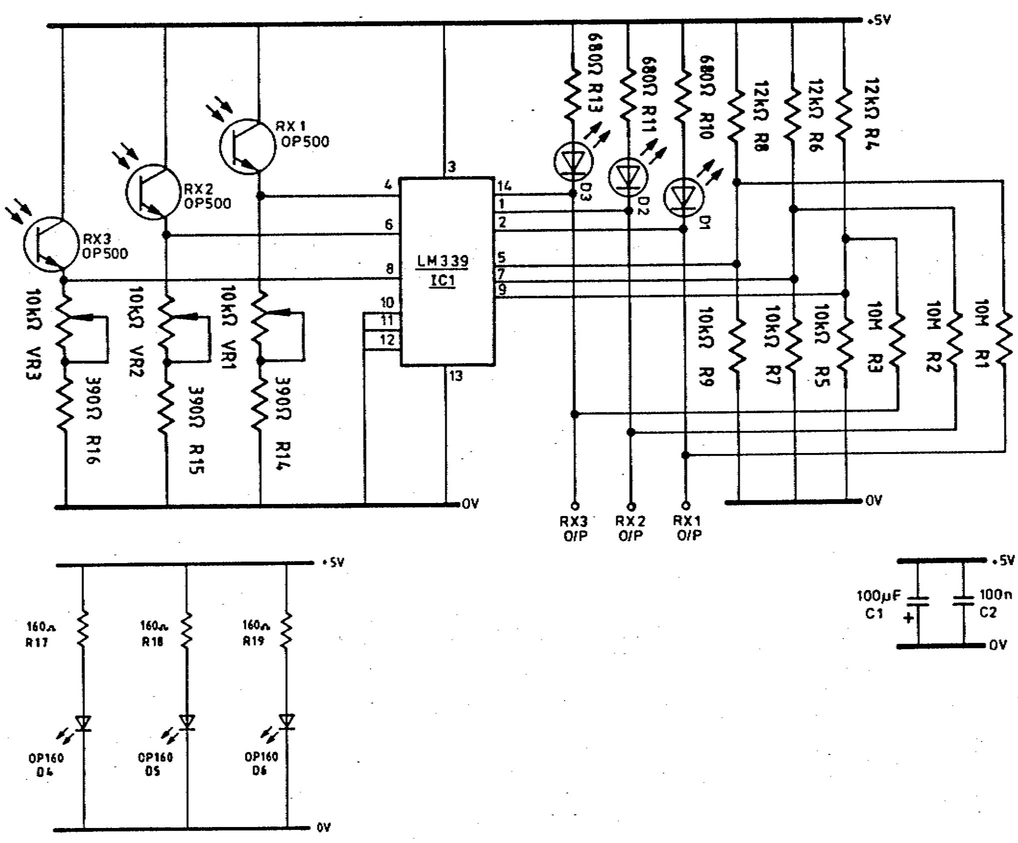
Electrical Adjustments

1. **Robot Optics Board - Set Up Procedure**

   Check voltages on pins 5, 7 and 9 of LM 339 are about 2.3V each.

2. **Jaws Rotation and Jaws Open/Close Function**

   (a) Run motor to hardware limit position. Check LED turns on only when hardware limit is reached. Note this position must always be approached by driving towards reference. **Note on ATLAS II, drive ATLAS to limit and adjust to mechanical limit by hand.**
   (b) Adjust multi-turn trimmer until the voltage on the emitter of the detector is about 3.5V. (Pin 6 on IC1 shown).
   (c) Check that LED is on for at least 3 motor steps.



Opto Transmitter and Receiver Circuit Diagram

3. Jaws Elevation Function

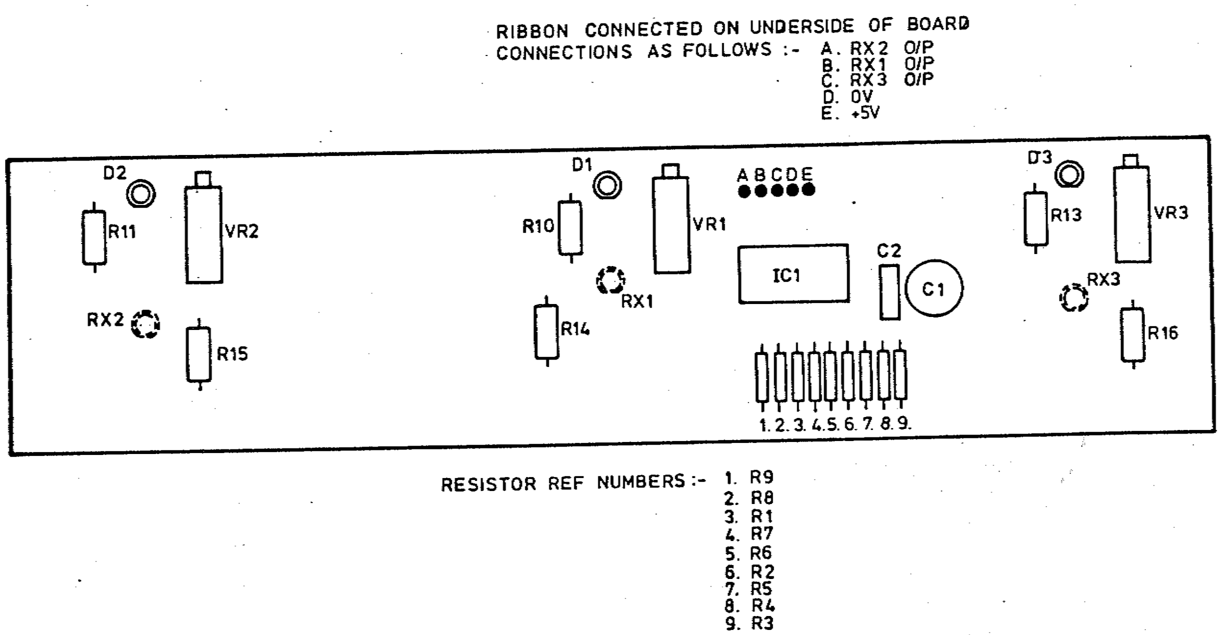
(a) Run motor to true mechanical limit position. Check LED turns on when this limit is reached.

(b) Adjust multi-turn trimmer until the voltage on the emitter of the detector is about 3.5V in this position. (Pin 8 on IC1).

(c) Turn the motor by hand, through 11 revolutions, (Note this is CW when standing at back of the robot) until the position is reached where the discs are partially aligned. Measure the voltage on the emitter of the detector.

- (i) If this voltage is no more than 1.5V maximum, the trimmer is correctly set up. Check that the LED is off in this position.
- (ii) If the maximum voltage is above 1.5V, adjust the trimmer until this is not so. Check the LED is off. Now return to the true reference position. Check that this voltage is no less than 3 volts. If it is, re-align discs and repeat step (c).

(d) Check that, in the true limit position, the LED is on for at least 3 motor steps.



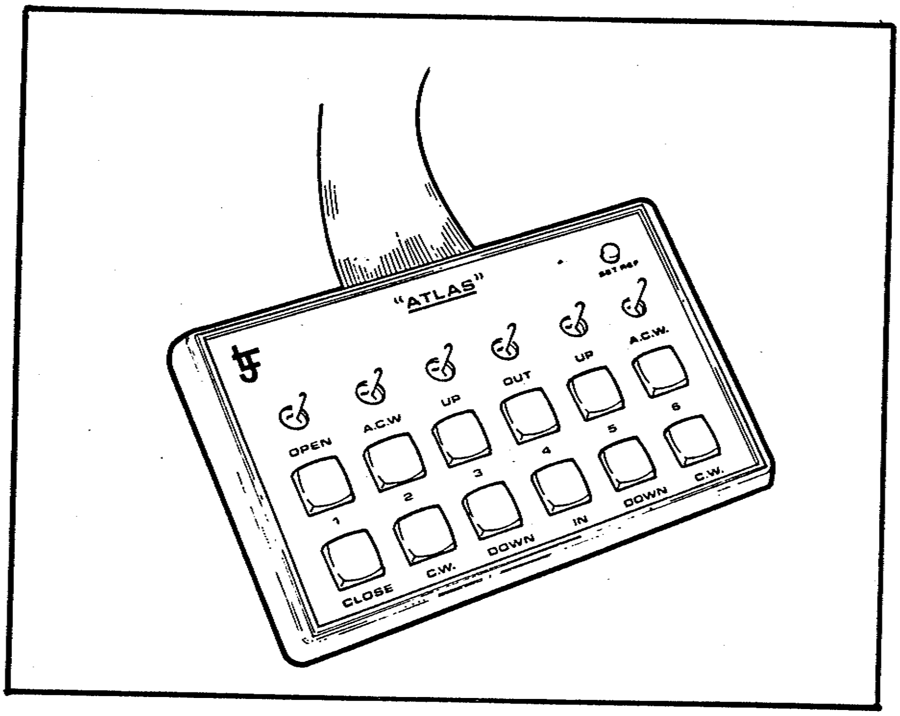
Opto Transmitter and Receiver Layout

Early ATLAS robots had limit switch boards which did not need any adjustment. The circuit diagram is given.

The new type boards can be fitted to earlier ATLAS Robots and are available from L.J. Electronics.

Section F Teach Pendant

The teach pendant is an external switch pad, directing the robot through a sequence of movements which the system will log and regenerate, as required. The control box provides 3-position speed selection and push-button forward/reverse drive switches for each movement functions.



Speed Switches

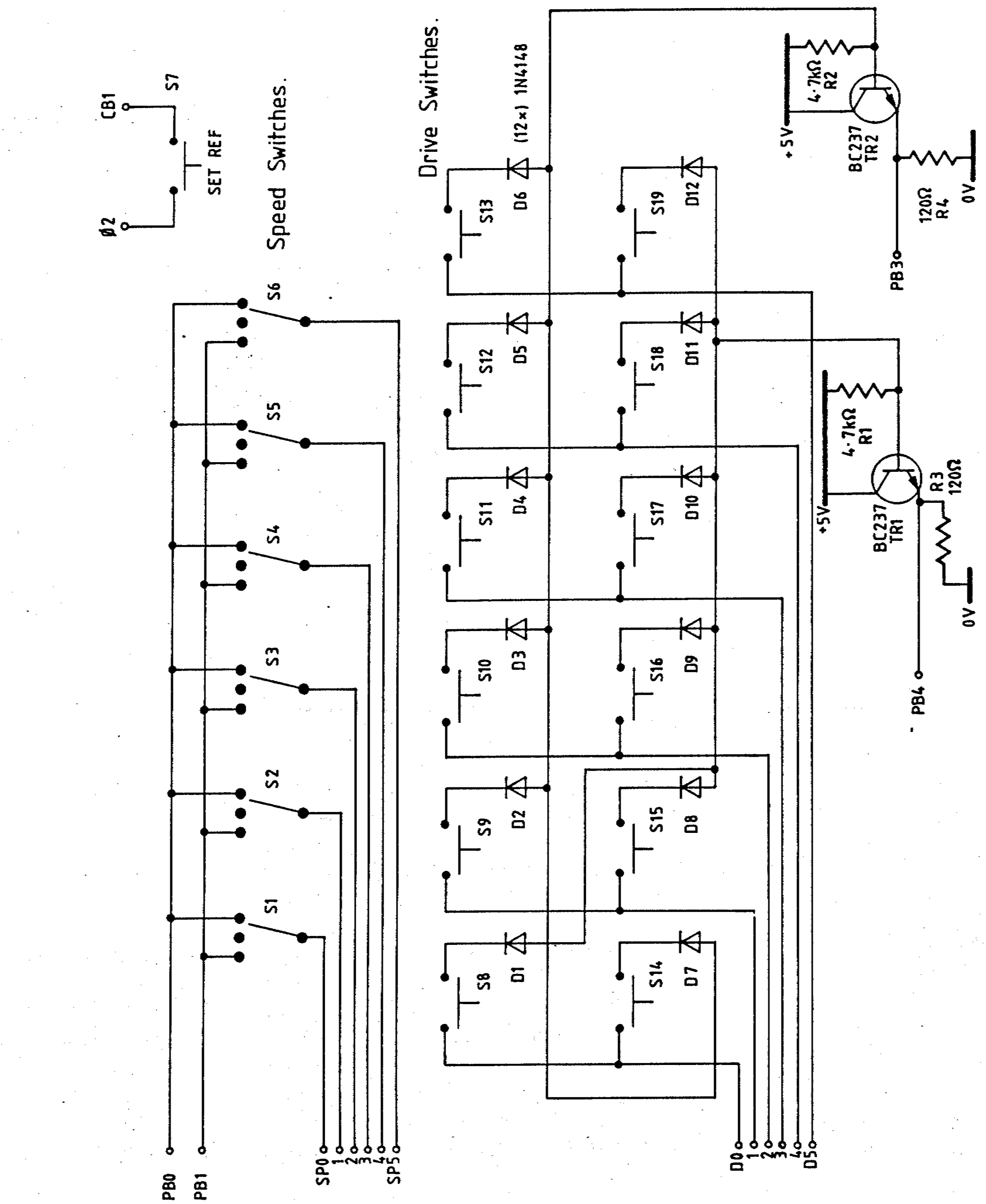
The lines SP0 to SP5 are connected to IC21 on the control card. When a code is set up on PA0, PA1 and PA2, this takes one of the lines SP0 to SP5 low. The microprocessor then reads the state of lines PB0 and PB1. If neither are low, the switch is in its middle position (medium speed). If PB0 is low, the switch is in its slow position, and if PB1 is low, the switch is in its fast position. The microprocessor takes each line (SP0 to SP5) low in turn; therefore, it can determine the position of each speed switch.

Drive Switches

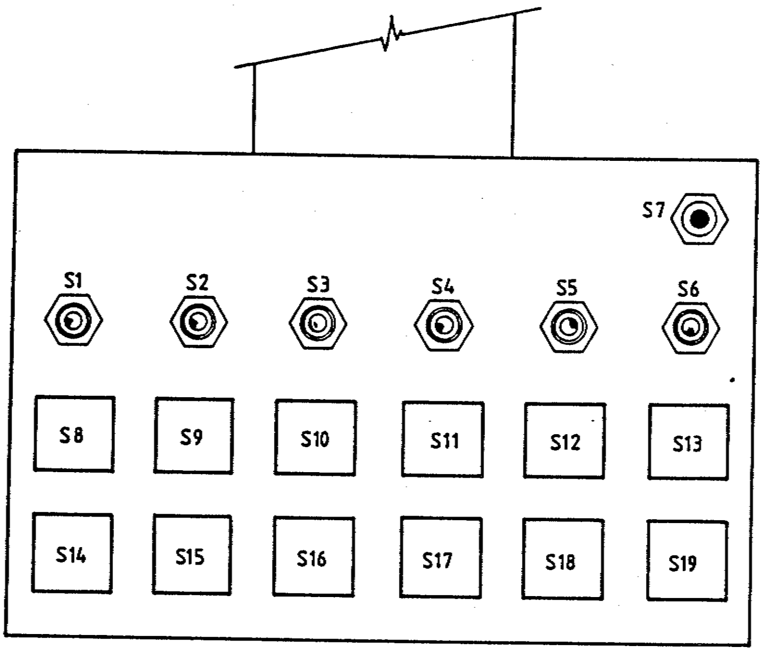
The lines D0 to D5 are connected to IC22 on the control card. When a code is set up on PA0, PA1 and PA2, the lines D0-D5 are taken low. If a switch is pressed, either PB4 or PB3 will be taken low. By reading these lines, and scanning a '0' through the D0-D5 lines, the microprocessor can determine which buttons are pressed.

Set Ref

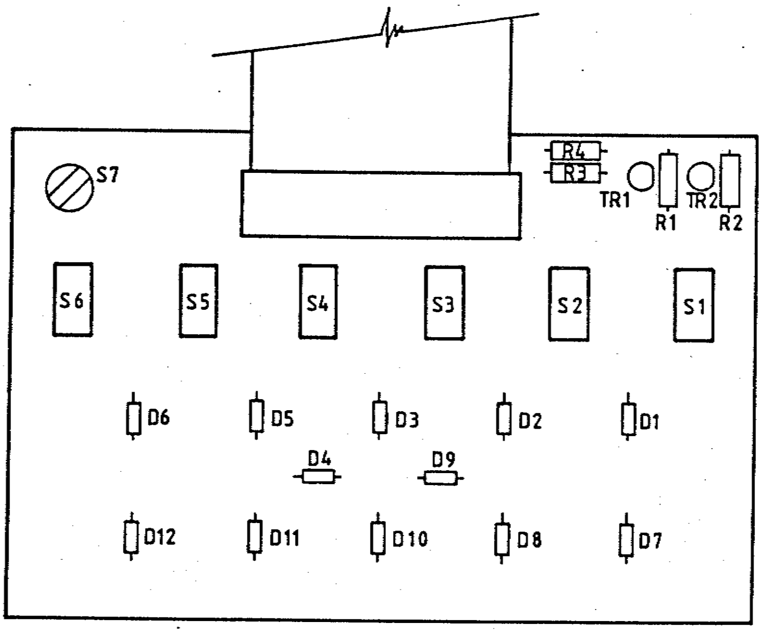
The SET REF button is a push button switch, with normally open contacts. Pressing the button connects CB1 on the 6522 to Ø 2.



ATLAS Teach Pendant Circuit Diagram



Top View



Bottom View

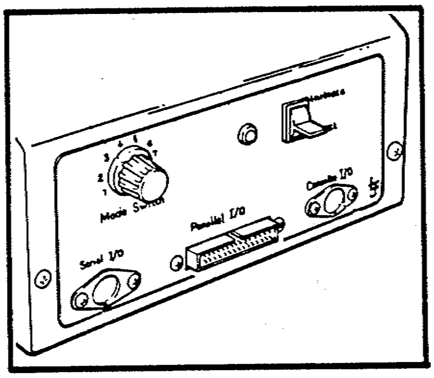
ATLAS Teach Pendant Layout Top View

Section G ATLAS External Interconnections

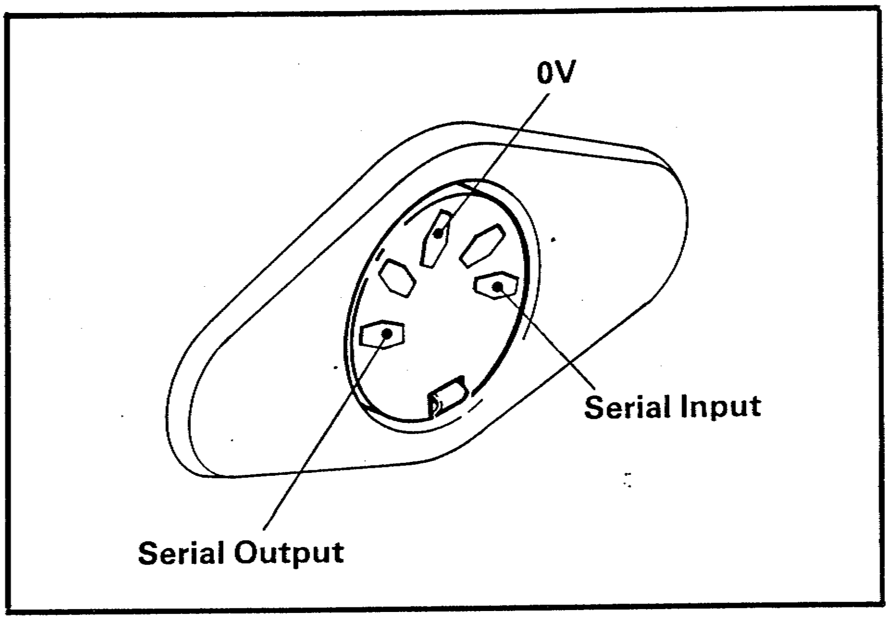
Introduction

The ATLAS Microprocessor can be 'accessed' externally via three sockets on the front panel.

Fast Serial Transfer Socket (DIN)

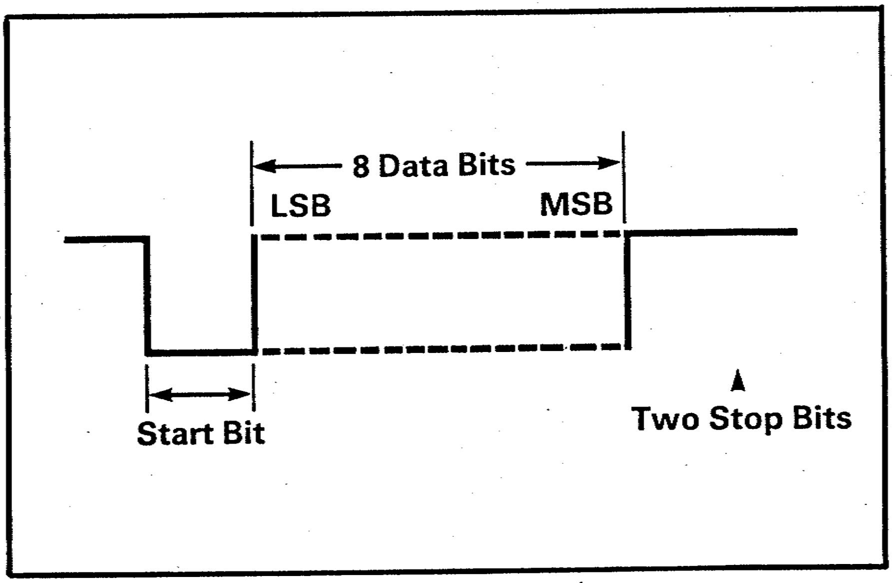


- Location: Left-hand side of panel
- Connections:-



Serial I/P is connected to Port B - bit 0 (PB0) of the ATLAS internal microcomputer 6522 VIA. A serial input program reads data in on this line at 9600 bits per second.

- Data format must conform to:



- Data transfer sequence must conform to:
  1st Byte - Reference Pointer (low byte)
  2nd Byte - Reference pointer (high byte)
  3rd Byte onwards.
  Data Table, terminated by string of 20 zeros.

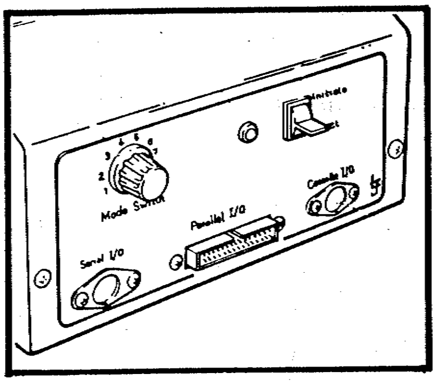
Note on ATLAS II: 1st Byte - Byte Count Low
2nd Byte - Byte Count High
Subsequent Bytes - All data stored in the ATLAS II 6k data memory.

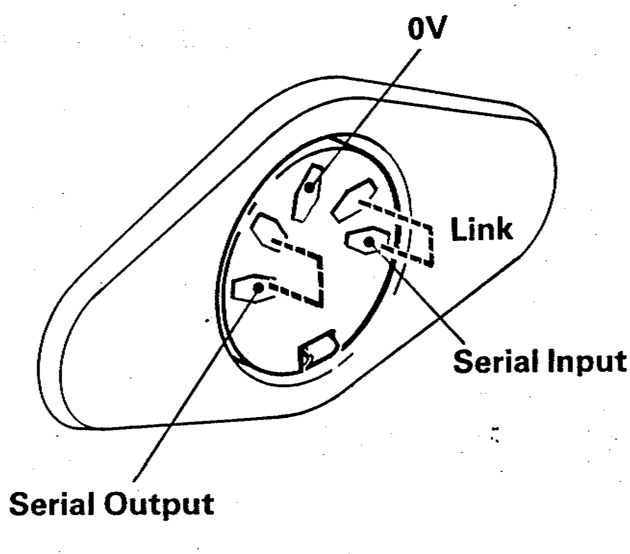
- Transfer effective in ATLAS control MODE 6.
- Serial O/P is connected to Port B - bit 2 (PB2) of the ATLAS internal microcomputer 6522 VIA. Data is transmitted at 9600 Baud in RS232 format. **Note: levels are TTL.**
- Data Transfer sequence is:

  As input format
- Transfer effective in ATLAS control MODE 4.

Cassette Serial Transfer Socket (DIN)

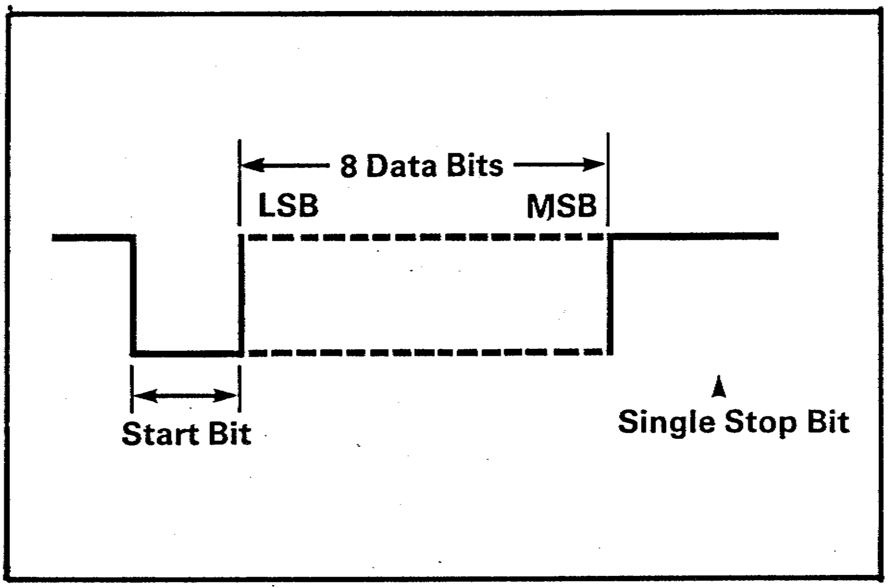
- Location - right-hand side of panel
- Connections:





- Cassette serial I/P is connected to Port B - bit 7 (PB7) of the ATLAS internal microcomputer 6522 VIA. A serial input program reads data in on this line at 300 bits per second in 'CUTS' Standard Cassette Format.

- Data formed must conform to:



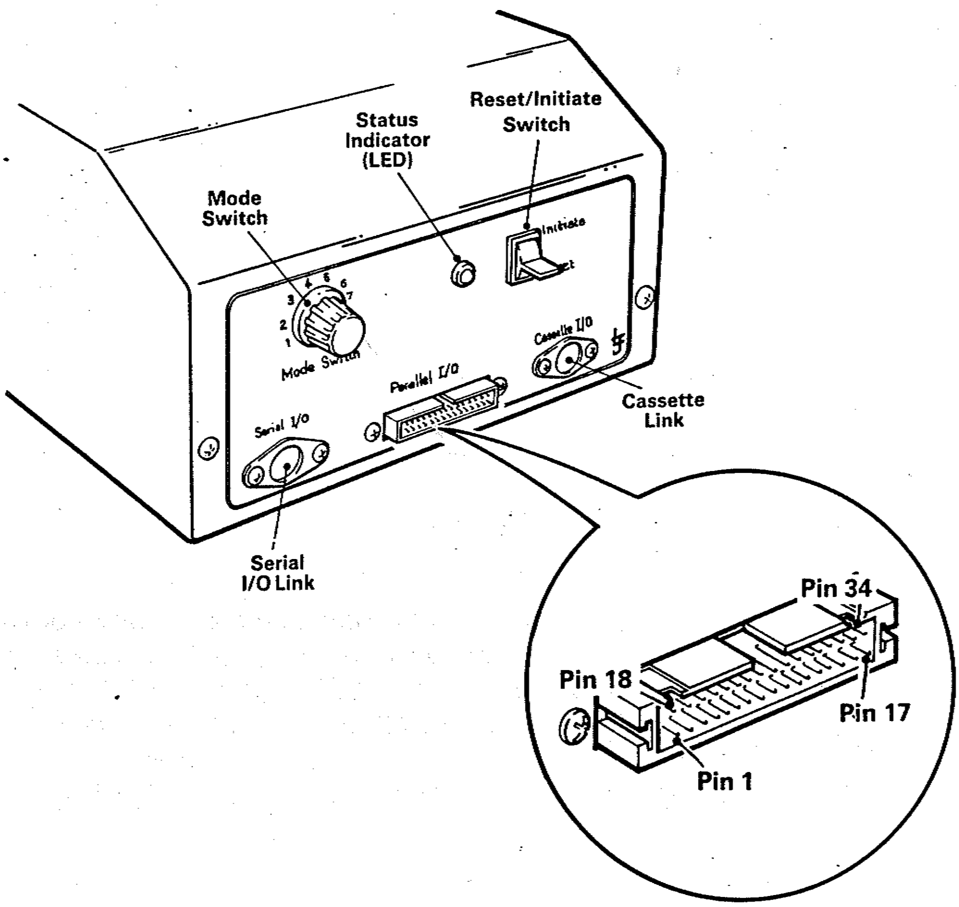
- Data transfer sequence - as fast serial transfer.
- Transfer effective in ATLAS control MODE 5.

- Cassette Serial O/P is connected to Port B - bit 6 (PB6) of the ATLAS internal microcomputer 6522 VIA. A serial output program transmits data via this line at 300 baud (modulated) for loading onto a Standard Cassette Tape Recorder.

- Transfer effective in ATLAS control MODE 4.

External Computer Control (34-way, Notch polarised plug)

- Location: centre of panel
- Connections:



	Pin No	Signal	Comments
DØ	1	PB0	*
	2	Ø2	
IØ	3	RST	
	4	RDY	
I1	5	IRQ	
I2	6	NMI	
D7	7	PA7	
D6	8	PA6	
D5	9	PA5	Uncommitted
	10	+5V	
C3	11	CB2	
C2	12	CB1	
CØ	13	CA1	
	14	0V	
C1	15	CA2	
	16	-	Not Connected
	17	-	Not Connected
D1	18	PB1	*
	19	Drive 1 (SP0)	
	20	Drive 2 (SP1)	Teach Pendant
	21	Drive 3 (SP2)	'Speed' Connections
	22	Drive 4 (SP3)	(To IC21 micro card)
	23	Drive 5 (SP4)	
	24	Drive 6 (SP5)	
D2	25	PB2	*
D3	26	PB3	*
D4	27	PB4	*
	28	PB5	
	29	Drive 1 (D0)	
	30	Drive 2 (D1)	Teach Pendant
	31	Drive 3 (D2)	'Forward'/'Reverse'
	32	Drive 4 (D3)	Connections (To IC22 micro card)
	33	Drive 5 (D4)	
	34	Drive 6 (D5)	

*Dual purpose

6522 I/O Usage

The 6522 Versatile Interface Adaptor chip occupies the 16 bytes from E000 to E00F in the Memory Map. It contains two 8-bit I/O Ports, four control lines, two programmable timers, and a shift register. The following registers are used in the ATLAS system.

E000: PB0-7
Port B Data Register

E001: PA0-7
Port A Data Register

E002: DDRB
Port B Data Direction Reg.

E003: DDRA
Port A Data Direction Reg.

E00C: Peripheral Control Register

E00D: IFR
Interrupt Flag Register

The two data registers correspond bit for bit, with the I/O lines PA0-7 PB0-7. If the corresponding bit in the data direction register is a '1', it defines a bit as an output. Similarly, a '0' defines an input.

The allocation of I/O lines is as follows:

PA0-2: Outputs

These are used in mode or motor selection. For example, code 000 on these lines selects motor 0 (jaws). Once this code is stored, the other port lines become dedicated to motor 0.

PA3: Output

This line is used to send the step pulse to the motor selected by PA0-2. This pulse must go from '1' to '0', then back to '1'.

PA4: Output

This line determines in which direction a selected motor is to step. This bit is at '0' to step towards the reference limit, '1' to step away from it.

PA5: Uncommitted

PA6: Input

This input echoes the status of the reference limit switch for a selected motor. '1' = open, '0' = closed.

PA7: Input

This line echoes the limit switch in the direction away from reference, but only for motors 3, 4 and 5 (arm in/out, up/down, cw/ccw). Motors 0, 1 and 2 have a software limit at this end of their movement.

PB0: Input

This line performs two functions:

a) Fast serial input - the serial input program reads data in on this line at 9600 bits per second.

b) In conjunction with PB1, reads the speed switch for a selected motor from the control box.

PB1: Input

Reads the speed switch

PB2: Output

This is the fast serial output. Data is sent at 9600 bits per second in RS232 format.

PB3, PB4: Input

This line reads the mode switch slider if the mode selected by PA0-2 is switched in, this line goes to logic '0'.

PB5: Input

This line reads the mode switch slider. if the mode selected by PA0-2 is switched in, this line goes to logic '0'.

PB6: Ouput

Serial data is fed to the cassette interface circuitry from this line. It is then converted into tones for recording on an ordinary cassette player. Logic '0' is converted into 1.2kHz and logic '1' into 2.4kHz.

PB7: Input

Tones from a cassette recorder are converted into logic levels and fed to this line for assembly into bytes of data. When the I/O adaptor unit is plugged in, and the ATLAS is initiated in mode 7, some of the I/O lines are given different assignments. These are as follows.

PB0-2 = D0-2 = Motor Select
PB3 = D3 = Step Bit
PB4 = D4 = Direction Bit
PA5 = D5 = Uncommitted
PA6,7 = D6,7 = Limit Switches

To the user D0-5 appear to be inputs; D6,7 = outputs.

Control Lines

(See 'PCR' and 'IFR' also)

CA1: Input

When the reset/initiate switch is pressed up this line is pulsed by the Ø2 clock. It can also be pulsed low via socket C0 on the I/O adaptor. The system software recognises this as the 'initiate' signal.

CB1: Input

This input is connected to the 'set ref' button when the teach pendant is plugged in. Pressing SET REF causes CB1 to be connected to the system Ø2 clock. The software recognises this as 'secondary references'. CB1 is C2 on the I/O adaptor and pulsing C2 low when in Mode 3 causes the ATLAS to return to secondary reference.

CA2: Output

This output is connected to the indicator LED via a 390Ω resistor. When it is at logic '0' the LED is 'ON'. This LED indicates,

a) system ready for initiate
b) out of memory
c) serial output in progress
d) editor buffer almost full
CA2 is connected to C1 on the I/O adaptor. When it is plugged in, C1 indicates,

a) MPU fetching next block of data (mode 3)
b) Selected motor has hit a limit switch (mode 7)

CB2: Output

This output is only of use when the I/O adaptor is plugged in. It then becomes C3 and indicates,

a) End of data (mode 3)
b) Ready for Data (mode 7)

Peripheral Control Register

This register decides the status of the control lines CA1, CA2, CB1, CB2. In the ATLAS, these lines are defined as follows.

CA1: Input, sets interrupt flag on negative edge.
CA2: Output, set or cleared by bit 1 of PCR.
CB1: Input, sets interrupt flag on negative edge.
CB2: Output, set or cleared by bit 5 of PCR.

In practice, the ATLAS software only places 4 different codes in the PCR.

EE: CA2, CB2 high
EC: CB2 high, CA2 low
CE: CB2 low, CA2 high
CC: CA2, CB2 low

Interrupt Flag Register

The input lines CA1, CB1 are programmed to set bits in the IFR on a negative edge.

Bit 1 is set by CA1
Bit 4 is set by CB1
Bit 1 is cleared by reading or writing Port A.
Bit 4 by Port B.

Summary of the Microcomputer Input/Output Connections

PA0	Scan 000 to 100 for motor select
PA1	When INITIATE occurs, these lines
PA2	Scan 000 to 111
PA3	Step signal
PA4	Direction CW/CCW
PA5	Uncommitted
PA6	Datum reference limit switch
PA7	Full travel limit switch
PB0	9,600 Baud input (mode 6)
PB1	Speed switches
PB2	9,600 baud output (mode 4)
PB3	Forward/Reverse switches
PB4	
PB5	Mode switch wiper
PB6	Cassette Output
PB7	Cassette Input
CA1	Initiate input
CA2	LED indicator driver
CB1	Set reference input
CB2	End of data table signal (either Stop or Repeat will occur)

Section H ATLAS Setup/Commissioning

Introduction

The following is a list of checks that are to be done after repairs have been carried out, or if an ATLAS does not appear to be functioning correctly.

Driver Card Current Check

Remove the shorting link on each driver card, in turn, and connect an ammeter in series with the pins. The meter should read approximately 400mA if one phase is on, or 750mA max if two phases are on - adjust VR1 if necessary. If a problem is found, refer to Section C of this manual for more information on the drive card.

Limit Switch Check

Turn mode switch to position 1, press and release the INITIATE switch. Check ATLAS has moved to its reference position and the LED is flashing. Note: On ATLAS II the jaws open/close function closes the jaws by approx. 2mm after it sees its limit; therefore, this function must be moved manually by rotating the motor drive coupling before doing the following checks.

Remove top cover, disconnect the jaw, function motor plugs, and hinge up multiplexer board. Using a digital voltmeter, check voltage on TP1, 2 and 3. This should be approximately 3.5V. (Refer to Section G for complete optical limit switch set-up procedure).

If not, starting at the up/down limit, standing at the back of the robot turn the shaft CW away from reference, until the LED goes out. Now turn the shaft CCW towards reference, while monitoring TP3 with a DVM. Continue to turn the shaft CCW, until you have obtained a max reading on DVM. If you go past max reading, go back and come up to a peak reading in a CCW direction.

Adjust multiturn preset for 3.5V.

Setting the limits in this manner ensures that any play in the gear box which may give disc alignment error is compensated for.

For the other two functions, the motors turn CW towards reference. Therefore ensure that the max reading is obtained by turning the motor in a CW direction.

When all three limits have been set, the three LEDs should be lit. If so hinge down multiplexer board, and refit jaw motor plugs to the respective drive cards. Switch ATLAS to Mode 1 and INITIATE.

Refer to the ATLAS User Manual to design a sequence that will drive all functions to their 'away from reference' limit.

ATLAS I Mode Switch Check

Mode 1-3
Can be checked by designing a sequence and replaying it.

Mode 4 and 5 (Cassette I/F)

a) Design a sequence and save it on tape (Mode 4)
b) Switch to Mode 1 and initiate to clear ATLAS memory
c) Switch to Mode 5 and reload sequence.
d) Check ATLAS replays sequence.

Mode 4 and 6 (Cassette I/F)

a) Design a sequence and transfer it to another ATLAS or EMMA (use EMMA/ATLAS EPROM) in Mode 4.
b) Clear memory (Mode 1)
c) Load sequence back into memory using Mode 6.
d) Check ATLAS replays sequence.

Mode 7
Can be checked by switching to mode 7 and controlling ATLAS movements from an external computer such as EMMA using the EMMA/ATLAS EPROM.

Mode 8
Can be checked by selecting mode 8 and initiating twice. ATLAS should go into packing position. Mode 8 can also be checked by using the edit functions.

Screw and Cover Check

Refit top cover and check for loose screws and scratched covers.

ATLAS II Mode Switch Check

Mode 1-3
Can be checked by designing and replaying a sequence

Mode 4
Can be checked by performing a serial transfer.

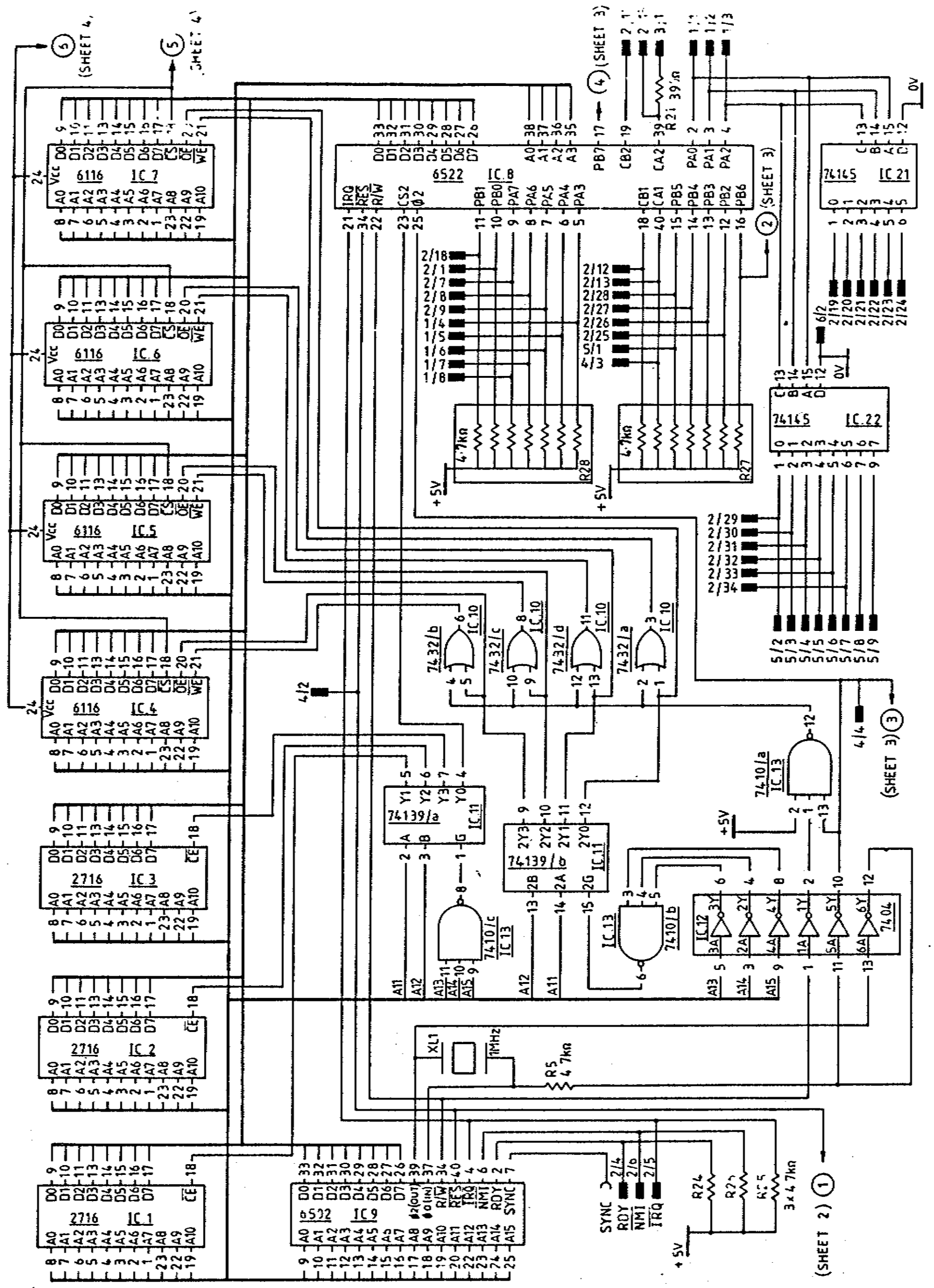
Mode 5
Can be checked by transferring a sequence to cassette and reloading the sequence.

Mode 6
Can be checked by performing a serial load

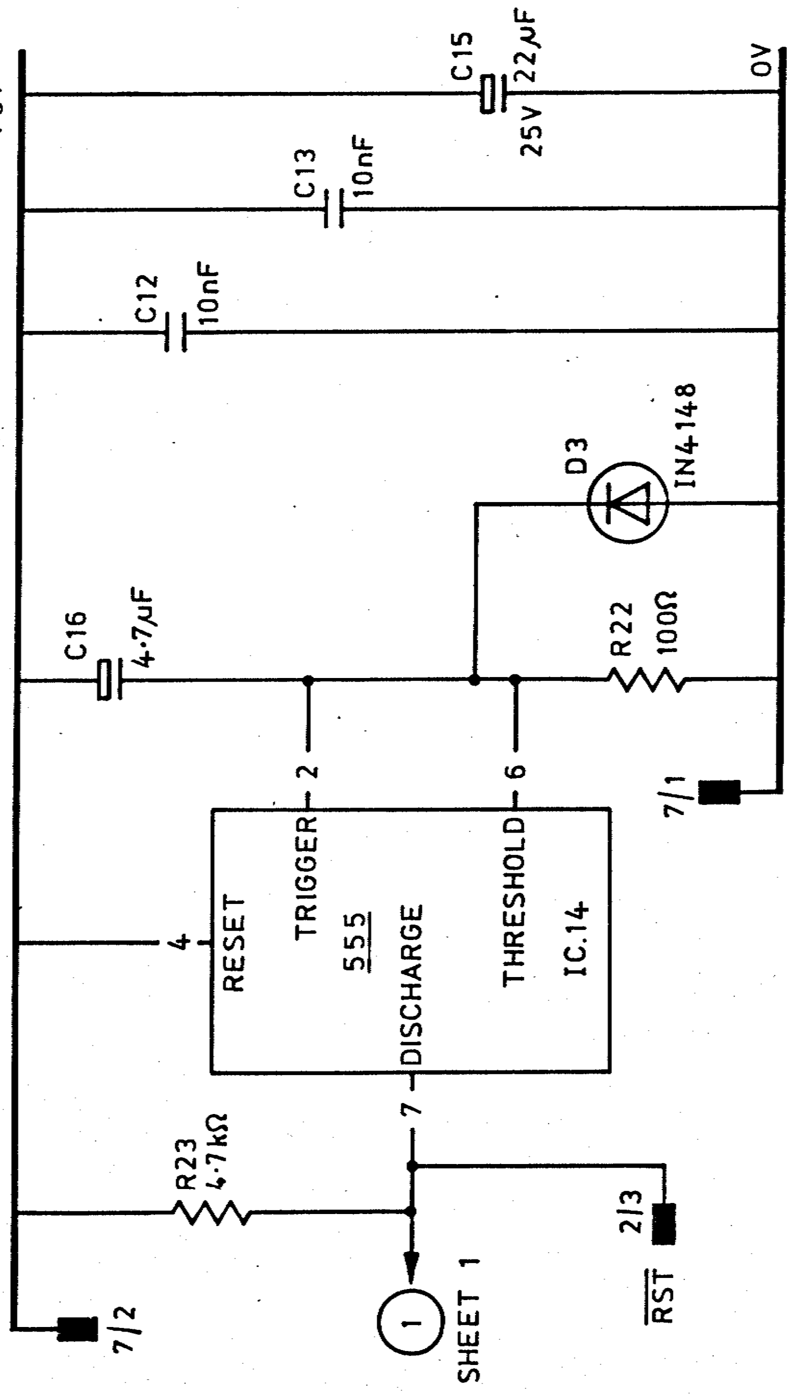
Mode 7
Can be checked by controlling the ATLAS by an external computer using the I/O adaptor.

Mode 8
Can be checked by performing edit functions.

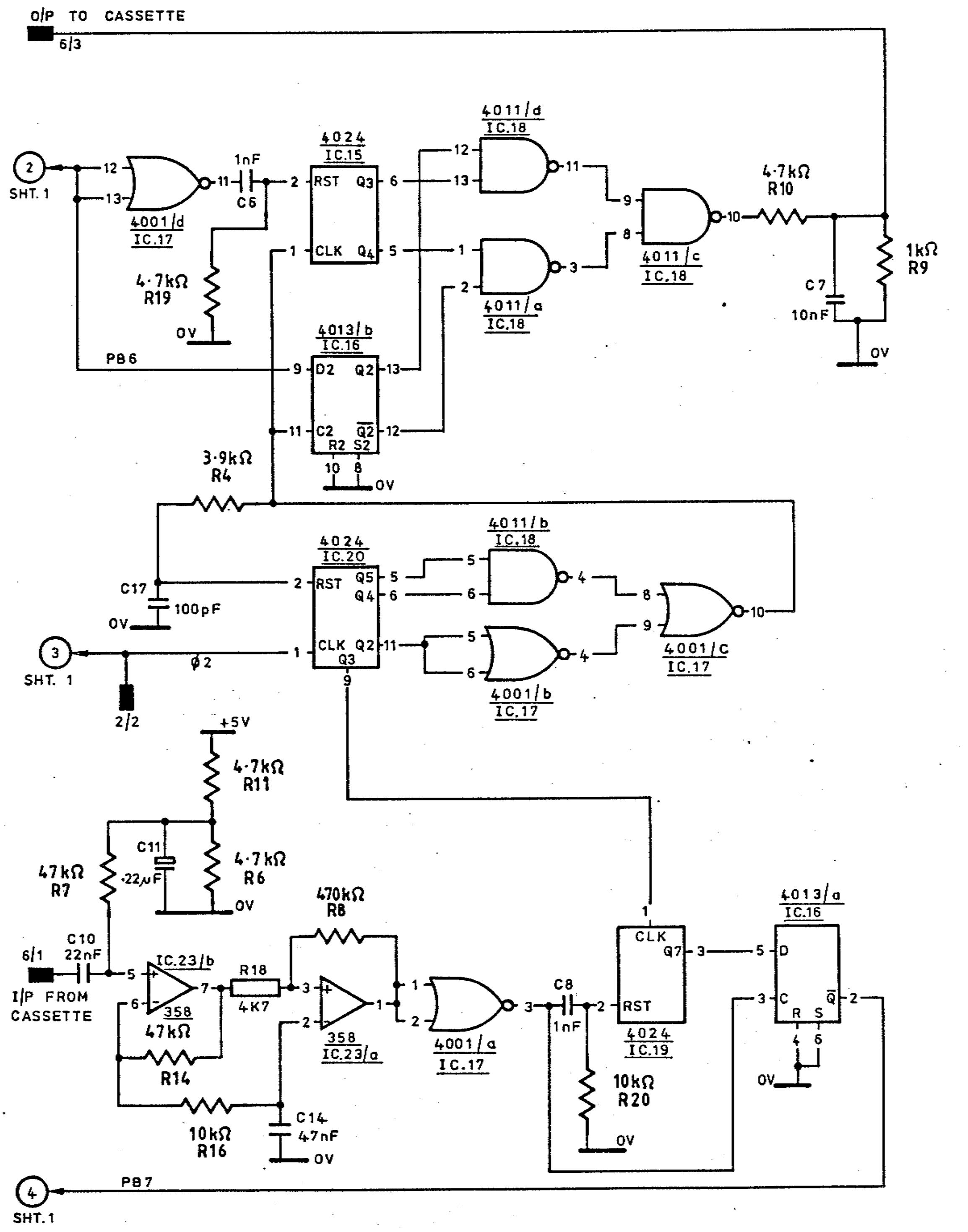
Section I Drawings



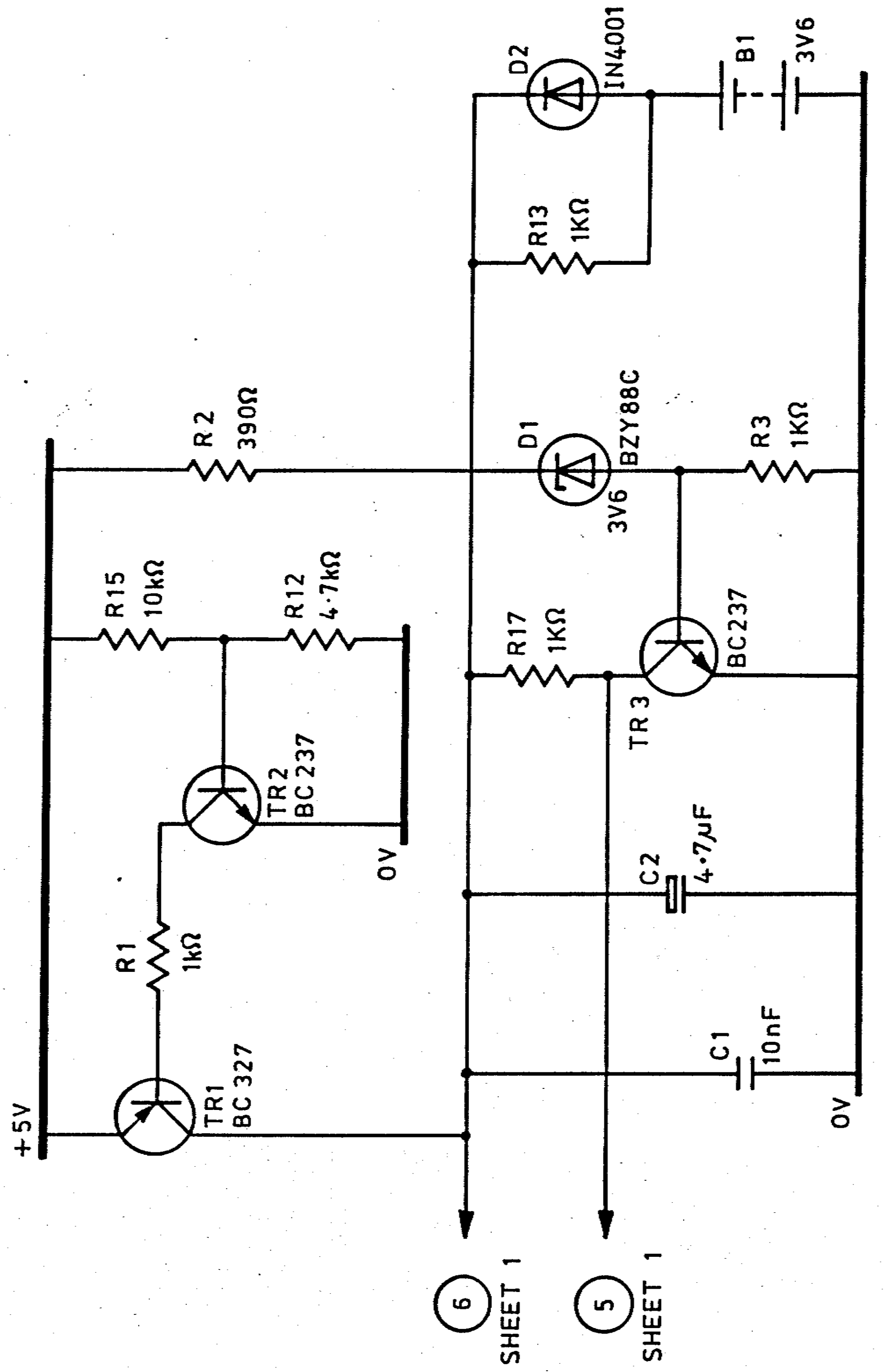
ATLAS Micro Card Circuit Diagram Sheet 1



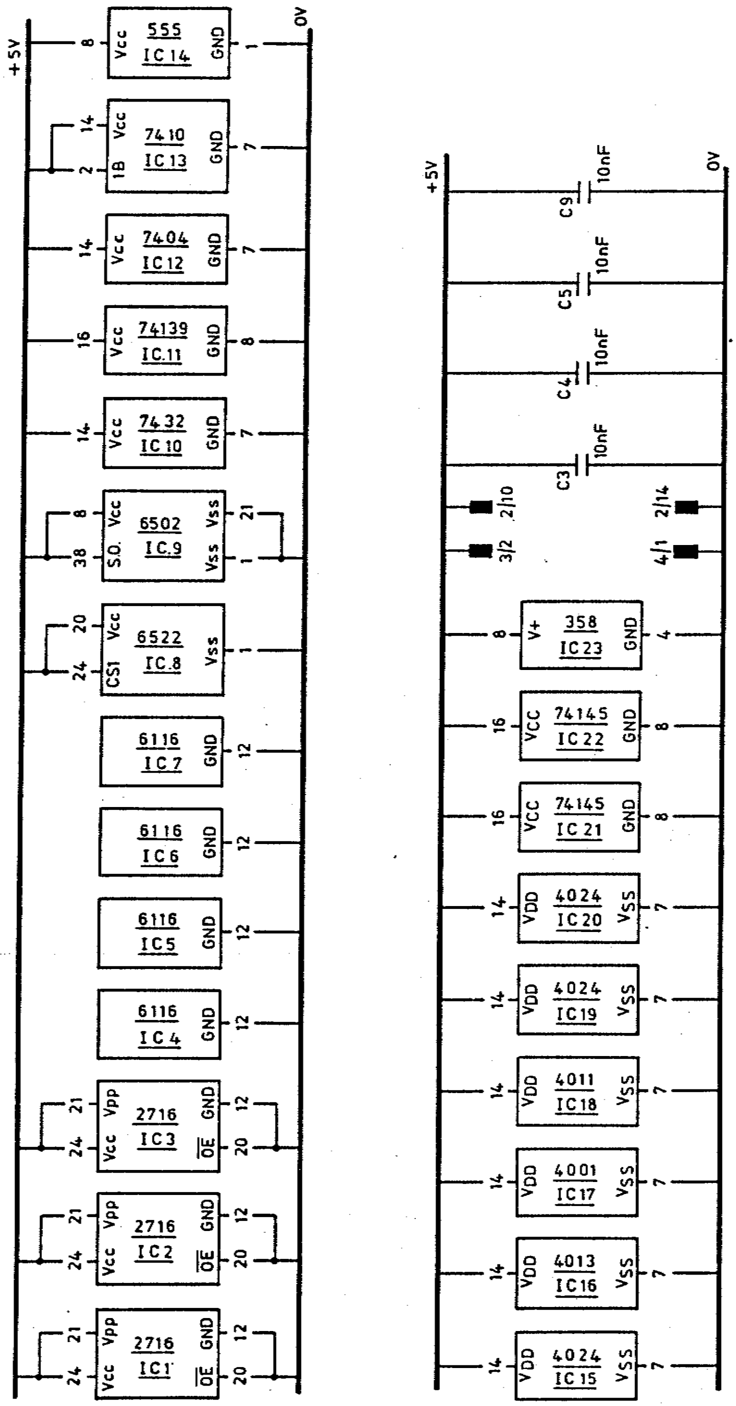
ATLAS Micro Card - Power on Reset Sheet 2



ATLAS Cassette Interface Sheet 3

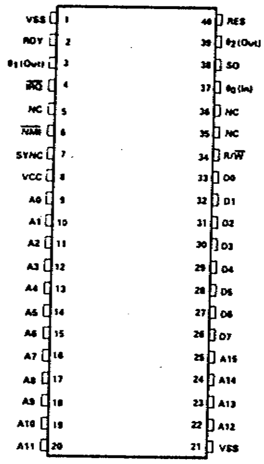


ATLAS Micro Card - Battery back-up Sheet 4

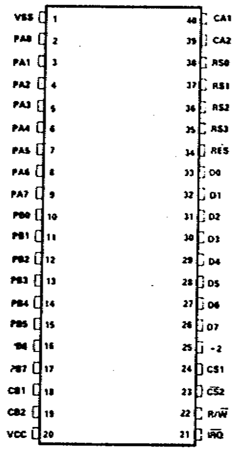


ATLAS Micro Card - Supply rail connections Sheet 5

Section J IC Pin Connections



6502



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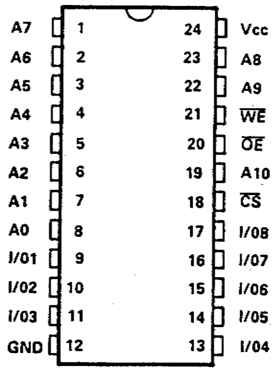
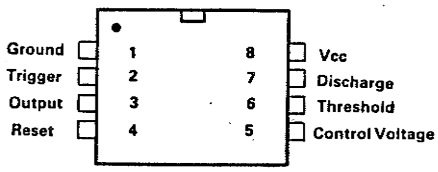
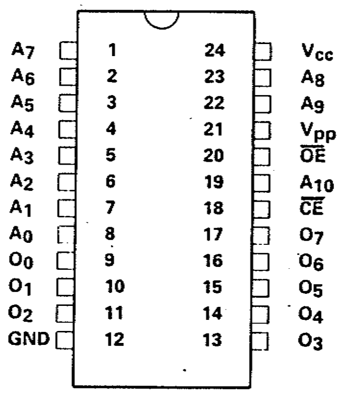


6116

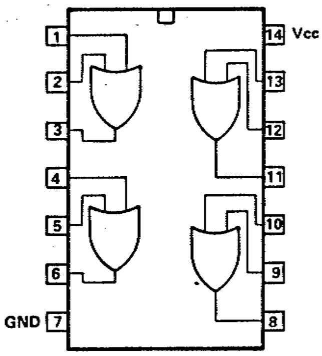


555

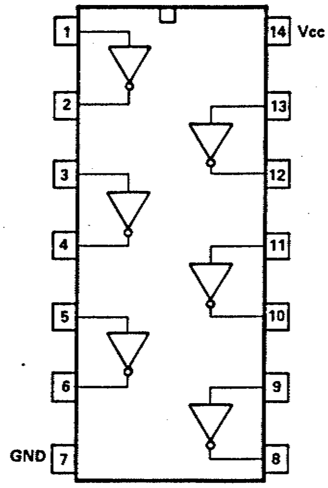


2716

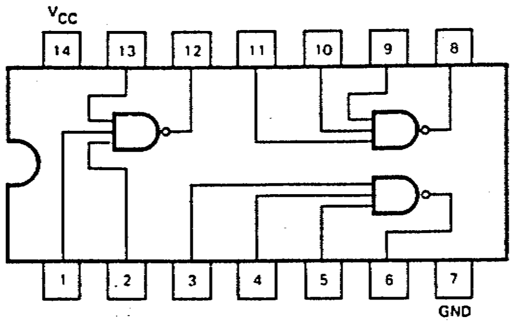
6116 74139 7410 74151 74145 74138

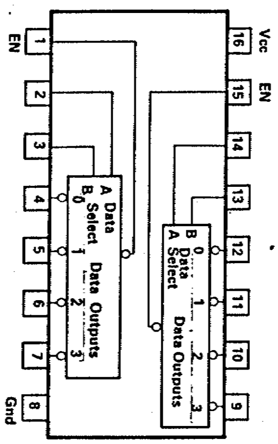


7432



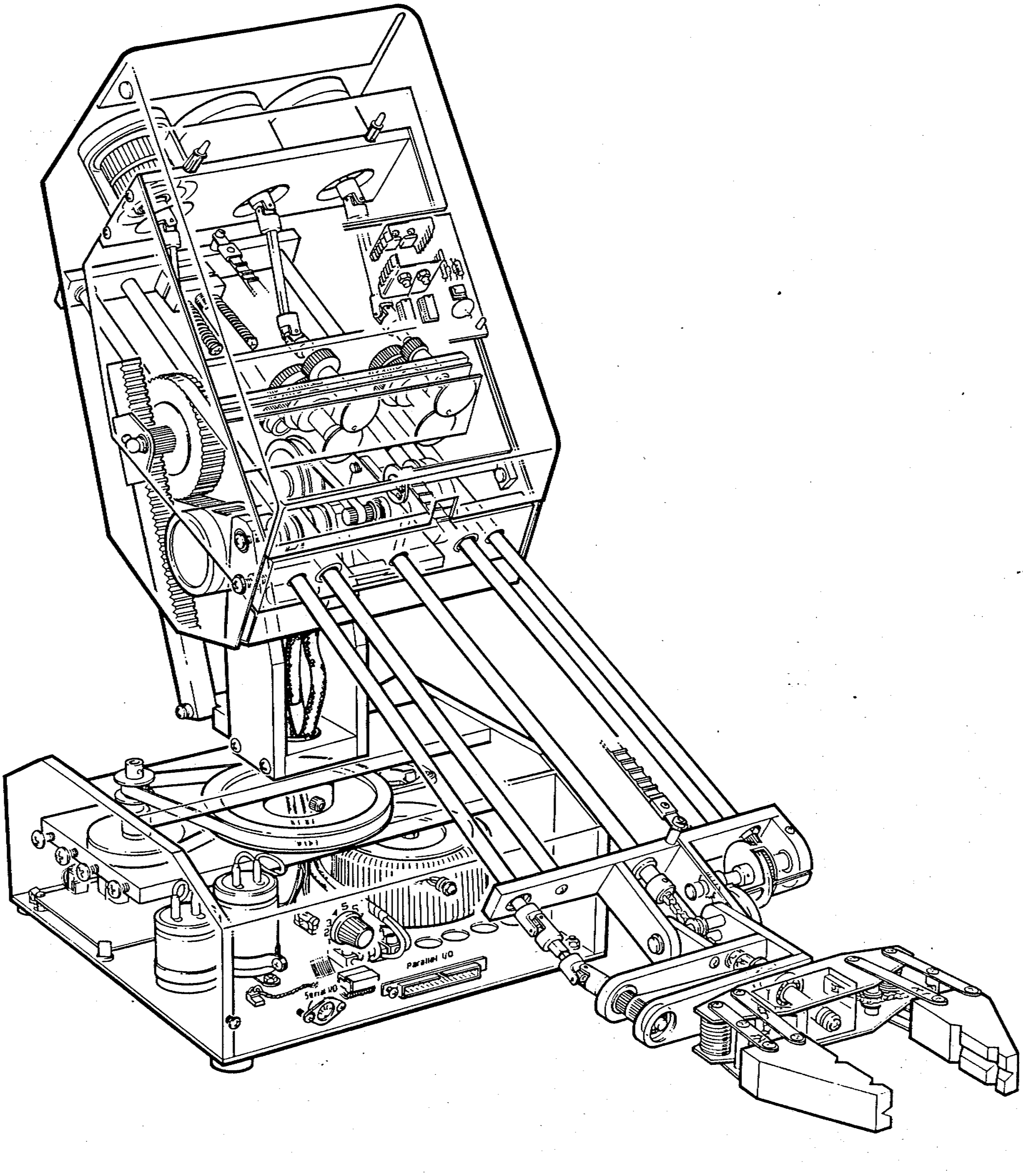
7404





74139

Section 2 Mechanical

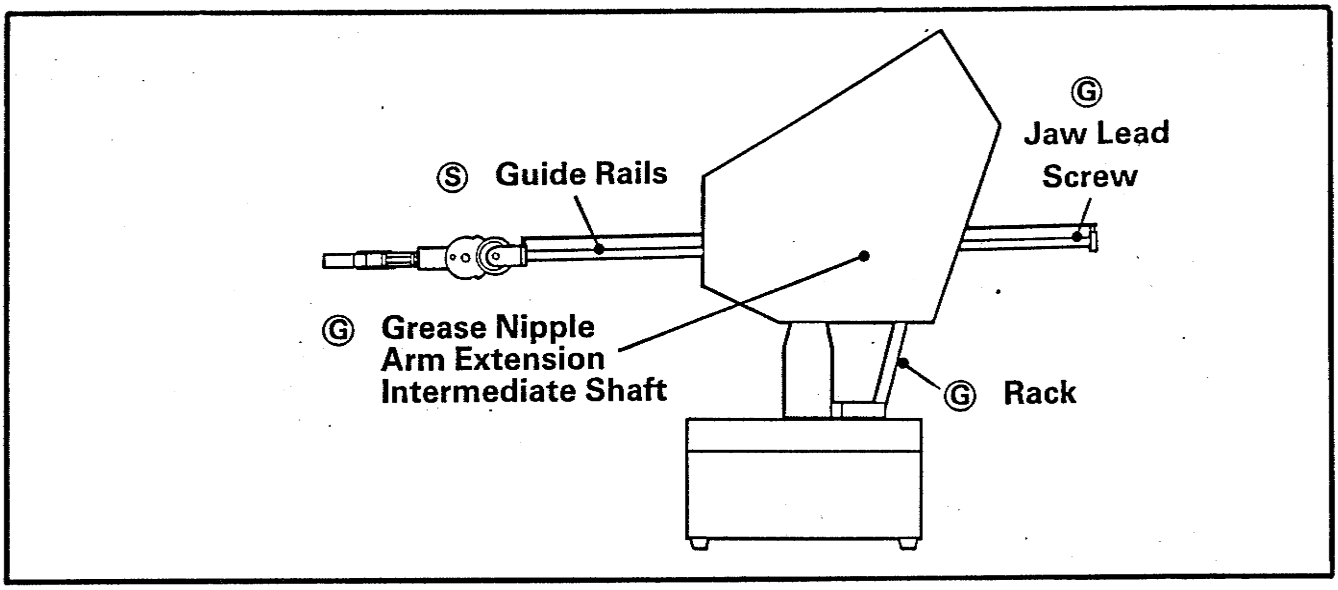


Section A Lubrication

Important Note: Disconnect the ATLAS from the power supply before removing any section

A1 Weekly Lubrication

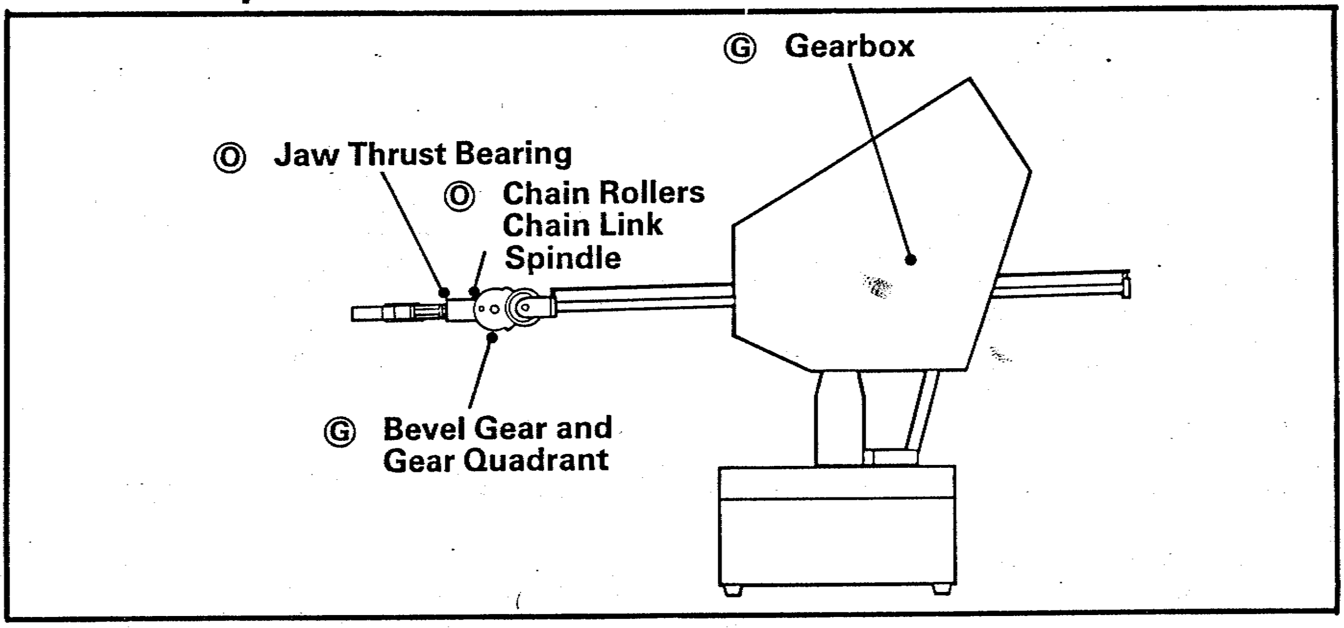
As shown below:



O = Oil
G = Grease
S = Silicon Spray

A2 Monthly

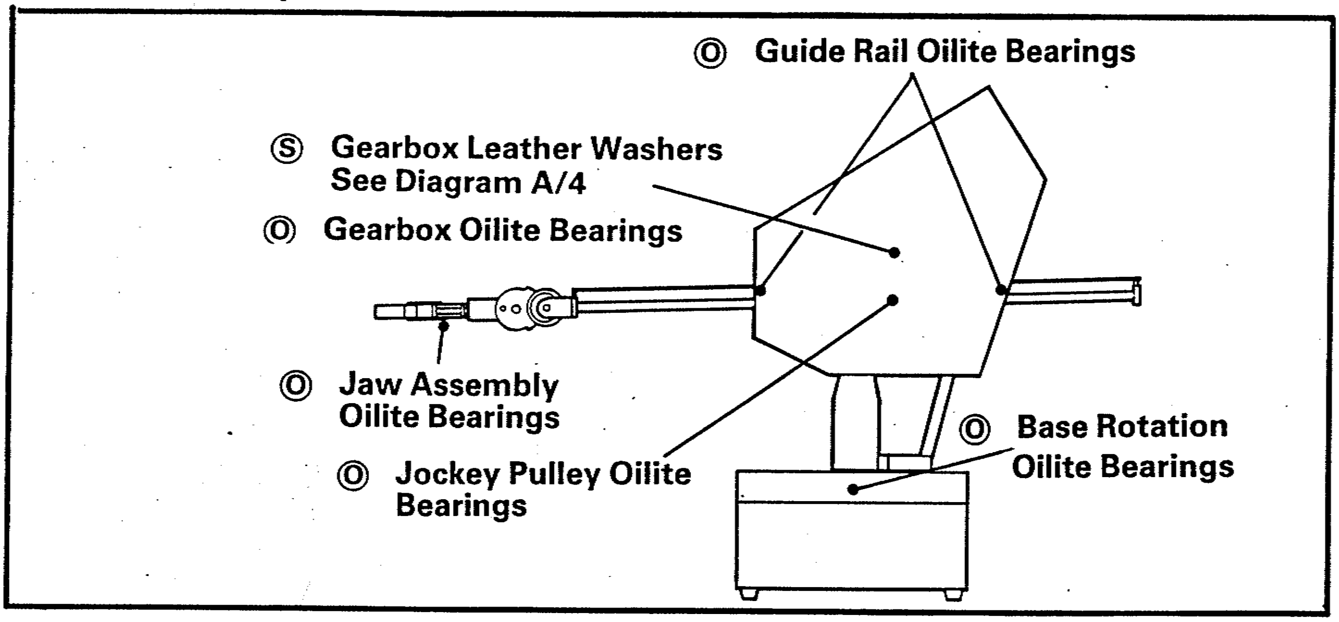
As shown below:



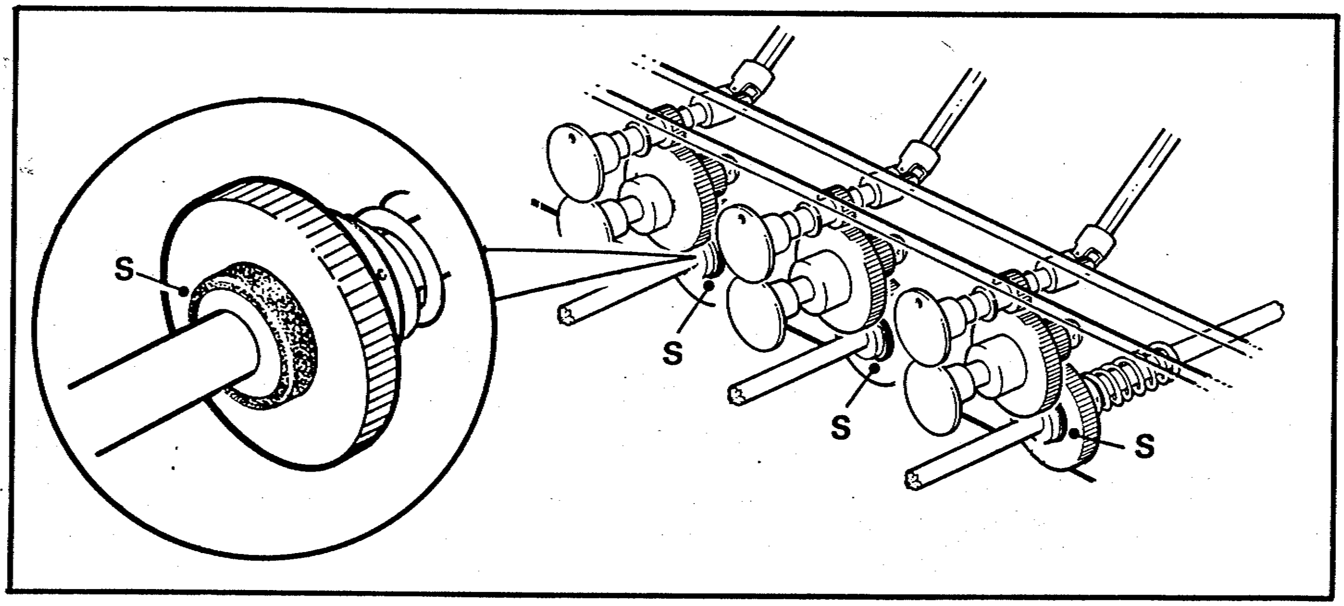
O = Oil
G = Grease
S = Silicon Spray

A3 Quarterly

As shown below:



O = Oil
G = Grease
S = Silicon Spray

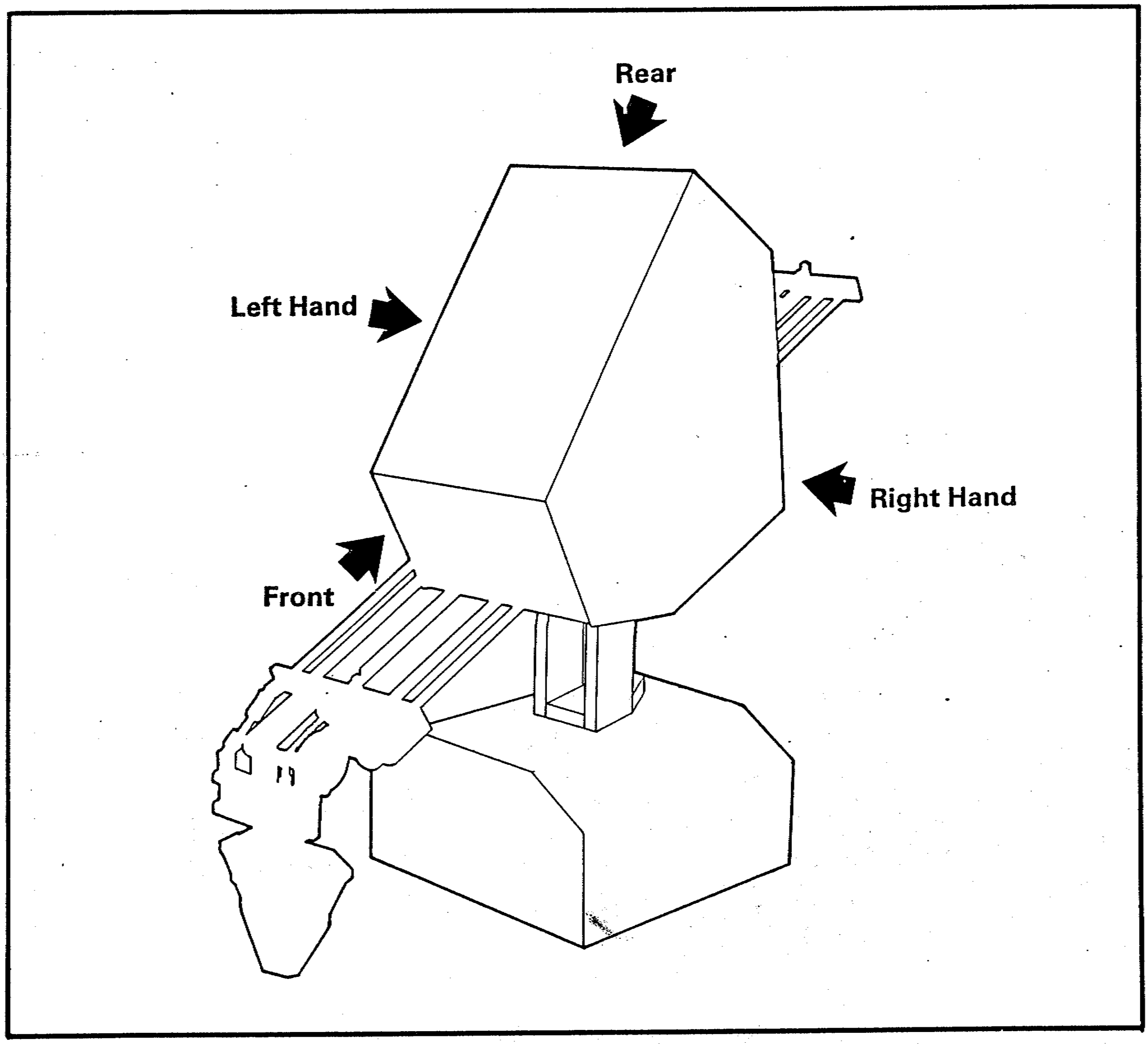


A4 Recommmended Lubricants

Oil = Shell Tonna T32 or any good quality mineral oil (SAE 30)
Grease = Shell Alvania R2 or any Lithium Based General Purpose Automotive Grease.
Silicon = Aerosol Spray available from L.J. Electronics.

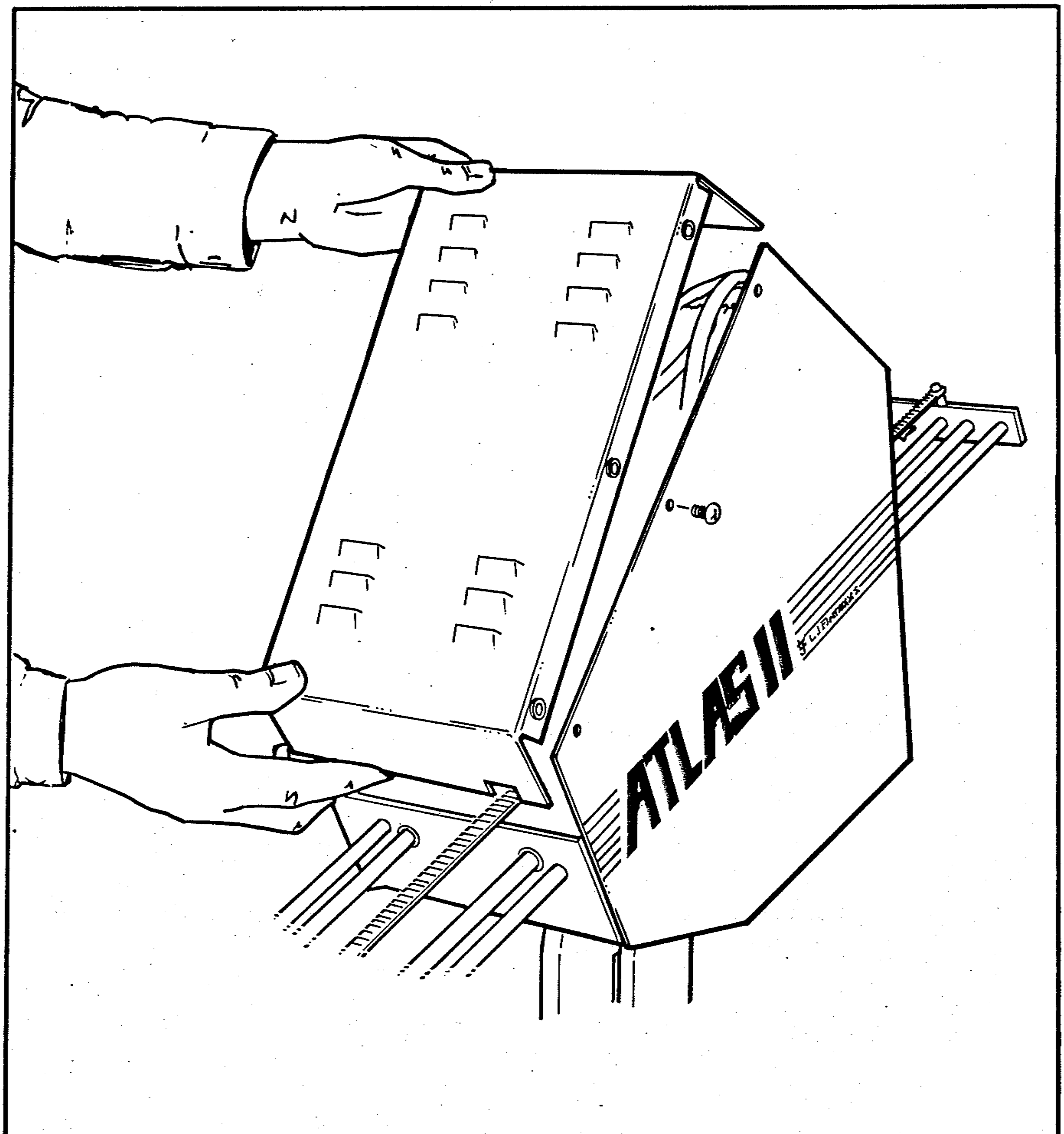
Section B Remove/Refit Panels

Note that all references in this section of the manual to R/H, L/H, Front, and Rear are as viewed in the diagram below, unless otherwise stated.



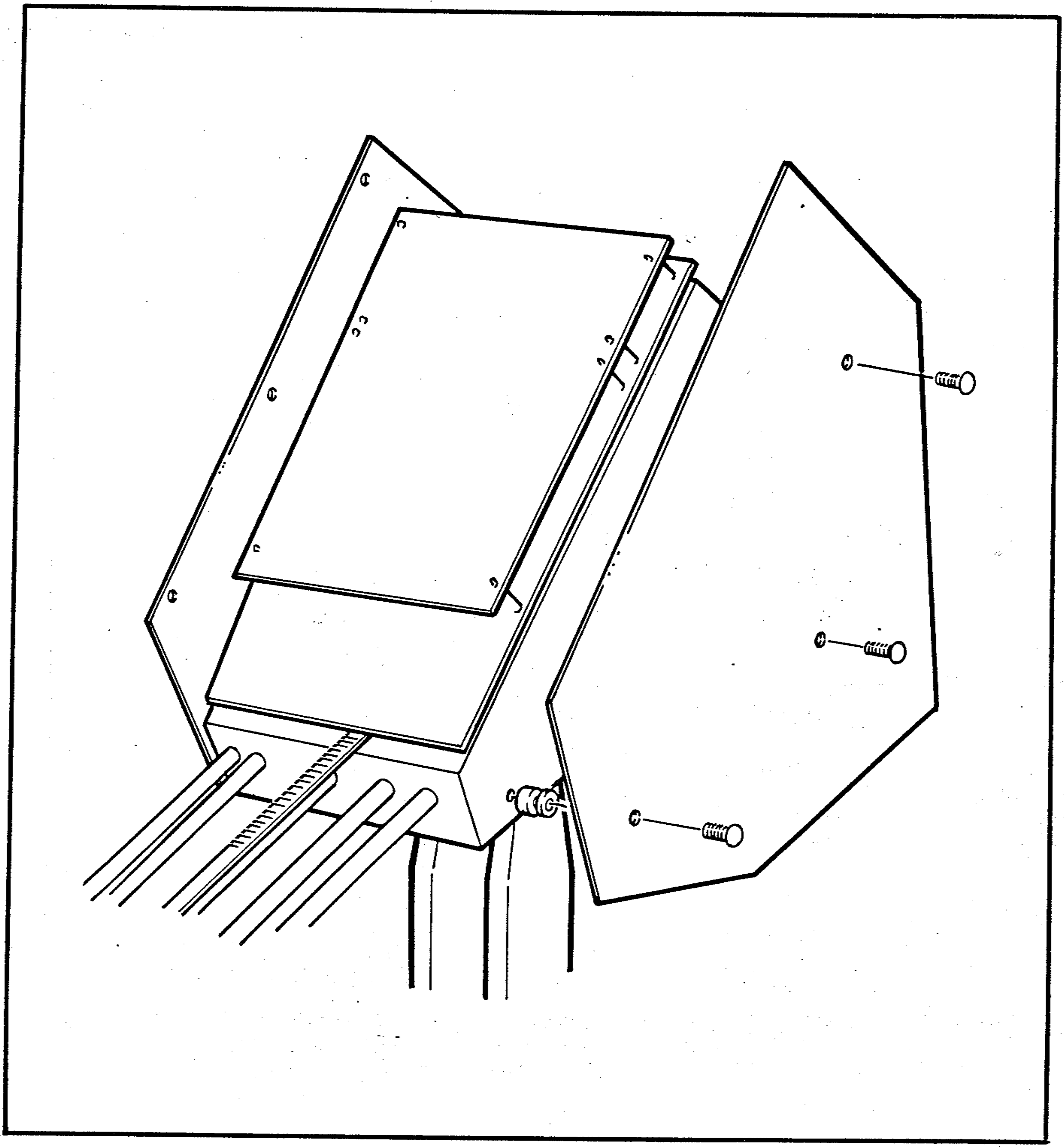
B1 Removal of the Top Panel

The Top Panel covers the Multiplexer/Demultiplexer PCB and motor drive PCBs. The Top Panel can be removed by removing the six screws along the top of the ATLAS as shown below.



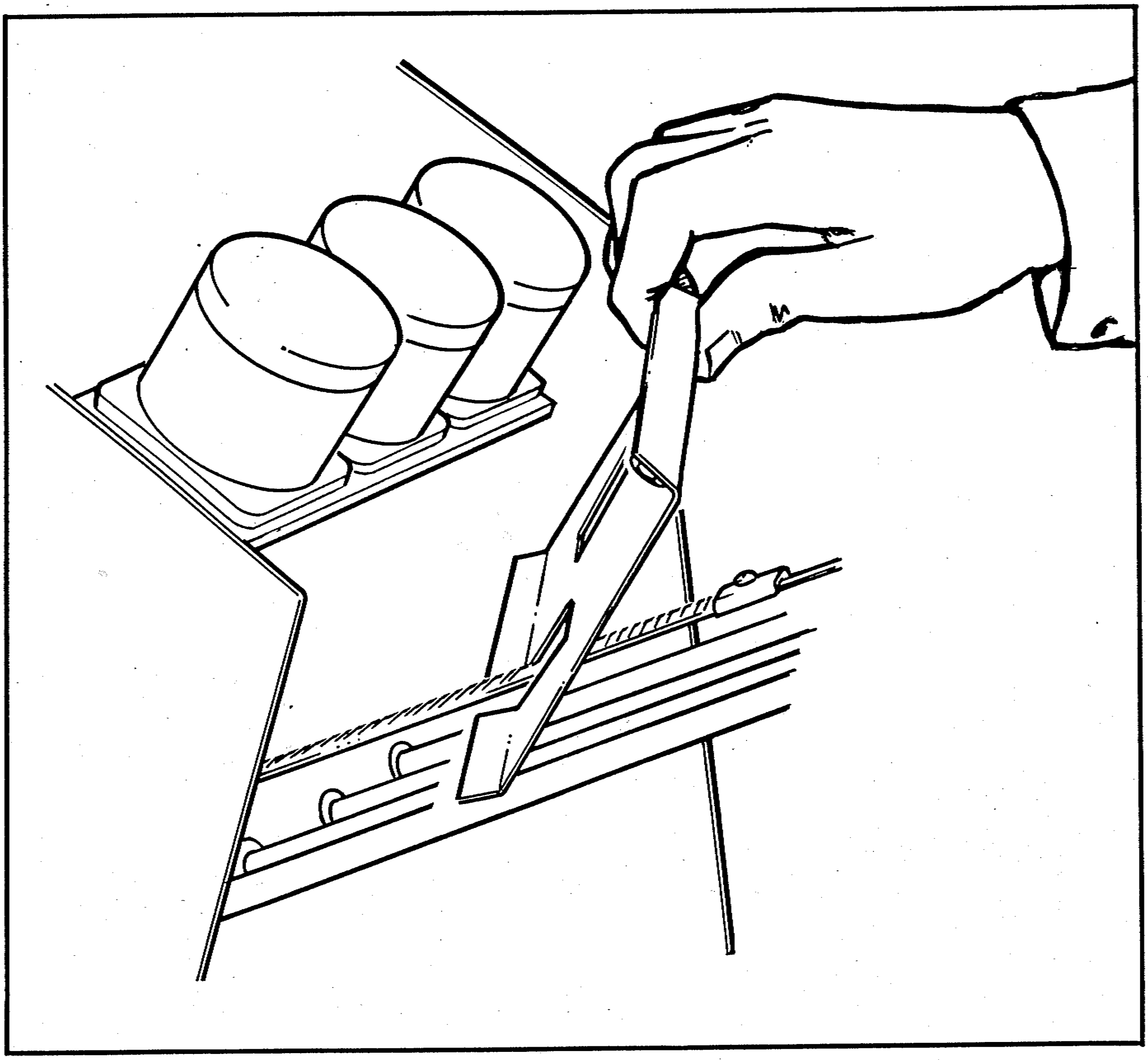
B2 Upper Side Panels

The Upper Side Panels are secured by three screws (in each). This can be seen below. When dismantling, note there are three loose spacers one behind each fixing screw. These should be kept with the side panel.



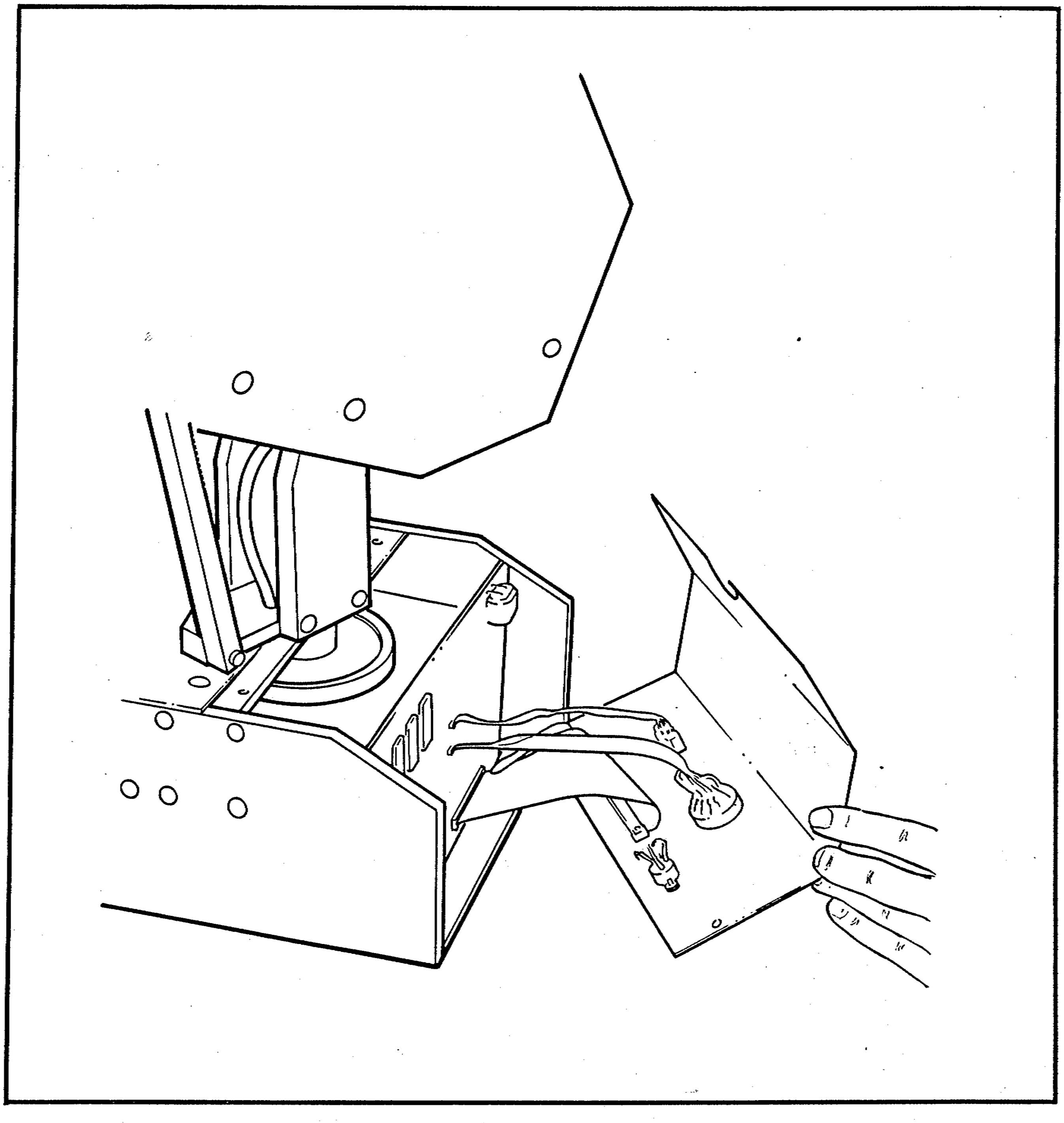
B3 Rear Cover

The Rear Cover is positioned at the back of the ATLAS underneath the Stepper Motor mountings. The Rear Cover is held in position by the two outer-most motor mounting screws. To remove the cover, position the ATLAS with the arm down, remove the two outer-most motor mounting screws as shown below.



B4 Base-Rear and Front Covers

These are the panels that cover the ATLAS Power Supply and micro-card. To remove the front cover, remove the four screws around the edge of the cover. Disconnect the push-on connectors which attach this panel to the ATLAS microcomputer as shown overleaf.



The rear cover is also secured by four screws. The power terminal connections must be released from the screw-in terminal just inside the base in order that this panel can be completely removed.

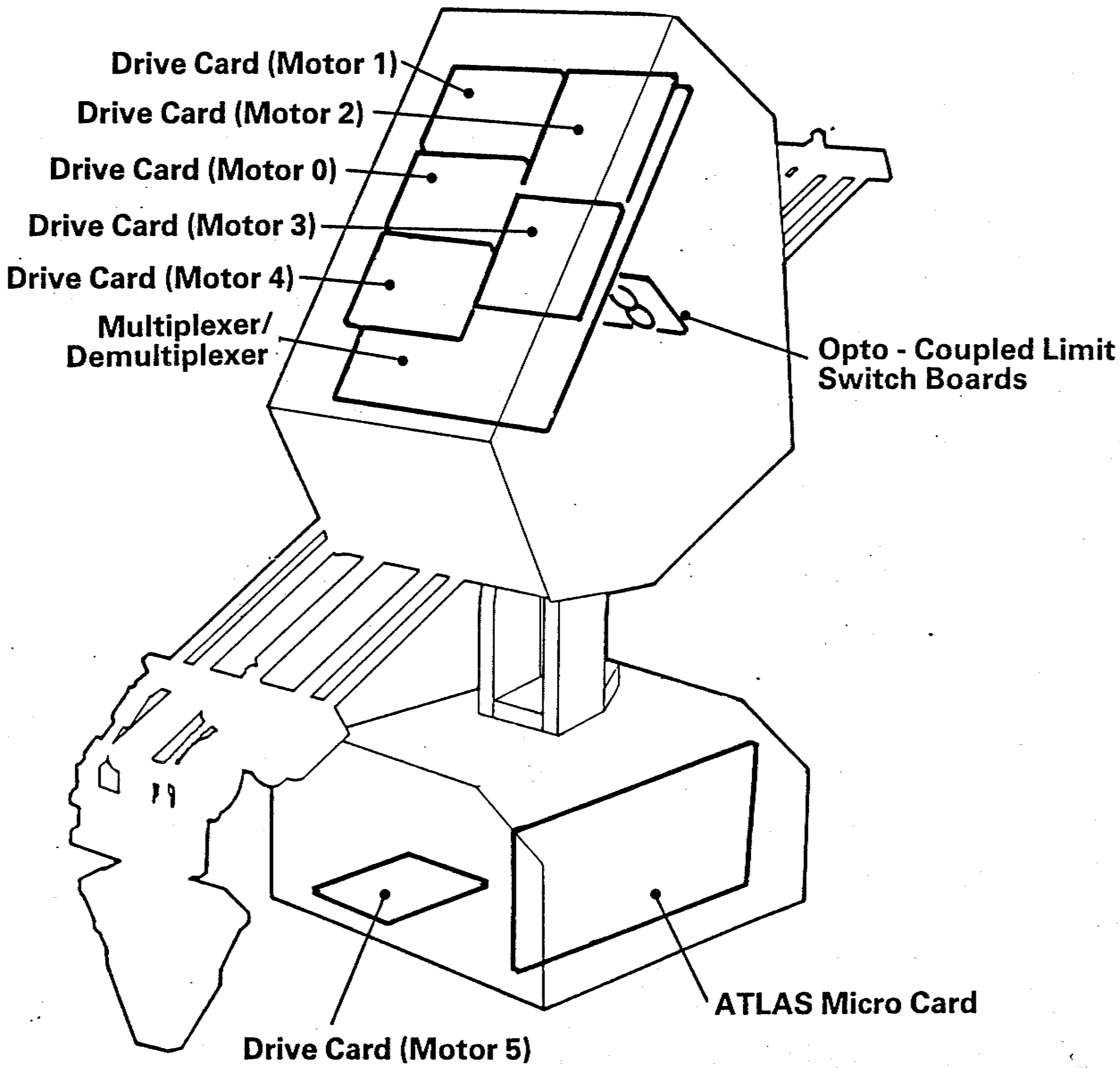
B5 Replacing Panels

The replacement of panels is a simple procedure of reversing the operation with information given above for dismantling.

Section C Remove/Refit Circuit Boards

Important Note: Disconnect the ATLAS from the power supply before removing any circuit boards.

The various circuit boards in the ATLAS are identified as shown below.



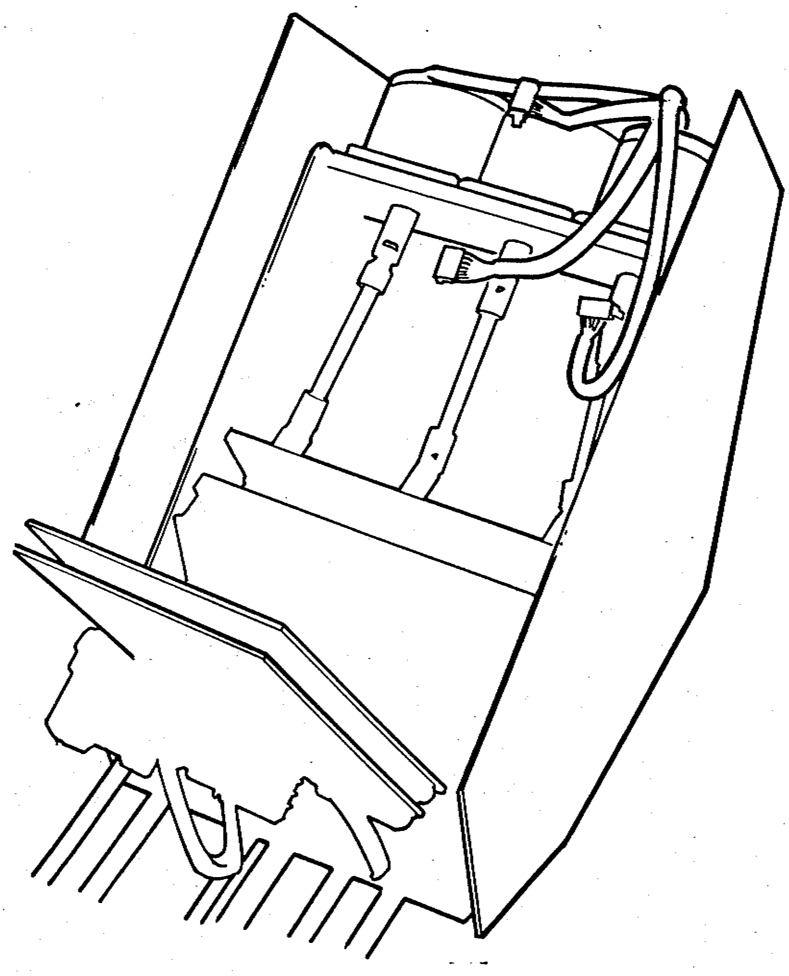
C1 Removal of the Motor Drive Cards Multiplexer/ Demultiplexer Circuit

The Multiplexer/Demultiplexer circuit board contains the drive cards for motor 0,1,2,3,4. Each of the motor drive cards can be removed from the Multiplexer/Demultiplexer board in or out of the ATLAS. Each of the cards is held by spring clips. Release these clips and the card can be lifted from the Multiplexer/Demultiplexer.

To remove this as one complete unit follow the procedure shown below.

- Remove the Top Panel as shown in B1.
- Disconnect the motor cables from the 5 amplifier pcbs - these connections are made via 6-way 0.1″ in-line sockets.

  Disconnect all leads at the front of the demultiplexer board. There are 4 push-on 0.1″ sockets and one screw-in terminal strip



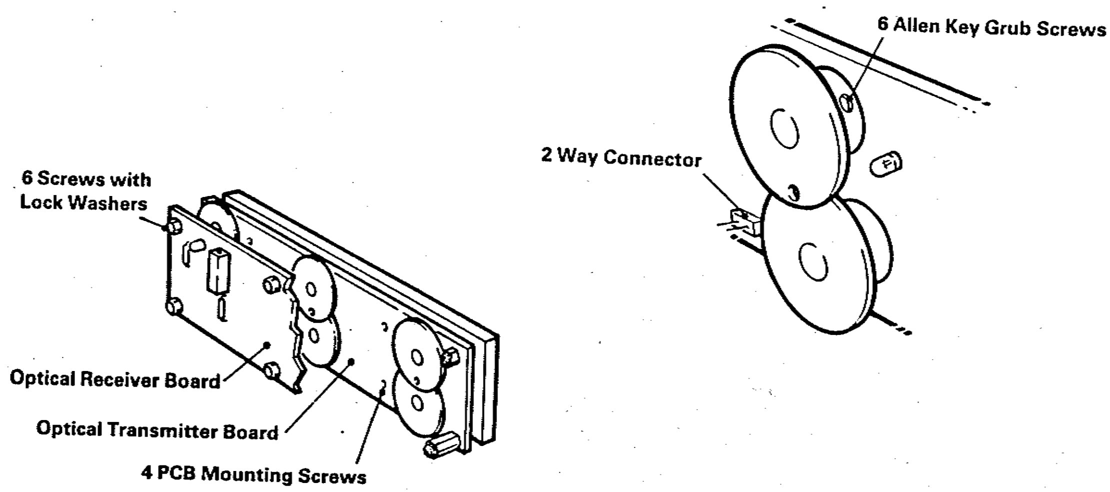
The demultiplexer board is secured by hinges at the front corners of the board. Each hinge is secured by 2 screws, through the pcb. Loosen both screws on one hinge, then remove the front-most screw entirely - care must be taken in doing this, since there is a lock washer under the screw. This hinge can now be pushed clear of the side plate and this will allow the complete pcb assembly to be angled out. Remove this complete assembly.

C2 Removing Motor Drive Card Number 5

Remove the Base Back Panel as shown in Section B.
Remove all the PCB connections from the motor drive card. Release the spring clips securing the card and lift clear of the base.

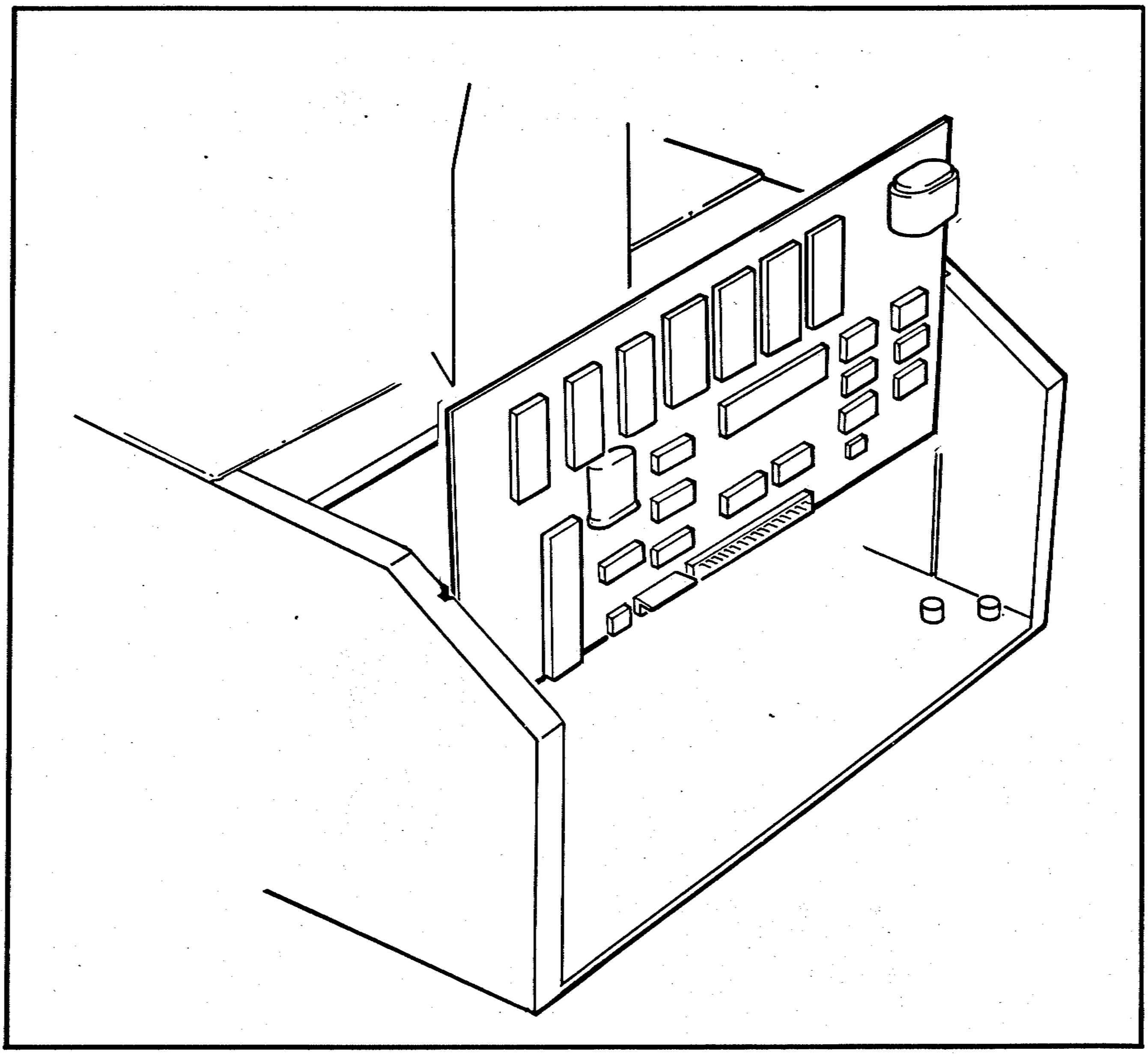
C3 Removing the Opto-Coupled Limit Switch Board

Remove the top panel as shown in Section B. Lift the Multiplexer/ Demultiplexer board up as shown in C1. Remove the outer board from the six mounting spacers (6 screws with lock washers).
Ease the board away to release the 2-pin connector. Remove the 6 discs by releasing the Allen Key securing bolt. Remove the second pcb which is held to the arm by 4 screws.



C4 Removing the ATLAS Micro-Card

Remove the Base Front Panel as shown in Section B. Disconnect the 5 push-on connectors which attach this panel to the ATLAS microcomputer. Slide the microcomputer pcb out vertically from the base, removing a push-on connector from each side of the board as this is done.



C5 Replacing Circuit Boards

Use the same procedure as shown above in reverse order.

Section D Arm Rotation

General Description

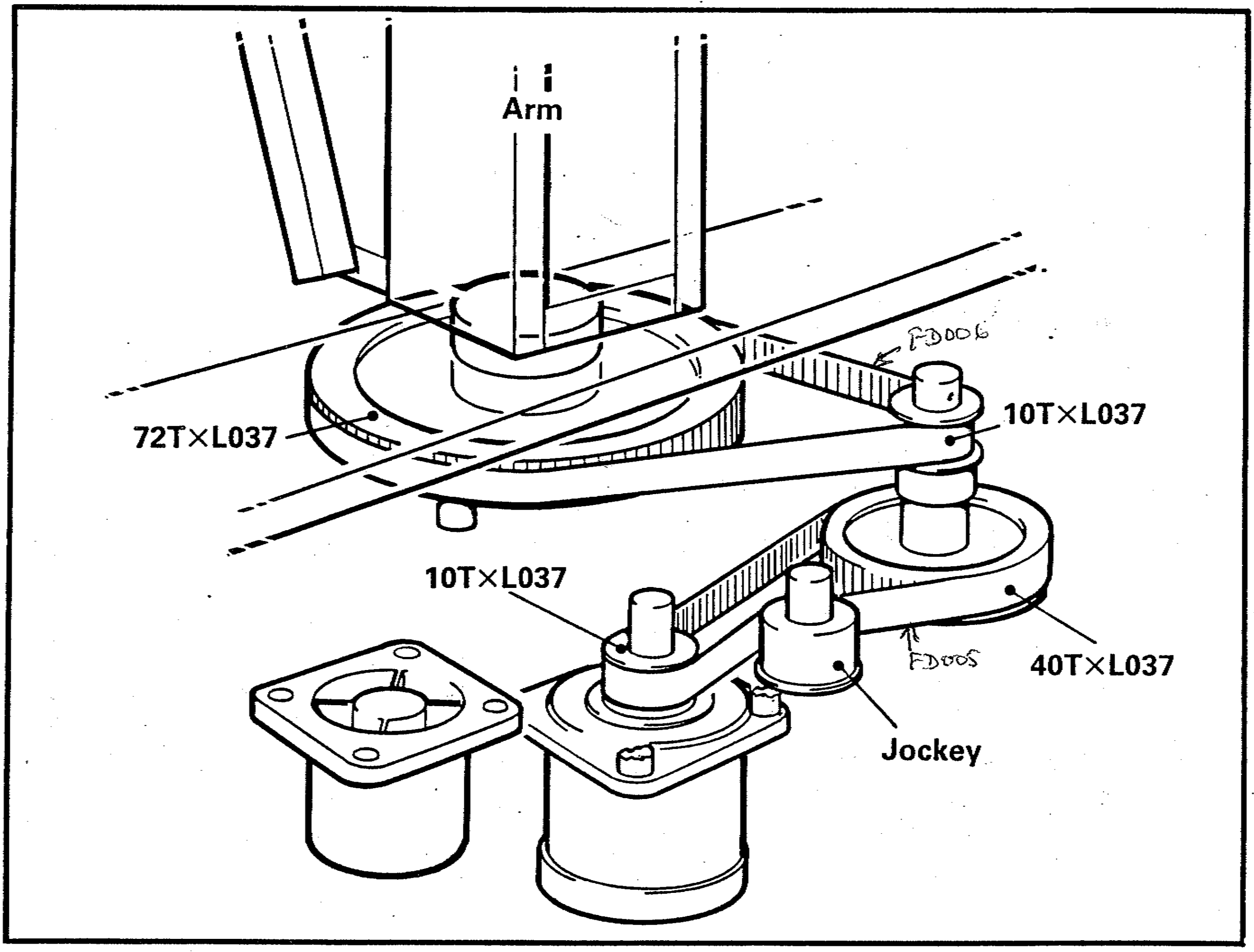
The arm can rotate through 370°. This function is driven by stepper motor via two toothed belts, with a vertical intermediate layshaft. The overall ratio is 28.8:1. The main rotation shaft, layshaft and jockey pulley all run on 'Oilite' bearings and require minimal lubrication. The lower toothed belt is adjusted by a sliding jockey pulley. Adjustment of the upper belt is by moving the motor support plate.

The rotation limit stop is incorporated on the lower base pivot plate. No adjustment of this stop is provided. The drive mechanism is shown in diagram D/1.

D1 Adjusting Lower Belt

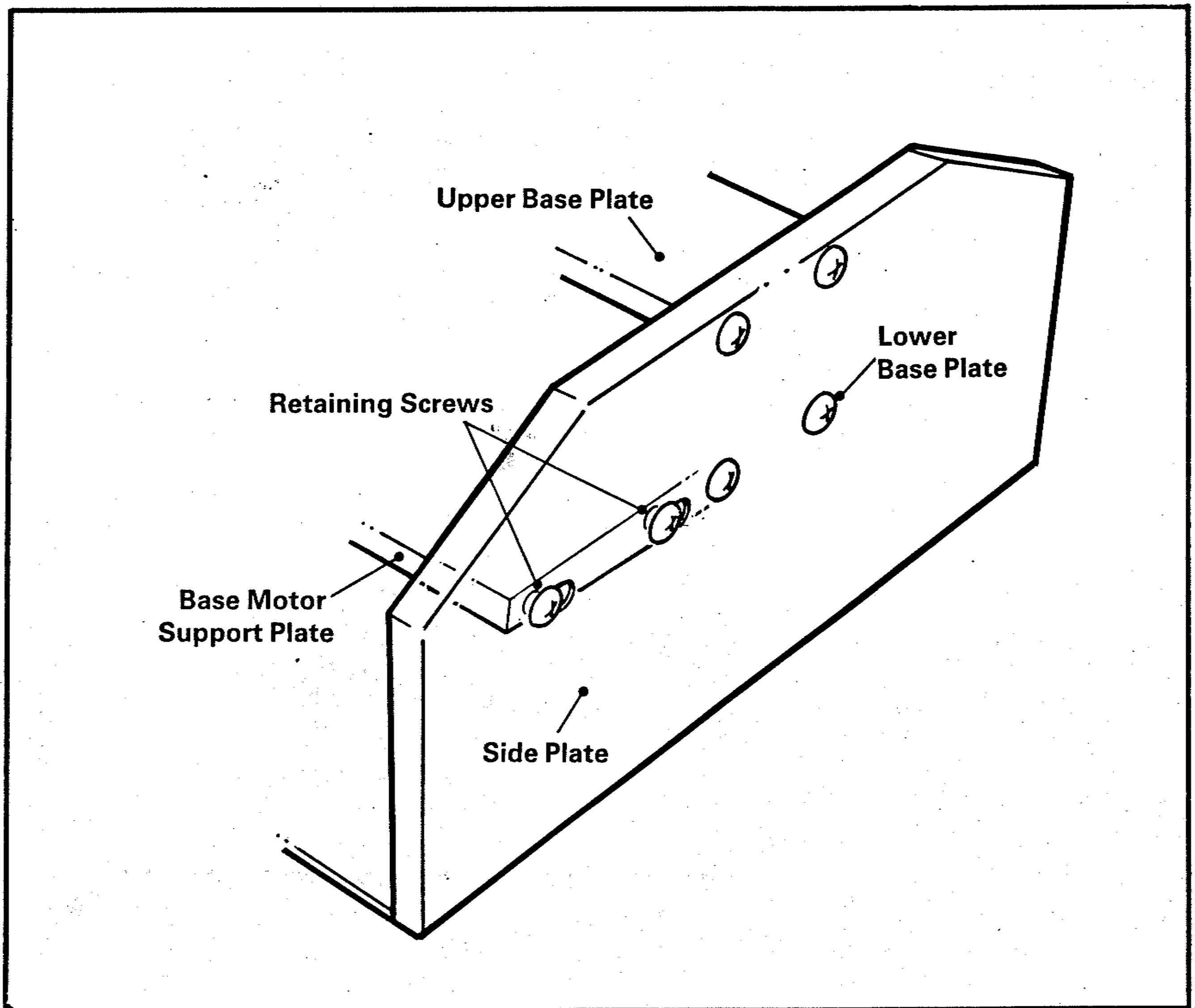
Remove base panel (mains switch side) see section B. Slacken jockey pulley retaining screw. Push jockey pulley firmly inwards. Hold pulley in position and tighten retaining screw. Replace panel.

Diagram D/1



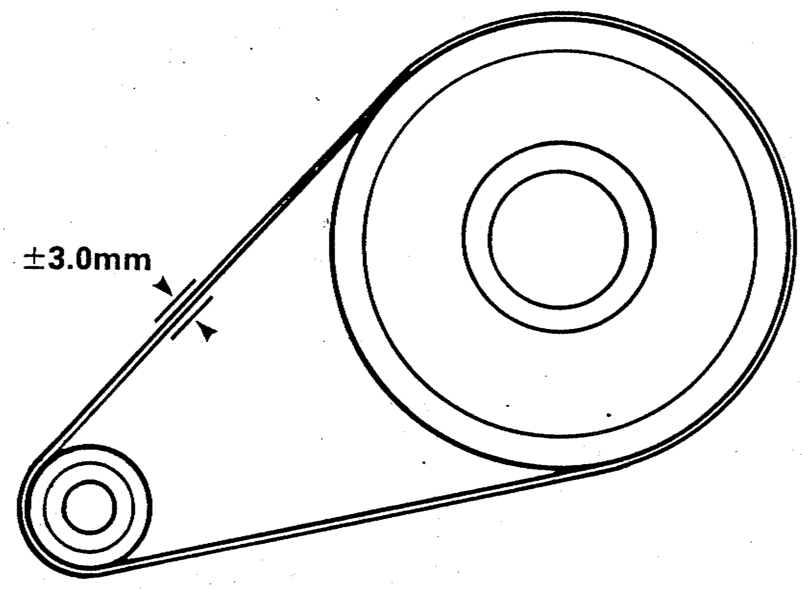
D2 Adjusting Upper Belt

Remove base panel (mains switch side) see section B.
Slacken 4 screws retaining motor support plate see diagram D/2.
Using suitable lever between motor support plate and adjacent pivot plate, move motor support plate outwards to obtain required belt tension, see diagram D/3. Tighten 4 retaining screws. Refit base panel.



D3 Replacing Lower Belt

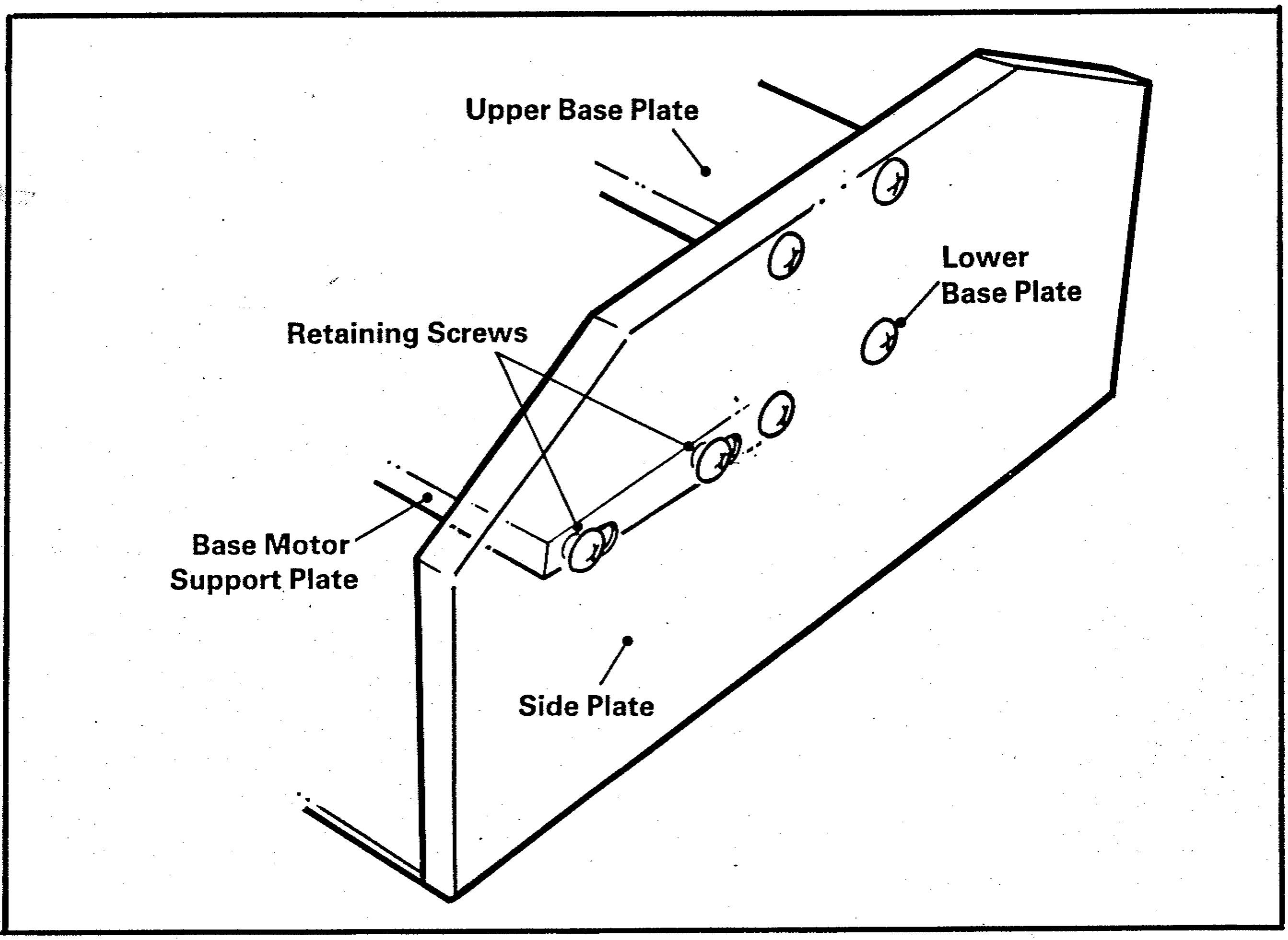
Remove base panel (mains switch side) see section B.
Remove stepper motor 6 pin connector.
Remove fan leads from connector block.
Remove 4 motor support plate retaining screws, see diagram D/2.
Push motor support plate inwards to disengage top belt from pulley.
Slide motor support plate outwards to clear side plates.
Slacken jockey pulley retaining screw.
Remove 3 stepper motor retaining screws, noting position of wires relative to mounting plate.
Reassemble in reverse order to above.
Adjust belts as in section D1 and D2.



Upper Belt Tension

D4 Replacing Upper Belt

Remove both base panels see section B.
Slacken 4 motor support plate retaining screws, see diagram D/2.
Push motor support plate inwards to disengage top belt from pulley.
Slide micro-card from location slots.
Remove 8 pin connector from front of card and 2 pin connector from rear of card. Micro-card and panel can now be removed completely from ATLAS. Remove wires marked 1, 2, 3 and 4 from terminal block.
Remove 3 pin connector from stepper drive card. Lift card from locations to allow connector to pass under card.
Remove 4 screws retaining upper and lower pivot plates to L.H side plate see diagram D/4.
Lie ATLAS over on L.H side (protect paintwork by placing soft cloth on work bench).
Remove 4 screws retaining upper and lower pivot plates to R/H side plate. Withdraw base assembly from ATLAS.
Remove belt by passing it over one end of lower pivot plate.
Reassemble in reverse order to above.
Adjust belt as in Section D2.



D5 Replacing Stepper Motor

Follow instructions as in section D3.

Note: Replacement motors are supplied with drive belt pulleys fitted.

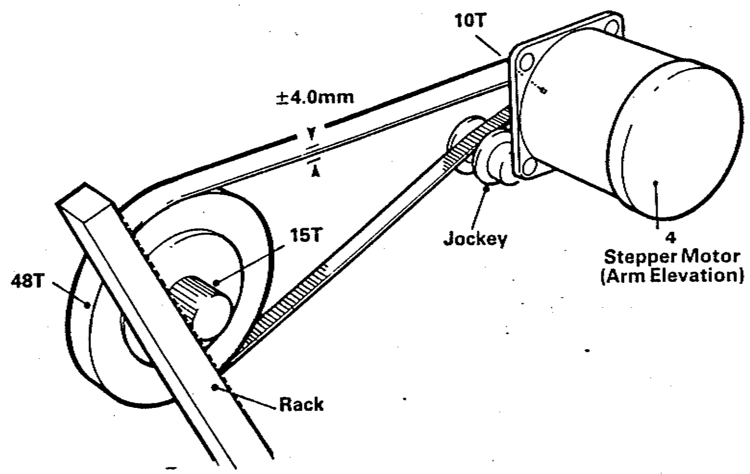
Section E Arm Elevation

General Description

The arm can be elevated +20° −60° from the horizontal position. Drive is by stepper motor via a toothed belt to a final rack and pinion drive mechanism. The pinion and jockey pulleys run on 'Oilite' bearings. Belt adjustment is provided by moving the pinion pulley in its locating slot.

E1 Belt Adjustment

Remove both side panels and the top panel, see Section B.
Slacken pinion pulley retaining screw.
Pull pulley back against belt.
To obtain required belt tension, see diagram E/2.
Tighten pulley retaining screw.
Refit panels.



E2 Replacing Belt

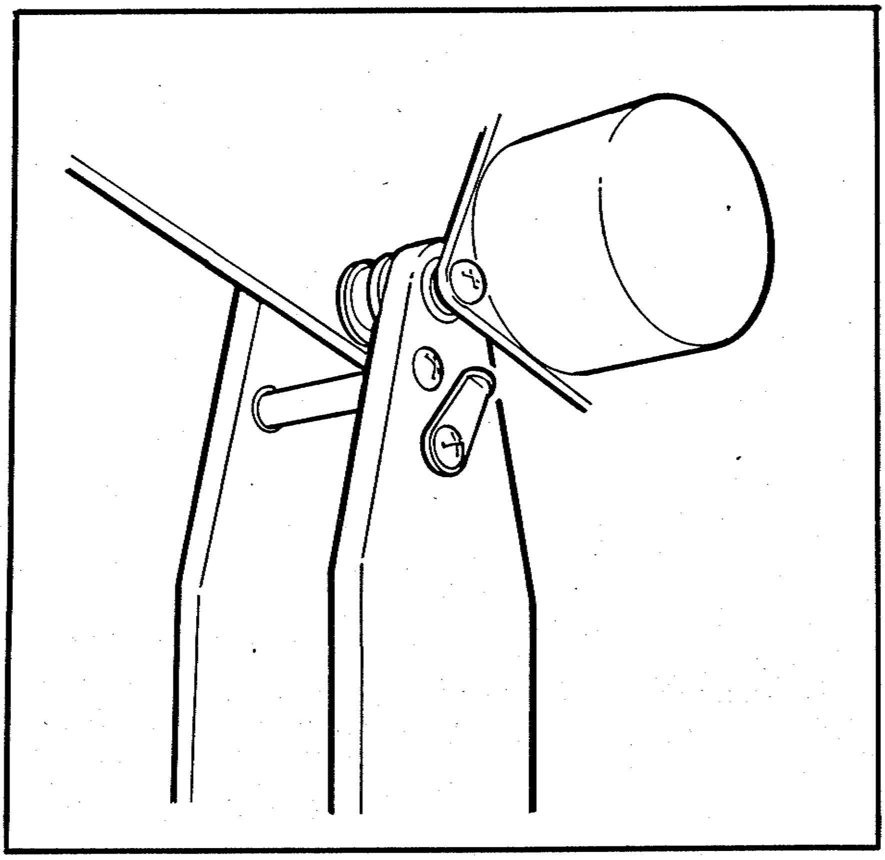
Remove both side panels and the top panel, see Section B.
Slacken pinion pulley retaining screw. Remove pinion runner plate retaining screw.
Remove pinion runner plate.
Disengage pinion from rack, allow rack to rest against base.
(Protect base paint work).

Slide pinion pulley forwards to slacken belt.
Remove belt from motor pulley.
Reassemble in reverse order to above.
Tension belt as in Section E1.
Lubricate rack as in Section A.

E3 Replacing Stepper Motor

Remove both side panels and the top panel, see Section B.
Slacken pinion pulley retaining screw.
Push pinion pulley forwards to slacken belt.
Remove 6 pin connector from elevation drive card.
Remove cable strap.
Remove 4 motor retaining screws. Access to the upper screw is provided through holes in L/H inner side plate.
Remove motor.
Reassemble in reverse order to above.
Adjust belt as in E1.

Note: Replacement motors are supplied with drive belt timing pulleys fitted.



E4 Down Limit Stop Adjustment

Slacken stop retaining screw. Rotate stop until abutment face sits squarely on stepper motor flange, see diagram E/3. Tighten retaining screw.

E5 Pinion Rack Adjustment

Set arm in horizontal position.
Slacken gib-strip lock nuts ½ turn.
Adjust 2 grub screws to obtain a 0.05mm clearance between rack and pinion see diagram E/4.
Tighten lock nuts.
Check clearance at extreme up/down limits.
Adjust gib strip if required.

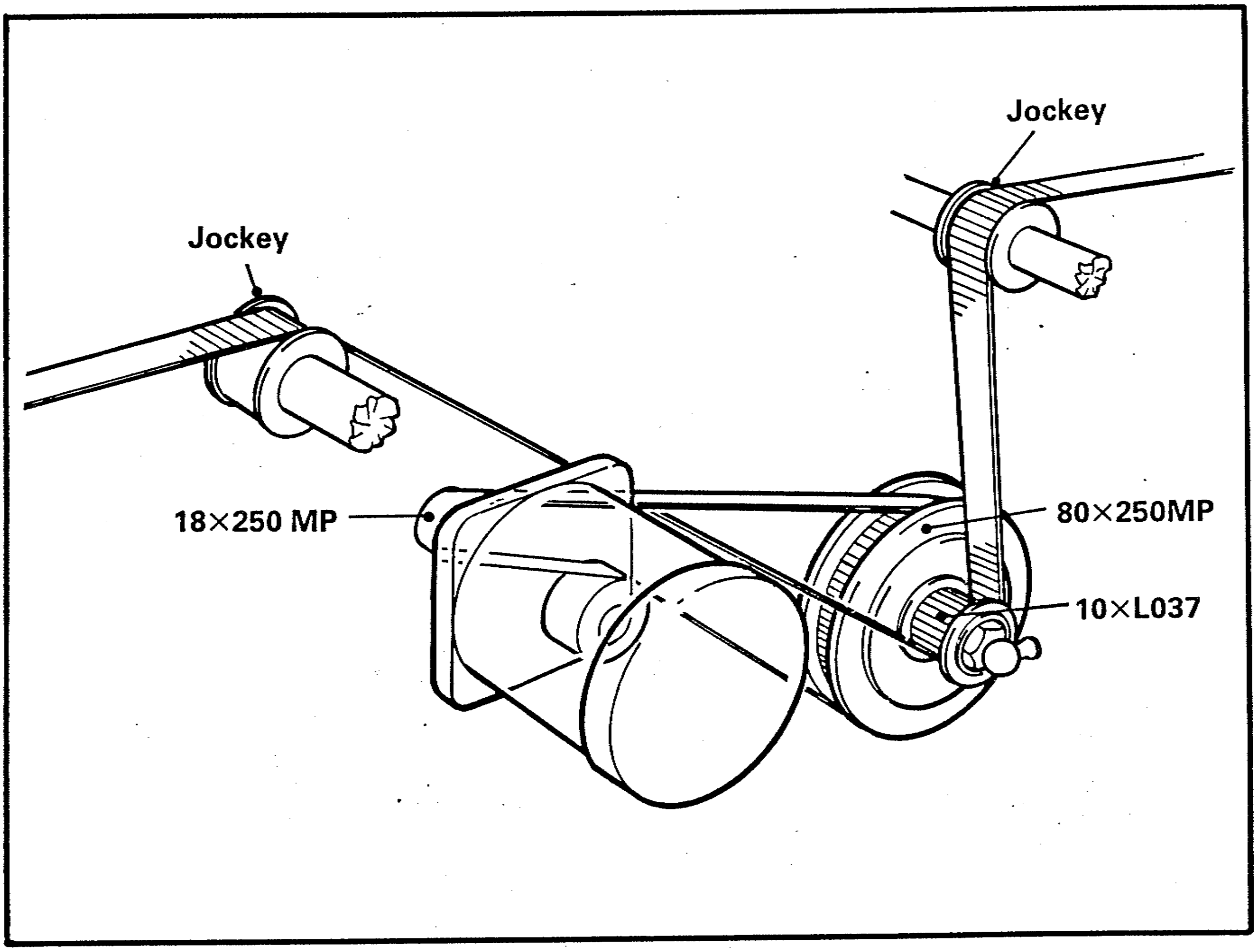
Section F Arm Extension

General Description

The arm consists of two main guide rails running in 'Oilite' bearings. The ends of the rails are located by spreader plates. These plates also carry the bearings for the JAW movement drive shafts. The arm has a maximum travel of 320mm. The extension mechanism is driven by stepper motor via a toothed belt to an intermediate shaft. This, in turn, drives a linear toothed belt, which is attached to the spreader plates. Belt adjustment is provided by a slotted location for the first belt pulley and a slotted anchor strap for the linear belt. See diagram F/1.

F1 Adjusting Linear Belt

Set arm to horizontal position.
Extend arm to outer limit.
Slacken socket head screw retaining belt strap on rear rail spreader.
Adjust belt to give tension shown in diagram F2. This should be achieved without deflecting arm. Tighten retaining screw.



F2 Adjusting Intermediate Drive Belt

Remove both side panels and the top panel, see Section B.
Slacken linear belt, see Section F1.
Slacken intermediate pulley retaining screw. Pull pulley assemble firmly backwards to obtain required belt tension, see diagram F/2.
Tighten retaining screw ensuring grease nipple faces towards the of the rear arm.
Adjust linear belt, see Section F1.
Replace panels.

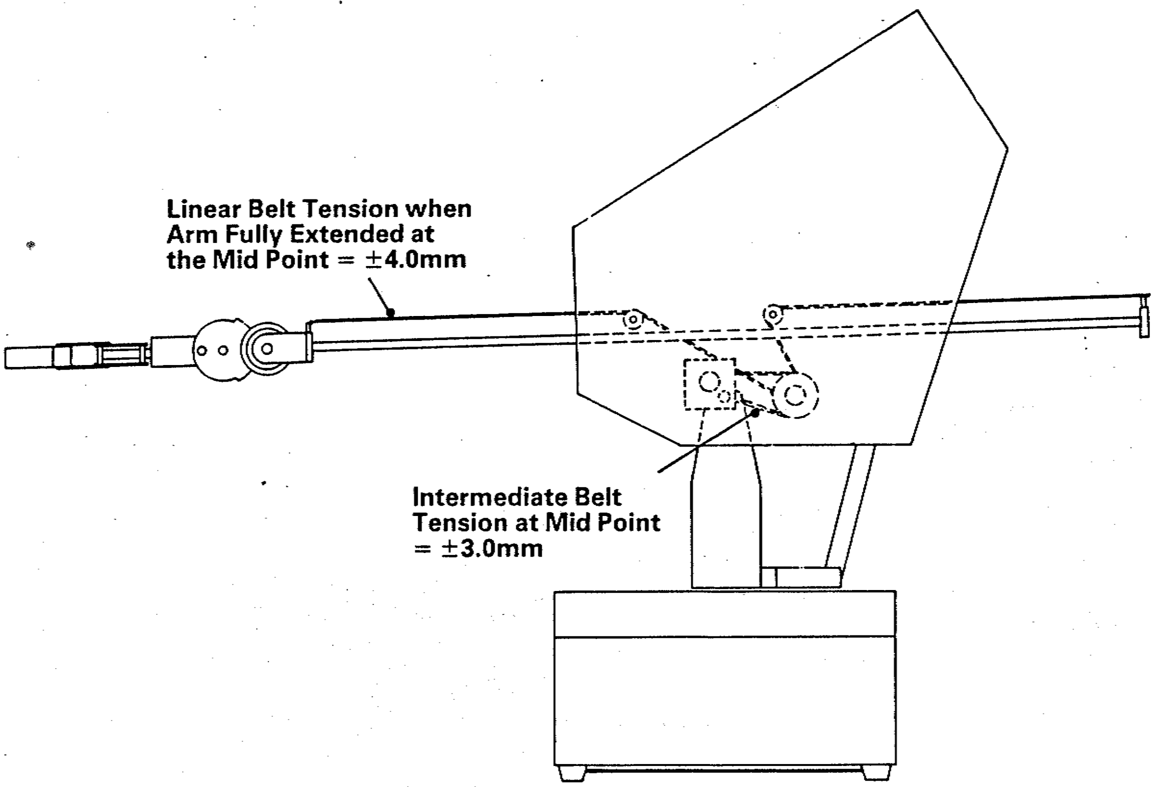


Diagram F2 - Correct Belt Tension Arm Extension

F3 Replacing Linear Belt

Remove both side panels and the top panel, see Section B.
Hinge-up the multiplexer board, see Section C.
Remove socket head screws retaining each end of belt.
Remove screw from each belt grip.
Remove belt grips from belt.
Remove belt from pulleys, and jockey wheels.
Refit replacement belt ensuring that it locates correctly on all pulleys.
Refit belt grips.
Refit belt retainers to spreader plates.
Adjust belt tension, see Section F1.
Replace the multiplexer board, see Section C.
Replace panels, see Section B.

F4 Replacing Intermediate Drive Belt

Slacken linear belt as in Section F1.
Remove intermediate belt retaining screw noting washer positions.
Remove pulley assembly.
Remove belt from motor pulley.
Refit replacement belt.
Replace pulley assembly ensuring grease nipple faces towards rear of arm.
Adjust belt, see Section F2.

F5 Replacing Stepper Motor

Remove top and side panels, see Section B.
Slacken linear belt, see Section F1.
Slacken first drive belt see Section F2.
Remove 6 pin connector from drive card.
Remove cable strap.
Remove 4 motor retaining screws, access to upper screws is provided through holes in R/H inner side plate.
Remove motor.
Reassemble in reverse order.
Adjust belts as in Section F1 and F2.

Note: Replacement motors are supplied with drive belt pulleys fitted.

F6 Resetting Guide Rails

Drive arm to its inner limit, stop.
Remove top bevel gear guard.
Slacken rail retaining screws at front end (one 'Posidrive' one hexagon head screw).
Retighten screws.
Drive arm to its outer limit, stop.
Slacken rail retaining screws at rear.
Retighten screws
Drive arm to both extreme limits several times to ensure it is not jamming.
Lubricate rails, see Section A.
Replace bevel gear cover.

Section G Wrist Elevation

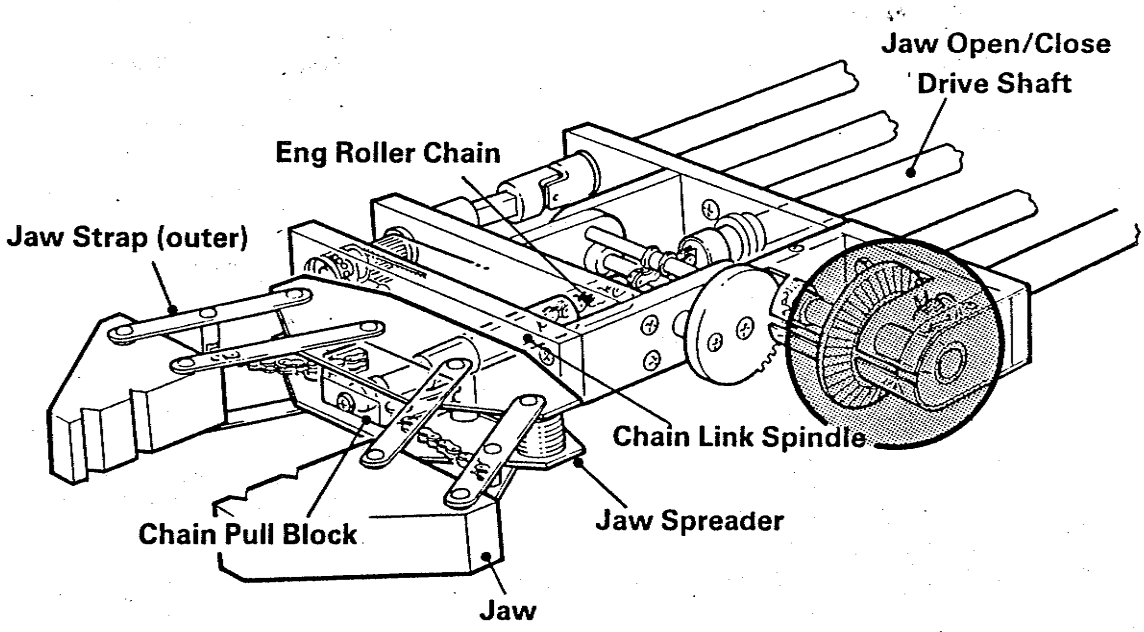
General Description

The wrist may be elevated ±70° from arm axis. Drive is by stepper motor through a reduction gearbox to a drive shaft which is an integral part of the arm. The drive shaft terminates in a bevel gear assembly driving an intermediate shaft. This shaft in turn rotates a gear quadrant which is attached to the wrist elevation arm.

The drive shaft runs in 'Oilite' bearings through the gearbox and is supported at each end by precision double sealed radial ball bearings. The intermediate shaft and wrist elevation shaft run in 'Oilite' bearings. The wrist elevation mechanism is shown in diagram G/1.

G1 Setting Wrist Elevation Reference Position

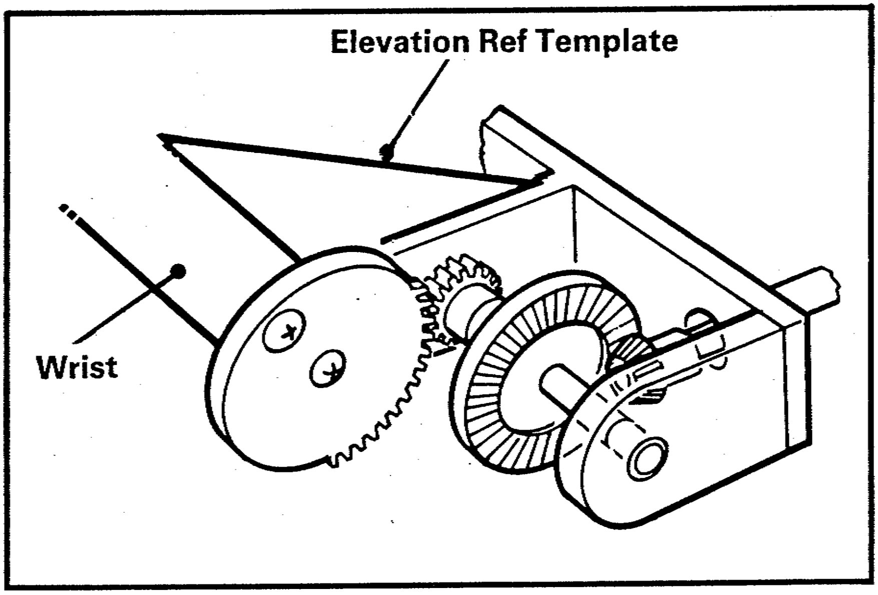
Return ATLAS to optical - electronic reference.
Remove bevel gear upper and lower guards.
Slacken two grub screws retaining large bevel gear.
Disengage bevel gear by sliding along shaft.
The jaws are now free to be elevated by hand.
Set jaw using template see diagram G/2.
Engage bevel gear by sliding back into mesh with small gear.
Pull large gear firmly against small gear to obtain minimum backlash.
Tighten two grub screws.
Lubricate bevel gears as in Section A.
Refit guards.



G/1. Setting Wrist Elevation Reference Position

G2 Bevel Gear Backlash

Refer to Section G1.



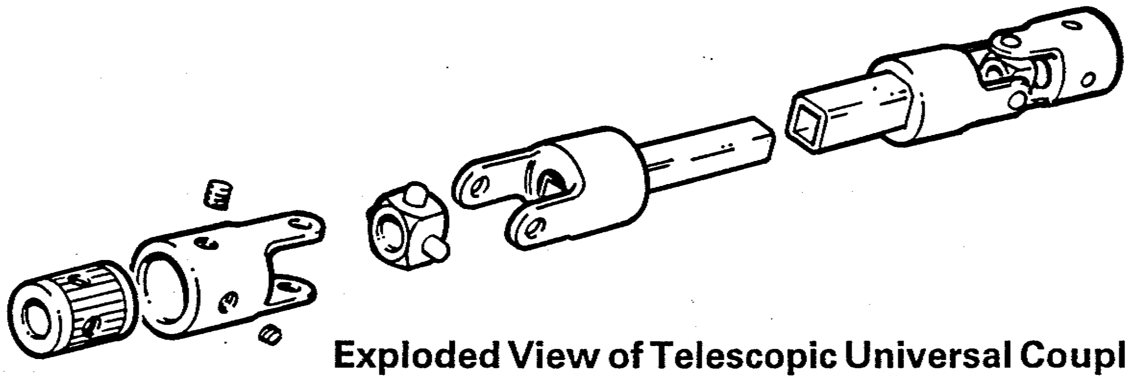
G3 Remove/Refit Jaw Assembly

Set arm, wrist elevation and jaw rotation to horizontal position.
Remove linear belt retaining screw from front rail spreader.
Remove chain adaptor retaining screw, see diagram G/3.
Remove chain adaptor (front).
Remove small 'Posidrive' screw retaining chain adaptor thrust bearing.
Remove chain adaptor (rear) and thrust bearing from shaft.
Slacken grub screws retaining telescopic universal coupling.
Slide coupling from shaft nearest jaw, allow coupling to fall from shaft.
Withdraw coupling from jaw rotation drive shaft.
Remove bevel gear guards.
Remove front rail retaining screws (one 'Posidrive', one hexagon head).
Gently ease jaw assembly from rails. It may be necessary to lightly tap the rail spreader in order to free it from drive shaft bearings.
Refitting jaw assembly is in reverse order to above.
Note orientation of universal coupling 'ears', see diagram G/4.
Set bevel gear backlash as in Section G1.
Set linear belt tension as in Section F1.
Set guide rails as in Section F6.
Set jaw reference positions as in Sections G1, H1 and I1.

Note: Replacement jaw assemblies are available from manufacturers.

G4 Replacing Stepper Motor

Remove side and top panels as in Section B.
Hinge up circuit boards as in Section C.
Slacken 2 grub screws retaining universal coupling to motor.
Remove motor retaining screws.
Withdraw motor.
Refitting motor is reverse of above procedure.
Reset jaw elevation reference position, see Section G1.



Exploded View of Telescopic Universal Coupling as used on ATLAS II

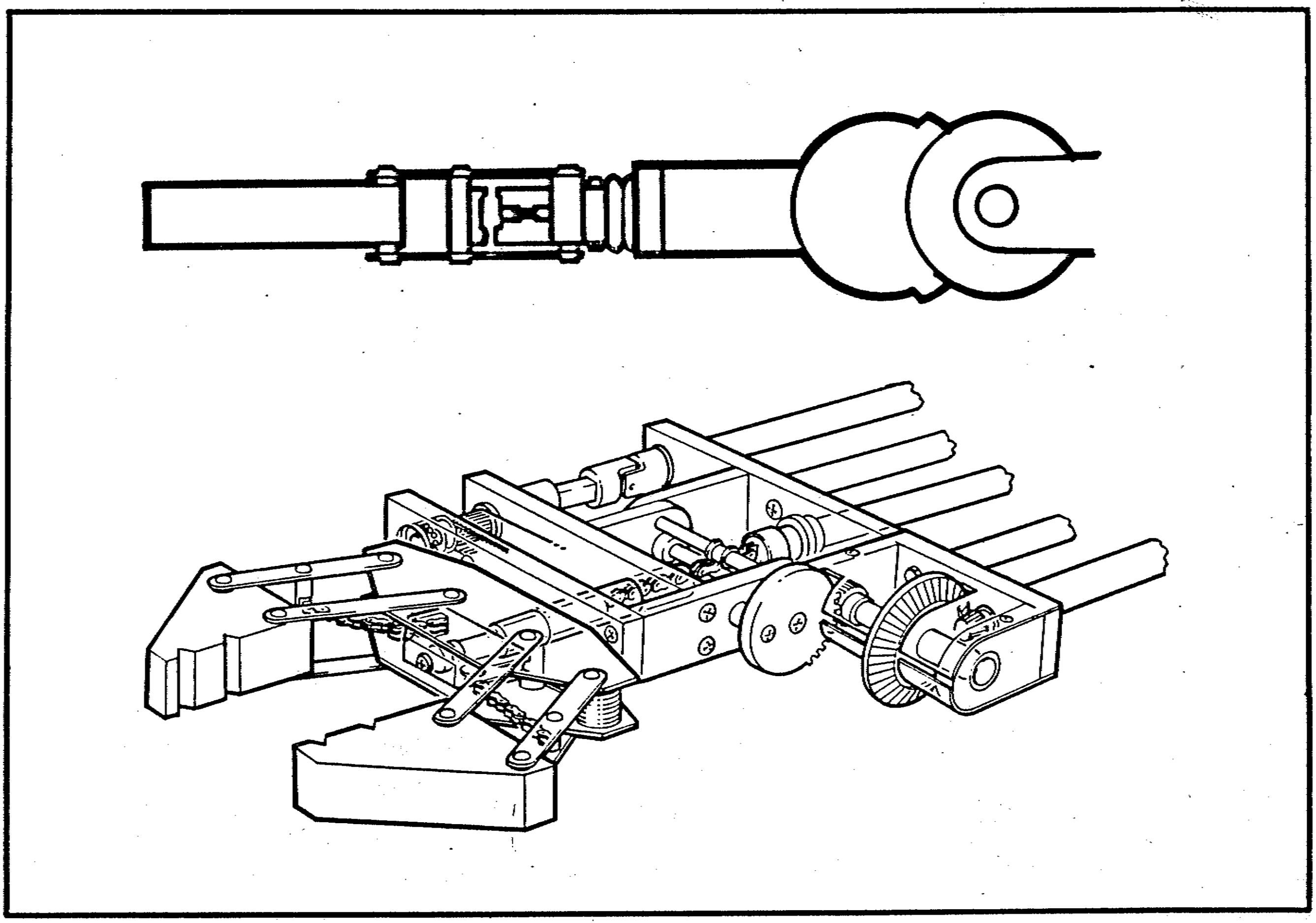
Section H Wrist Rotation

General Description

Continuous rotation of the wrist is provided by stepper motor through a reduction gearbox to a drive shaft. This drive shaft is an integral part of the arm. The final drive is via a toothed belt. The drive shaft runs in 'Oilite' bearings through the gearbox and is supported at each end by precision double sealed radial bearings. The jaw rotation spindle runs in 'Oilite' bearings with a ball thrust race between jaw mechanism and bush.

H1 Setting Wrist Rotation Reference Position

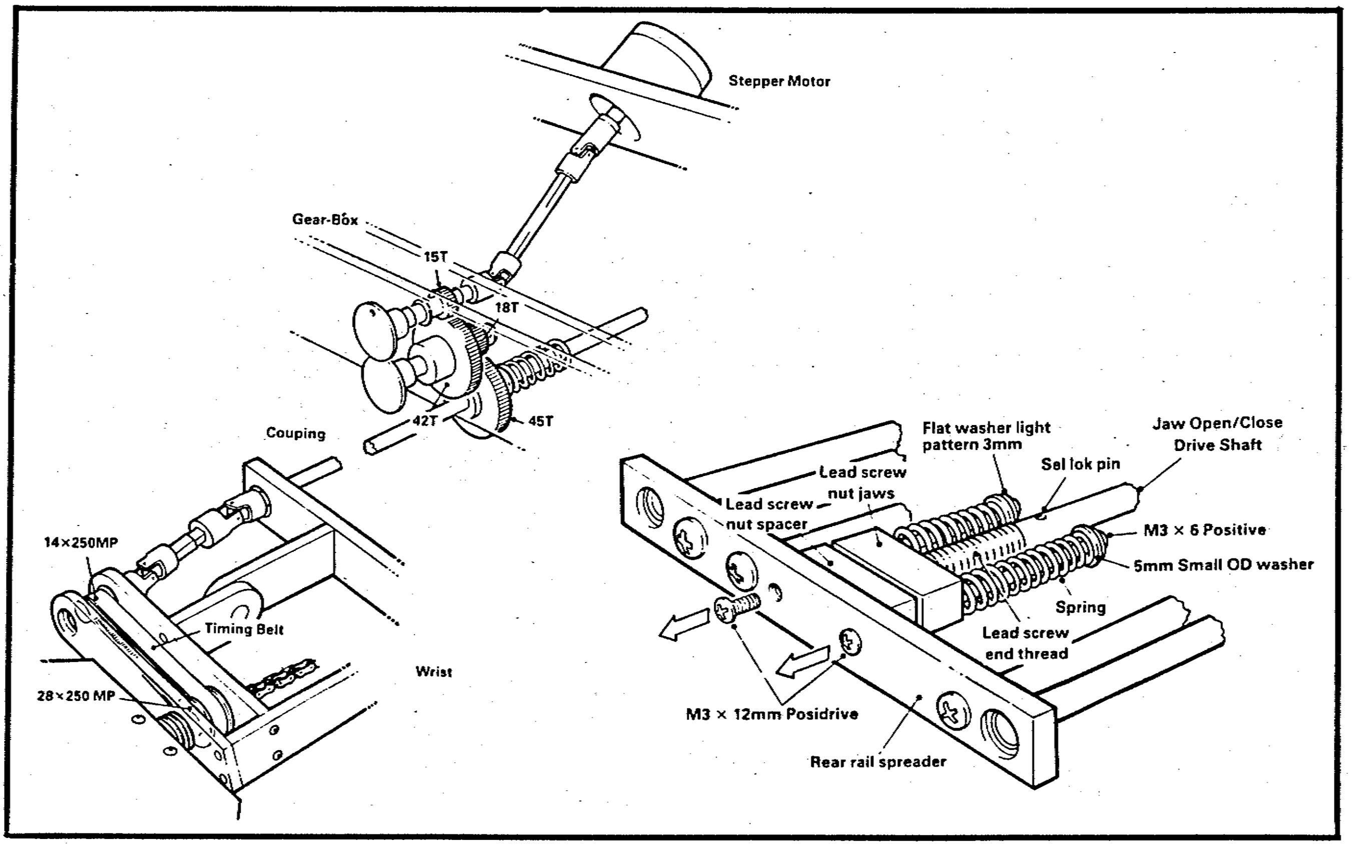
Return ATLAS to optical - electronic reference.
Slacken two grub screws retaining telescopic coupling to drive shaft.
Turn jaws so they are parallel with rotation bearing plates, see diagram H/1.



H2 Remove/Refit Belt

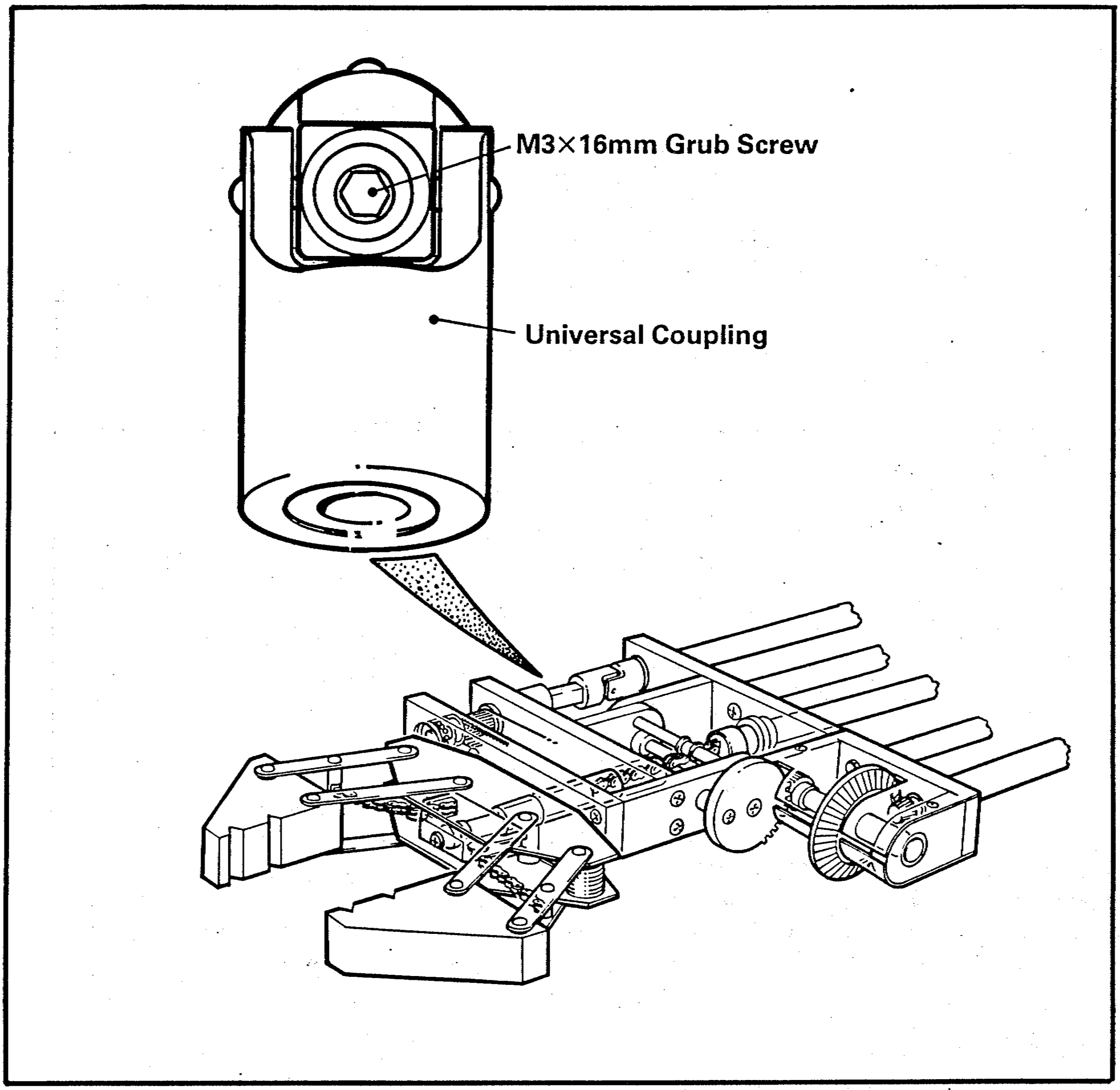
Remove two screws retaining lead screw nut spacer to rear spreader plate, see diagram H/2.
Release chain spring link by prising open with small screw-driver.
Slacken jaw rotation pulley grub screws.
Withdraw jaw rotation shaft from pulley and bearings.
Remove two screws on R/H side of jaw rotation plate.
Slacken screw on L/H side of jaw rotation plate.
Remove belt from R/H side of jaw rotation plate by easing plate forward.
Refit replacement belt.
Replace two screws in R/H side of jaw rotation plate, leaving screws slack.
Use a 3/8" DIA dummy shaft to align rotation 'Oilite' bearings.
Tighten three jaw rotation plate retaining screws.
Reassemble in reverse order to above, noting the following points.

The jaw rotation pulley is fitted with boss to rear of ATLAS.
Ensure chain is correctly located on rollers.
To provide slack in chain to help fitting spring joining link, a small wire such as a paper clip can be inserted vertically through chain link to hold jaws closed, see diagram H/5.



H3 Telescopic Coupling Backlash Adjustment

Elevate wrist to limit.
Rotate jaw until access is obtained through hole in spider of coupling, see diagram H/3.
Using 1/16"A/F hexagon key, turn grub screw C/W until backlash is eliminated from square coupling shaft.



H4 Changing Telescopic Coupling

See Section G3.

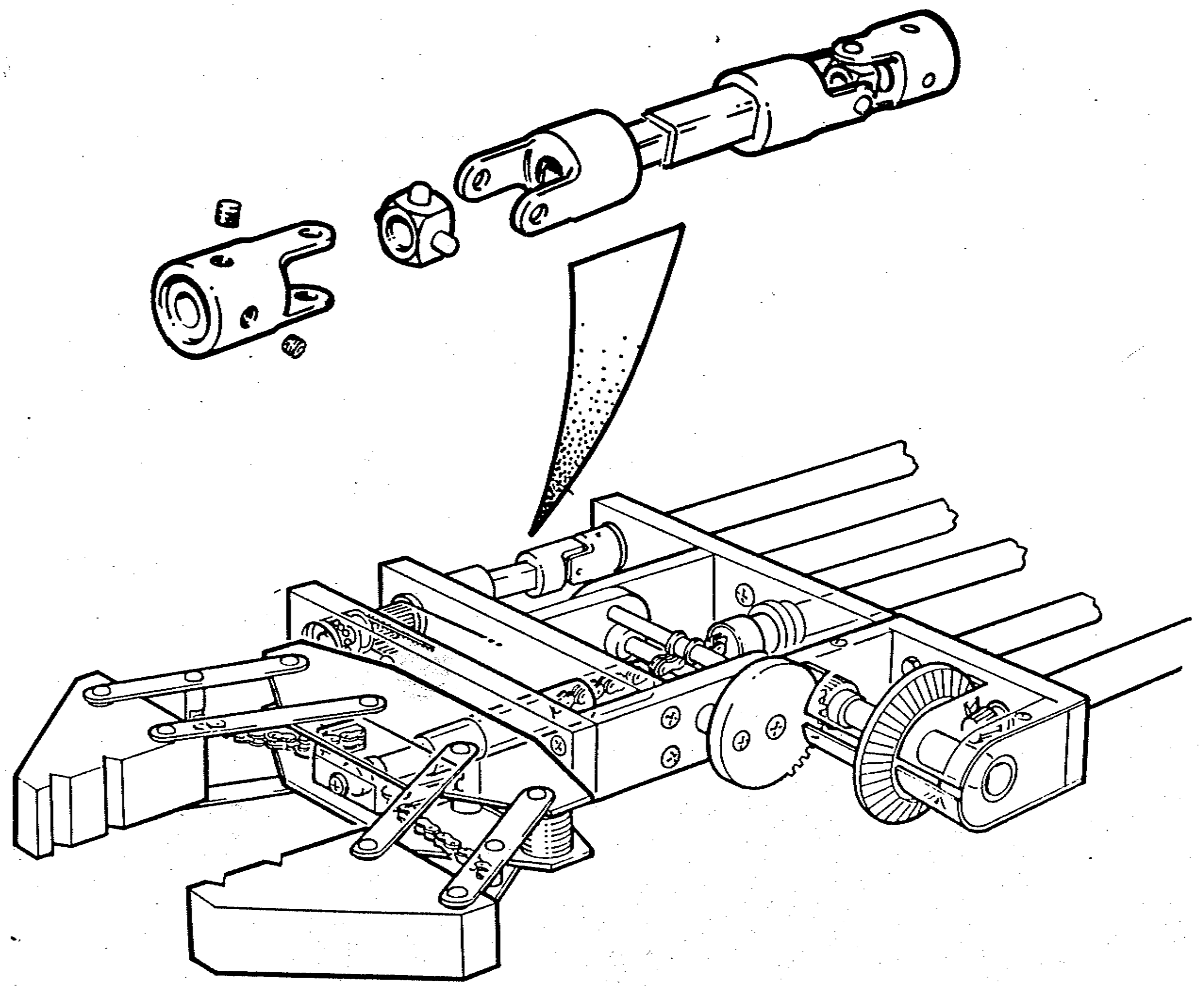


Diagram H/4

H5 Changing Stepper Motor

See Section G4.
Reset wrist rotation reference position see Section H.

Section I Jaw Open/Close

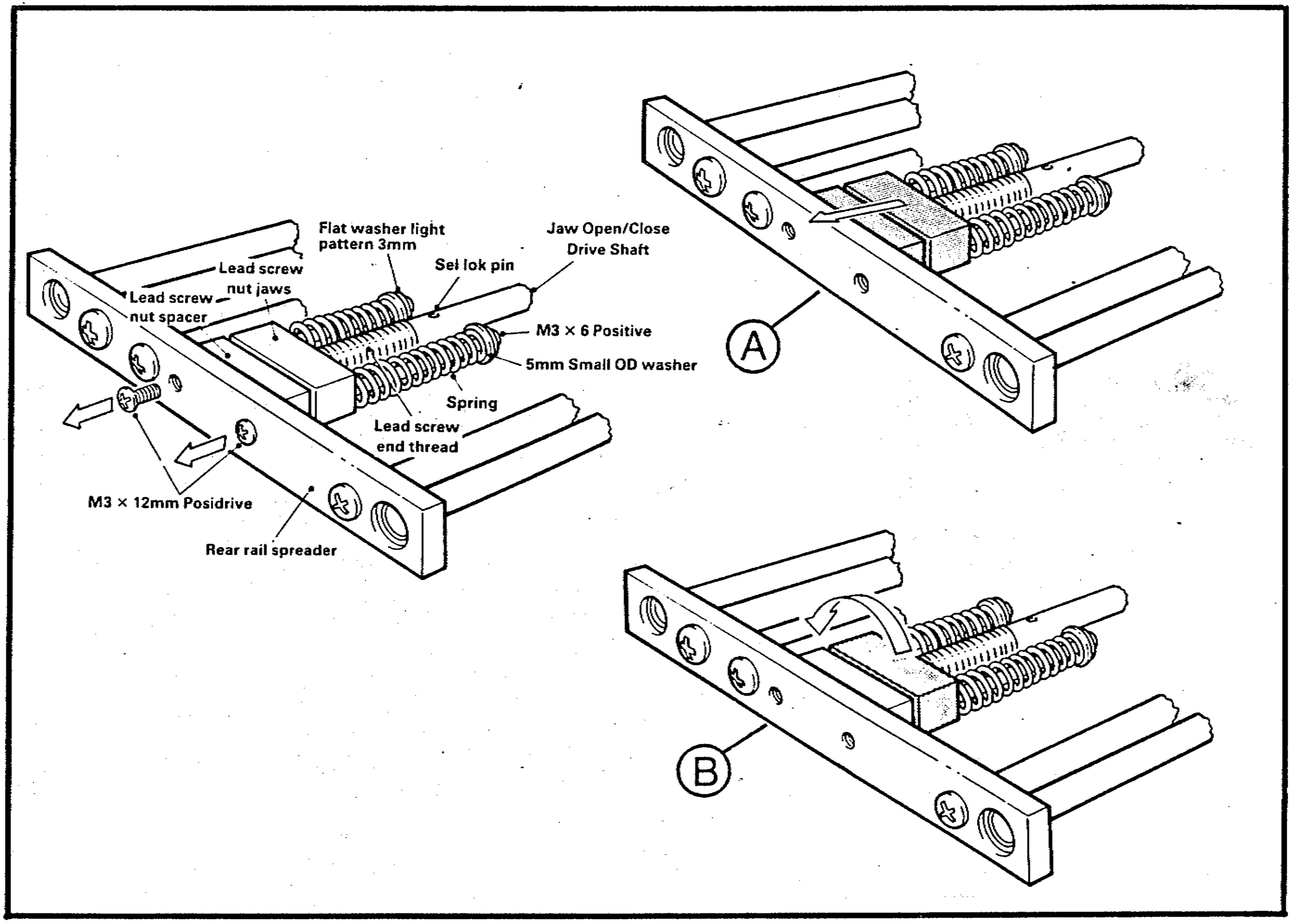
General Description

This is a two jaw parallel motion gripper. It is activated by twin draw chains which are attached to a rotating lead-screw. This mechanism is stepper motor driven via a gearbox to the lead-screw shaft.

The jaw gripper pressure is by twin compression springs and is released by cylindrical torsion springs. The jaw mechanism is shown in diagram I/1.

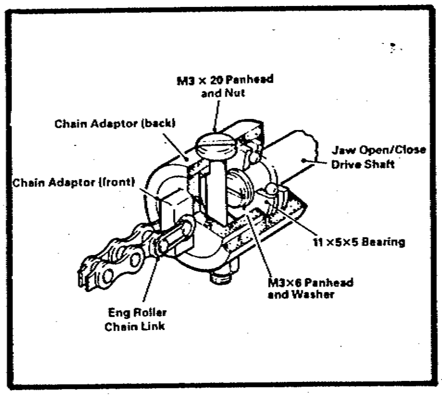
I1 Jaw Setting

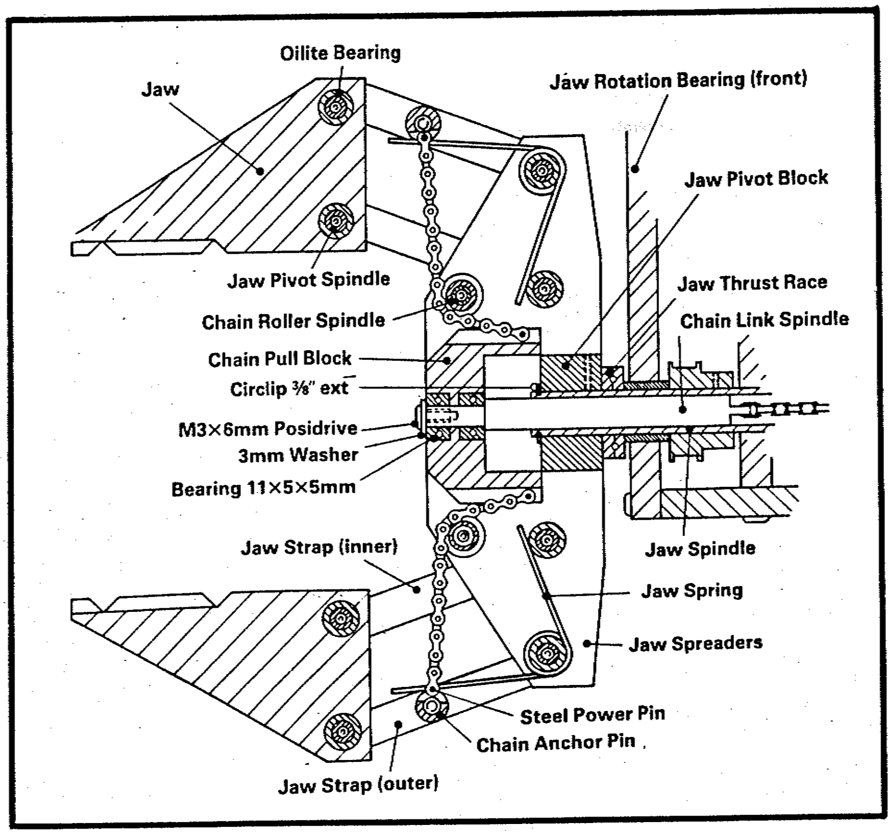
Return ATLAS to optical - electronic reference.
Remove two screws retaining lead screw nut spacer, see diagram H/4.
With one hand, pull lead screw assembly back against rear rail spreader. Ⓐ
Check width of jaw opening, this should be 50mm +2mm.
To decrease setting turn nut assembly C/W **Viewed from rear of ATLAS.** Ⓑ
To increase setting turn nut CC/W.
One turn moves jaw approximately 3mm.
When setting is correct replace 2 retaining screws.



I2 Remove/Refit Chain

Remove jaws as in Section H2.
Remove thrust bearing. With jaws removed from ATLAS hold jaws together and remove chain spring joining link from chain spindle.
Remove chain from chain spindle.
To remove twin chains proceed as follows, see diagram I/2.
Withdraw chain pull block as far as possible.
Drive out two 1/16" DIA 'Sel-Lok' pins.
Remove chain anchor pin retaining screws.
Remove anchor pin and chain from jaw assembley, note pins are spring loaded.
Remove chains.
To refit chains replace anchor pins but retain only on one screw, taking note that jaw return springs are located correctly.
Place end of chain in anchor pin slot.
Push chain retaining pin through open end of anchor pin and through hole in chain link.
Replace other anchor pin retaining screw.
Refit other end of chain to pull block.
Hold jaws closed and fit single chain to chain spindle using spring joining link.
Operate jaw by hand to ensure that it functions correctly.
Ensure chains are located correctly on rollers.
Refit assembly as in section H2.





I3 Changing Stepper Motor

See Section G4.

Reset jaws as Section I1.

Section J Gearbox

General Description

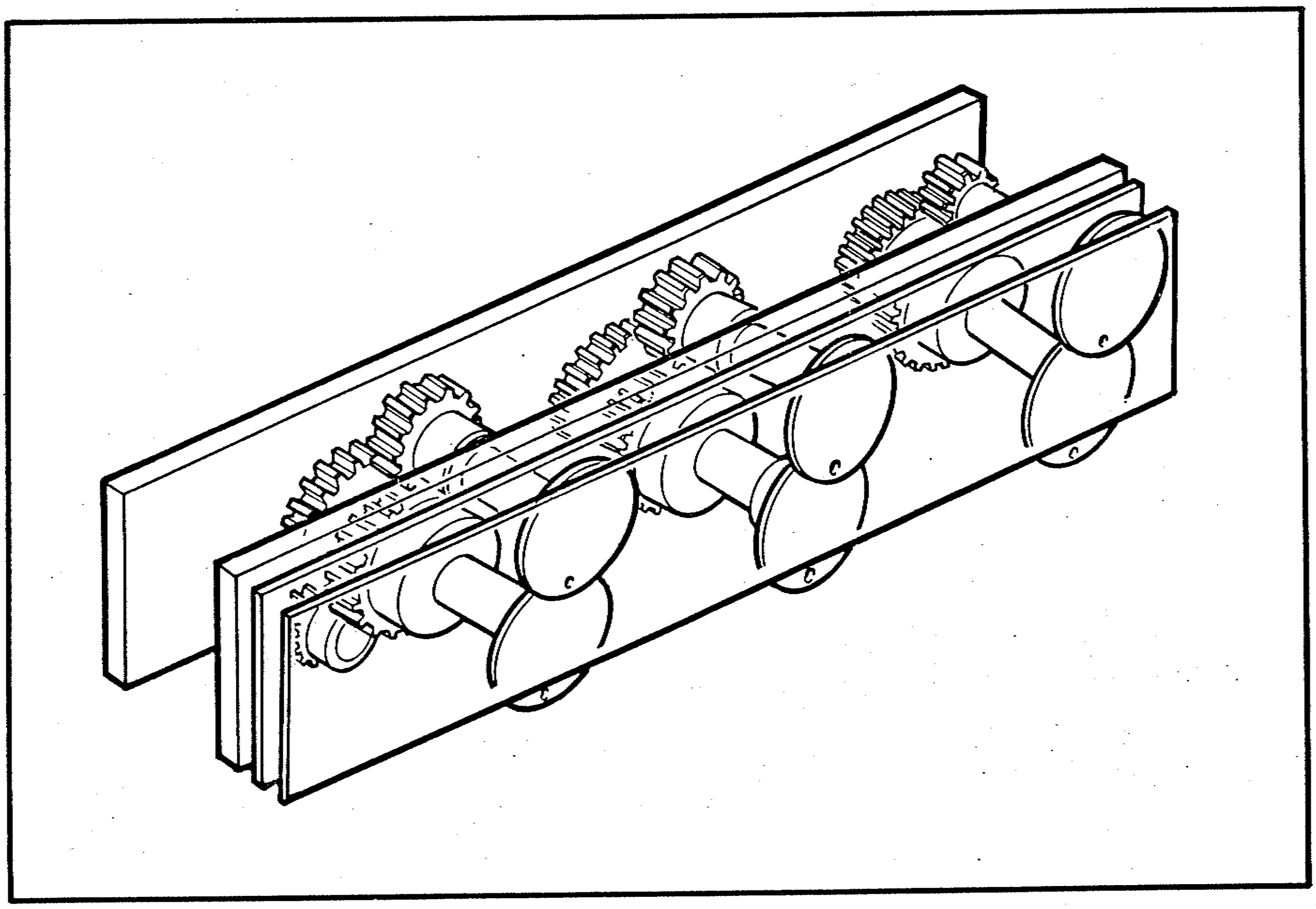
The three jaw functions are all driven via a gearbox. Each function has an input shaft, intermediate shaft and output drive shaft. All gears are Involute Spur Gears.

The input shaft gears are steel meshing with a nylon gear on the intermediate shaft. The intermediate shaft also has a steel gear which is in mesh with a brass gear on the output drive shaft. Transmission from the brass gear to the output shaft is by a key in a keyway.

The gearbox shafts all run on 'Oilite' bearings. Attached to the ends of the input and intermediate shafts are the optical limit switch discs.

The gearbox has no user serviceable parts and only requires periodic lubrication. (see Section A).

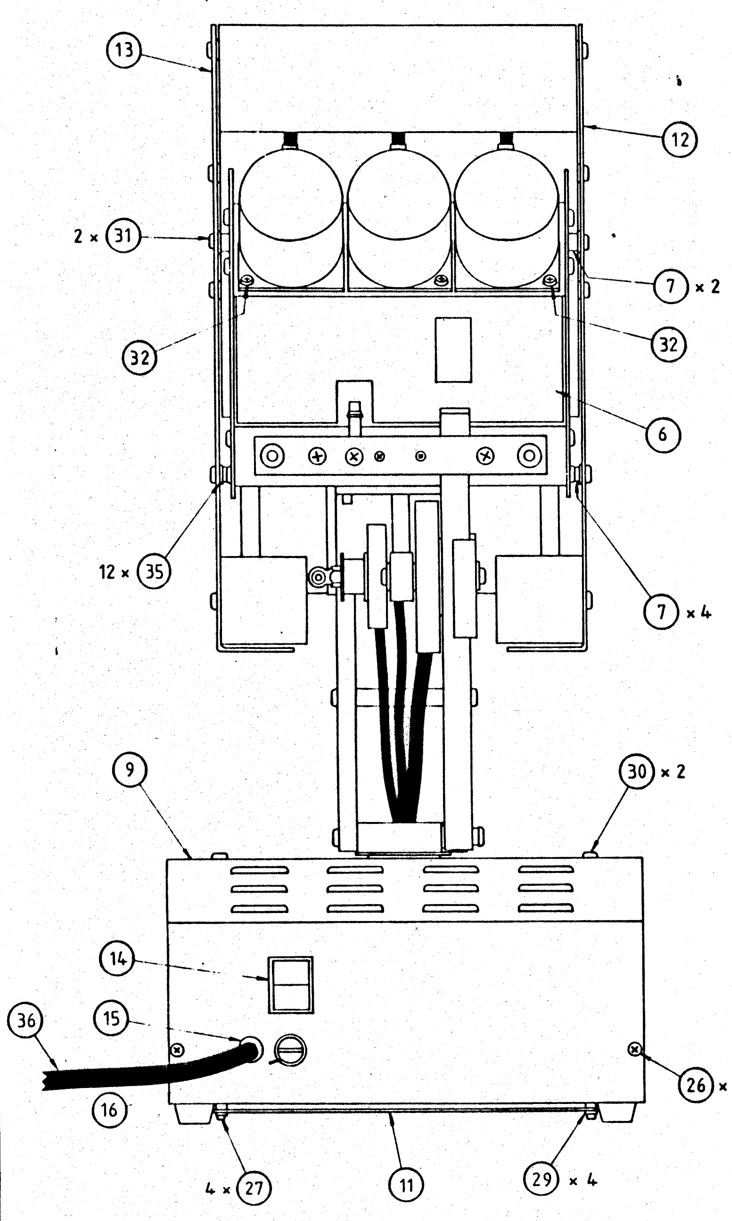
In the event of a gearbox fault, this should be referred to the manufacturers' service department.



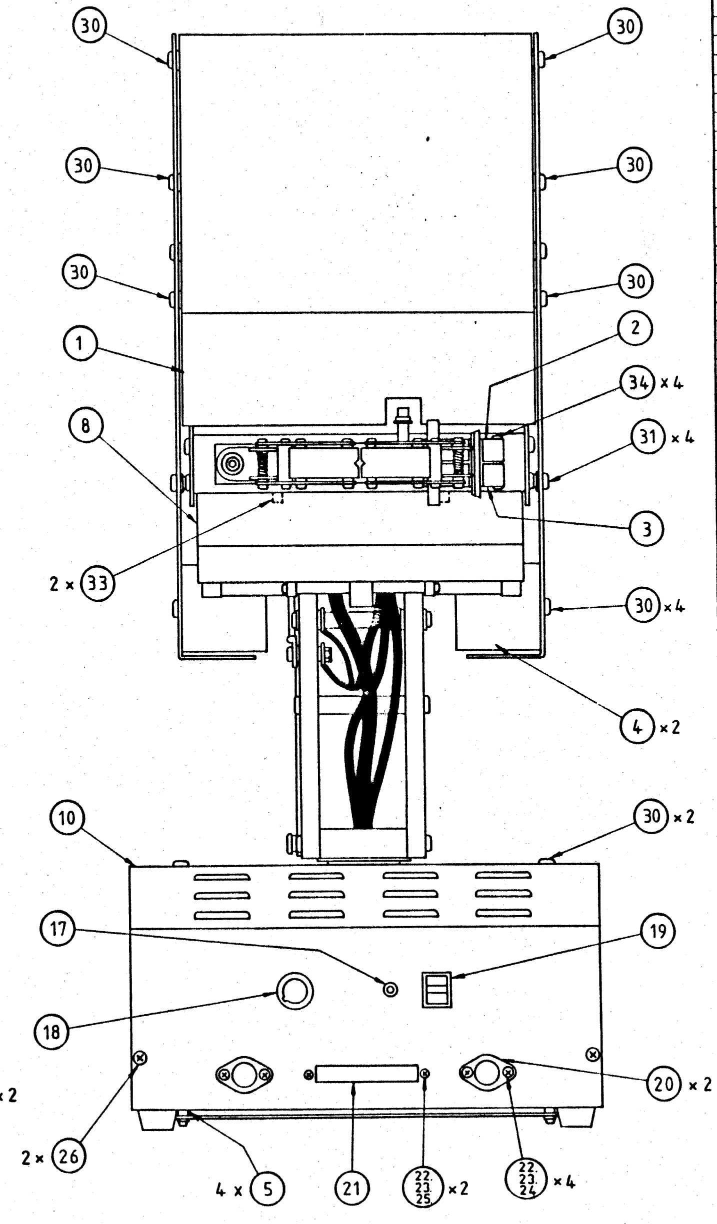
ATLAS Technical Manual

Section K General Assembly Drawings

REAR VIEW

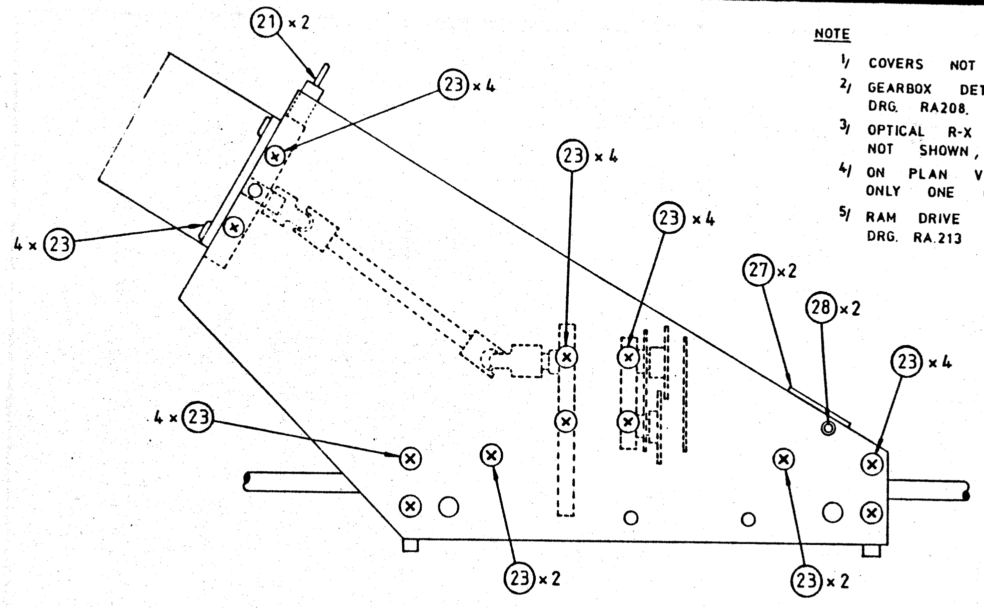


FRONT VIEW



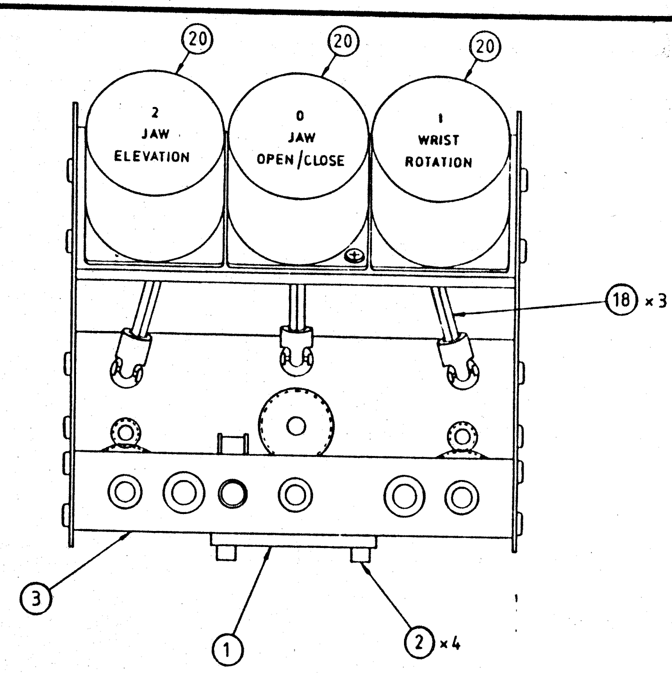
No.	PART No	DESCRIPTION
1	RA130	TOP COVER
2	RA135	ELEVATION GEARWHEEL COVER GUARD (TOP)
3	RA134	ELEVATION GEARWHEEL COVER GUARD (BOT)
4	RA136	BALANCE BLOCK
5	RA614	M4 x 4 mm SPACER
6	RA129	REAR COVER
7	RA133	OUTERSIDE PANEL SPACER
8	RA128	FRONT COVER
9	RA127	BASE REAR SIDE PANEL
10	RA126	BASE FRONT SIDE PANEL
11	RA002	BASE SHIELD
12	RA131	OUTER SIDE PANEL (LEFT)
13	RA132	OUTER SIDE PANEL (RIGHT)
14	AS015	MAINS ROCKER SWITCH
15	AH007	RUBBER GROMET
16	AH021	FUSE HOLDER
17	A005	RED L.E.D.
18	AS002	8 - WAY ROTARY SWITCH
19	AS018	PADDLE SWITCH
20	AS023	DIN SOCKET
21	AT044	34 - WAY CONNECTOR
22	AF004	M3 SHAKE PROOF WASHER
23	AF001	M3 NUT NICKEL PLATED
24	AF008	M3 x 6mm PANHEAD POSIDRIVE (N. P.)
25	AF009	M3 x 10mm PANHEAD POSIDRIVE (N. P.)
26	RA581	M4 x 6mm PANHEAD POSIDRIVE
27	AS002	M4 x 10mm PANHEAD POSIDRIVE (N. P.)
28	AF015	M4 NUT (NICKEL PLATED)
29	RA593	M4 SHAKE PROOF WASHER
30	RA595	M5 x 10mm PANHEAD POSIDRIVE
31	RA596	M5 x 16mm PANHEAD POSIDRIVE
32	RA597	M5 x 20mm PANHEAD POSIDRIVE
33	RA616	M5 x 6mm CAP HEAD
34	RA581	M3 x 6mm PANHEAD POSIDRIVE
35	RA617	NEBAR WASHER
36	AW001	MAINS LEAD

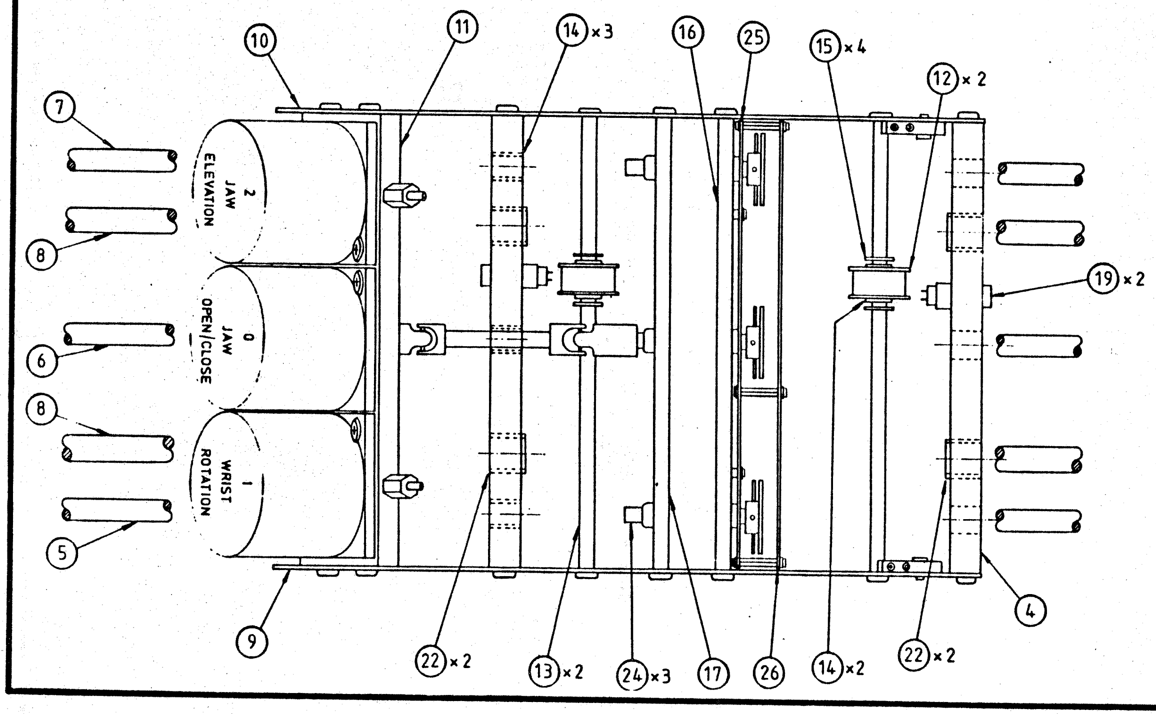
NOTE
EXCLUDING BALANCE BLOCK MOUNTING SCREWS, NEBAR WASHERS TO BE USED ON ALL SCREWS ON OUTER SIDE COVERS AS SHOWN.



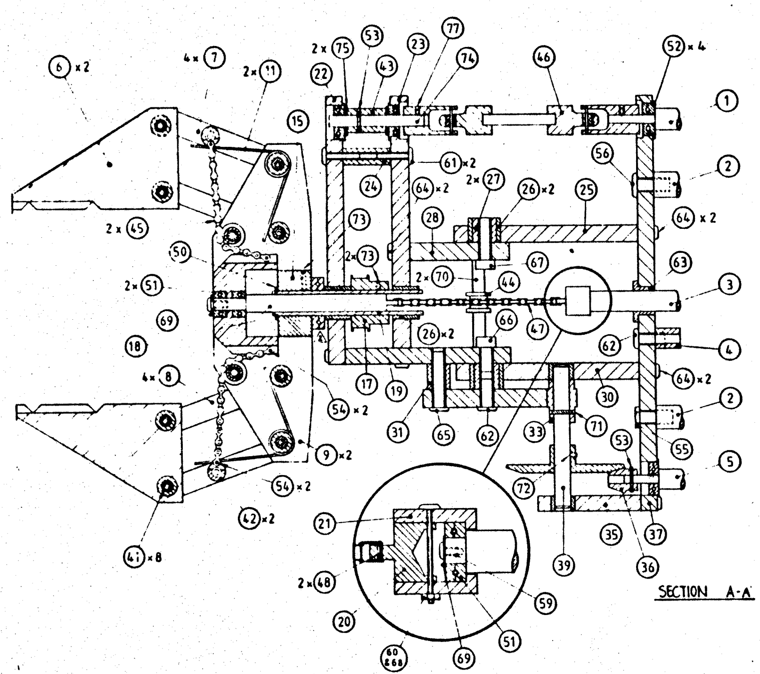
NOTE

1/ COVERS NOT SHOWN, SEE DRG. RA212.
2/ GEARBOX DETAIL NOT SHOWN, SEE DRG. RA208.
3/ OPTICAL R-X & T-X BOARD DETAILS NOT SHOWN, SEE DRG. RA209.
4/ ON PLAN VIEW FOR CLARITY ONLY ONE COUPLING SHOWN.
5/ RAM DRIVE BELT NOT SHOWN, SEE DRG. RA.213





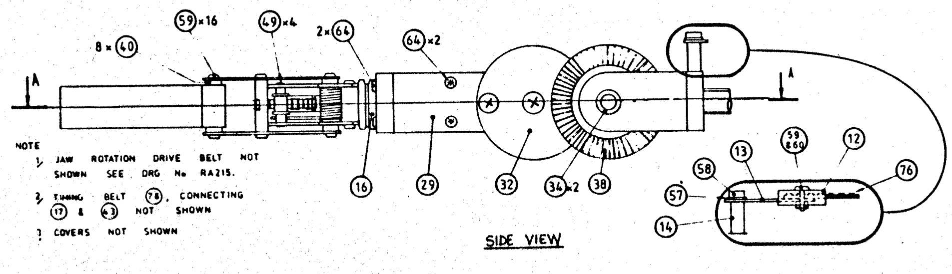
No.	PART No.	DESCRIPTION
1	RA041	MOTOR BODY MOUNTING PLATE
2	RA607	M5 x 10 CAP HEAD
3	RA059	ARM BEARING SUPPORT (REAR)
4	RA058	ARM BEARING SUPPORT (FRONT)
5	RA081	JAW ELEVATION DRIVE SHAFT
6	RA080	JAW OPEN / CLOSE DRIVE SHAFT
7	RA079	WRIST ROTATION DRIVE SHAFT.
8	RA078	FIXED RAIL
9	RA055	INNER SIDE PANEL (LEFT)
10	RA056	INNER SIDE PANEL (RIGHT)
11	RA057	MOTOR MOUNTING PLATE
12	RA066	·437" BORE JOCKEY PULLEY
13	RA051	PULLEY SPINDLE
14	RA537	OILITE BEARING 5/16" I D x 7/16" OD x 1/2" LG
15	RA525	NO GROOVE CIRCLIP 8mm
16	RA060	FRONT GEARBOX PLATE
17	RA061	REAR GEARBOX PLATE
18	RA528	COUPLING (LARGE)
19	AS017	LIMIT SWITCH
20	AM038	6V. 1·2A STEPPER MOTOR
21	AF049	PCB MOUNTING PILLAR PLASTIC
22	RA541	OILITE BEARING 3/8" I D x 5/8" OD x 5/8" LG
23	RA595	M5 x 10 PANHEAD POSIDRIVE
24	RA062A	UPPER GEARBOX SHAFT
25	LJE149	ATLAS OPTO T/X PCB
26	LJE150	ATLAS OPTO R/X PCB
27	RA052	P.C.B HINGES
28	RA588	5mm RIVET



SECTION A-A

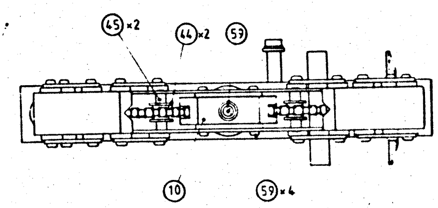
No.	PART No.	DESCRIPTION
1	RA081	WRIST ROTATION DRIVE SHAFT.
2	RA078	FIXED RAIL.
3	RA080	JAW OPEN / CLOSE DRIVE SHAFT.
4	RA083	LIMIT SWITCH STOP (FRONT).
5	RA079	JAW ELEVATION DRIVE SHAFT
6	RA124	JAWS
7	RA122	JAW STRAP (OUTER).
8	RA121	JAW STRAP (INNER).
9	RA113	JAW SPREADERS
10	RA120	CHAIN PULL BLOCK.
11	RA521	JAW SPRING (FRONT).
12	RA088	BELT CLAMP
13	RA086	RAM FRONT STRAP
14	RA085	BELT LIFT PILLAR
15	RA112	JAW PIVOT BLOCK
16	RA532	JAW THRUST RACE 3/8" BORE.
17	RA516	JAW ROTATION PULLEY (28T).
18	RA119	CHAIN LINK SPINDLE.
19	RA111	JAW SPINDLE.
20	RA117	CHAIN ADAPTOR (FRONT).
21	RA118	CHAIN ADAPTOR (BACK).
22	RA108	JAW ROTATION BEARING (FRONT)
23	RA107	JAW ROTATION BEARING (BACK)
24	RA109	ROTATION BEARING SPACER
25	RA092	ELEVATION PIVOT PLATE
26	RA539	OILITE BEARING 3/8" I.D x 1/2" OD. x 3/8 LG.
27	RA101	WRIST PIVOT PIN
28	RA103	JAW ROTATION SIDE PLATE (RIGHT).
29	RA102	JAW ROTATION SIDE PLATE (LEFT)
30	RA093	ELEV. GEARSHAFT & PIVOT SUPPORT
31	RA097	ELEVATION GEAR SPACER.
32	RA553	BRASS SPUR GEAR (60T)
33	RA554	MILD STEEL SPUR GEAR (20T)
34	RA535	OILITE BEARING 1/4" I.D x 3/8" OD. x 1/4" LG.
35	RA094	ELEVATION GEARSHAFT SUPPORT.
36	RA555B	SMALL BEVEL GEAR 28T
37	RA076	FRONT RAIL SPREADER.
38	RA555A	LARGE BEVEL GEAR (48T)
39	RA095	ELEVATION GEARSHAFT
40	RA548	OILITE BEARING 3/16" I.D. x 5/16" O.D. x 3/4" LG.
41	RA114	JAW PIVOT SPINDLE
42	RA123	CHAIN ANCHOR PIN

No	PART No	DESCRIPTION
43	RA514	14T JAW ROTATION PULLEY
44	RA106	CHAIN ROLLER
45	RA116	CHAIN ROLLER SPINDLE (1/2")
46	RA527	SMALL COUPLING
47	RA505	ENG. ROLLER CHAIN 1475 PITCH
48	RA506	ENG. ROLLER CHAIN LINK
49	RA586	M3 x 5mm COUNT. POSIDRIVE
50	RA526	CIRCLIP 3/8" EXT.
51	RA530	BEARING 11mm x 5mm x 5mm
52	RA531	BEARING 1/2" x 3/16" x 3/16" FLANGED
53	RA570	SEL-LOK PIN 1/16 x 7/16 LG
54	RA568	STEEL POWER PIN 1/16" x 3/8"
55	RA594	M5 x 16mm HEX.
56	RA596	M5 x 16mm PANHEAD POSIDRIVE
57	RA613	4mm NICKEL PLATED WASHER
58	RA592	M4 x 20mm CAP HEAD.
59	RA581	M3 x 6mm PAN HEAD POSIDRIVE
60	RA585	M3 NUT
61	RA591	M4 x 12mm PANHEAD POSIDRIVE
62	RA595	M5 x 10mm PANHEAD POSIDRIVE
63	RA545	OILITE BEARING 5/16" I.D. x 1/2" O.D x 3/8
64	RA583	M3 x 12mm PANHEAD POSIDRIVE
65	RA605	M5 x 25mm PANHEAD POSIDRIVE
66	RA607	M5 x 10mm CAPHEAD
67	RA608	M5 x 16mm CAPHEAD
68	RA584	M3 x 20mm PANHEAD POSIDRIVE
69	RA579	3mm WASHER (LIGHT PATTERN)
70	RA105	CHAIN ROLLER SPINDLE (1·82)
71	RA571	SEL-LOK PIN 3/32" x 7/16" LG.
72	RA590	M4 x 4mm GRUB SCREW
73	RA580	M3 x 3mm GRUB SCREW
74	RA110	ROTATION PULLEY SPINDLE
75	RA606	5mm SMALL O.D. WASHER
76	RA084	RAM BELT DRIVE
77	RA611	M3 x 4mm GRUB SCREW
78	RA504	TIMING BELT 87 x 250MP

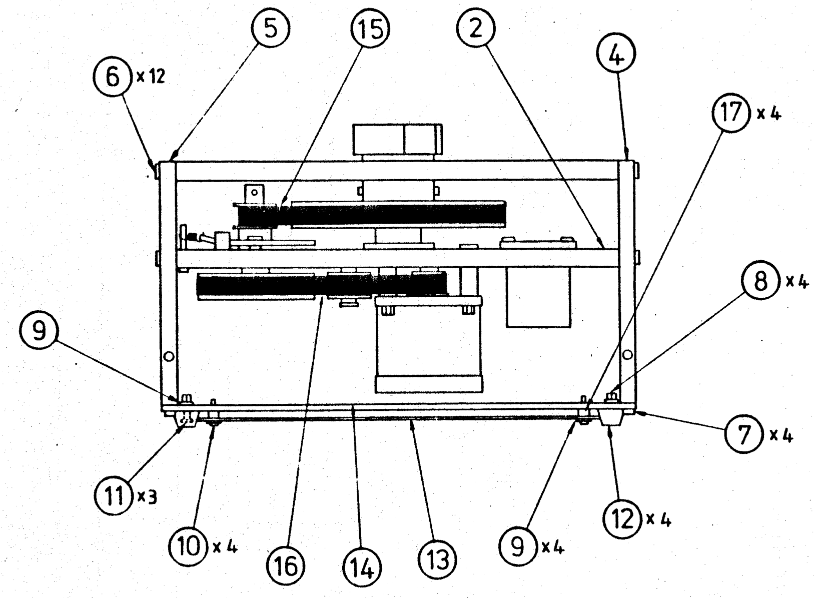


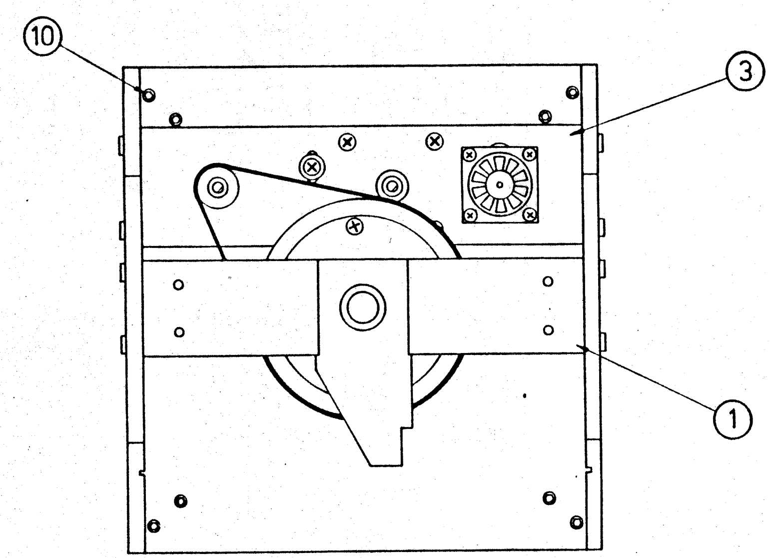
NOTE
1. JAW ROTATION DRIVE BELT NOT SHOWN SEE DRG No RA215.
2. TIMING BELT (78), CONNECTING (17) & (43) NOT SHOWN
3. COVERS NOT SHOWN

SIDE VIEW



FRONT VIEW





NOTE

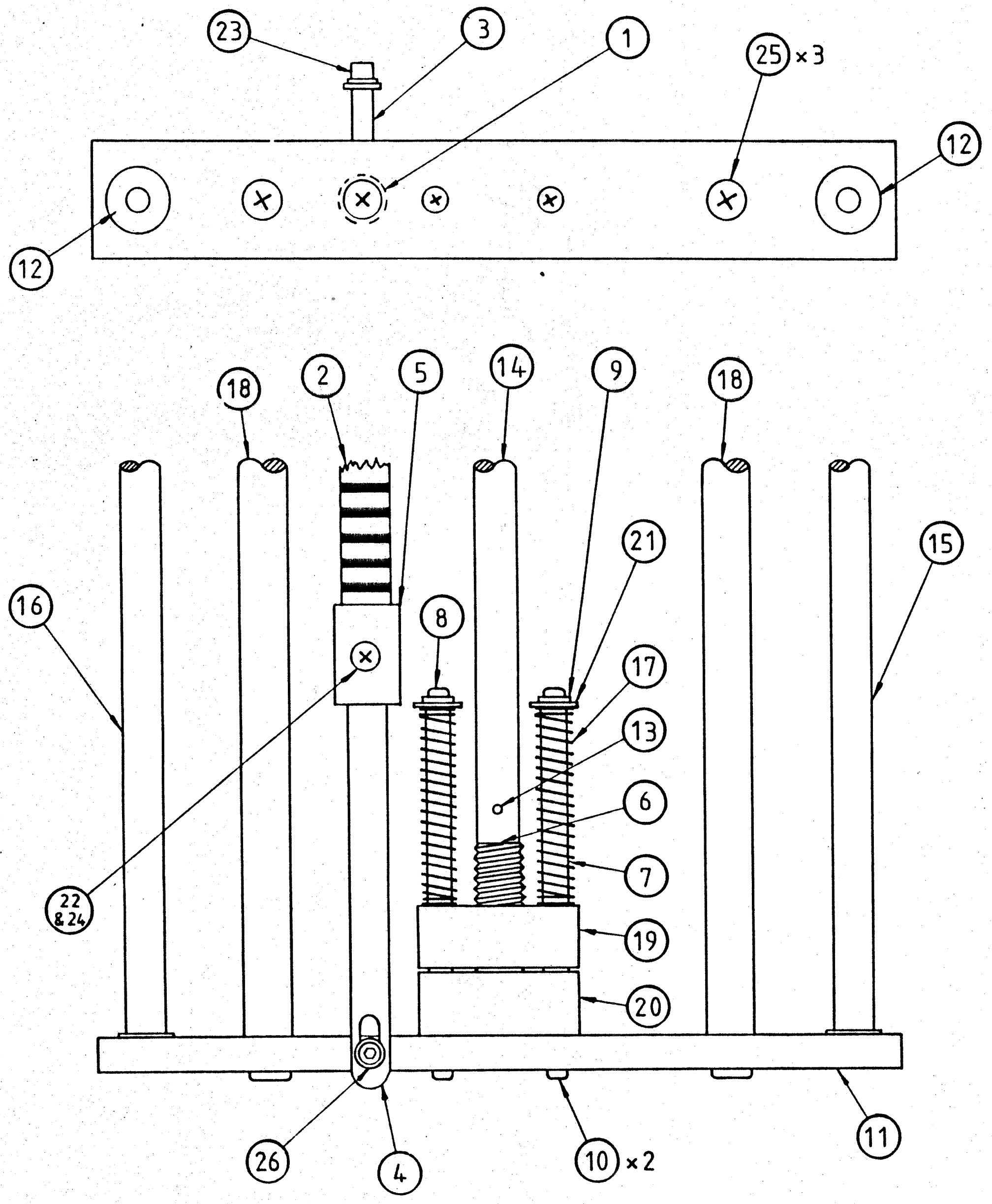
1/ ALL WASHERS ALREADY SHOWN ON SUB-ASSEMBLY DRAWINGS NOT SHOWN FOR CLARITY.

2/ FOR CLARITY NO DETAIL SHOWN ON BOTTOM OF LOWER BASE PIVOT PLATE.

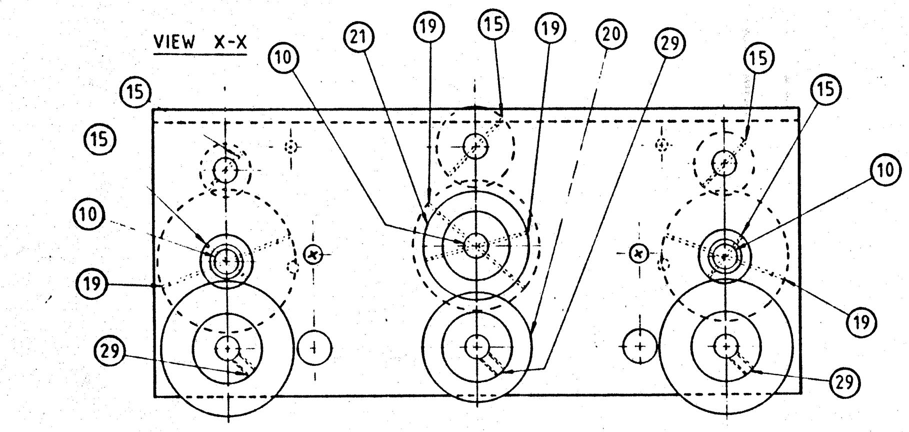
3/ FOR FURTHER BELT DRIVE DETAILS SEE DRG. No. RA216.

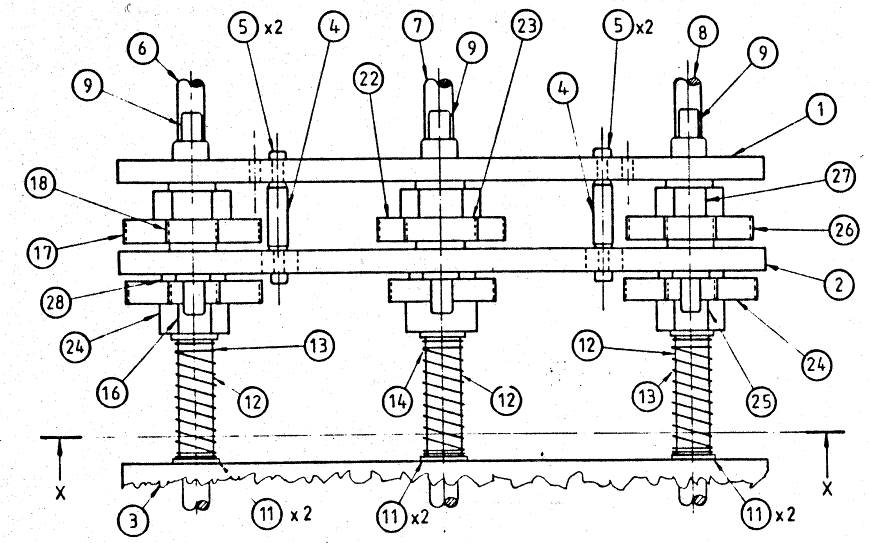
4/ COVERS NOT SHOWN, SEE DRG. No. RA212.

Nº	PART Nº	DESCRIPTION
1	RA201	UPPER PIVOT PLATE ASSEMBLY DRAWING
2	RA202	LOWER PIVOT PLATE ASSEMBLY DRAWING
3	RA203	BASE DRIVE ASSEMBLY DRAWING
4	RA003	BASE SIDE PLATE (LEFT)
5	RA004	BASE SIDE PLATE (RIGHT)
6	RA597	M5 x 20 PAN HEAD POSIDRIVE
7	RA591	M4 x 12 PAN HEAD POSIDRIVE
8	AF015	M4 NUT (NICKEL PLATED)
9	RA593	4 mm SHAKE PROOF WASHER (NICKEL PLATED)
10	AF021	M4 x 10 PAN HEAD POSIDRIVE (NICKEL PLATED)
11	AF021	M4 x 12 PAN HEAD POSIDRIVE (NICKEL PLATED)
12	AH19	5/8" RUBBER FOOT
13	RA002	BASE SHIELD
14	RA001	BASE PANEL PLATE
15	RA501	TIMING BELT 170 x L037
16	RA502	TIMING BELT 130 x L037
17	RA614	M4 x 4 SPACER



No.	PART No.	DESCRIPTION
1	RA082	REAR LIMIT STOP
2	RA084	RAM DRIVE BELT
3	RA085	BELT LIFT PILLAR.
4	RA087	RAM REAR STRAP
5	RA088	BELT CLAMP
6	RA090	LEAD SCREW END THREAD
7	RA091	DRIVE NUT SPRING PIN
8	RA581	M3 x 6mm PAN HEAD POSIDRIVE.
9	RA579	FLAT WASHER LIGHT PATTERN 3mm
10	RA583	M3 x 12mm PAN HEAD POSIDRIVE
11	RA077	REAR RAIL SPEADER
12	RA531	BEARING 1/2" x 3/16" x 3/16" FLANGED.
13	RA612	SEL LOK PIN 1/16" x 5/16"
14	RA080	JAW OPEN / CLOSE DRIVE SHAFT
15	RA081	WRIST ROTATION DRIVE SHAFT.
16	RA079	JAW ELEVATION DRIVE SHAFT
17	RA522	SPRING , JAW REAR.
18	RA078	FIXED RAIL
19	RA089	LEAD SCREW NUT , JAWS
20	RA096	LEAD SCREW NUT SPACER , JAWS
21	RA606	5mm SMALL O.D. WASHER.
22	RA581	M3 x 6mm PAN HEAD POSIDRIVE
23	RA592	M4 x 20mm CAP HEAD
24	RA585	M3 NUT.
25	RA596	M5 x 16mm PANHEAD POSIDRIVE
26	RA613	4mm NICKEL PLATED WASHER SMALL O.D.



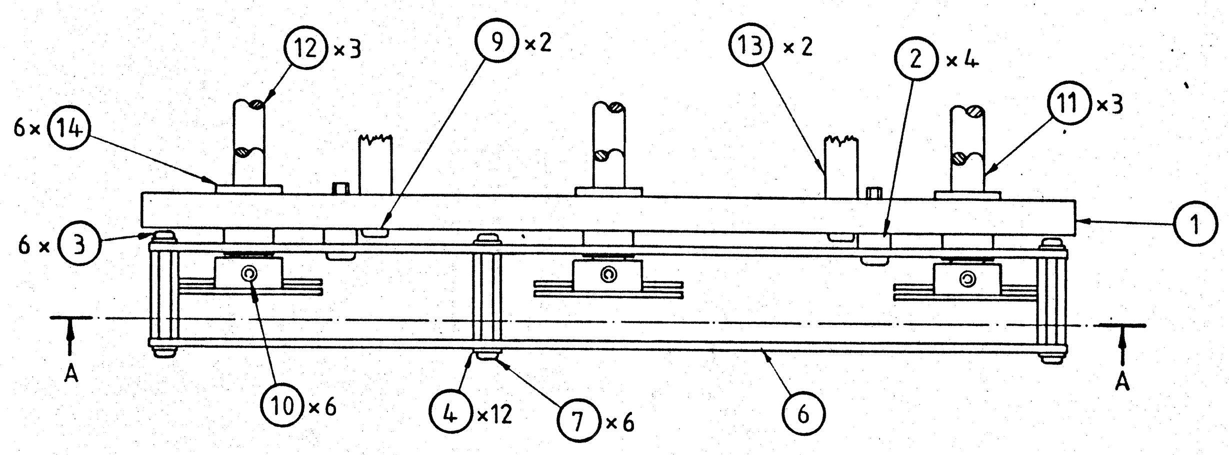


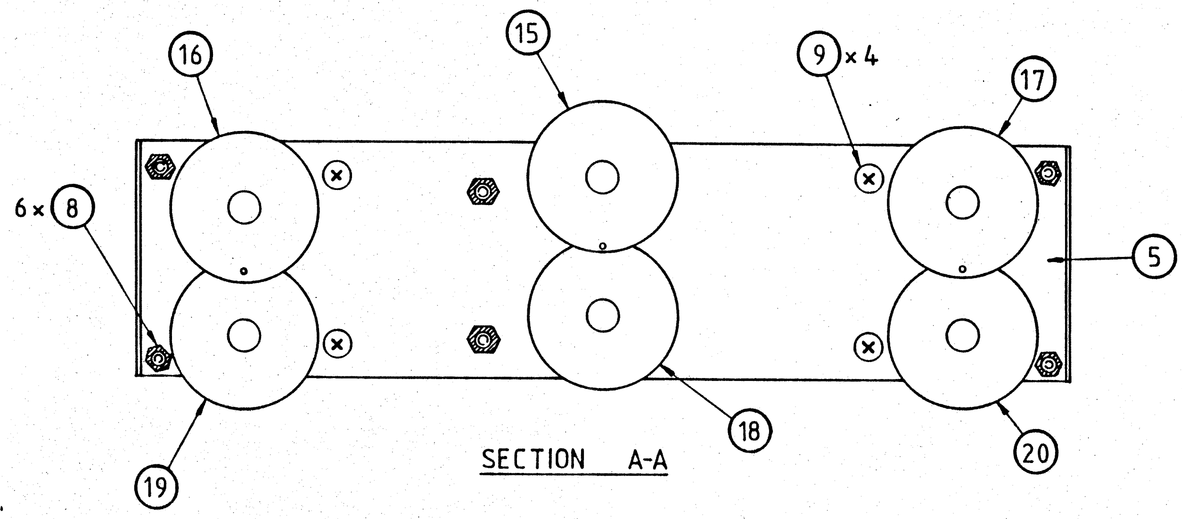
1/ ON FRONT GEAR PLATE ALL SHAFT HOLES FITTED WITH OILITE BEARING 1/4" I.D. x 3/8" O.D. x 1/2" FLANGED (RA547).

2/ ON REAR GEARBOX PLATE THE TOP SIX SHAFT HOLES FITTED WITH OILITE BEARING 1/4" I.D. x 3/8" O.D. x 3/8" FLANGED (RA546), AND BOTTOM THREE SHAFT HOLES FITTED WITH OILITE BEARING 5/16" I.D. x 1/2" O.D. x 3/8" FLANGED (RA545).

3/ BUSH FLANGES ON TOP SIX SHAFTS ONLY TO BE BETWEEN GEARBOX PLATES.

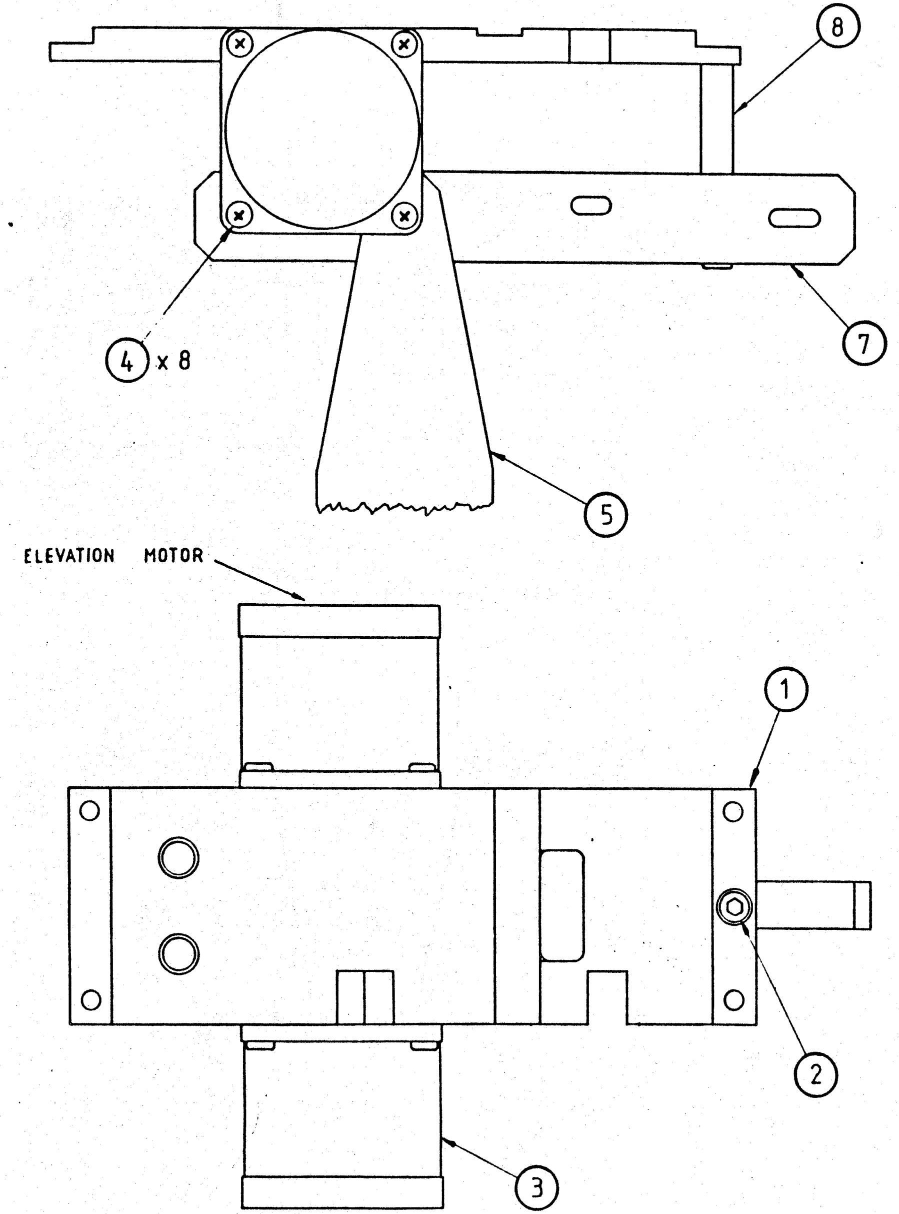
Nº	PART Nº	DESCRIPTION
1	RA060	FRONT GEAR BOX PLATE.
2	RA061	REAR GEAR BOX PLATE.
3	RA059	ARM BEARING SUPPORT (REAR)
4	RA063	GEAR BOX PLATE SPACER.
5	RA583	M3 x 12mm PAN HEAD POSIDRIVE.
6	RA079	WRIST ELEVATION DRIVE SHAFT
7	RA080	JAW MOTION DRIVE SHAFT
8	RA081	JAW ROTATION DRIVE SHAFT
9	RA062A	UPPER GEARBOX SHAFT.
10	RA062B	LOWER GEARBOX SHAFT.
11	RA575	FLAT WASHER LIGHT PATTERN 5/16"
12	RA064	GEAR SPACER
13	RA524	ELEV. / ROT. GEAR SPRING.
14	RA523	JAW GEAR SPRING.
15	RA571	SEL-LOK PIN 3/32" x 7/16" LG.
16	RA558	ELEVATION, FINAL DRIVE GEAR 16T.
17	RA561	ELEVATION, 2ND GEAR (NYLON) 58T.
18	RA564	ELEVATION, 1ST DRIVE GEAR 21T.
19	RA572	SEL-LOK PIN 3/32" x 3/4" LG.
20	RA556	JAW, SHAFT DRIVE GEAR (BRASS) 35T.
21	RA560	JAW, FINAL DRIVE GEAR 35T.
22	RA563	JAW, 2ND GEAR (NYLON) 53T.
23	RA566	JAW, 1ST DRIVE GEAR 29T.
24	RA557	ELEV. & ROT. SHAFT DRIVE GEAR (BRASS) 45T.
25	RA559	ROTATION, FINAL DRIVE GEAR 15T.
26	RA562	ROTATION, 2ND GEAR (NYLON) 42T
27	RA565	ROTATION, 1ST DRIVE GEAR 18T
28	RA074	LEATHER WASHER 5/8" I.D. x 1·0" O.D.
29	RA065	SHAFT GEAR PEG

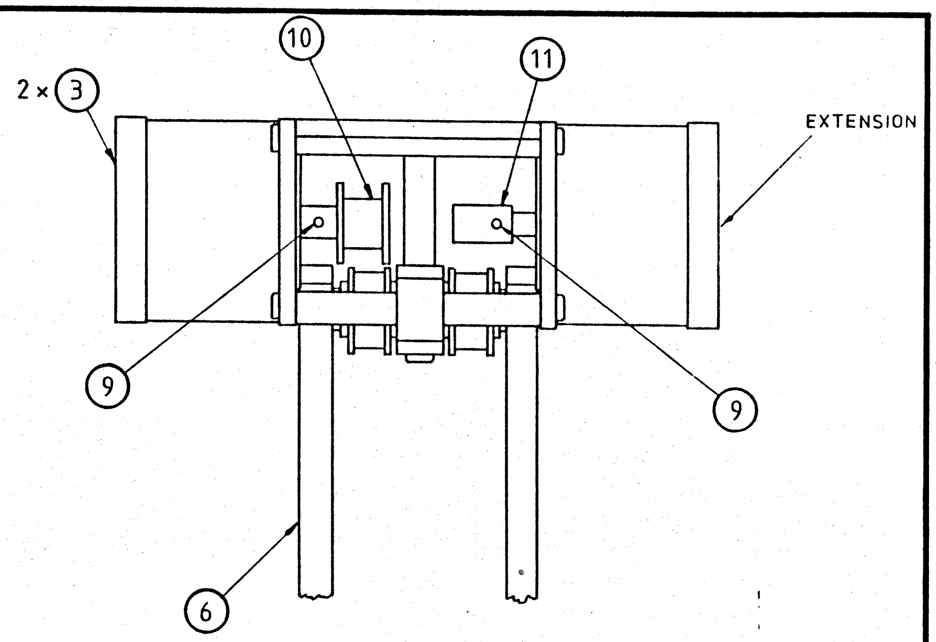




SECTION A-A

No.	PART No.	DESCRIPTION
1	RA060	FRONT GEARBOX PLATE
2	RA615	M3 x 3 SPACER
3	AF009	M3 x 10 PANHEAD POSIDRIVE (NICKEL PLATED)
4	AF004	3mm SHAKE PROOF WASHER
5	LJE 149	OPTICAL TRANSMITTER BOARD
6	LJE 150	OPTICAL RECEIVER BOARD.
7	AF008	M3 x 6mm PANHEAD POSIDRIVE (NICKEL PLATED)
8	AF031	M3 x 16mm HEX. SPACER
9	RA583	M3 x 12mm PANHEAD POSIDRIVE
10	RA580	GRUB SCREW M3 x 3mm
11	RA062A	UPPER GEARBOX SHAFT
12	RA062B	LOWER GEARBOX SHAFT
13	RA063	GEARBOX PLATE SPACER
14	RA547	OILITE BEARING 1/4"ID x 3/8"OD x 1/2" FLANGED
15	RA068	JAWS OPEN / CLOSE LIMIT SWITCH DISC (TOP)
16	RA070	WRIST ROTATION LIMIT SWITCH DISC (TOP)
17	RA072	WRIST ELEVATION LIMIT SWITCH DISC (TOP)
18	RA069	JAWS OPEN / CLOSE LIMIT SWITCH DISC
19	RA071	WRIST ROTATION LIMIT SWITCH DISC.
20	RA073	WRIST ELEVATION LIMIT SWITCH DISC.

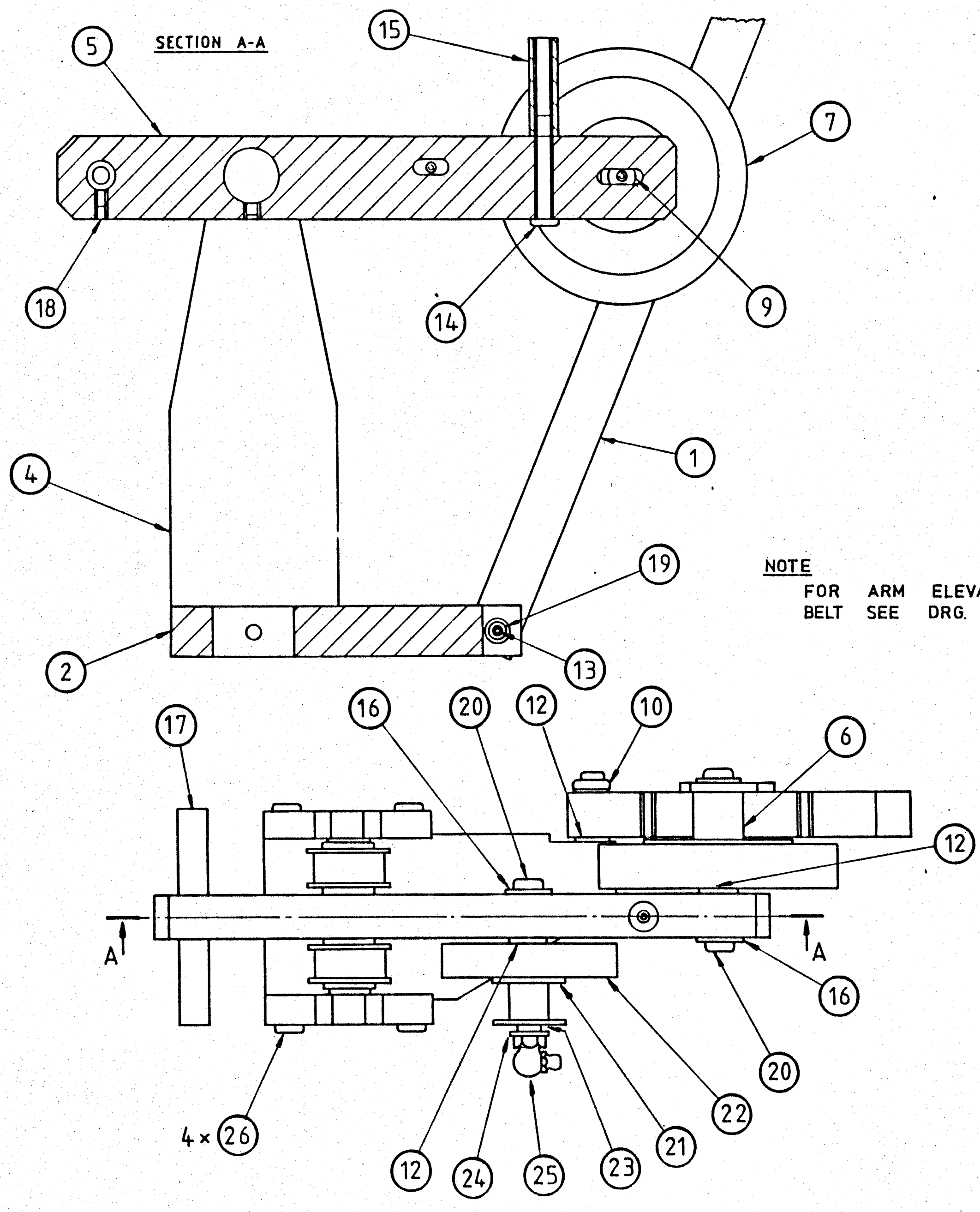




NOTE

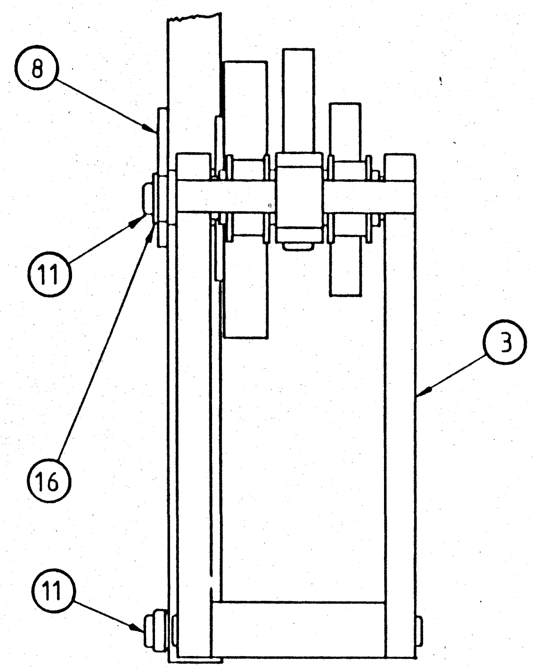
FOR ARM EXTENSION DRIVE BELT LAYOUT SEE DRG. No. RA213.

No.	PART No.	DESCRIPTION
1	RA041	MOTOR BODY MOUNTING PLATE
2	RA610	M5 x 12 HEX. COUNTER-SUNK
3	AM038	6V. 1·2A. STEP MOTOR
4	RA595	M5 x 10 PAN HEAD POSIDRIVE
5	RA026	ELEVATION SIDE PLATE FRONT
6	RA027	ELEVATION SIDE PLATE REAR
7	RA028	ELEVATION LEVER
8	RA035	BODY SPACER
9	RA580	M3 x 3 GRUB SCREW
10	RA509	TIMING BELT PULLEY 10 x L037
11	RA515	TIMING BELT PULLEY 18 x 250MP

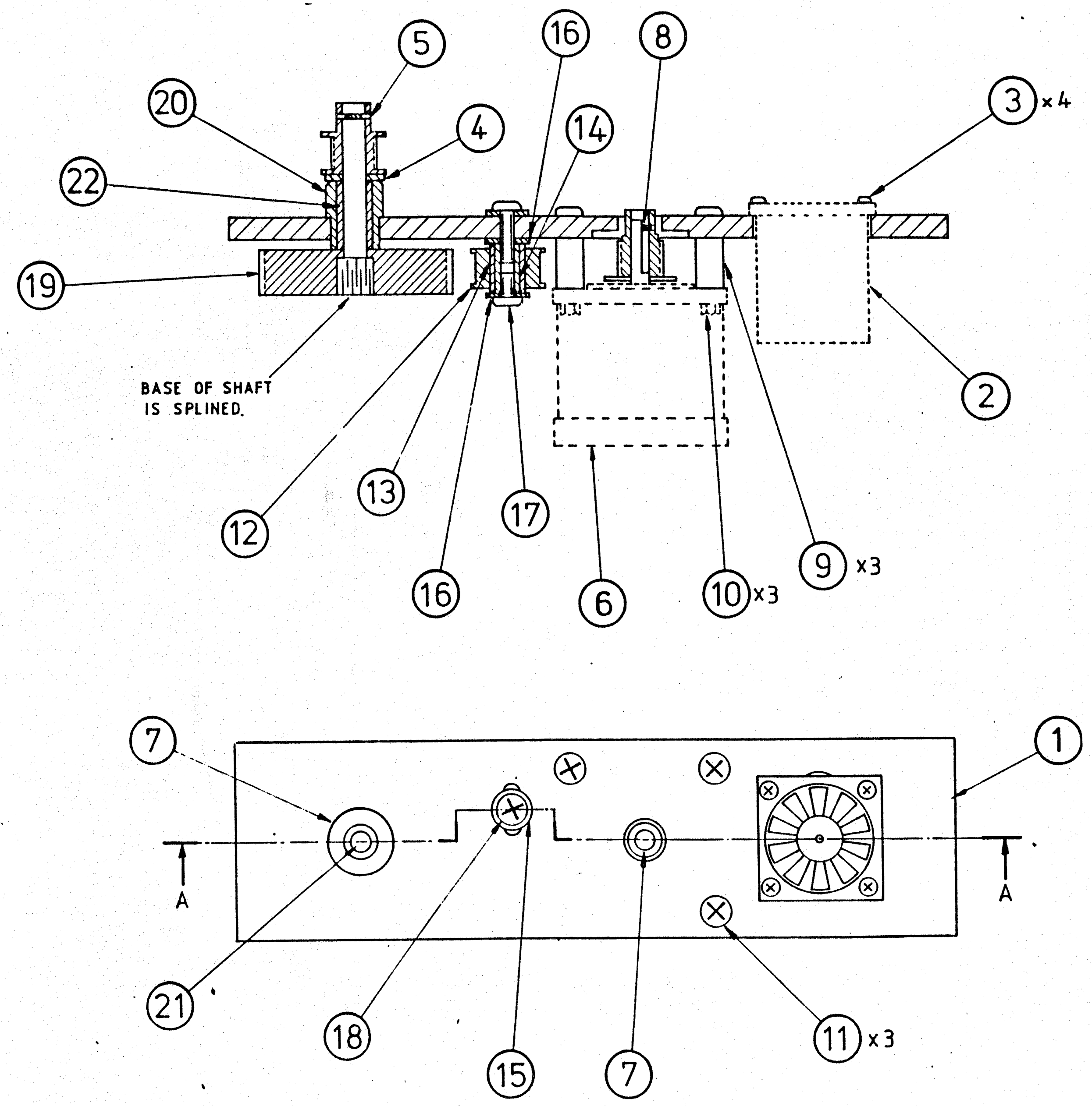


NOTE

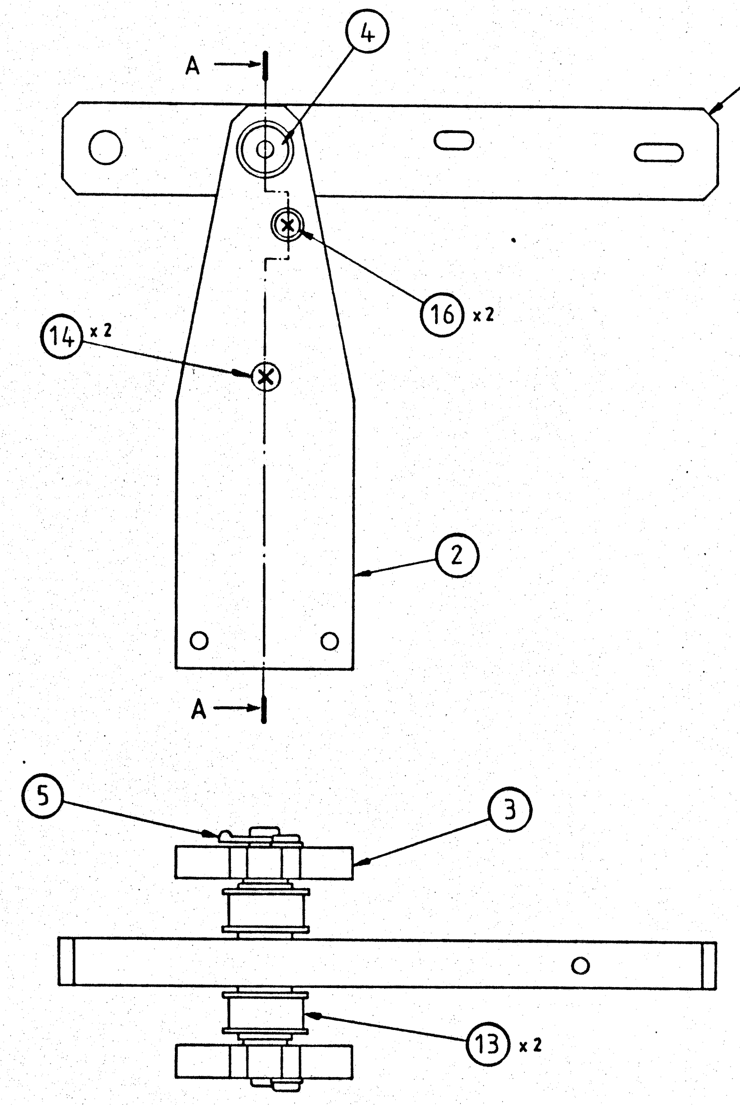
FOR ARM ELEVATION DRIVE BELT SEE DRG. No. RA214.

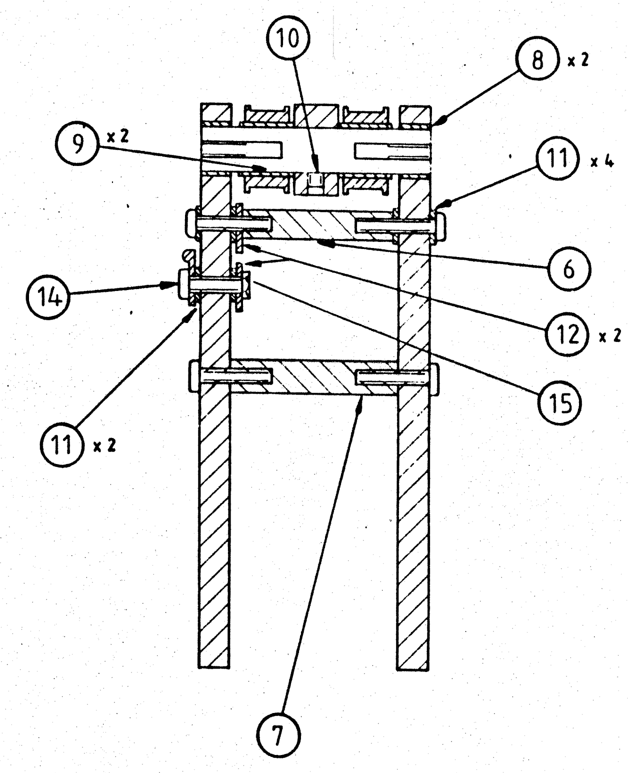


N°	PART N°	DESCRIPTION
1	RA030	RACK
2	RA018	ROTATION BASE PLATE
3	RA026	ELEVATION SIDE PLATE FRONT
4	RA027	ELEVATION SIDE PLATE REAR
5	RA028	ELEVATION LEVER
6	RA551	ELEVATION RACK PINION 15T
7	RA512	TIMING BELT PULLEY 48 x L037
8	RA032	RACK SUPPORT PLATE
9	RA040	RACK PULLEY PIN
10	RA042	RACK SPACER
11	RA595	M5 x 10 PAN HEAD POSIDRIVE
12	RA606	5mm SMALL O/D WASHER
13	RA031	RACK BEARING PIN
14	RA598	M5 x 35 PAN HEAD POSIDRIVE
15	RA035	BODY SPACER
16	RA576	5mm WASHER HEAVY PATTERN
17	RA036	ELEVATION MOTOR SPACER
18	RA602	M5 x 6 GRUB SCREW
19	RA600	M5 x 20 CAP HEAD
20	RA609	M5 x 25 PAN HEAD POSIDRIVE
21	RA510	TIMING BELT PULLEY 10 x L037
22	RA517	TIMING BELT PULLEY 80 x 250MP
23	RA039	RAM PULLEY PIN
24	RA573	1/4" WASHER LIGHT PATTERN
25	RA534	M6 x 90° GREASE NIPPLE
26	RA597	M5 x 20 PAN HEAD POSIDRIVE

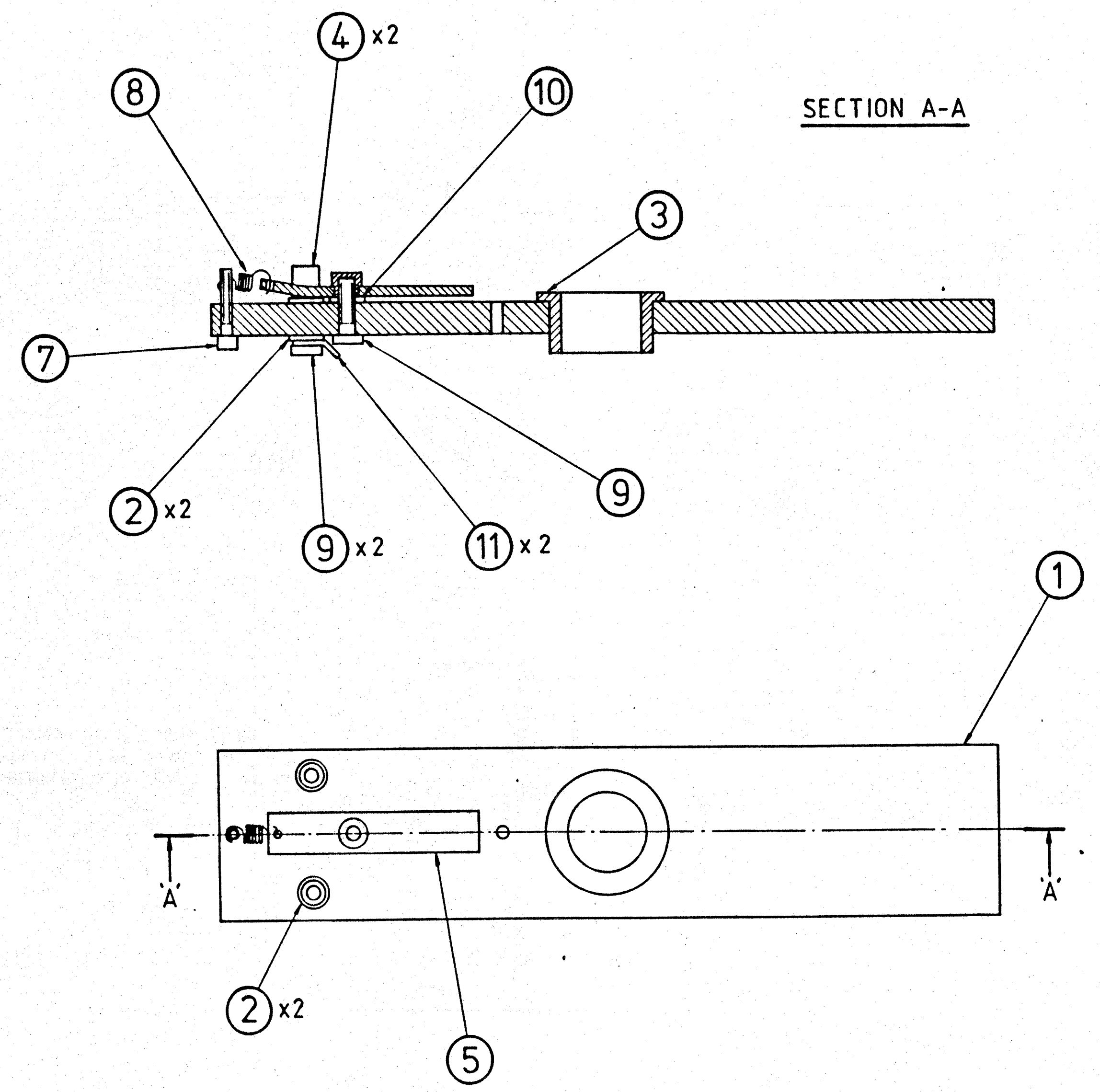


Nº	PART Nº	DESCRIPTION
1	RA007	BASE DRIVE MOTOR SUPPORT.
2	AM012	12V. D.C. FAN.
3	RA591	M4 x 12 PANHEAD POSIDRIVE
4	RA574	FLAT WASHER LIGHT PATTERN 3/8".
5	RA570	SEL-LOK PIN 1/16" x 7/16" LG.
6	AM038	6V. 1·2A STEPPER MOTOR
7	RA509	ROTATION TIMING BELT PULLEY 10T x L037.
8	RA580	M3 x 3 GRUB SCREW.
9	RA008	BASE DRIVE MOTOR SPACER.
10	RA603	M5 NUT.
11	RA599	M5 x 40 PAN HEAD POSIDRIVE
12	RA066	JOCKEY PULLEY (·437") BORE.
13	RA009	BASE JOCKEY BEARING PIN.
14	RA537	OILITE BEARING 5/16" I.D. 7/16" O.D. 1/2" LG.
15	RA576	FLAT WASHER HEAVY PATTERN 5mm.
16	RA606	FLAT WASHER LIGHT PATTERN 5mm
17	RA608	M5 x 6 PAN HEAD POSIDRIVE.
18	RA597	M5 x 20 PAN HEAD POSIDRIVE.
19	RA511	ROTATION TIMING BELT PULLEY 40T x L037.
20	RA011	BASE LAYSHAFT BEARING HOUSING.
21	RA010	BASE LAYSHAFT.
22	RA540	OILITE BEARING 3/8" I.D. x 1/2" O.D. x 3/4 LG



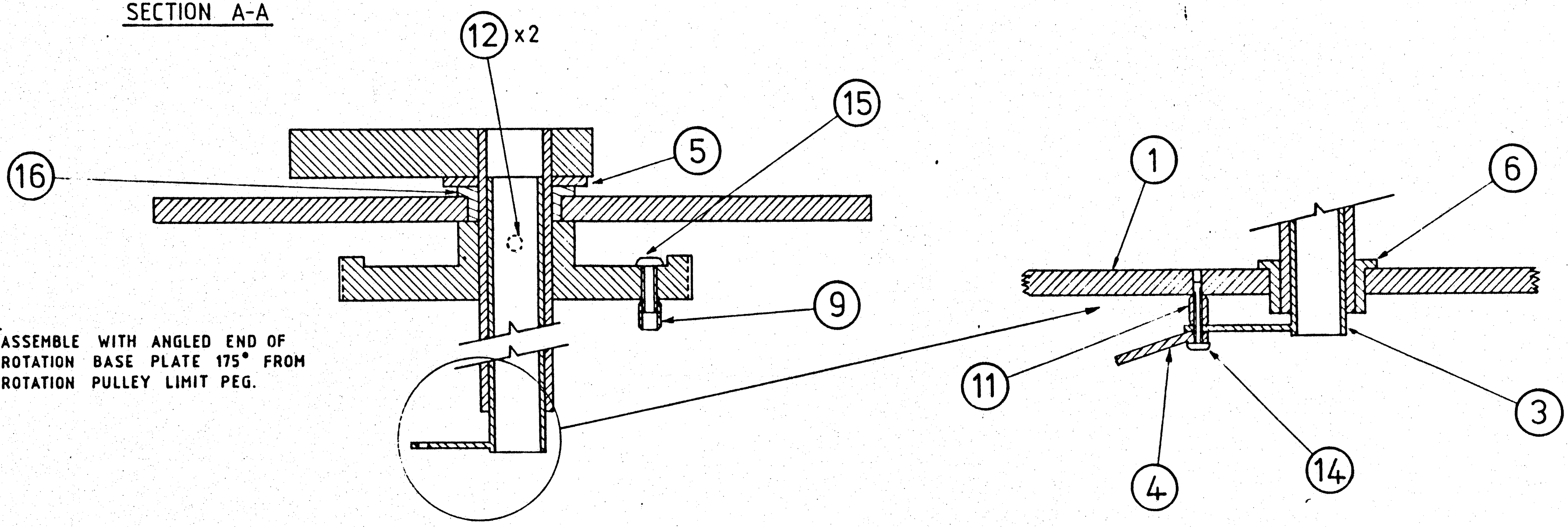


N°	PART N°	DESCRIPTION
1	RA028	ELEVATION LEVER
2	RA026	ELEVATION SIDE PLATE (FRONT)
3	RA027	ELEVATION SIDE PLATE (REAR)
4	RA029	ELEVATION PIN
5	RA033	ELEVATION DOWN LIMIT
6	RA034	ELEVATION UPPER LIMIT
7	RA037	ELEVATION SIDE PLATE SPACER.
8	RA542	OILITE BEARING 1/2" I.D. x 5/8" O.D. x 3/8" LG.
9	RA543	OILITE BEARING 1/2" I.D. x 5/8" O.D. x 5/8" LG.
10	RA602	M5 x 6 GRUB SCREW
11	RA533	5mm INSULATION BUSH
12	AF029	5mm SOLDER TAG
13	RA038	JOCKEY PULLEY (·625") BORE
14	RA596	M5 x 16 PANHEAD POSIDRIVE
15	RA603	M5 NUT
16	RA597	M5 x 20 PANHEAD POSIDRIVE



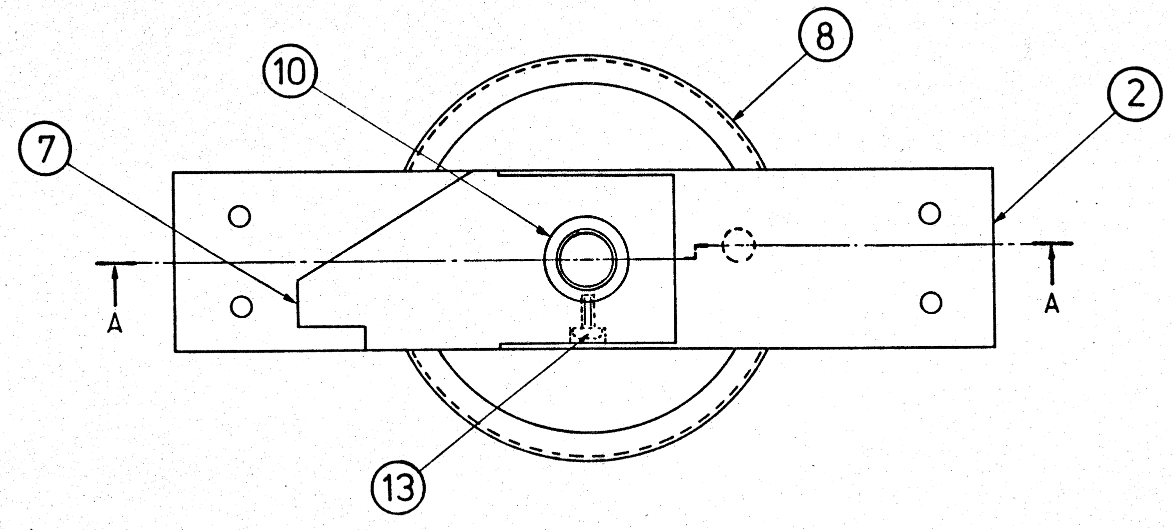
Nº	PART Nº	DESCRIPTION.
1	RA006	BASE PIVOT PLATE (LOWER)
2	RA533	INSULATING BUSH.
3	RA544	OILITE BEARING 1"ID x 1 3/4 OD x 3/4" FLANGED.
4	RA013	ROTATION STOP.
5	RA014	ROTATION STOP BAR.
6	RA015	ROTATION STOP PIVOT.
7	RA592	SCREW M4 x 20 CAP HEAD.
8	RA520	SPRING (BASE ROTATION)
9	RA596	SCREW M5 x 16 PAN HEAD POSIDRIVE.
10	RA606	WASHER M5 SMALL O/D.
11	AF029	SOLDER TAG. M5.

SECTION A-A



NOTE

ASSEMBLE WITH ANGLED END OF ROTATION BASE PLATE 175° FROM ROTATION PULLEY LIMIT PEG.



Nº	PART Nº	DESCRIPTION.
1	RA006	BASE PIVOT PLATE (LOWER).
2	RA005	BASE PIVOT PLATE (UPPER).
3	RA016	CABLE PROTECTION TUBE.
4	AH023	CABLE TAG.
5	RA578	FLAT WASHER LIGHT PATTERN 1".
6	RA544	OILITE BEARING 1" I.D. x 1 1/4" O.D. x 3/4" FLANGED.
7	RA018	ROTATION BASE PLATE.
8	RA019	ROTATION TIMING BELT PULLEY 72T x L037.
9	RA013	ROTATION PULLEY LIMIT PEG.
10	RA017	ROTATION SPINDLE.
11	RA085	SPACER.
12	RA607	M5 x 10 CAP HEAD.
13	RA595	M5 x 10 PAN HEAD POSIDRIVE.
14	RA584	M3 x 20 PAN HEAD POSIDRIVE.
15	RA596	M5 x 16 PAN HEAD POSIDRIVE.
16	RA020	OILITE BEARING 1" I.D. x 1 1/4" O.D. x 1/2" FLANGED.

Appendix Section

Appendix 1 Fault Finding and Diagnostics

Mechanical Fault Diagnosis Chart Base Rotation

Fault	Diagnosis	Rectification
Motor runs but movement does not occur	Belts broken or not on pulleys	Change belts Tighten belts
Motor does not run	Faulty motor Limit switch sticking	Change motor Lubricate pivot bearing, change return spring.
Motor misses steps	Tight shaft bearings Belts too tight Rotation jamming on base panels.	Lubricate bearings. Re-adjust belts. Refit base panels.
Base rotation does not return to reference	Limit switch sticking Limit stop pins adrift or missing	Lubricate pivot bearing. Change return spring. Refit pins
Excessive backlash	Belts slack Pulley retaining screws loose	Tighten Belts Tigthen screws
Rattle from base	Panels loose. Motor loosen on mounting	Tighten panels. Tighten motor retaining screws

Mechanical Fault Diagnosis Chart Arm Elevation		
Fault	Diagnosis	Rectification
Motor energised but will not elevate arm.	Weight in jaws over specified limit Pinion jamming on rack	Reduce weight. Clean and lubricate rack and pinion Remove shaft, clean and lubricate.
Elevation movement is intermittent	Pulley seized on shaft. Pulley scuffing on rack, Burr on rack.	Remove pulley clean and lubricate. Remove rack. Deburr rack. Deburr clean and lubricate
Rack has excessive side movement	Pinion runner plate Retaining screw loose. Rack retaining screw loose	Tighten screw Tighten screw
Excessive backlash and/or	Loose belt Pinion shaft worn Runner plate worn	Re-adjust belt Replace shaft Replace runner plate
Rattle from rack	GIB strip loose Rack and pinion worn	Re-adjust GIB strip Replace racxk and pinion
Motor does not run	Faulty motor	Change motor

Mechanical Fault Diagnosis Chart Arm Extension		
Fault	Diagnosis	Rectification
Motor energised but will not extend arm or movement is intermittent	Guide rails misaligned Belt too slack Belts too tight Rails tight in bearings. Tight keyway in drive shafts Bent shaft Intermediate pulley tight or seized	Re-align guide rails and lubricate Re-adjust belts Re-adjust belts Lubricate rails De-burr keyways with oilstone Return ATLAS to manufacturer Remove pulley from shaft clean and lubricate.
Excessive back-lash	Belts too slack Motor pulley loose.	Re-adjust belts Tighten pulley retaining screw
Excessive movement of arm at full extension	Guide rail bearing worn	Return ATLAS to manufacturer

Mechanical Fault Diagnosis Chart	Wrist Elevation	
Fault	Diagnosis	Rectification
Motor runs but does not rotate	Universal coupling loose Key adrift or broken	Tighten coupling retaining screws Return ATLAS to manufacturer
Drive shaft rotates but does not elevate jaws	Bevel gear loose on shaft	Tighten bevel gear retaining screws
Motor energised but wll not elevate jaws or elevation is intermittent	Excessive drag on friction washer Gearbox shafts tight Bevel gear too far in mesh Burrs or dirt on bevel gear or gear quadrant Bevel gear shaft or jaw pivots tight or seized	Lubricate washer Lubriate gearbox Re-adjust gear Clean and de-burr gears Lubricate shaft bearings
Elevation does not return to reference	Optical discs loose on shafts Dirt in holes of discs Excessive side play in gearbox shafts	Tighten discs retaining screw Clean discs Return ATLAS to manufacturer
Jaw runs off end of gear quadrant	Jaw setting incrorrect See also jaw does not return to reference	Reset jaw
Excessive back-lash	Bevel gears too slack Quadrant retaining screws loose. Wear in bevel gear shaft bearing. Wear in jaw elevation pivot bearings	Adjust bevel gears Tighten screws Return jaw assembly to manufacturer

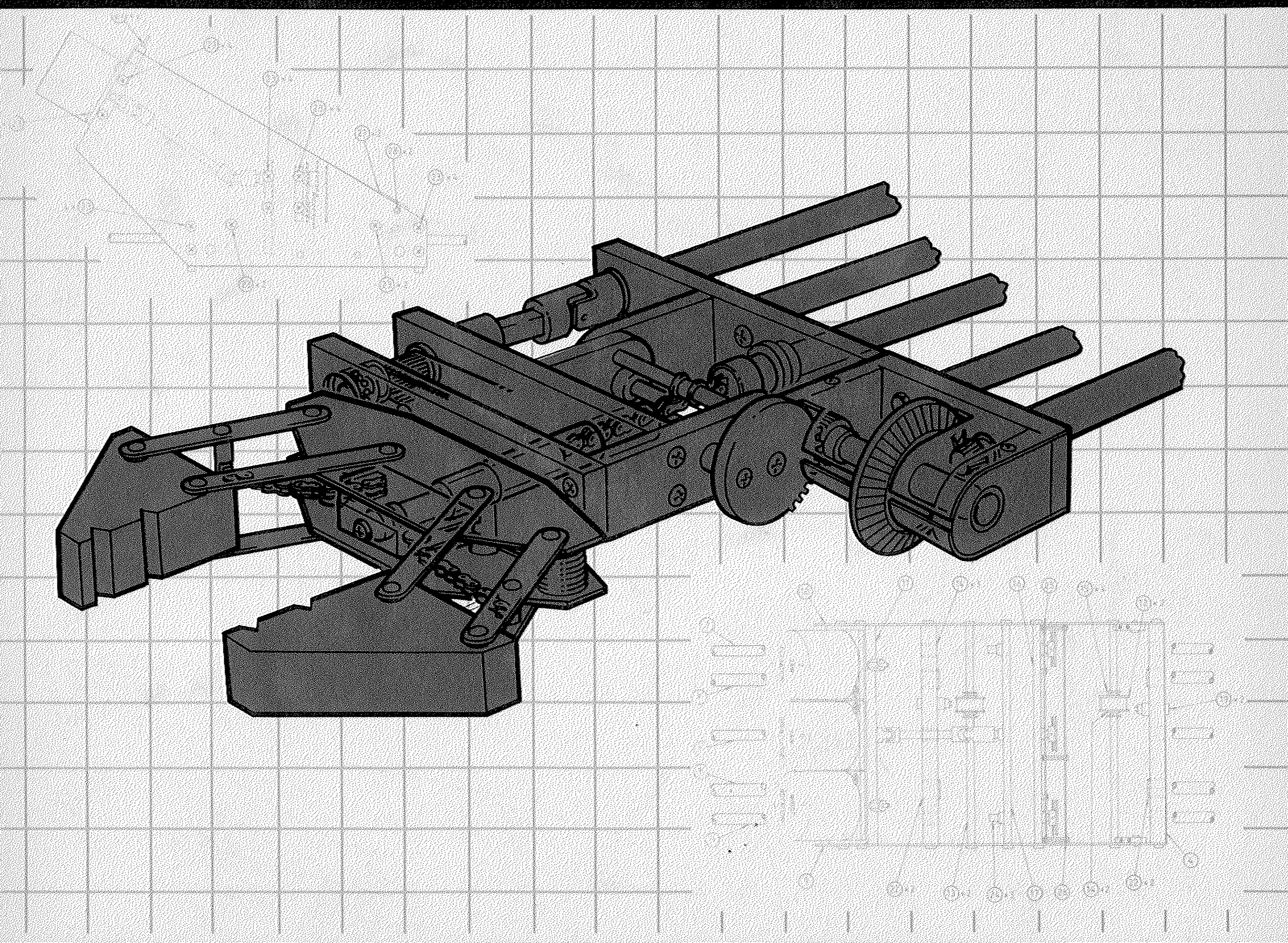
Mechanical Fault Diagnosis Chart	Wrist Rotation	
Fault	Diagnosis	Rectification
Motor runs but does not rotate	Univeral coupling loose. Key adrift or broken	Tighten coupling retaining screw. Return ATLAS to manufacturer
Drive shaft rotates but does rotate jaws	Telescopic universal coupling screws loose	Tighten screws
	Jaw rotation pulley retaining screws loose	Tighten screws
Motor energised but will not rotate jaw or jaw rotation is intermittent	Excessive drag on gear box friction washer	Lubricate washer
	Gearbox shaft tight	Lubricate gearbox
	Jaw rotation bearings tight	Lubricate bearing
	Chain link spindle binding in jaw rotation spindle	Remove jaw assembly. De-burr spindle and lubricate
Jaw rotation does not return to reference	Optical disc loose on shafts	Tighten disc retaining screw
	Dirt in holes of discs	Clean discs
	Excessive side play in gearbox shaft	Return ATLAS to manufacturer
Excessive backlash	Jaw rotation pulley loose on shaft	Tighten pulley retaining screw
	Telescopic universal couping worn	Replace coupling Adjust coupling (Anti backlash type)
	Tooth belt stretched	Replace belt

Mechanical Fault Diagnosis Chart Jaw Open/Close		
Fault	Diagnosis	Rectification
Motor runs but does not rotate drive shaft	Universal coupling loose	Tighten coupling retaining screws
	Key adrift or broken	Return ATLAS to manufacturer
Drive shaft rotates but does not open jaws	Broken chain	Fit new chain
Motor energised but will not open/close jaws or movement is intermittent	Excessive drag on friction washers	Lubricate washer
	gearbox shaft tight	Lubricate gearbox
	compression springs closed coiled	Re-adjust jaw setting
	Chain jamming	Lubricate and/or fit new chain
	Jaw mechanism damaged	Change jaw assembly
	Chain link spindle binding in jaw rotation spindle	Remove jaw assembly. De-burr and lubricate spindle
	Chain thrust bearing tight	Fit new thrust bearing
Jaw will not open	Chain jammed on rollers	Re-align chain in rollers, lubricate
	Chain link spindle binding in jaw rotation spindle	Remove jaw assembly. De-burr and lubricate spindle
	Broken return spring	Replace jaw assembly
	Jaw bearing tight	Lubricate jaw assembly

	Electrical Fault Diagnosis	General
Fault	Diagnosis	Rectification
Robot will not arrive at reference	Front panel light not flashing. Motor still running Missing limit control switch	Check limit switches Replace limit switch Reset opto limit control voltages
Motor does not run	Motor fuse blown on multiplexer board or in the base for motor No 5. Motor Drive card faulty. Error or fault in motor selection from the micro-card	Replace fuse. Repair or replace drive card. (Note to isolate a faulty drive card, a substitution can be made with one of the good drive cards) Perform a micro-card function test and isolate fault and repair.
Jaws not opening/ closing correctly	Jaws missing limits	Reset optic limit controls
Robot base hot	Fan not running	Check fan supply voltage Replace fan if faulty

Fault	Diagnosis	Rectification

L.J. Electronics



LJ Electronics Inc
1886 Larchwood
Troy, Michigan 48083
U.S.A.
Telephone: (313) 524 2565

LJ Electronics Ltd
Francis Way
Bowthorpe Industrial Estate
Norwich, NR5 9JA. England
Telephone: (0603) 748001
Telex: 975504

Distributor