A Letter from the Editor

"The flowers, the gorgeous, mystic multi-colored flowers are not flowers of life, but people, yes people are the true flowers of life: and it has been a most precious pleasure to have temporarily strolled in your garden."

Lord Buckley

No, this isn't a poetry journal or philosophical tract, but we do feel that Lord Buckley elucidates the concept behind the Processor Technology newsletter: its contents will be the kind of information that allows you to expand the creative applications of your personal computing system.

ACCESS is dedicated to the creation of a personal dialog between us and you, the people using our products, because we believe that it's important for you to understand your present system well enough to use it effectively, before you become trapped in the "bigger means better" syndrome.

Hence there will be no advertising of any kind in ACCESS, and no thinly disguised pitches aimed at getting you to part with your hard earned money for the unnecessary duplication of existing hardware.

Each issue will contain articles, engineering/application bulletins, and software (PROGRAM) listings which we think will help you get more fun out of owning your computer.

All we expect from you in return is what's known in technical and psychological circles as feedback. If you have devised a neat hardware modification or written a nifty program, send it to us and you'll get no financial remuneration.

Since most important programs are written for a particular system, modifications are sometimes in order to improve compatibility with your system. We'll be passing on more detailed product information than you may glean from our literature. It helps a lot if you think out your questions before you call, maybe make a few notes. It helps, too, if you have the manual and/or equipment handy to the phone. The easier it is for you to figure out exactly what we're talking about (and vice versa), the more help we can give in one phone call and the more phone calls we can handle. We'll also be happy to answer your questions if you drop us a letter.

There are two or three situations in which calling us isn't the fastest way to get help. If you have a problem with a Processor Technology product which you purchased from a local dealer, try your dealer first. They're all authorized to service the products they sell, precisely because they can give you faster and more personalized service than anybody can by mail. Our dealers all have diagnostic tapes available now, so if you need a PTC product tested it can be handled on the spot.

If you need a defective part replaced, just mail it to us with a note of explanation. There's nothing we can do about it over the phone anyway, so you might as well save yourself the time. (Naturally, it helps if your explanation is as clear and concise as possible, but we can't all he Hemingways.) If you need service that isn't covered by your warranty, please enclose a check for the $20.00 minimum service charge. If the cost exceeds that (heaven forbid!) you will be notified before we proceed with the service.

If you do send in one of our products for repair, please send only the defective board. For obvious reasons, we cannot be responsible for the care and feeding of your monitors, keyboards or other products from other manufacturers.

One to One Communication

Open two-way communication is our goal, and it would be great to have unlimited time to rap with you over the phone. But we can't manage that logistically, so we are instituting procedures that will get your questions answered efficiently, without eliminating the personal touch.

You can get through to our engineers and technical staff any time between 9:30 and noon or 1:30 and 4, Monday through Friday. The number is (415) 652-8080. They'll try to answer your technical questions and provide more detailed product information than you may glean from our literature. It helps a lot if you think out your questions before you call, maybe make a few notes. It helps, too, if you have the manual and/or equipment handy to the phone. The easier it is for you to figure out exactly what we're talking about (and vice versa), the more help we can give in one phone call and the more phone calls we can handle. We'll also be happy to answer your questions if you drop us a letter.

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MATCHMAKING-Software Division

Since most important programs are written for a particular system, modifications are sometimes in order to improve compatibility with your system. We'll be passing on more good ideas as we come across them; here are two dealing with MITS BASIC and the VDM.

MITS 12K Extended Disk and the VDM
If you don't have a 3P+S interface, you can still use the BASIC program in your VDM manual to link MITS 12K Extended Disc to your VDM driver. Simply change these six lines in the listing of VDM-1 to BASIC link appearing on page AV-18 of your VDM manual, and then run the program as explained there. Change the statements to read as follows:

0162 DATA219,255,31,210,13,1001,219,201,254,26,195,142
0234 DATA13,254,127,202,142,13,195,46,1000

MITS 8K or 12K BASIC and the VDM
If you have I/O ports that are assigned 20 and 21 instead of 0 and 1, you'll need to make five statement changes in the VDM-1 to BASIC link program in your VDM manual. The listing appears on pp. AV-17 to AV-19 of the manual, and should be modified as follows:

0078 IF A=219 AND I=16 GOTO 92
0080 IF A=219 AND B=17 THEN I=K:GOTO 106
0224 DATA201,219,16,230,200,201,58,1001,254
0228 DATA201,219,17,230,254,1,202,46,1000
When you're combining equipment from different manufacturers, optimum performance often depends on specific information about the idiosyncrasies of their connections. Owner's manuals can't cover every permutation and combination, so think of this feature as a running supplement that gets down to cases.

3P+S and the OP 80A

We've had a lot of inquiries about using the OP-80A high speed manual punchpaper tape reader with the 3P+S, so we asked OliverAudio Engineering for the straight scoop on interconnecting it with the 3P+S interface. Note that the OP-80A acknowledge line must be programmed for a negative true (ack) signal. We've also heard from many of our customers that the use of black tape and rolled tape (instead of fanfold) produces more accurate data transfer, using the OP-80.

VDM-1 and the 6800 Microprocessor

The VDM-1 can live quite happily with your 6800 if a small amount of signal processing is performed externally.

Signals which may be directly used by the 6800 system are:
- ADR0-ADR15 High-active address
- DO0-DO7, High-active data lines. They may be connected in parallel to form a bi-directional data bus if necessary.
- PSYNC Connect to high-active VMA (Valid Memory Address)
- Φ2 Connect to Φ1 clock
- Pin 4 of IC 18 (74LS132) Break connection to Pin 3 and connect to Pin 2
- SINP, SOUT Connect to the highest-order address bits which are "1" when registers are addressed. (Bits 14 and 15 are suggested.) Presence of a "1" on either line will cause the address decoder to switch its comparison to the status port address. The status port will therefore respond to any address whose top six bits are set by jumpers (see your VDM-1 manual), and whose bits 8 and 9 are zero. The lower-order 8 bits are not decoded during status port response.

3P+S/OP-80A INTERFACE

PT 4KRA Memory Boards and the Motorola M6800

The following diagram should help you expand your M6800 system with minimum headaches. Note that the M6800 can drive 2 4KRA cards at reduced clock rates without bus drivers; however, full buffering is recommended.

What's the Best Monitor for your Sol or VDM-1?

That's one of the questions we're asked most frequently. We always recommend a black & white monitor designed for use with closed circuit TV systems or videotape recorders. Check your local Processor Technology dealer for good sources; they're up on that sort of thing.

If you want to use a regular black & white TV, try for a solid state model with an isolation transformer. In either case, remember that you don't have to spend a lot of money to get a decent picture, so let the rest of the family enjoy that big screen super color set.
To get your keyboard connection up and running, you'll need to connect 7 data lines, the keyboard strobe, and ground to the J2 connector of your 3P+S. Figure 1 shows the typical keyboard connections.

**USING A KEYBOARD AND THE VDM WITH THE ALS-8**

**KEYBOARD INTERFACE**

**TYPICAL KEYBOARD CONNECTIONS**

![Keyboard diagram](image)

**The keyboard strobe.** This circuit tells the processor when a key has been pressed. You'll need to install an additional IC (preferably in a 16 pin DIP socket) in the unused IC pad in the lower right corner of your 3P+S, and connect it to pin 7 of J2. It's used to condition the strobe. Use a 74LS109 or 74109. (Figure 2)

**To wire the 74109:**
1) Connect pins 2 and 3 to ground.
2) Pins 16 (VCC) and 8 (GND) are already connected on board.
3) Connect pin 1 to pin 1 of IC 15 to provide a pull-up connection.
4) Connect pin 5 to pin 11 of IC 15 to reset the flip-flop when data has been accepted.
5) Connect pin 7 to a point on 3P+S leading to J2 pin 12. This point will go low when the strobe occurs.
6) Connect pin 4 to a point on 3P+S leading to J2 pin 7, the point where the strobe from the keyboard will be connected.

**The data lines.** Either seven or eight data lines are used to transmit the ASCII code for the key being pressed to the computer. They're connected to the B port inputs of the 3P+S in the following manner:

<table>
<thead>
<tr>
<th>Keyboard Signal</th>
<th>3P+S J2 Connector</th>
<th>Data Bit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bit 1</td>
<td>Z</td>
<td>D0</td>
</tr>
<tr>
<td>Bit 2</td>
<td>Y</td>
<td>D1</td>
</tr>
<tr>
<td>Bit 3</td>
<td>X</td>
<td>D2</td>
</tr>
<tr>
<td>Bit 4</td>
<td>W</td>
<td>D3</td>
</tr>
<tr>
<td>Bit 5</td>
<td>V</td>
<td>D4</td>
</tr>
<tr>
<td>Bit 6</td>
<td>U</td>
<td>D5</td>
</tr>
<tr>
<td>Bit 7</td>
<td>T</td>
<td>D6</td>
</tr>
<tr>
<td>Bit 8*</td>
<td>S</td>
<td>D7</td>
</tr>
</tbody>
</table>

*Pin J2-S is left unconnected if your keyboard doesn't have an eighth bit.

**Ground, +5V, -12V.** These provide power for the circuitry of the keyboard. Ground is simply connected to pin 12 of J2. +5V and -12V (regulated) should be provided by a separate power supply. Some KYBDS only require +5V. Figure 3 shows an example of one, assembled on a small piece of perf board and attached to the keyboard or main frame. Jumper it to the keyboard connector.

**ASSEMBLE ON SMALL PIECE OF PERF BOARD AND ATTACH TO KYBD OR MAINFRAME AND JUMPER TO KYBD CONECTOR**

**Jumper areas.** Only two are important for the keyboard interface: Area A must be jumpered for address 0 (i.e., all to ground), and Area B must be jumpered from left to center, to set port A at 0 (status) and port B at 1 (data) to correspond to Processor Technology software.

**Testing the interface with ALS-8.**
1) Turn on the computer and examine location E000H. When you hit Run, the address lights should look like this:

```
    1 0 0 0 H
    * * o o o o o
```

   * = Light on     o = Light out

2) Be sure the keyboard is sending upper case characters. Type EXEC E024, then hit the carriage return key. Address light A13 should blink instantaneously at this point.

3) Type IODR/SYSIO/0 FE77, then hit the return key. Again, address light A13 should blink.

4) Now hit Space, Space, Return; wait a moment and then hit Control Z. The screen should now be blank.

5) Hit Control S. The word SPEED? should now appear in the lower left corner of the screen. If it doesn’t, you may have to adjust the horizontal and vertical controls on the VDM to get this message onto the visible portion of the screen.

6) Type 1; you should get an automatic carriage return, then type DUMP 0 FFFF and hit Return. Memory will now dump on the VDM display. You can hit the Escape key to stop the dump.

7) Now you're ready to start programming with the ALS-8! Try some of the examples from the ALS-8 manual to familiarize yourself with its operation.

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**Hoare's Law of Large Programs**  
*Inside every large program is a small program struggling to get out.*

---

**Good News for our Customers in Europe: VDM-1 and the European 50 Hz Standard**

The European television standard maintains the same horizontal rate as the U.S. (15,750 Hz), but it defines a raster of 625 lines at a field rate of 50 Hz. The effect is to increase the number of scan lines on the screen.

It's quite easy to modify your VDM-1 to work on this standard. Simply disconnect pin 5 of IC 8 from pin 6, and reconnect it to ground (pin 4). This increases the modulus of the counter to 8 in the VDISP time, resulting in 4 extra character lines (52 scan lines) on the display. The total is now 312 scan lines per field, the equivalent of 624 per frame.

The field rate should be close enough to 50 Hz to reduce any swim effects to less than 0.1 Hz. You may have some trouble centering the display in the frame, because the standoff time to VSYNC from the bottom of the display is still on the 60 Hz standard. If the effect is objectionable, increase Resistor R 34 in series with the VPOS control.

---

**Rule of Accuracy**

*When working toward the solution of a problem it always helps you to know the answer.*

**Sattinger's Law**

*It works better if you plug it in.*
Once upon a time, in a curious little place, there was a Sol system and a programmer sitting around with nothing to do. So Newett Awl decided to tell his computer a bedtime story, and VDM-1 helped him out by drawing the pictures.

Try it on your system. Ol’ Uncle Sol makes a great babysitter.
Ups and Downs or How to Type in Upper Case Only without Shifting

If you have a keyboard with both upper and lower case operation, the frequent shifts are a pain when you are entering alphanumeric data. Here's a simple cure that sets data bit D5 low when a lower case alphabetic character is output from the keyboard, thus presenting it to the computer as upper case.

You'll need two chips, either a 7404 and a 7408 or a 74LS04 and a 74LS08. (Either pair works fine.) Install them on a small piece of perf board as shown in the diagram, and tie all unused inputs to +5V.

The pins you'll be using on the 04 chip are 3, 5, 9, 11, and 13; on the 08 chip use 4, 5, 9, 10, 12, and 13.

FLASH ~~ VDM Access Flicker Eliminated

That blasted flicker you get whenever the VDM memory is being frequently accessed occurs because the screen is blanked for a very short time whenever the processor reads or writes to memory. You can eliminate it by modifying the timing system so than VDM memory is accessed only when the beam of the picture tube is off the visible portion of the screen. The VDM has a timing signal that indicates this condition, and you can use it to synchronize access to display memory.

Connect a jumper wire from pin 13 of IC 39 to pin 5 of IC 39. This hooks up an unused section of IC 39 to DI bit 1. Connect a wire from IC 39 pin 14 to IC 15 pin 9. (This allows programs which access the VDM memory to use the timing signal.)

Now when C8 is input, bit 1 will be low whenever the display memory can be accessed.

We'll explore the implications further in the next issue, and provide an example program or two.

Murphy's Law of Thermodynamics
Things get worse under pressure.
Lowery's Law
If it jams—force it. If it breaks, it needed replacing anyway.

Application News
Ham Computer Based on Sol Terminal System

SYSTEM 4000 ham computer was developed by Curtis Electro Devices, Inc., Box 4090, Mountain View, Ca. 94040. The company makes ham keyers and an industrial line of PROM programmers. We asked the president, John G. Curtis, to comment on working with the Sol system; he did all of the hardware and software work himself, developing programs for the Sol Terminal on ALTAIR with ALS-8, VDM 1, 40K of RAM, 3P+ 1, Tarbell cassette system, Bytesaver, ASR-33 TTY, and Motorola video monitor. Jack's report was glowing:

"I had no previous experience or training software development. It was all learned on the fly from books and practical experience. (Try, try and try again!!)... Not too much assistance was required. The ALS-8 is easy to use and the Simulator program is absolutely essential. The Editor is also absolutely necessary. (Everything is necessary!!)..."

"The Sol went together with a minimum of effort and trouble even though it was one of the first units actually put on the line. There were things which didn't work but with the help of PTC (especially Bob Marsh and Aram) things were put in order in a hurry.

"In my opinion, the Sol terminal is the most ideal small computer system available today (certainly at that price) and every needed feature is there. For our purposes it was absolutely ideal from every standpoint. We are now able to get the computer into the ham shack on a commercial basis. This has been predicted for sometime, now it has happened."

System 4000 Ham Computer

The SYSTEM 4000 is a full scale standard desk top minicomputer specially equipped with firmware programs and interfaces for the amateur radio operator. Being a stand-alone computer, it can also run business, educational, scientific or games programs.

The SYSTEM 4000 is derived from the Sol terminal Computer and can take advantage of Processor Technology's programs and accessories. System 4000 uses the standard S-100 bus for plug-in accessory boards, and the owner can add or exchange PROM integrated circuits to update the system.

Features:

- **Morse reader**, capable of receiving code at speeds of 6-250 WPM (or higher). CRT or TTY output, selectable for upper and lower case.
- **Paddle keyer**, with dot= and dash memory, iambic and full self completion. CRT or TTY output.
- **Keyboard keyer**, sends Morse from keyboard. CRT or TTY output.
- **ASCII terminal**, half or full duplex.

Complete details can be obtained by writing to: Curtis Electro Devices, Inc., P O. Box 4090, Mountain View, Ca. 94040.

Murphy's Third Law
In any field of scientific endeavor, anything that can go wrong will go wrong.

Sevarenid's Law
The chief cause of problems is solutions.

Brooks's Law
Adding manpower to a late software project makes it later.

O'Tooles's Commentary on Murphy's Laws
Murphy was an optimist.
A major purpose of this newsletter is helping you stomp out the bugs that inevitably occur even in the best of systems. Bug Squad will be a regular feature. We'll tackle the problems we've encountered most frequently, and you're also invited to send in any problems that have been bugging you. Send solutions, too, if you've found them. Share the wealth.

For starters, here's how to fix a few of the bugs that crept into early Sol systems:

**Memory Protect/Unprotect Lines**

The bug: Erratic behavior when early Sol-PC, Sol-10, and Sol-20 units are used with S-100 bus compatible memory modules.

The squasher: On early Sol circuit boards, the protect (pin 70) and unprotect (pin 20) lines are floating. Simply ground bus line 70 on the Sol PCB itself to disable the memory protect signal.

**Current Loop Source**

The bug: R23, a 470 ohm 1/2w resistor, is incorrectly tied to +5 on early Sol PC boards, producing less than a full 20mA current to teletype connections.

The squasher: Reconnect R23 to +12V which is only 1/4" away. Check to make sure that R29 remains connected to +5V. We suggest that the 20mA current loop connections (such as for ASR33) be made as follows:

### Consol Source Listing

For those of you who haven't seen it yet, here's the source list for the minimum Sol operating System, CONSOL. It provides all necessary display routines, along with standardized calling points for input/output operations.

```
COPYRIGHT 1976

C000 C001 C002 C003 C004 C005 C006 C007 C008 C009 C010 C011 C012 C013 C014 C015 C016 C017 C018 C019 C020 C021 C022 C023 C024 C025 C026 C027 C028 C029 C030 C031 C032 C033 C034 C035 C036 C037 C038 C039 C040 C041 C042 C043 C044 C045 C046 C047 C048 C049 C050 C051
```

--- CONSOL ---

**Law of Selective Gravity (The Butted Side Down Law)**

An object will fall so as to do the most damage.

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```

--- Consol Source Listing ---

For those of you who haven't seen it yet, here's the source list for the minimum Sol operating System, CONSOL. It provides all necessary display routines, along with standardized calling points for input/output operations.
Page 7
THIS ROUTINE GETS CHARACTERS FROM THE SYSTEM KEYBOARD.

1. Clear first 256 bytes.
2. Point to system ram.
3. Get the value.
4. Input command.
5. Output hex 16 bit value.
6. Bump the line count.
7. Compare addresses.
8. Output hl as hex 16 bit value.
9. Execute command.
10. Zero the crc.
13. Clear the uart flags.
15. Start tapes and select speed.
16. Set speed.
17. Convert it.
18. Execute command.
20. Zero the crc.
22. Output hl as hex 16 bit value.
23. Read the header.
24. sled.
25. Enter command.
27. Compare de and d6.
32. Compare de and d6.
33. Compare de and d6.
34. Compare de and d6.
35. Compare de and d6.
38. Compare de and d6.
40. Compare de and d6.
**Caution:** This routine is used to turn tape units off.

**Description:**
- **Function:** Turns tape units off.
- **Immediate Use:** Within the context of tape unit management.
- **Usage:** Call this routine to ensure tape units are turned off as required.

**Example Usage:**
```assembly
C3FB DI      ; Initialize tape units
C3FB 0956 *  ; Instruction for tape unit operation
C3FB 0955 *  ; Additional parameters
C3FB 0954 *  ; Further details
C3FB 0953 *  ; Optional notes
```

**Related Routines:**
- **C3EE D3 FA:** OUT STAPT GIVE COMMAND
- **C3ED AF:** TOFF XRA A
- **C3ED:** ROUTINE TURNS THE TAPE UNITS OFF
- **C3D7:** TREDY IN STAPT GET THE DATA
- **C3D4 C3 C6 C3:** JMP TAPIN NOT MODE...STAY IN LOOP
- **C3CD DB FC:** IN KDATA CHECK FOR MODE WHILE WE'RE WAITING

**Document Notes:**
- Port assignments and equivalent hex values are listed below for ease of reference.

---

**Data Table: Port Assignments**

<table>
<thead>
<tr>
<th>Port</th>
<th>Assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>DI</td>
<td>Initialize tape units</td>
</tr>
<tr>
<td>TOFF</td>
<td>XRA A</td>
</tr>
<tr>
<td>ROUTINE</td>
<td>TURNS THE TAPE UNITS OFF</td>
</tr>
<tr>
<td>TREDY</td>
<td>IN STAPT GET THE DATA</td>
</tr>
<tr>
<td>TAPIN</td>
<td>NOT MODE...STAY IN LOOP</td>
</tr>
<tr>
<td>KDATA</td>
<td>CHECK FOR MODE WHILE WE'RE WAITING</td>
</tr>
</tbody>
</table>

**hexadecimal values:**
- DI: 0956
- TOFF: 0942
- ROUTINE: 0941
- TREDY: 0925
- TAPIN: 0923
- KDATA: 0918

---

**Conclusion:**
This routine is essential for managing tape units within the system, ensuring they are properly turned off as needed. It is part of a larger context of tape management routines, each serving specific functions to maintain the integrity of data handling and system operations.
009E 22 F1 04    0710 S H L D  S H E D + 3 6 D H  F I R E M A N
00A1 2A 78 01    0720 L H L D  F R A 1   . .  T H E  L I T T L E  E N G I N E
00A4 22 24 05    0730 S H L D  S H E D + 3 A 0 H  A L S O
00A7 2A 7A 01    0740 L H L D  F R A 2   . .  H A D  A  C O W C A T C H E R
00AA 22 26 05    0750 S H L D  S H E D + 3 A 2 H  L O T S  O F  F U N N Y
00AD 22 28 05    0760 S H L D  S H E D + 3 A 4 H  W H E E L S  A N D  T H E
00B0 22 2A 05    0770 S H L D  S H E D + 3 A 6 H  T H I N G S  T H A T  C O N N E C T E D
00B3 2A 7C 01    0780 L H L D  F R A 3   . .  A N D  T W O  V E R Y  T I N Y
00B6 22 2C 05    0790 S H L D  S H E D + 3 A 8 H  W H E E L S  A T  T H E  V E R Y
00B9 22 2E 05    0800 L H L D  F R A 4   . .  V E R Y  B A C K
00BC 22 ZE 05    0810 S H L D  S H E D + 3 A 9 H  A L T O G E T H E R  I T  L O O K E D
00BF 22 80 01    0820 L H L D  F R A 5   . .  Q U I T E  L O N E L Y  A N D  Y E T
00C2 22 30 05    0830 S H L D  S H E D + 3 A C H  I T  A P P E A R E D  V E R Y
00C5 01 DF FF    0840 L X I   B , - 2 1 H   . .  F U N N Y  J U S T  S I T I N G
00C8 21 62 05    0850 L X I   H , S H E D + 3 D E H  T H E R E  O N  T H E
00CB 36 19       0860 R A I L S  M V I   M , 1 9 H   . .  R A I L S
00CD 03          0870 I N X   B   . .  W I T H  N O T H I N G  A T  A L L
00CE 23          0880 I N X   H   . .  E V E R
00CF AF          0890 X R A   A   . .  T O  D O
00D0 A8          0900 X R A   B   . .  W E  L L  !
00D3 C2 CB 00    0910 J N Z   R A I L S   . .  L E T ' S  R U N  I T  J U S T  F O R  F U N
00D6 C3 D4 00    0920 J M P   H O S T L E  . .  F U N N Y  J U S T  S I T I N G
00D9                1000 .
00DD A8          0910 X R A   B   . .  W E  L L  !
00E2 C5 D4 00    0920 J M P   H O S T L E  . .  F U N N Y  J U S T  S I T I N G
00E5                1000 .
00EE 21 80 01    0940 L H L D  F R A 6   . .  V E R Y  B A C K
00F0 22 26 05    0750 S H L D  S H E D + 3 A 8 H  W H E E L S  A T  T H E  V E R Y
00F3 2A 7C 01    0780 L H L D  F R A 3   . .  A N D  T W O  V E R Y  T I N Y
00F6 22 2C 05    0790 S H L D  S H E D + 3 A 8 H  W H E E L S  A T  T H E  V E R Y
00F9 22 2E 05    0800 L H L D  F R A 4   . .  V E R Y  B A C K
00FB 22 ZE 05    0810 S H L D  S H E D + 3 A 9 H  A L T O G E T H E R  I T  L O O K E D
00FC 22 80 01    0820 L H L D  F R A 5   . .  Q U I T E  L O N E L Y  A N D  Y E T
00FF                1000 .
0102 01 40 03    1070 T R A V L   L X I   B , 6 4 . 1 3  , M A K E  T R I P  1 3  M I L E S
0105 0E D0       1100 C H O O   P U S H   B   . .  C H U F F  O N E
0108 CD FF 00    1100 C A L L   S T R O K   M A K E  F O R W A R D  M O T I O N
010B 0F 01    1100 C A L L   T U R N   T U R N  W H E E L S
010E 0B 01    1120 D C X   B   . .  C L I C K  O D O M E T E R
0111 AF          1130 X R A   A
0114 A8          1140 X R A   B   . .  1 3  M I L E S  Y E T ?
0117 A8          1150 X R A   A
011A 0F 01    1170 C H O O   C O M P   C   . .  E N O U G H  C O A L ?
011D 0E D0       1270 J N Z   C H O O   N O
0120 04 01    1150 C O A L   N O   . .  P U T  M O R E  O N !
0123 11 7E      1280 R E T   . .  D O  N E X T  T R I P
0126                1290 .
0129 21 01 CC    1180 S T R O K   L X I   H , 0 C C 0 1 H   M O V E  D O W N  T H E  T R A C K
012C                1300 .
012F 21 00 CC    1300 T U R N   L X I   H , 0 C C 0 0 H   T U R N  W H E E L S
0132 0E D0       1310 H I S S   M V I   B , 7   . .  D O  4  A X L E S
0135 11 23      1320 I N X   H
0138 0E 06       1330 C P I   6   . .  F I N D  C O W C A T C H E R
013B C2 12 01    1340 J N Z   H I S S   L O O K  A G A I N
013E 23 1350     1350 F O U N D   I N X   H
0140 AF          1360 A X L E   M V I   A , M
0143                1370 .
0146 11 01       1380 J N Z   N X T 1
0149 11 7E 14    1390 L X I   D , 1 4 E H   N E X T  Q U A R T E R  T U R N
0152                1400 .
0155 06 07       1410 A X L 1   M V I   B , 7   . .  D O  4  A X L E S
0158 12 01       1420 A X L 2   M V I   M , D   W H E E L S  M O V E D  H E R E
015B 05          1430 D C R   B   . .  L A S T  W H E E L ?
015E                1440 .
0161 52 01       1440 J Z   W O R K   I ' V E  B E E N  W O R K I N '   . .
0167 73          1460 M V I   M , E   ( S I D E  R O D S  M O V E D  H E R E)
016D 05          1480 D C R   B   . .  L O N G  D A Y  . . .
0170                1490 .
0173 25 01       1500 J N Z   A X L 2
0176                1500 .
0179 FE 14       1510 N X T 1   C P I   1 4 H   Q U A R T E R  T U R N
017C C2 3C 01    1520 J N Z   N X T 2
017F 11 2D 13    1530 L X I   D , 1 3 2 D H
0182 39 C3 01    1540 J M P   A X L 1
0185 C3 FE 13    1550 N X T 2   C P I   1 3 H   Q U A R T E R  T U R N