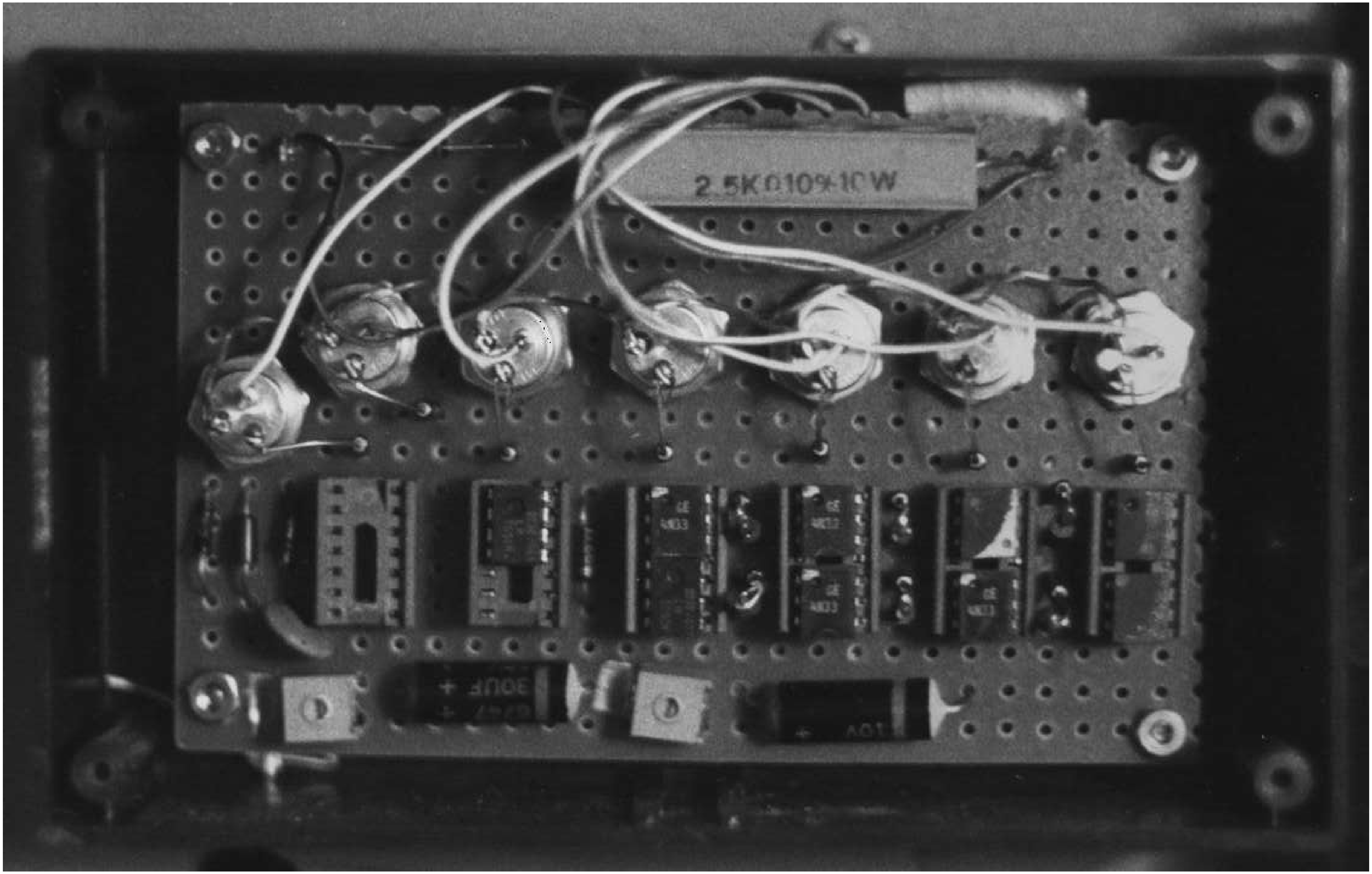
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Robert Glaser N3IC
3922 Algiers Road
Randallstown, Md 21133

Interfacing the Friden Justowriter

It does not take very long before the computer hobbyist learns that he can't go very far without some type of hard-copy printer. There are many candidates for home printers. Several companies are now providing dot matrix printers in the 40 column class. These cost in the vicinity of $300. The narrow width paper presents a large restriction on what the printer can be used for. BASIC programs can generally be listed on these devices, but little else can be printed without large compromises. Assembly listings usually require at least 72 columns to include line numbers, addresses, data, op-codes, and comments. A very common hard-copy device is the ASR-33 teletype. The ASR-33 takes care of BASIC and assembly listings quite adequately, and has the bonus of both a paper tape punch and reader. A new ASR-33 costs about a thousand dollars, and used ones run up from $400. A less expensive alternative is a Baudot teletype; these can be procured for about $100.

All of the above printers share a common drawback -- they are upper case only. If you wish to do text processing, an upper/lower case machine is imperative. A number of new machines are on the market which fit this bill, but prices are $3000 and up. How do you justify putting a $3000 peripheral on a $300 computer?

If you are willing to do some interfacing, there are reasonably priced alternatives available. There are a number of Friden flexowriters and justowriters available on the surplus market. They cost from $200 on down. I obtained a Justowriter and have been satisfied with its operation, considering the cost. It has upper and lower case, a prerequisite in my situation, and uses a commonly available carbon ribbon. The carbon ribbon makes the print quality excellent. Although the ribbon may only be used once, it is very long and does not require replacement too often. The justowriter is unique from most other printers in one respect: the characters are not all the same width, and do not take up the same amount of space. Many "i"s can be fit on a line, while not as many "M"s fit in the same space. You can consider this feature good or bad, depending upon your use. Luckily, a modification can be made which forces all letters to take up the same amount of space (the largest space). For assembly listings, or other uses when the output is supposed to line up in columns, it is best to remove the justification; for listing BASIC programs or anything with long lines, the justification feature can be used to fit more on a line than could otherwise be done. With a suitable program, magazine quality can be achieved with the printer in the justifying mode. A disadvantage of the printer is that it does not recognize ASCII code. This is not a serious restriction, however, because a simple subroutine in the processor can easily take care of the code conversion. A more serious drawback is it requires 100 volt levels to be switched to drive it. It is certainly not TTL compatible! (Be sure not to plug it directly onto your computer bus!) Two ways immediately come to mind to control it: relay and solid state drivers. Being religiously an anti-relay bigot, I opted for the latter approach. (Anyone want to try VACUUM tubes?)

Hardware

A simple place to feed the printer is at the paper tape reader. The Friden is "fooled" into thinking your computer is a paper tape. The reader is on the left side of the machine. Remove the reader cover by loosening the screws and sliding it off. Looking at its underside, eight switches which are driven by the reader nubs should be seen. By soldering stranded wires onto the contacts, the printer can be operated. Figure 1 shows the view. On the top of the diagram, the two screws are actually the leads to the strobe relay. The one on the left is the strobe line, and the one on the right is the common +50 volt line. The three top contactors are bits 1, 3, and 5. Directly below and to the right of the bit 1 contactor, the -50 volt line can be picked up on the second from the bottom contact. Bits 0, 2, 4, and 6 are available in a row underneath the other contactors. For bits 1, 3, and 5 the proper contact to connect to is on the bottom side; for bits 0, 2, 4, and 6 use the top contact. Be careful not to short out any lines. The diodes in the DC supply cannot handle overload. If they should blow out, they can be replaced with modern silicon rectifiers. The diodes are plugged into sockets on the back left side. It is simplest to solder new diodes across the old ones and retain the ability to plug them in. There is room behind the reader to place a minibox containing the switching hardware.

The schematic of the level shifting hardware is shown in fig 2. Any high voltage (150 volt or more), medium power NPN transistor may be used for the switching. Seven are required. The transistors should be able to handle several hundred milliamperes. Transistors intended to operate from the line voltage fit the need. The diodes across the solenoid coils should have a PIV of 200 or more. These are only used to suppress transients from the inductive kick of the coils. The switching transistors are driven by optical isolators. These eliminate any possible grounding problems. Unless connections short, there is no chance of the high voltages making their way into your computer. Bits 0 through 5 are needed, plus the strobe line. The strobe line tells the printer to print the character. The Darlington pair in the 4N33 is off until the internal light emitting diode is turned on. A parallel output port from the processor is needed. Bit 0 of the output port is used as the strobe line. When this bit pulses low, the two 555 one-shots are fired. After firing, the width one-shot provides power to the LEDs. The strobe solenoid is always pulsed. At this time, if any of the bits 2 through 7 from the computer are low, then that corresponding LED will be turned on, activating that solenoid. After the one-shot falls, all LEDs and solenoids are off. The width control should be adjusted so that just one character is typed for every strobe pulse. Start with the control at maximum resistance and back it off until this point is reached. It would be possible for the processor to run the printer with only the width one-shot. A suitable delay loop would be required to leave time for each character to be printed. This is wasteful of CPU time, and it is easier to adjust the interface with the addition of the rate one-shot. A single bit of input is required to read the rate one-shot. When the strobe pulse is given, the one-shot fires, going high. The processor can read the input bit to determine if the printer is ready for another character. The printing speed can be adjusted by varying the rate adjustment. Initially, the control should be at maximum resistance. Adjust the control until the speed is reached where the printer begins making mistakes, and move it back a little. (Naturally, this adjustment must be made with the computer sending output.)

Software

To operate the machine from an ASCII oriented computer, a suitable subroutine is required. The routine, written for an 8080, prints the ASCII equivalent character from the accumulator and returns. The Friden has an upper case and a lower case shift. It latches in either mode, so the routine must keep track of which mode it is in, and switch it when necessary. Although the justowriter is both upper and lower case, it lacks some special characters in the ASCII set. To counter this drawback, the driving subroutine prints words for these special characters. For "+" it prints " PLUS ", for "<" it prints " LESS ", for "=" it prints " EQUAL ", for ">" it prints " GREATER ", and for "^" it prints " POWER ". The vertical bar (ASCII 7C) comes out as the cents symbol. A 7F is translated into a null, a 05 into an upper case shift, a 06 into a lower case shift, a 08 into a backspace (it takes 5 backspaces to get to the original spot when removing the justification), a 09 is a tab (can be set in the back of the printer), a 0A does a carriage return with no delay, a 0B spaces one unit, and a 0C spaces three units. These last two would only be used in the justifying mode. The case shifts are not needed when going through the routine, but are provided in case some special circumstance required them. A 0D is translated into a carriage return and 5 nulls to provide time for the carriage to be returned. The lookup table could easily be changed to satisfy any other arrangement. The subroutine could be used to handle any machine with the appropriate code table.

A flowchart is shown in fig 3. On entry, the parity is stripped and all registers are saved. The table is searched for the character in the accumulator. If not found, the routine exits. When found, the conversion code is looked up, and checked to see what type it is. There are three types: regular characters, characters which are translated into multiple characters, and characters which may be printed in either upper or lower case. A 01 specifies that a multiple conversion is to take place, and the ASCII characters to form the word follow the 01 in the code table. The word ends upon a 00. For regular characters, the low bit is zero, and for characters which may be printed in either upper or lower case, the low bit is one.

If a multiple conversion is to take place, the letter is fetched and the routine calls itself. When the 00 is reached, the program exits.

If a normal character is encountered, it is checked to see if it is upper or lower case. If bit 1 in the code is high, it is upper case. Once the case is checked, the mode of the printer is checked. If it is not the correct case, the upper or lower case shift is sent. The character is printed, registers are restored, and the subroutine returns. For the few characters which may be printed as either upper or lower case, the case checks are bypassed.

In the listing, the output port is set up as port 11. The input bit is sent to bit 7 of the input port, in this case port 11. The PRT subroutine prints the actual value from the accumulator to the printer. PRT waits for the printer to be ready, sends the character with the strobe low, then waits a bit and sends the same character with the strobe high. This triggers the one-shots in the hardware.

The code table is set up with the ASCII characters starting at TABLE, and the corresponding Friden characters at CODE. For the multiple conversion characters, the ASCII table is filled with 80 where the replacement characters are. This retains the correspondance between the two tables. The MODE byte must be in RAM, and the rest may be in ROM.

It is possible to set up a time-sharing program which prints a file on the printer independently of what the operator is doing. I have such a routine in my operating system. When a file is to be printed, whenever the input/output routines are called, the printer ready input is checked. If it is low, then a character from the file to be printed is sent to the printer. In this fashion, the printer routine is never called unless the printer is ready for a character. The CPU does not waste time waiting for the printer. Multiple conversion is an exception, for when a multiple conversion takes place, during that word the printer robs the CPU from the operator. This waiting can be eliminated by removing the multiple conversions and adding a carriage return one-shot and ORing it with the WAIT signal. For normal non-sharing applications, this is not of significance.

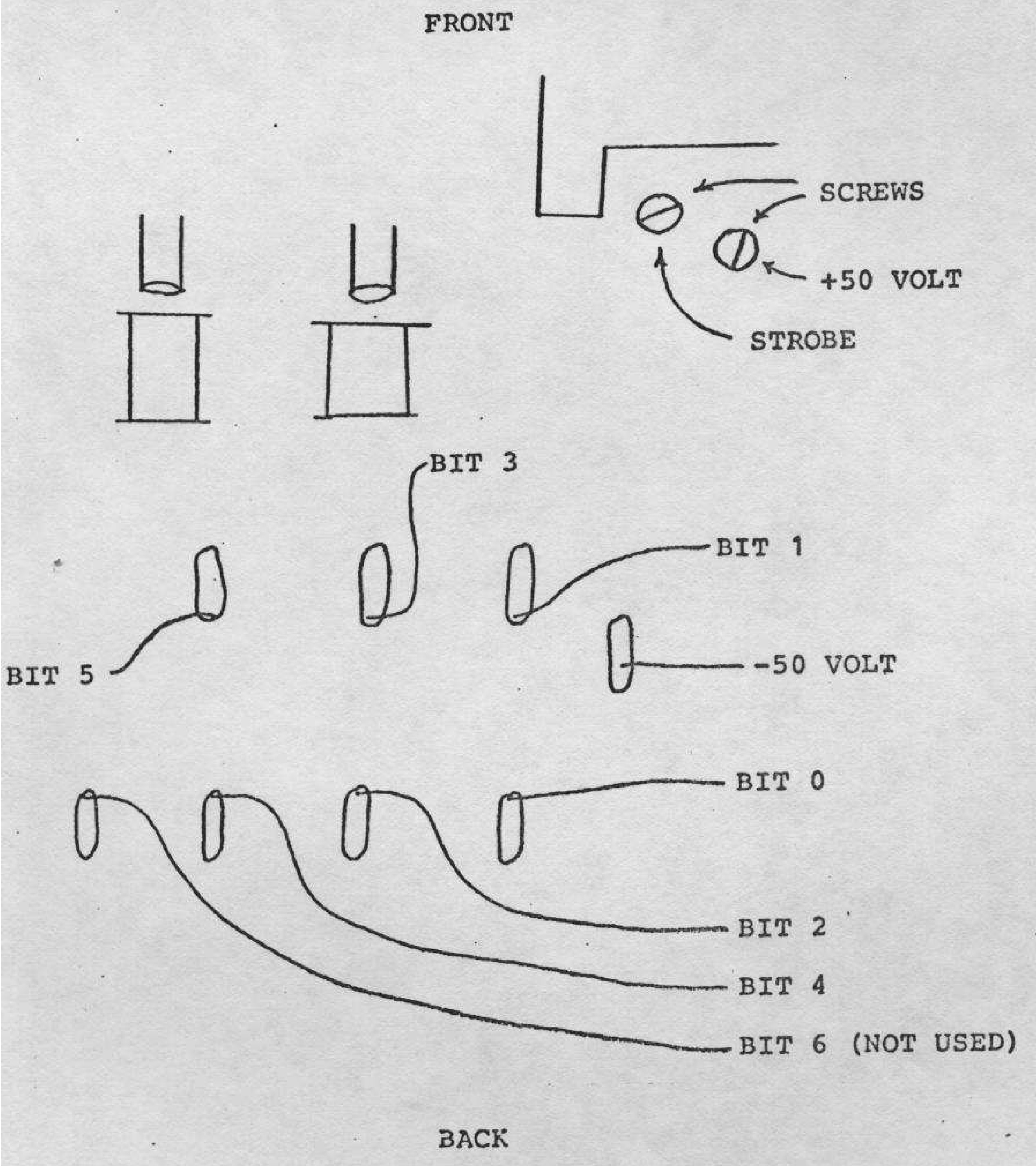
Operation

The printer runs about 8 characters per second. This is not particularly fast, but the primary concern with this type of printer is the quality, not the speed. The entire carriage moves. By placing the printer on a table and placing fanfold paper on the floor, there is enough freedom of movement for the machine to print correctly for a number of pages. The justowriter uses friction feed, which is not as good as sprocket hole feed for long term operation, but I have found that by proper initial paper alignment six or more pages can be printed without need for readjustment of the paper position. Considering the slowness of the printing, checking it every 20 or 30 minutes is adequate.

To modify the justowriter for even character spacing, there are three bars which must be kept in certain positions. Remove the bottom plate. As shown in fig 4, there are three bars on the left. The two top ones must be kept in the outward position, and the bottom one must be kept pushed in. A simple, though unglamorous way to accomplish this is with some monofilament fishing line and a strong rubber band. Tie a loop of monofilament around the two top bars. Bring the other end of the lead around to the right side of the machine. Tie another length of monofilament to the bottom bar and loop it under the flat plate behind and to the right of it. Tie the ends of the string to a heavy rubber band. With the machine together and upright, by looping the rubber band around the large connector on the right of the machine, pressure is placed to keep the bars in the necessary positions. All that is necessary to put the device into the justify/no justify modes is the connection or disconnection of the rubber band. It sounds crude, and it is, but it works. Samples of the printing with and without the justification are shown.

I have used the justowriter for a year with few problems. It is a clunky machine, but it provides excellent copy at a low price. Thanks to Marc Leavey, M.D., WA3AJR, for the photographs.

FIG 1- VIEW FROM UNDERSIDE OF PAPER TAPE READER



WIRES ARE SOLDERED TO THE UNDERSIDE OR TOPSIDE OF THE BIT SWITCHES

THE -50 VOLT LINE IS THE SECOND FROM THE BOTTOM CONTACT, AND STICKS OUT A LITTLE

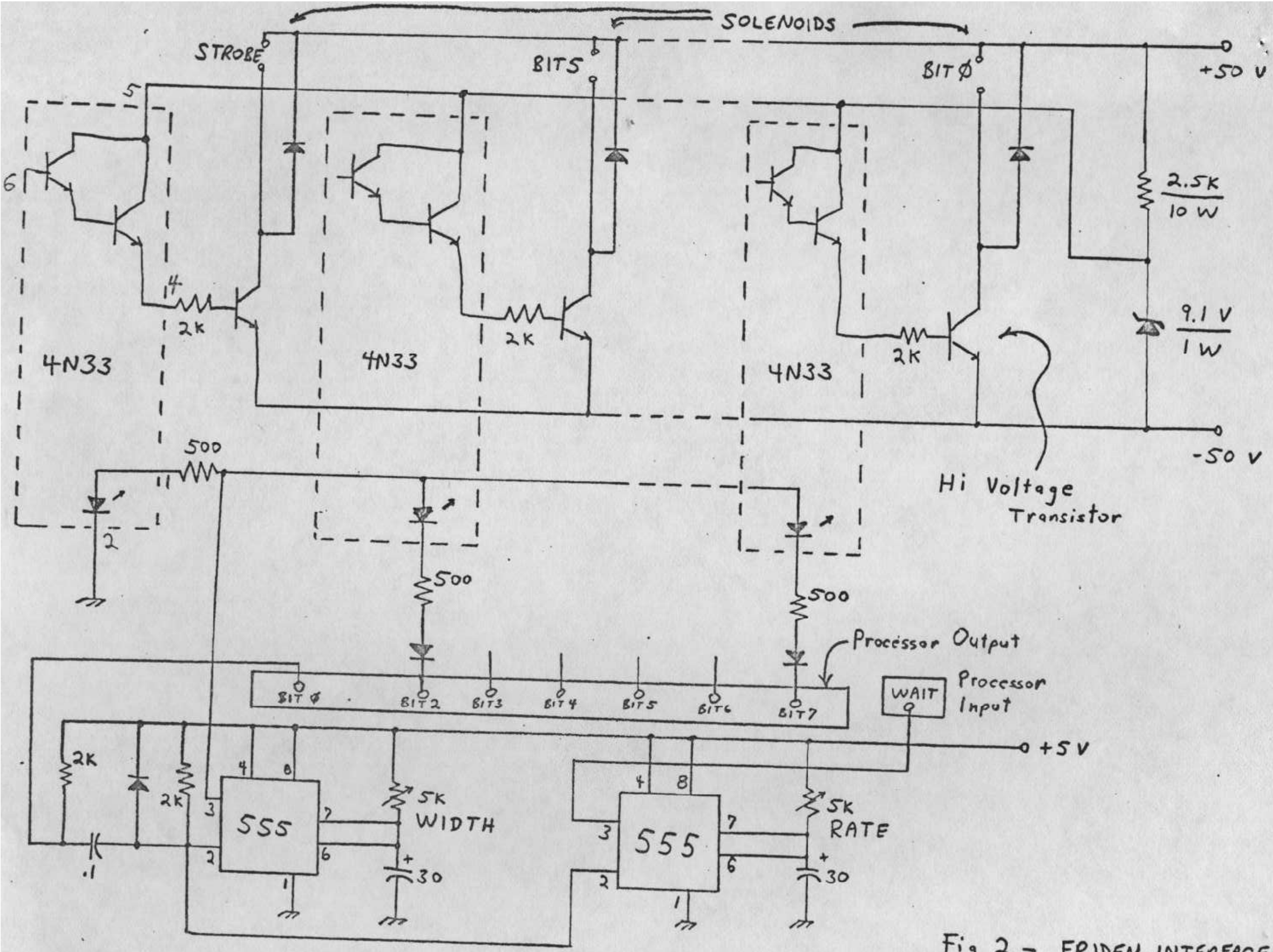


Fig 2 - FRIDEN INTERFACE

Fig 3 - FLOW CHART
FOR PRINT

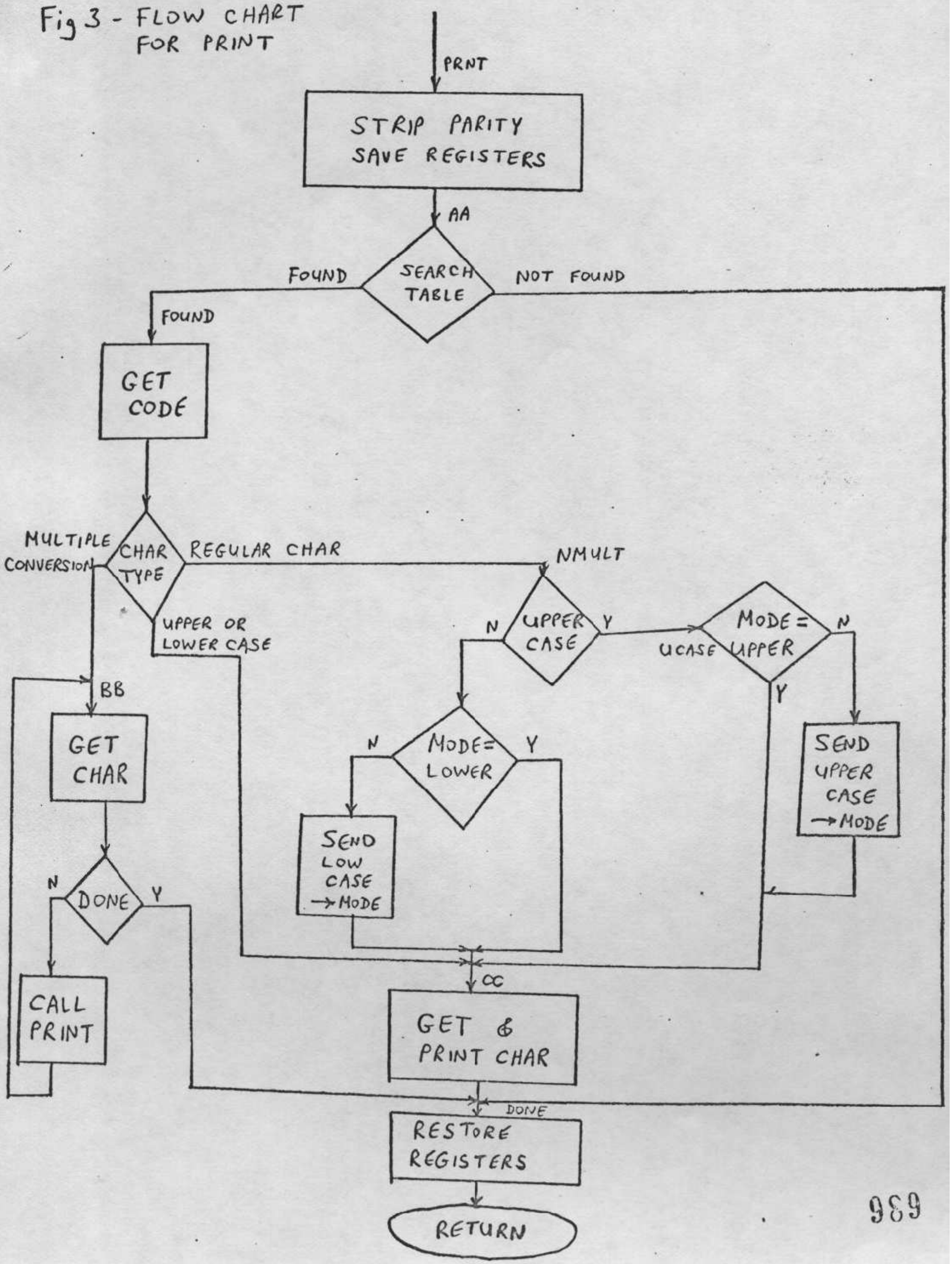
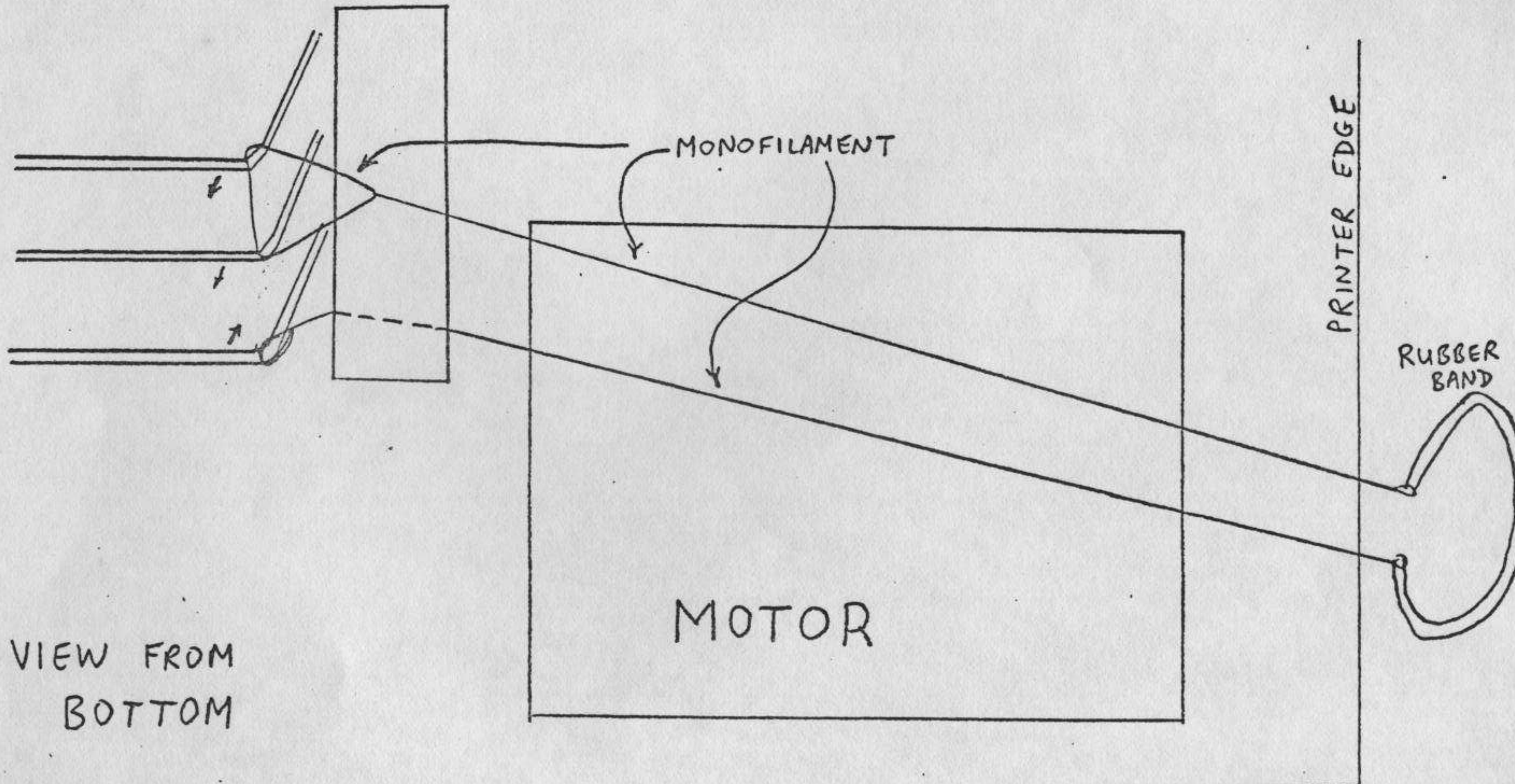


FIG 4 - REMOVAL OF CHARACTER JUSTIFICATION



VIEW FROM BOTTOM

From Spectrum Magazine, May 1977, page 29.

Everybodys doing it, Computing at home

The demand for own er operated microcomputers has blossomed, creating a brand new market for kits, peripherals, and software

Slavery is immoral, servants are expensive, and socio political consciousness raising has given the family pet a monopoly on loyalty and obedience. Yet the human ego still longs to dominate a more productive, skilled, and responsible entity.

The microprocessor based microcomputer seems destined to satisfy this need soon on a grand scale. Costs are down, applications are up, and a whole new cottage industry catering to amateur or hobby computing needs has emerged during the past two years.

Most of the products available from these very new but thriving businesses are kits, and much of the distribution is mail order, patience advised. But many urban and suburban dwellers will find that a suitable electronic serf is available off the shelf from a nearby computer store, though the local phone book may not help much in locating an address. Chances are the retailer you want was not in business a year ago. Besides, store owners often opt for offbeat names like Byte Shop, Itty Bitty Machine Company, or Kentucky Fried Computers. Some advertise in the how to electronics/hi fi press found on local newsstands, while others use the established amateur radio journals. Of course, the best references are the microcomputer hobby publications themselves. These are just as new as the products they describe, and may also be a little hard to find initially. Whatever your nearby opportunities, be sure and see p 31 of this article for a reviw of several active, and apparently healthy, microcomputer periodicals.

From core to cassette

Fans of Future Shock will find that hobby computing makes a classic Exhibit A. Things are changing so fast that 1975 and early 1976 are now nostalgically referred to as the good old days by those who first recognized own, buying sample chips and setting up laboratory space at home for experiments.

The first entrepreneur to tap this growing interest on a significant scale was H. Edward Roberts, whose company, MITS formerly Micro Instrumentation and Telemetry Systems, Albuquerque, N. Mex., had once been involved in the scientific calculator market. Spectrums calculator roundup of April 1974 counted MITS among the early vendors selling advanced personal calculators. As calculator prices tumbled, MITS, Bowmar, and many other assembler/producers lost out to the vertically integrated giants like Texas Instruments, Hewlett Packard, and later National Semiconductor.

Mr. Roberts responded by designing a computer construction project plans and parts available from MITS based on the Intel 8080. MITS kit, now known as the Altair 8800, was first described in a January 1975 Popular Electronics feature article. Reader interest was far greater than anticipated, and MITS was soon swamped with orders from turn on computer fans.

Not long afterward, MITS first competipon arrived. Processor Technology, Emeryville, Calif., was probably the first company offering memory boards compatible with the Altair 8800. And the parade is far from over.

Among MITS more succesful challengers to date has been IMSAI Manufacturing, originally a tiny consulting firm headquartered in San Leandro, Calif., that did occasional microprocessor design work. According to IMSAI director of industrial and commercial sales, Arnold Karush, about 18 months ago the example of MITS success inspired a we can do it too attitude among IMSAIs engineering staff. Soon they had designed the IMSAI

- 1 -

Magnetic Tape and Paper Chart Reader

This unit serves two functions: it reads NRZ encoded magnetic tape, and reads a pointer position for use with a paper chart reader. The unit serves as an interface between the tape deck and chart reader and a digital computer.

Figure 1 shows the block diagram of the system. The tape deck feeds three data channels and a time channel to the input card. Each of the four channels are treated identically in the input card. The head currents are amplified, fed to comparators, and the original digital signal is then reconstructed. Each of the three data signals is fed to a counter board. The counters

Figure 5 - Sample of Justowriter printing