TEAGUE ENTERPRISES

DESIGN - TESTING - MANUFACTURING

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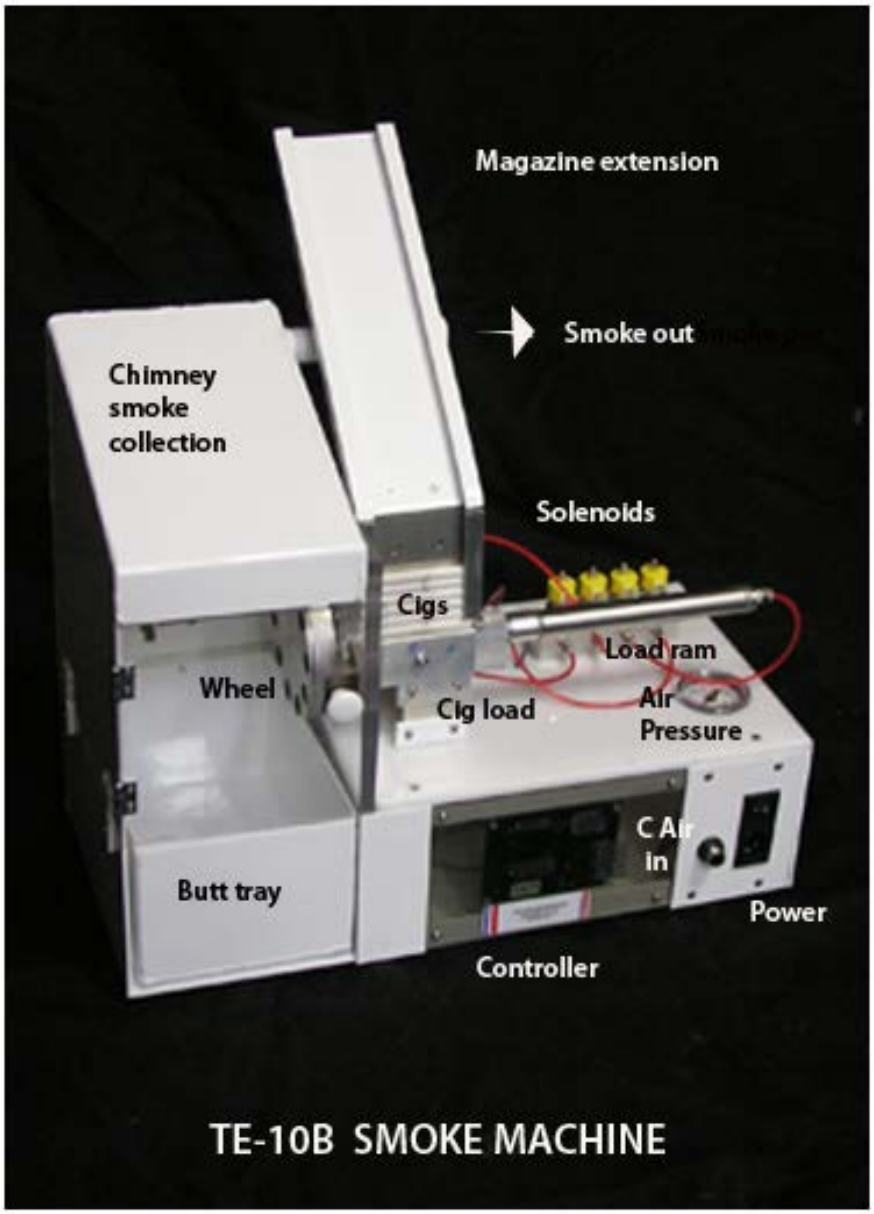
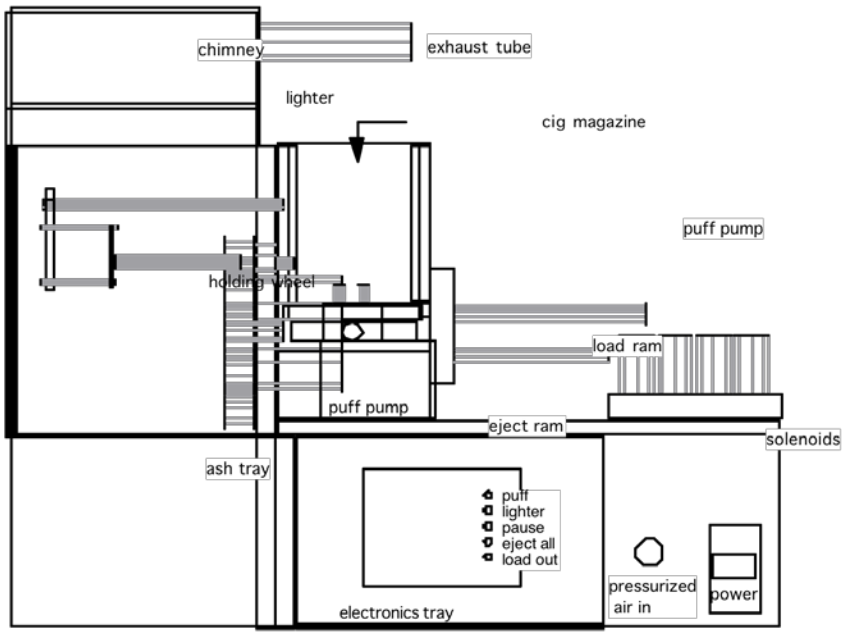
TE-10B Operating Instructions Aug 2015



General Description: Smoking Machine



Smoke machine

The TE-10b is a microprocessor controlled cigarette smoking machine that produces either side-stream or main-stream smoke (or a combination of the two) from research cigarettes. Regular commercial cigarettes with a diameter of 0.311" (7.9 mm) and length less than 3.2" (81.3 mm) can also be used. Cigarettes are automatically loaded into a wheel, lit, puffed and ejected. One to ten cigarettes can be smoked at a time using the FTC method of puffing for 2 seconds, once a minute at a volume of 35 cm^3. Up to 40 cigarettes can be placed into the machine for loading at one time and cigarettes are smoked for 9 minutes each. Ejected cigarettes are extinguished in a water tray. The number of cigarettes, in the one cigarette configuration, needed for one hour of operation is 6.6. Burning three cigarettes at a time would use 20 cigarettes an hour and so on.

Smoking systems generally have a smoking machine, some method to mix and dilute the smoke and an exposure unit. In conjunction with a mixing and aging chamber, a range of concentrations with side-stream, main stream or mixed smoke can be produced. The machine's applications include use with animal and cell culture exposure systems, serial animal exposure chambers and nose-only chambers. To maintain a target concentration a dynamic system is required where smoke is produced at a constant rate, mixed and diluted, and metered to the exposure cabinet at a constant rate and then exhausted. TSP levels from .01 milligram per cubic meter to 600 mg/m^3 have been generated with TE systems. The whole body system consists of the TE-10 in a hood unit with the mixing chamber. Flow is metered to the exposure chambers and comes back to the fan under the hood and then exits to be exhausted. The number of cigarettes and the flow rate through the chambers determines smoke concentration.

Operation:

The TE-10 uses a custom designed microprocessor board to control the smoking machine operations. The cigarettes are loaded in the magazine by tilting the cigarettes and placing them one on top of the other, with the filter on the right side, until they reach the top. Air cylinders that perform the loading and ejecting tasks operate the moving parts. The solenoids are activated by 12 vdc from the microprocessor and operated with compressed air. The air control solenoids are three-way valves normally open to the air cylinder side. The sequence starts by moving cigarettes from the magazine into the chamber for placement of the cigarette into the wheel. With the solenoid in the "on" position, air is opened to the spring return air cylinder. The piston is connected to the sliding receiver at the bottom of the stack of cigarettes in the magazine. The program starts when the power is turned on and the number of cigarettes to be placed in the wheel is determined. The motor is activated and searches for the zero position by rotating the wheel until a magnet in the wheel activates a switch. The stepper motor then moves the wheel to the eject position and activates the eject ram and the magazine load ram to place a cigarette into the load chamber. The program then moves to the load position and activates the load ram air cylinder by pushing the cigarette into the wheel. As the cigarette moves counterclockwise to the one o'clock position the lighter turns on. The lighter duty cycle number adjusts the power to the lighter wire. This is set at the start of the smoking and should not have to be reset. At the 12 o'clock position, the cigarette contacts with the lighter and starts burning. A two second puff is then taken on the new cigarette. The puff signal turns on the puff pump, which is calibrated to flow at 1.05 LPM, and results in a puff of 35 cubic centimeters. The machine continues to load cigarettes, light and puff them corresponding to the number chosen in the start program. Cigarettes move around so each is puffed once a minute for two seconds. Each cigarette is puffed nine times and is then ejected by the eject ram where it falls into the ashtray and is extinguished by the water. The cigarette is then replaced by a new cigarette from the magazine and starts the same cycle of lighting and puffing as the first set.

Research Cigarettes:

Most of the smoking systems being used in the US are using standard reference cigarettes. There are a number of these cigarette types and are sold by the University of Kentucky, Lexington, KY. The most widely used is the 3R4F cigarette (low tar modern cigarette). More information on the composition and analysis of the reference cigarettes and purchasing of the cigarettes can be obtained by contacting them. As part of the FTC method the cigarettes are stored at 4°C until needed. At least 48 h prior to use, the cigarettes are placed in a closed chamber at 23°C along with a solution of glycerin/water (mixed in a ratio of 0.76/0.26) to establish a relative humidity (RH) of 60%.

TE-10 description:

The machine is composed of four sections: **cabinet, cigarette handling, chimney and ash collection tray.**
The **cabinet** houses the power supply, air pressure gauge, solenoid block, and electronics tray (control microprocessor).

- **Power supply** –110 to 240 VAC power unit delivers 12 VDC regulated power for the microprocessor, solenoids, lighter and stepper motor. Fuse (4 Amp) is above the switch on front of machine.
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- **Air pressure gauge** -- 0 to 60 psi from air connection on front of cabinet indicates air pressure to solenoids for air pistons. A user-provided air regulator is needed to provide pressure at 25 PSI (monitored by a pressure gauge) to operate the air cylinders. "Presto-loc" fittings are used throughout the system and the tubing must be pushed in securely to insure proper sealing on the tubes.
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- **Solenoids** – The four solenoids direct the compressed air to activate the three air pistons. When off top connector is open to the room.
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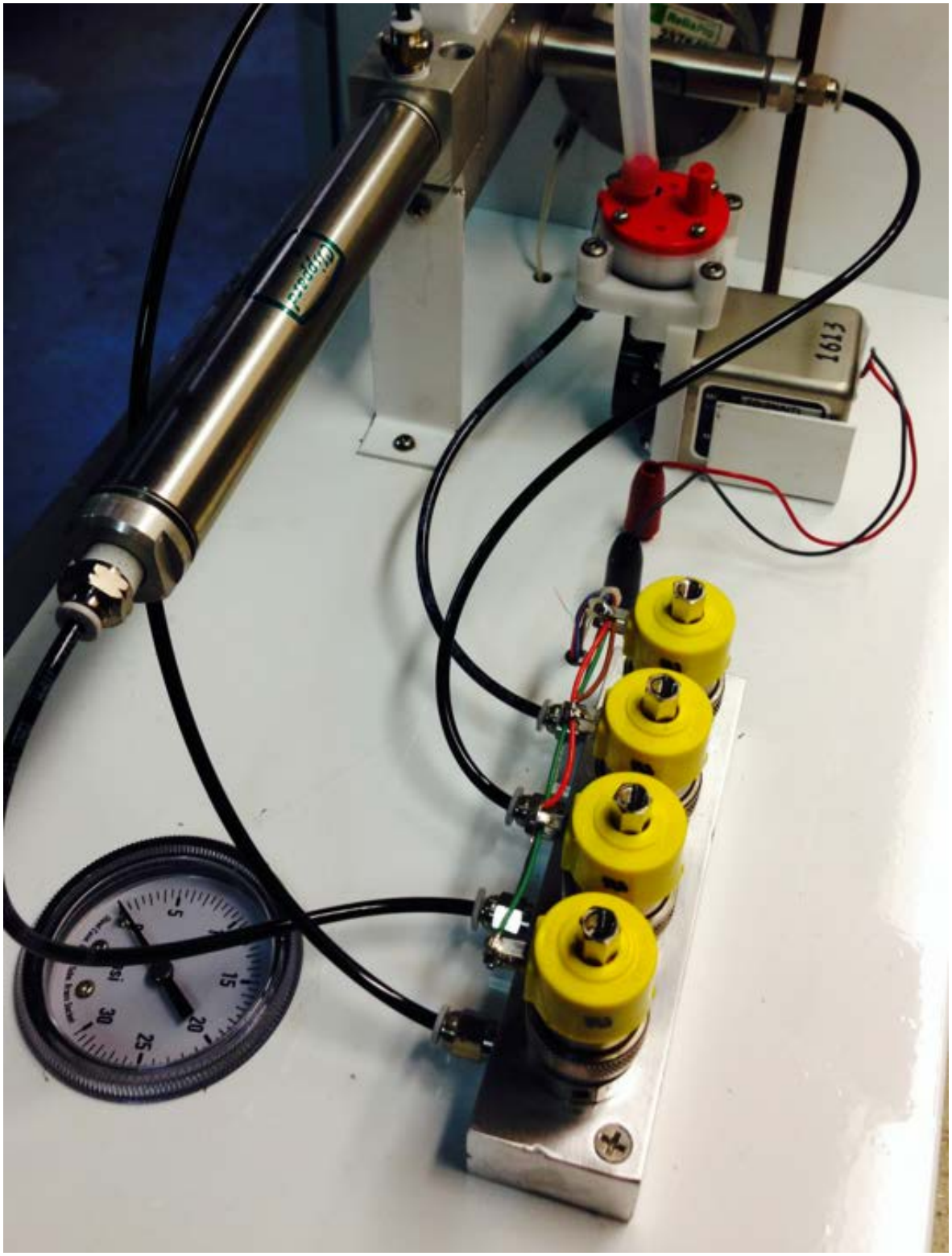
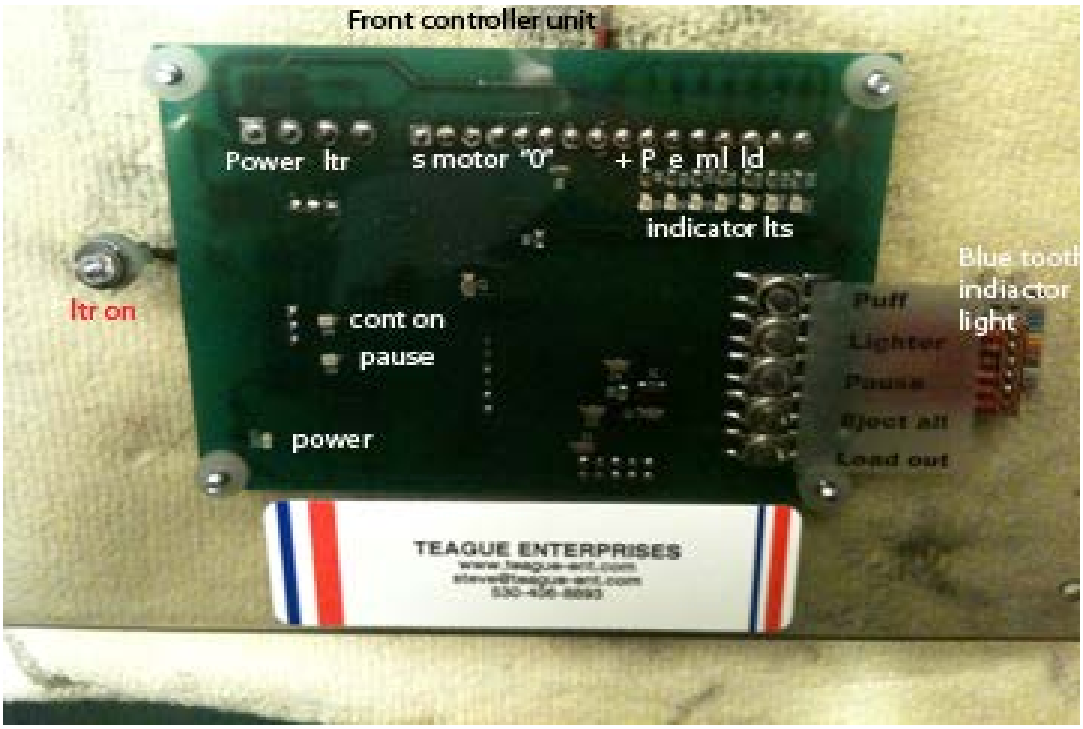
- **Air pistons**

1. Magazine load – moves cigarettes into loading chamber. Spring return.
2. Load – (ram cylinder) pushes the cigarette into the wheel. Uses two solenoids one to activate the rod and the other to retract it.
3. Eject – pushes the cigarette out of the wheel. Spring return.



- **Controller** – the removable Lexan plate holds the electronics board. This contains the microprocessor and blue tooth adaptor for communication with the controller to change the parameters.



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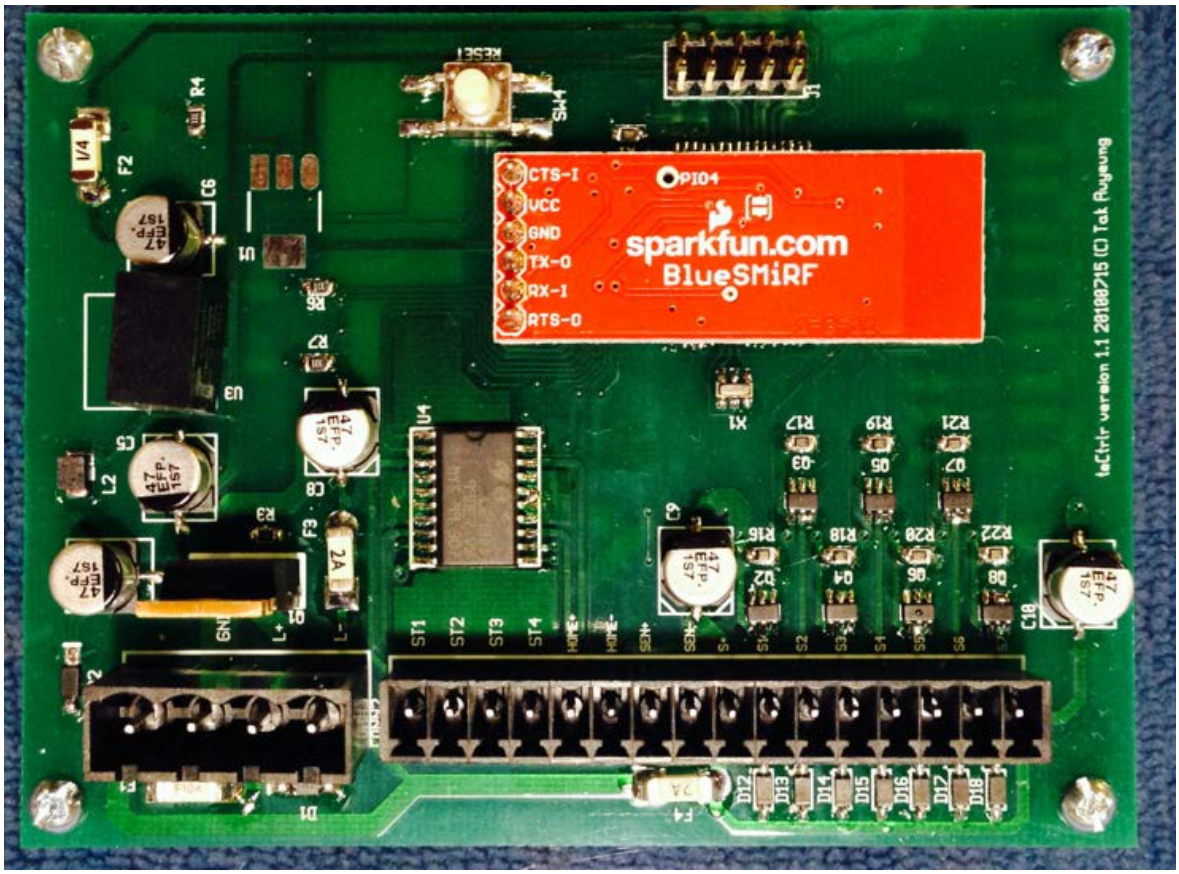


Start Up Procedure:

1. Make sure the loading mechanism is free of debris, puff pump has been cleaned and everything is connected and in place.

2. Place fresh water in the extinguishing ash drawer to a level about half to three quarters full.

3. Plug in the pressure line and adjust line pressure to 20 – 30 PSI on smoking machine gauge.

4. Load magazine with research cigarettes in the proper orientation (filter to rear).

5. Plug in machine and push the power rocker switch.

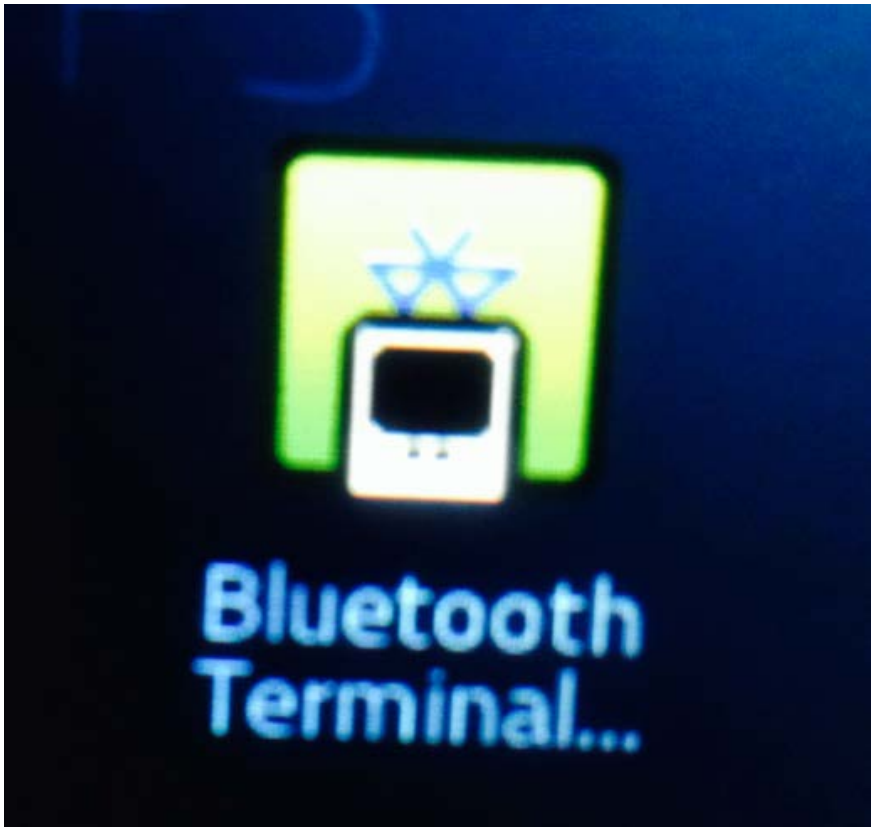
6. After the machine is turned on and wheel stops the program may be changed to desired settings. The wheel has a magnet in the backside that activates a reed switch to set the zero position. The “pause” button must be depressed immediately after wheel stops to change any option on the controller. The switch must be depressed until the pause light is illuminated. If the pause is not operated the machine will run with the last settings that the controller was set at.

- Initial set up
  - Turn on the machine, the carousel rotates twice and stops, the red LED should then be lit.
  - Press the “PAUSE” button as soon as the red LED is lit (you have a 5-second window), keep pressing the “PAUSE” button until the green LED is also lit.
  - Release the “PAUSE” button, both the red LED and the green LED should remain lit.
  - Now the machine is in configuration mode. Configure using the following procedure:
    - You need a terminal emulation program that can connect to serial ports. Options for connecting to a PC (no Mac :( ) or android device.
    - FOR PC
      - “PuTTY” is a good option. It is an open source product, therefore it is free of charge, and free to distribute.
      - You also need bluetooth connectivity.
        - Some laptop computers have built-in bluetooth capabilities.
        - If your computer does not have bluetooth capabilities, you can purchase a bluetooth-USB dongle.
      - Enable bluetooth, then click the bluetooth icon in the notification area.
      - Select “Show Bluetooth Devices”
      - The TE-10 will report as a FireFly-XXXX (XXXX being a hexadecimal number, a sequence of digits and letters from 'A' to 'F').
      - If the TE-10 does not show up, click “Add Device” at the upper left corner. You only need to perform the following steps once.
        - Select the “FireFly-XXXX” device, click “next”
        - When asked, select “Enter the device's pairing code” (second option).
        - The pairing code is “1234” (without the quotes).
        - Right-click on “FireFly-XXXX”, select Properties
        - Select the “Services” tab
        - Take note which serial port the device is connected to. Typically, this is “COM3”, “COM4”, “COM5” and etc.

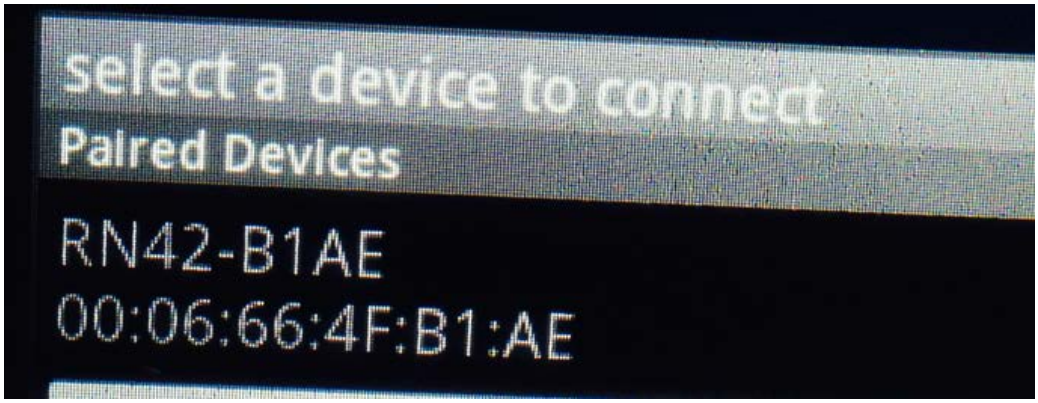
FOR ANDROID DEVICE (smart phone, Visio tablet, Google Nexis 7)

The device must be paired first by going to settings and tap on bluetooth
Search for devices.
After it identifies device pair with device by entering 1 .. 2 .. 3.. 4
This only has to be done one time and if controller came with tablet it is already on the tablet and ready to use.
If not on tablet or phone download and install the application “Bluetooth Terminal Emulator”

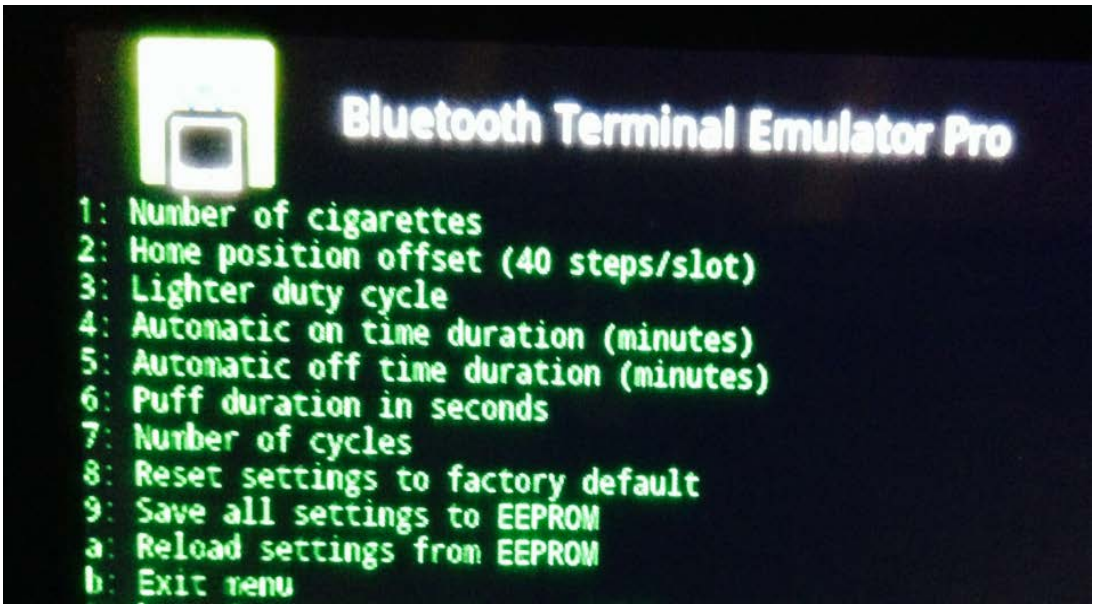
Open the downloaded app “Bluetooth Terminal Emulator “



When it opens choose the paired device



The program will read “connected to device” and a curser will show up in the upper left corner.
Open the keyboard and hit return.
The following screen should show up:



SET UP AND CHANGING PARAMETERS FOR SMOKING

1: Number of cigarettes.
Click on 1 and the number of cigarettes will show up as :
Number of cigarettes = 10 (or whatever it was set at the last time it was saved)
To increase number of cigarettes press + to number desired.
To decrease number us – and after desired number of cigarettes press enter.

To save the number of cigarettes when machine is turned it must be saved by pushing 9 to save all settings to EEPROM.

2. Home position offset (40 steps per slot) Wheel offset alignment

When the machine first turns on the wheel turns until a magnetic switch is triggered by a magnet in the wheel. The index number is the number of steps the motor moves after it is triggered, before it stops.

The wheel should be aligned up with the hole of the cigarette loader. This number is usually about 32-36.

The position can be checked by taking the pusher tool and placing it in the wheel to test if the position is exactly in the proper location.

Once this is set and saved it should not have to be set again. Unless a different wheel is put on.

3. Lighter power duty cycle:

The number indicates power level 12 to 14 is about right

If cigarettes are not lighting due to low temperature of the wire after it has been working check the connection first. Tighten nuts and clean lighter wire.

To increase power use + and decrease –

Note that increasing number too much will cause wire to burn out prematurely.

4. Automatic on time duration.

The *on time* may be set for any time from 1 to 999 minutes.

The time is set by using the + and – keys.

This is the interval of time the machine can programed to operate for.

When the time is completed the machine will eject all cigarettes and stop.

5. Off time. The *off time* has the same range and is set the same way as *on time*. If the *off time* is set to zero the *on time* is never activated. After the indicated *off time* is timed out the machine starts up again. For example if the *on time* is set to three minutes and the *off time* is set for 2 minutes. The machine will load the cigarettes and light them puffing only three times and then eject all the cigarettes. After two minutes the machine will load the cigarettes again and go through three puffs before ejecting them

MANUAL OPERATIONS

While the machine is running several operations can be used to help keep the cigarettes burning or put cigarette in, adjust the ml, check puff flow, etc.

a. Puff on. The first key is pushed to turn the puff pump on. This may also be used to clean the puff pump in the methanol cleaning method detailed in the maintenance section. To turn off push the button again.

b. Lighter on. The second button will turn on the power to the lighting wire. Push on to turn power on. To turn off push button again.

c. Pause. The 3th button on the top below the "pause" will stop the machine and stop immediately the operation at wherever it is. To restart the machine just push the button again.

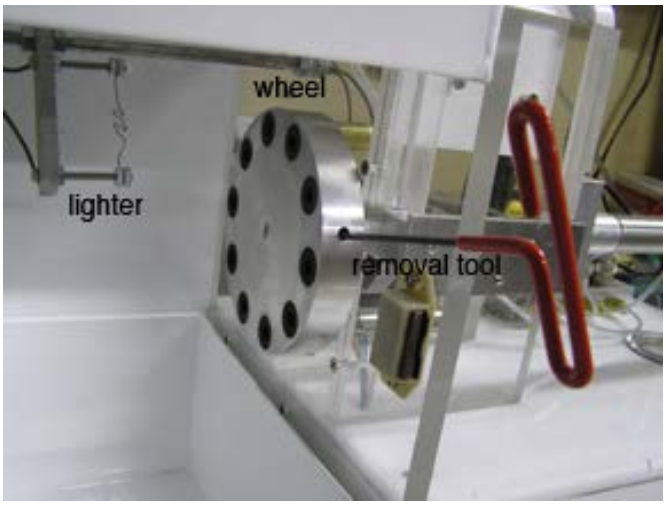
d. Eject all. The 4h button on the top below "eject" will eject all the cigarettes and stop the machine. The machine waits for the current cycle to finish before initiating the command.

e. Load out will activate the magazine load solenoid. This will push the ml out for adjustment, cleaning and when the ml drawer is removed to enable it to be put back on.

The **cigarette handling** parts include the cigarette-holding device (magazine), the cigarette-metering device (magazine load mechanism), the load piston, eject piston, the wheel that holds the cigarettes and the puffing pump.

- Magazine – holds the cigarettes stacked on each other.

- The lower part is part of the magazine feeds cigarettes into load slot.
    - The upper part is an extension attached to lower section and is made of aluminum and canted at about 30 degrees. Up to 40 cigarettes can be loaded into the magazine and extension.
- Magazine load – drops the cigarettes into the loading slot. A spring return air cylinder moves the sliding knife out to allow the cigarette to fall into the slot.

- Load – the load air piston pushes the cigarettes into the wheel. The cigarettes are pushed into the wheel from the loading chamber by an air piston with a 5 inch) displacement. The rod is retracted by applying air to the air piston return port.
- Wheel – is an aluminum wheel 4.5 inches in diameter with ten holes tapered to hold the cigarettes. The wheel is held onto the shaft of the stepper motor by an Allen screw in the side of the wheel.
    - 

    - New wheel modification to align wheel and distance placement
    - 
- The load piston pushes the cigarette through so that 3/8 of an inch (9.5 mm) of the cigarette is held in the wheel hole. A gasket in each hole made of 1/8 inch neoprene with an inner diameter of 0.30” (7.6 mm) holds the cigarette in a gas tight seal for puffing.
    1. Eject – at this location (at 6 o’clock) a rod from a spring return air piston pushes the cigarette out of the wheel. Each cigarette is puffed nine times and then ejected by the piston to fall into the ash tray containing water where it is extinguished
    2. Load – at this position (about 2 o’clock) the cigarette is loaded into the wheel by the load piston.

3. Puff—cigarettes are ignited by a nichrome wire and puffed once a minute at the top most or "puff" position. The puff hole contains a Teflon tube held against the wheel by a spring to provide adequate suction for puffing. The smoldering cigarette is puffed for 2 seconds at a flow rate of 1.05 LPM to provide a standard FTC puff of 35 cubic centimeters.

- Puffing pump—A 12 VDC pump is used to provide the negative pressure for the proper flow rate. In the mainstream plus side-stream configuration, mainstream smoke is added to the side-stream smoke at the exit of the collection hood.

PUFF CONNECTOR MOD 3 (Nov 14)

The "Puff Connector" modification 2 was developed in Nov 2014 to make a better seal from the back of the rotating wheel to the puff pump. The problem with the former seal was inability of washer to conform to the wheels changing angle due to the wobble caused by the wheel not being true. The wheel as manufactured with a ¼ inch hole in center is very hard to keep at a right angle to the shaft. This is because of the clearance that has to be used to put wheel on the shaft of the stepper motor and the set screw holding the wheel on the shaft. The need to remove the wheel frequently for cleaning and servicing connector parts results in wearing and eventual slack so the wheel does not exactly line up with shaft. The cylinder sealing piece permits the face of the cylinder to move with the wheel and remain parallel to the back so a better seal can be achieved. An "O" ring is placed on face to make a better seal for puffing. Another "O" ring in the inside hole for the brass tube allows movement of the cylinder while sealing on the tube. The tube is also much larger which help with tar plugging up tube so rapidly. The spring holds the cylinder sealing piece with enough pressure to seal and not hang up the rotating of the wheel.

Parts of the puff connection pieces.
Cylinder sealing piece.
"O" ring on face for sealing to wheel.

Inside boar “O” ring for sealing on connector tube
Back counter boar to hold spring

Connector tube
Brass tube ¼ inch OD for connection to puff pump inlet

Spring
Spring holds cylinder onto wheel.

Aluminum block
Holds tube and cylinder onto face with screws.

The **chimney** area contains the wheel and lighting wire. This area encloses the burning cigarettes to capture the smoke from the smoldering cigarettes.

- Lighting wire – a nichrome wire 0.02 inches (0.51 mm) in diameter made of Ni 80/ Cr 20 is suspended by two posts on a ceramic post made of 6-32 bolts. Wire is held in place by two opposing nuts. (New lighter wires can be purchased from Teague Enterprises)
- Chimney – made of aluminum on top with a tube out of one side for collecting the smoke. A door on the front allows access to the interior. Mainstream smoke is added to the side-stream smoke immediately after the collection tube leaves the chimney.

The **ash collection bin** is an aluminum box that is partially filled with water.

- Ashtray – aluminum drawer, which can hold a little over 4 liters of water. It is filled 1/2 to 3/4 full and extinguishes the cigarettes as they fall into the water when ejected.

Daily Maintenance:

1. Clean enclosure hood, wheel and magazine with spray soap solution. If debris is lodged behind the wheel, the wheel should be removed and the face and wheel should be cleaned.

2. Clean tar from puff port with cleaning swab dipped in methanol.
    a. Remove the tubing from the brass fitting on the back of the puff port.
    b. With the wet cotton swab push the swab (Q tip) through several times to remove tar.
    c. Remove the floating Cylinder sealing piece and clean around spring area.

3. Vacuum tobacco chaff and other debris on unit and in loading mechanism.

3. Clean pump by running methanol through pump after each days use. If pump does not operate at required flow rate, disassembly and cleaning of pump head will have to be performed.

    a. Disconnect the tubes from the fittings (puff port and exhaust tube) leaving on pump.

    b. Place the exhaust tube into a small beaker. (Exhaust tube is closest to motor.)

    c. Put about 25 ml of methanol into pump using a wash bottle or squirt bottle by just squirting some into the inlet port as the pump is turned on.

Weekly Maintenance:

1. Remove chimney and clean using methanol or some general purpose cleaner.

2. Clean out the chimney tube by running a rag soaked with methanol through it. Check the tube leading to the puff meter to make sure it is not obstructed by tar.

3. Remove the wheel and clean the ports and examine the gaskets for wear. Replace them if the gaskets will not hold the cigarettes tightly enough to form a gas tight seal. **Be very careful not to tighten setscrew with too much force, as this will distort wheel and shaft causing problems with centering the wheel as wheel hole is distorted.**

As Needed.

1. Replace hose from smoking machine to dilution chamber.
2. Remove door from dilution chamber and clean out with methanol and wipes. Also the fan must be cleaned and checked for operation. Do not turn on before the fan has dried out. The door is replaced and put back on after it is cleaned and allowed to dry out. If gasket is damaged or silicone was used originally replace the gasket with new material.
3. Remove line to the chambers by taking off the hose connecting to the dilution chamber. The pressure lines from the gauges on the front of the hood should be removed from the orifice meter. Examine the meter and hose and clean if necessary. If the hose is very dark it is easier to replace them than try to clean them.
4. Clean the valves going to the chambers by soaking in methanol and cleaning out.
5. Chambers should be cleaned and the distribution tubes cleaned out also. The tubes can be removed from the back of the chambers by removing the ductwork and pulling the tubes out.

Special Procedures:

Set Index offset number:

This may be needed if the electronics tray is replaced or a new wheel is put on.

1. With the controller paired to the blue tooth the number for index should be pushed.
2. Check the alignment by putting the cigarette pusher in the load hole (3 o'clock position facing wheel) or looking through side to see if the hole is aligned with the load hole.
3. Move wheel CW or CCW by pushing the + or - buttons. Wheel should move one step. By moving the wheel forward or backward (CCW or CW) the hole should just align with the loading hole.
4. When wheel is aligned #6 or save all is pressed then 8 and the machine will start operation. This number should be somewhere about 32 to 35.
5. No more adjustments should be necessary, as the machine will remember this number.

Unjamming cigarette:

1. Turn off machine.
2. Move the wheel so it is aligned with the holes on the faceplate.
3. Push cigarette from wheel side with pusher tool or rod into the loading chamber.
4. Move the cigarettes up with the holder and secure them so they are out of the way.
5. Pull the magazine load out and remove the smashed cigarette with a pair of pliers.
6. Vacuum out the debris with a vacuum cleaner by pulling out the magazine load mechanism several times while holding the vacuum nozzle in the tray.
7. Restart the machine.

Ignition wire replacement:

1. Use the replacement wire (nichrome -Ni 80%, Cr 20% .0120 inch), which is bent into the proper shape. The bent wire can be deformed into a convex shape (facing toward the cigarette). This form helps prevent the cigarette from catching on the end of the wire lighter and bending the lighter.
2. Remove the hood by taking out the four screws holding it on. This will facilitate access to the lighter post and make it much easier.
3. Remove the old lighter by screwing retaining screw out several turns and pulling off with pliers and holding on to the post with another pliers. Be careful not to break the ceramic post holder (it is brittle). The posts can also be removed from the holder and then pulled off the wire lighter.
4. Put a new nichrome wire around the post and tighten bolt on nut. Check nut on post connection to make it is secure on the wire from the lower unit.

Cleaning, checking and repair of puff pump:

Puffing pump—A 12 vdc pump is used to provide the negative pressure for the proper flow rate. In the mainstream plus side-stream configuration, the mainstream smoke is added to the side-stream smoke at the exit of the collection hood.

The pump is turned on for two seconds at the end of the cycle for each cigarette being smoked and cannot be changed. Because the smoking machine follows the FTC method when the flow rate is 1.1 LPM the puff will be 37 CCs.

Flow rate can be checked with the machine running by connecting a flow rate meter with a mass flow meter or a rotameter type such as “Visi-Float” flowmeter. The exhaust tube is disconnected from the chimney tube and connected to the bottom of the flowmeter. The picture shows flow around 2 LPM, which is about right because the cigarette will drop the pressure and flowrate to be close to the 1.11 LPM ideal flow.

Clean pump by running methanol through pump after each days use.

d. Disconnect the tubes from the fittings (puff port and exhaust tube) leaving on pump.

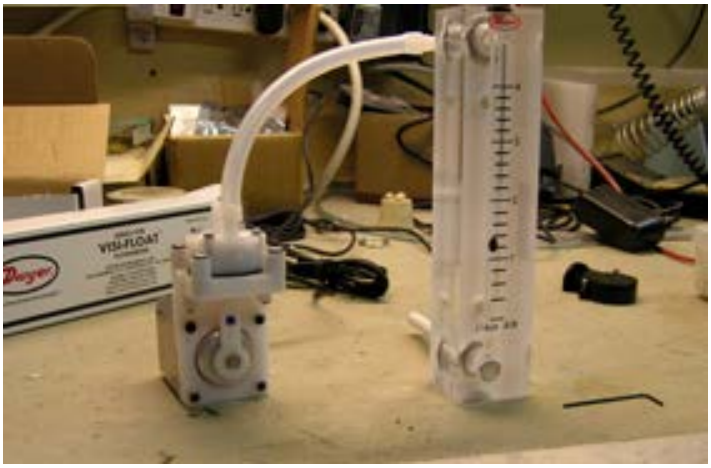
e. Place the exhaust tube into a small beaker. (Exhaust tube is closest to motor.)

f. Put about 25 ml of methanol into pump using a wash bottle or squirt bottle by just squirting some into the inlet port as the pump is turned on. The discharge will be collected in the beaker.

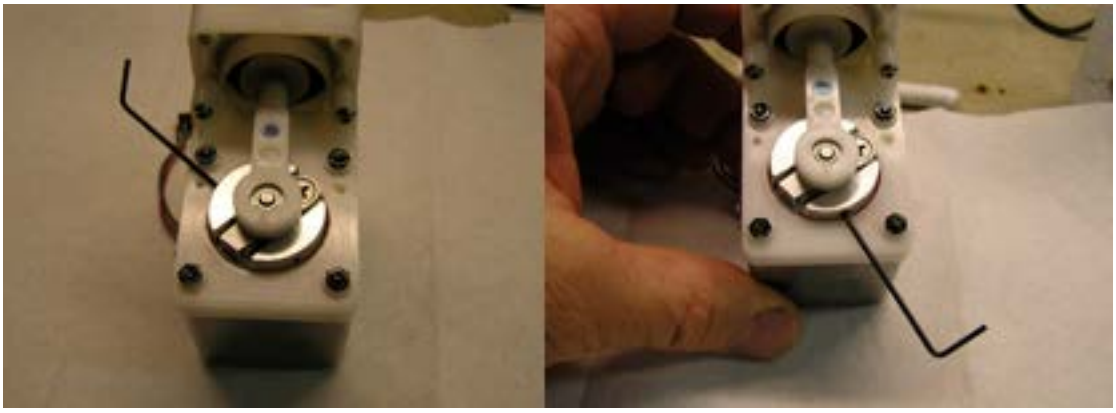
g. When the discharge is clear let it pump for about 15 seconds more.

Cleaning and checking the flow rate using a 12 VDC power supply will allow one to keep a second pump ready to install and can be done while the smoking machine is operating.

a. Cleaning is done the same way by squirting a small amount of methanol into the running pump and collecting it in a beaker.
b. Calibrating or checking the pump is done by hooking the pump to a flow meter such as the 4 LPM Visi-Flow meter.

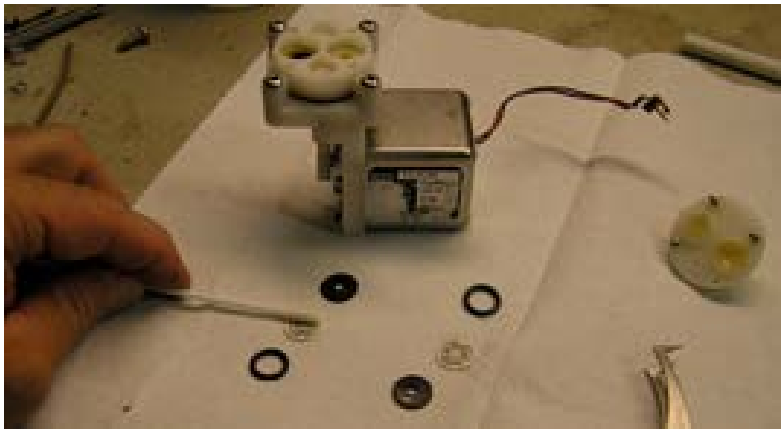


To change the flow rate the hex wrench is used to change the stroke. Movement of the cam is changed by loosing one screw and then tightening the opposite screw. Checking the flow rate and then adjusting the cam until the desired flow rate is achieved.



If pump does not operate at required flow rate, disassembly and cleaning of pump head will have to be performed.

Take off head with four screws and remove the valves. Care must be taken not to tare the Teflon valve. Clean with methanol using a Q-tip and reassemble. Be sure and replace the O-ring, valve and washer in the same order that as removed.



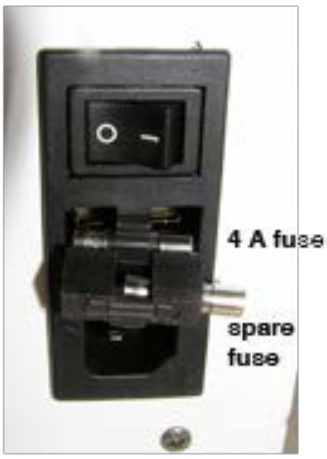
If the valves become torn or the rubber washer is distorted the valve assembly can be replaced. Instructions are in the replacement kit.

SUPPLIES:

Puff Pump can be purchased from Teague Enterprises with the plug attached and calibrated.

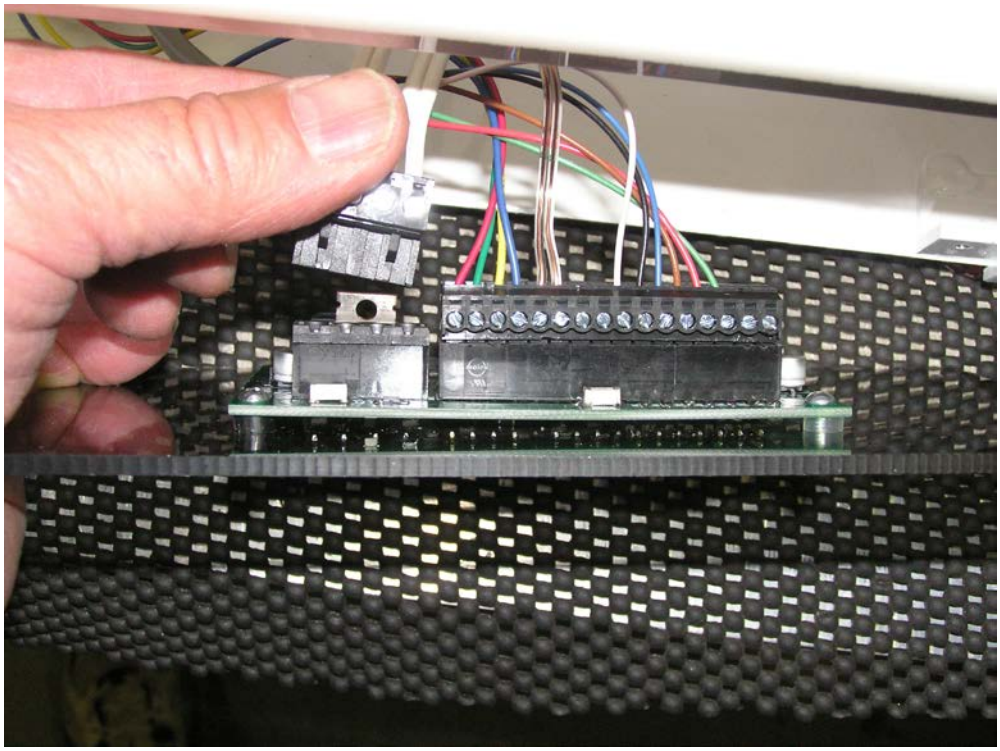
Checking and replacement of fuse.

1. Remove the power cord from the recipticle.
2. Using a small screwdriver pry the fuse drawer out.
3. The fuse may be checked by a resistance meter.
4. If none is available just replace the fuse with the spare one in the front part of the fuse drawer.

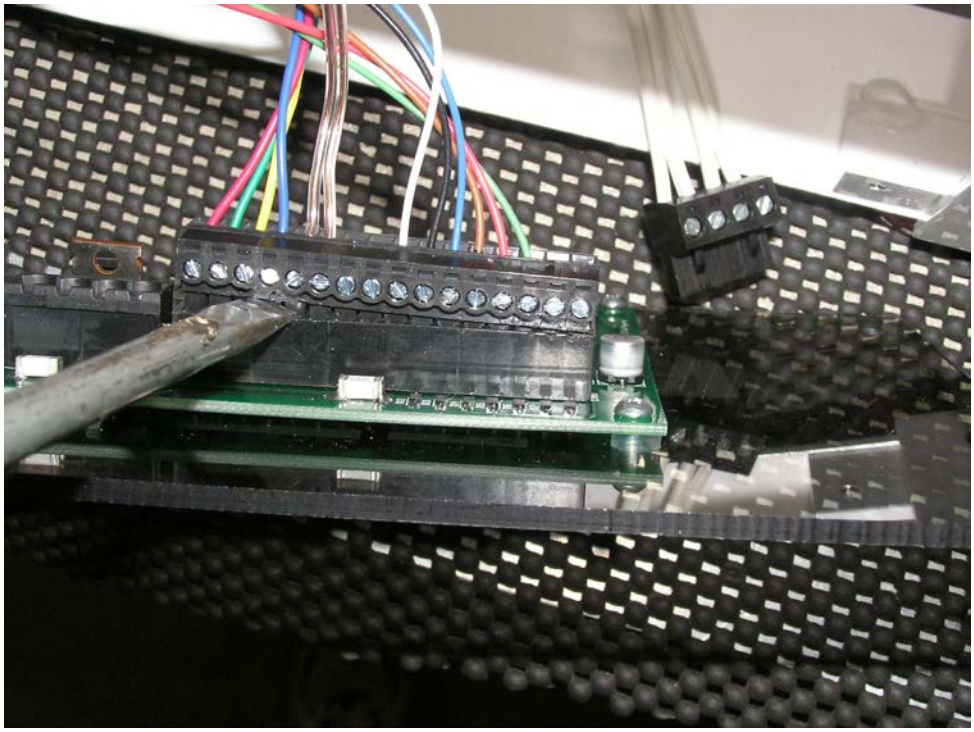


Removal and replacement of the electronics drawer

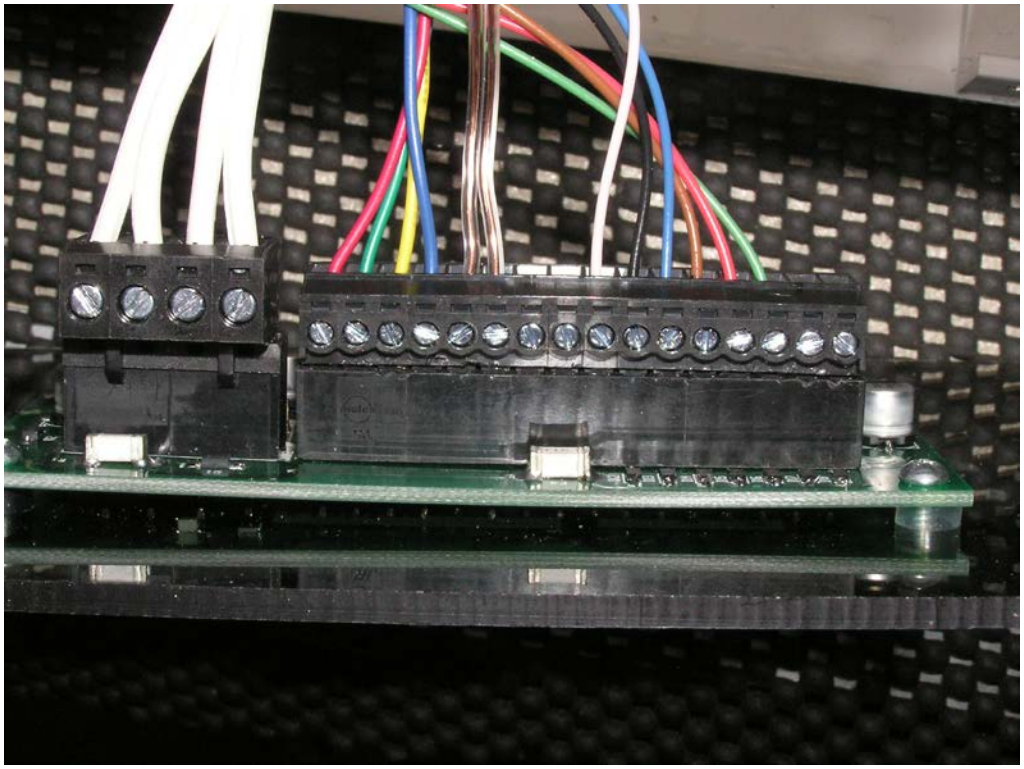
1. Remove the 4 screws from the drawer and pull it out from the machine.
2. Disconnect the two plugs by rocking them gently to remove. Do not disconnect the wires using the screw connectors the plugs will come out with a little pull.



3. The large plug is a little hard to get off and a screw driver may be use to remove the plug by placing it in the slot between the plugs. After it has started coming off it may be removed.



4. When replacing the plugs make sure they are in all the way. I may take some pressure on the large plug to seat it properly. Examine the plugs to insure they are in all the way.

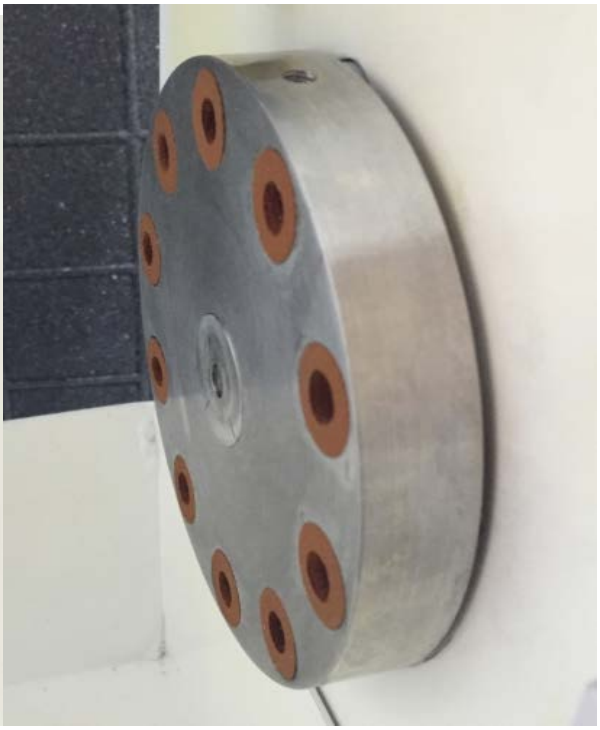


Removing and positioning of wheel with hub.

1. The hub is the piece that goes on the shaft of the stepper motor. It has two 10-32 hex head key set screws 90° apart.

2. The wheel is place on the hub with another set screw.


To position the wheel at the proper location the hub will have to be placed on the shaft at the proper distance from the wall or face of the machine. Start by cleaning the shaft of the motor so the marks from previous setscrews are smoothed off with the sandpaper. By moving the sandpaper around the shaft and then holding it on the shaft and moving front to back until the hub will fit on the shaft without difficulty. The hub can be located as close to the motor as possible without rubbing. The two setscrews should be positioned on the shaft flats or if there are not flats anywhere where it will be the best place and not wobble.

After the hub is on the wheel is placed so the back is flush with the collar on the hub back and the setscrew is between the other two screws. If it is too close to the face remove and move the hub to the best position, The wheel should be as close to the face without rubbing or about 1.5 mm. It can go out further if it needs to be but more than 3 mm may prevent the magnet from setting the zero point on the controller because it will not be close enough to activate the reed switch on the face. I may take an iteration or two to get it in the right place but will be easier to take off and put back in the right place after that.

Supplies:

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