

(Source : <https://theelectricsquirrel.wordpress.com/2013/11/22/east-radcliffe-ventilator-the-unofficial-manual/>)

East Radcliffe ventilator, the unofficial manual.

November 22, 2013 by [Mike](#)

The unofficial East Radcliffe service manual By Mike Yeats.

These came with a very slim users book, no more than four or five pages. As far as I know the company never produced a maintenance manual, you got your knowledge by finding out for yourself or if you were lucky your hospital sent you on a course to the company. Anyway, I decided to write my own maintenance manual, and here it is. The East Radcliffe has not been made or supported for many years, spares will be difficult to get, you could try the internet. (written 2013)



The humidifier

This was made from a domestic pressure cooker. The red knob on the top is simply parked there so it does not get lost, it is used to sterilise the unit. To sterilise the unit it is filled with water and the red knob screwed into the side of the control box (the part sticking out on the left). This overrides the thermostat and allows the unit to boil.



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In East Radcliffe ventilators, the pump is in the form of a rubber bellows which is lifted by an electrically driven cam on its intake stroke, and then falls under the influence of weights applied above the bellows during the inspiratory stroke.

A unidirectional disc valve at the inlet to the bellows ensures that air or other gas sucked in by the rising bellows is delivered to the patient during the inspiratory stroke, and not backwards out of the intake port.

Having inflated the patient's lungs, it is now necessary to expel the air from the patient's lungs in readiness for the next breath of air delivered by the bellows.

To ensure the correct directional flow of air to and from the patient during the inspiratory and expiratory strokes, valves are built in to the machine which are operated mechanically by electrically driven cams.

There are two such valves, one between the delivery bellows and the patient, and the second between the patient and the expired air port in the ventilator, from which the air is exhausted.

The driving cams are so arranged that only one of these valves is open at any one time, thus during the delivery stroke, only the inspiratory valve is open, the expiratory valve being closed, and during expiration the expiratory valve is open and the inspiratory valve closed, thus allowing the patient to breathe out through the expiratory port.

There are three tubes from the patient to the machine, the little one is the pressure tube and is connected to the pressure gauge, the other two are for inspiration and expiration.

In this way it is ensured that each inspiratory stroke will deliver completely fresh air to the patient.

To vary the number of breaths per minute, it is necessary to increase or decrease to speed of

rotation of the cams which operate the bellows and valves.

A range of six speeds is obtained by combining a three speed gear box, on some machines a four speed box, with two different driving knobs to vary the motor speed out-put. One of them is coloured red (the low speed) and the other is green (high speed), though the colour does fade after a time.

This is then transmitted via two differently geared chains from the motor to the gearbox.

The connection to the motor drive shaft is made via a 'dog' arrangement, or teeth, on each driving knob.

The two driving knobs produce two speeds; each range is independent of the other.

There are two electric motors, one, an a/c mains voltage permanent capacitor motor, and the other is a 12-volt D.C brush motor.

The driving chains run on gear wheels which rotate freely on both motor drive shafts, engagement of drive is by means of the driving knobs mentioned above.

If a drive change from one motor to another is required, it is necessary to remove the driving knob from one shaft and put it on the other, and then switch on the appropriate motor.

Should the mains electricity fail and a 12-volt car battery not available, then the machine may be operated by using the hand operation handle.

To engage the handle, push it in to the hole marked "hand operation", turn and push until it is properly engaged, respirations can then be maintained by turning the handle with a clockwise rotation.

It is important to turn the handle at an even speed to allow the patient the necessary inspiration and expiration times, turning the handle so that the bellows drops in time with your own breathing is a good idea.

The pressure given to the patient may be altered by adding or taking away weights from the weight arm, and by sliding the weights up and down the arm.

Should the patient require more than 21% oxygen then oxygen may be added to the inlet marked "oxygen" and this will be drawn in during each upstroke of the bellows.

Although the motor is of spark proof design, it is not recommended that flammable gases are used in conjunction with this machine.

Maximum volume is 1500 ml

Positive pressure 5 to 70 cm H₂O

The description just given is for an East Radcliffe ventilator, on different types of ventilator the opening and closing of the valves may be done by air, by step motor and scissor valves, magnets or by electrically controlled solenoids.

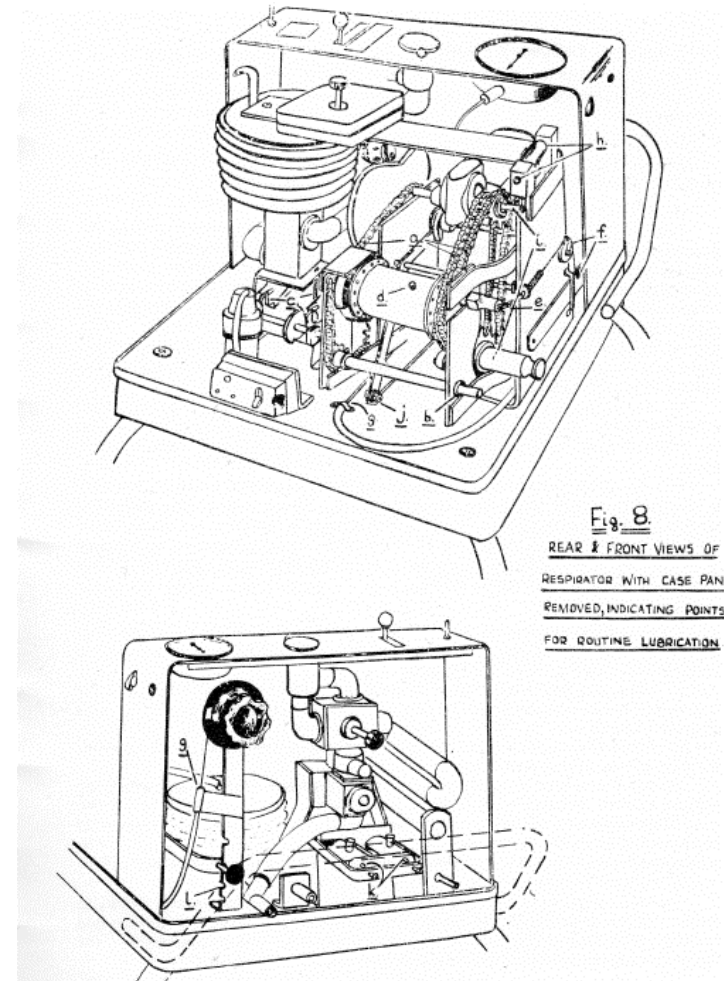
A gas flow diagram of the East Radcliffe is given in fig A.

Seeing that I have just written about the EAST RADCLIFFE ventilator (and because there are so many of them around the world), I will include a few hints to help if you should get any problems.

The East Radcliffe is a real backyard technology machine and seldom stops completely, whilst working in a district hospital in Nepal, one twenty year old Radcliffe we were trying to get going went up in a puff of smoke and stopped, it drew quite a large crowd, the mains motor had seized up through lack of use, it was about half an hour before it was cool enough to handle.

However I am confident that it will be working again as soon we get a new motor.

Assorted drawings from the official manual.



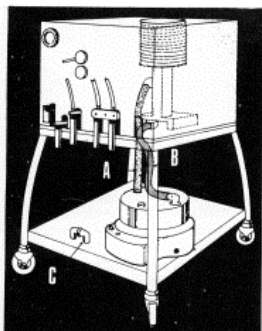


FIGURE 1

- A. Tube from positive pressure bellows to Humidifier inlet.
- B. Tube from Humidifier outlet to Inspiratory valve.
- C. 'U' piece connector.

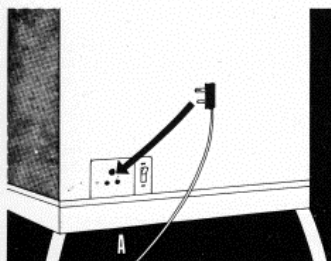


FIGURE 3

A. Humidifier switch socket.

Open circuit Anaesthesia — Model P.N.2.

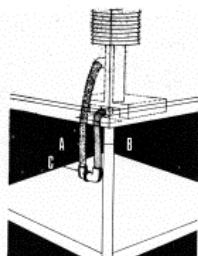


FIGURE 2

- A. & B. Tubes to and from respirator, to Humidifier.
- C. 'U' piece connector.

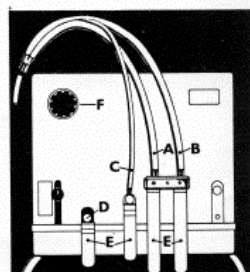
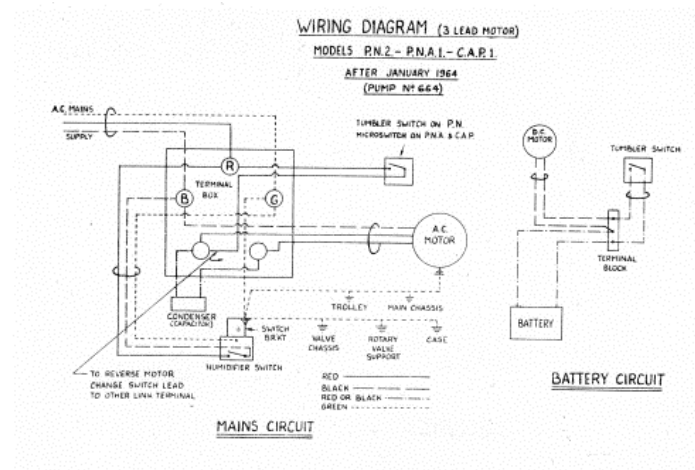


FIGURE 4

- (A) Inspiratory tube.
- (B) Expiratory tube.
- (C) Connector tube (pressure gauge to patient).
- (D) Connector 'D' is fitted to the base of the negative pressure bellows.
- (E) Water traps.
- (F) Negative pressure adjustment knob.



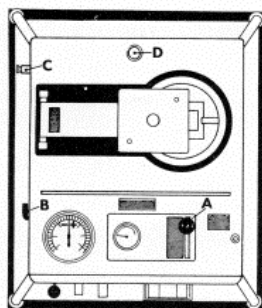


FIGURE 5
(view from top of respirator)
Model C.A.P.
(A) Change-over switch.
(B) Battery motor switch.
(C) Drive knob.
(D) Holder for drive knob not
in use.

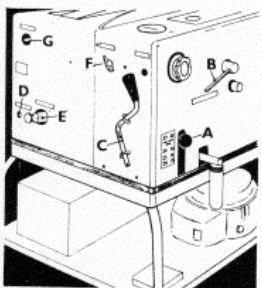


FIGURE 6
(A) Respiration rate selector.
(B) Spirometer handle.
(C) Hand operation handle.
(D) Hand operation spindle.
(E) Mains drive spindle.
(shown with drive knob
engaged).
(F) Battery motor switch.
(G) Battery drive spindle.

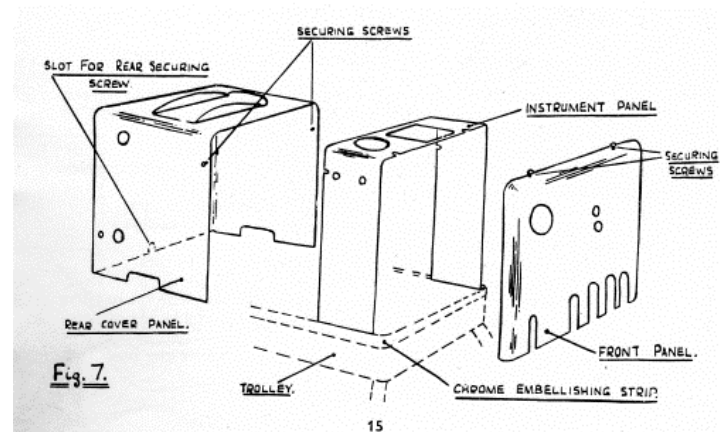
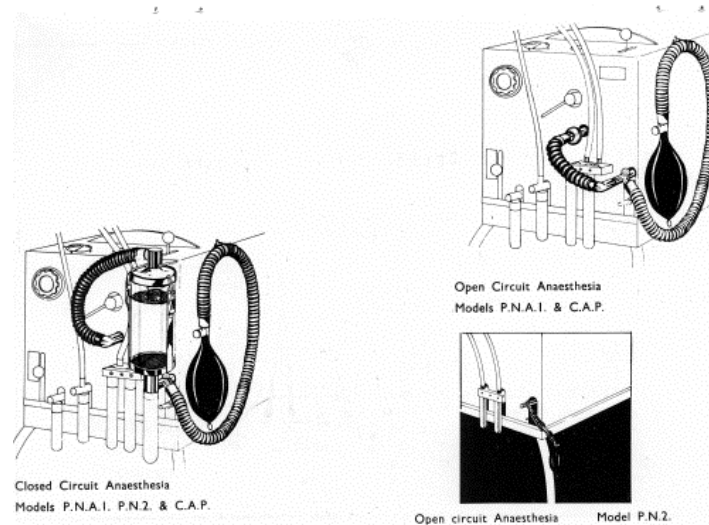


Fig. 7.

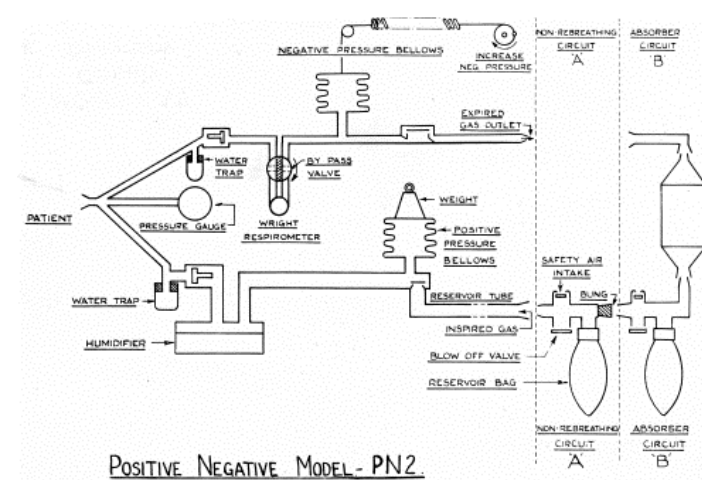
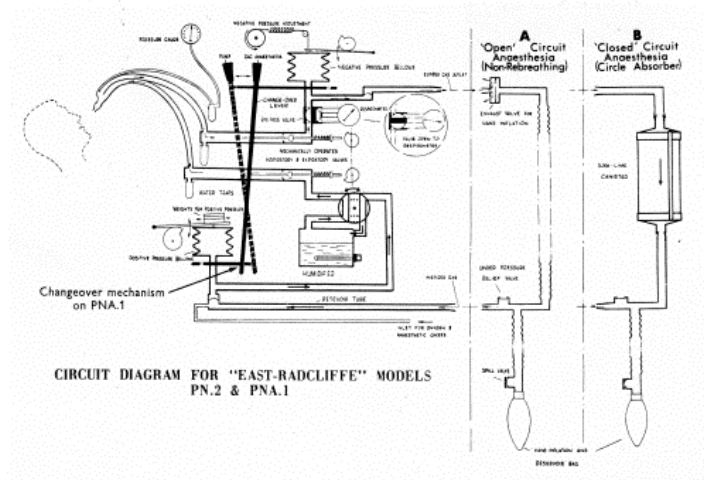
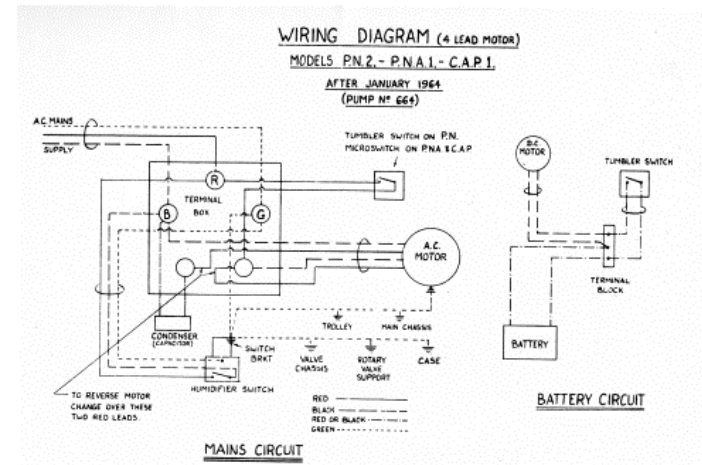
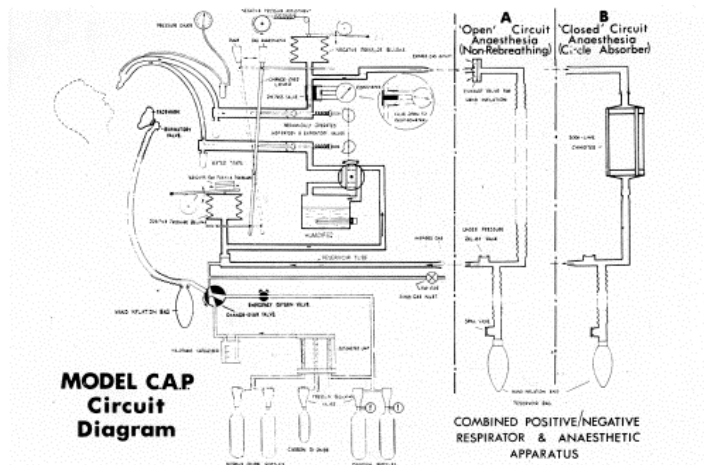
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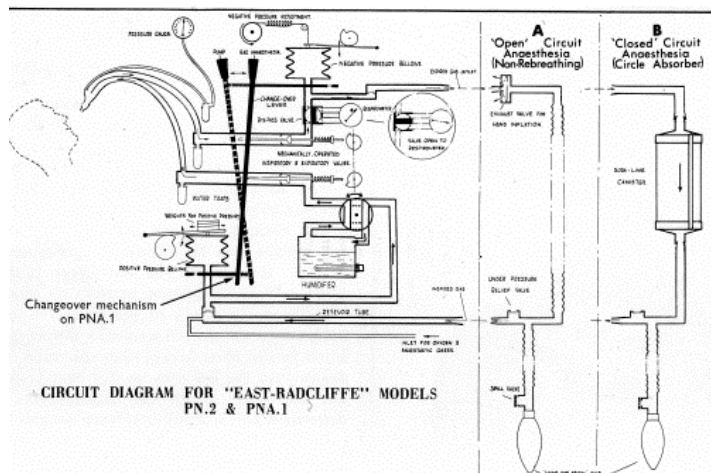


Closed Circuit Anaesthesia
Models P.N.A.1. P.N.2. & C.A.P.

Open Circuit Anaesthesia
Models P.N.A.1. & C.A.P.

Open circuit Anaesthesia Model P.N.2.





Some problems and solutions.

LOSS OF POSITIVE PRESSURE.

1. One or more moisture traps not properly fitted or missing. Fit correctly, or if you do not have any replacements then put a rubber bung in place, try not to use cork stoppers, as they are full of pores and could harbour germs in such a damp place. If you have done away with the water traps and you are using a humidifier then you will have to check for a build up of moisture at very frequent intervals. In theatres where humidification is not used then it doesn't matter as much.

2. Pressure gauge tubing disconnected at one end or the other. Remove the front case and refit it, if you have a clip that is small enough then fit one to each end of the tube.

3. Humidifier tubes disconnected (if fitted). Refit and secure with a clip if you think that they may come off again.

4. Humidifier plug not screwed in. Screw it in tightly, checking that the rubber washer is in place and in good condition. This applies the East's pressure cooker type of humidifier.

5. Lid of pressure cooker type humidifier not fitted properly. Make sure that it is locked in place fully, if it is still leaking and assuming that there is no damage to the locking flanges then the sealing gasket is faulty. These are the same size as on many domestic pressure cookers so you should be able to get one locally.

6. If no humidifier is being used, the double elbow is disconnected. This is underneath the machine where the humidifier would be. Re-connect it and if necessary fit a hose clip on each side to keep it gas tight.

7. Disc valve at the bottom of the positive bellows is stuck up. It could be dirty, or it could be that the cage that holds it has a cracked leg, this cage has four legs on it and is made of plastic,

when one of the leg cracks, the disc lifts up on inspiration as it should but instead of falling back on to the seat when the bellows has reached the top of its stroke, it gets caught in the crack thus trapping the disc up. What then happens is that the air taken in to the bellows goes back out of the machine rather than into the patient.

This last fault may happen now and again and then go away for a while, but it WILL return when you are not paying attention to the machine, and if you do not have a disconnection alarm fitted can be very dangerous.

From a distance it will look as if the machine is working as it should, closer inspection will show that the pressure gauge is not rising and that the bellows is falling to its full extent very quickly, you will also be able to feel gas coming out of the air intake port.

ALWAYS CHECK THIS DISC VALVE EVERY TIME YOU SERVICE THE MACHINE. HOW TO CHECK THE INSPIRATORY DISC VALVE.

First make a tool to help you do it more easily. Find a piece of metal about 300 mm long and about 6 mm in diameter, file or turn the last 25 mm down to about 3 mm diameter, then bend a hook on the narrow end.

- a. Remove the outer rear case,
 - b. Remove the weights from the weight arm.
 - c. Slide the weight holder back.
 - d. With a large screwdriver undo the screw holding the weight arm to the bellows top plate.
 - e. Lift the weight arm away from the bellows and let it hang down at the side of the machine.
 - f. With a spanner undo the bolt that clamps the two bellows top plates together. You will need to grip the top of the bellows and the discs whilst you undo the bolt. Sometimes they are quite tight.
 - g. Remove the two plates from the bellows. Remember that the smaller plate with the nut welded on to the back goes inside the first convolution on the bellows with the nut downwards and the larger one goes outside.
 - h. If at this point you have the special tool all you need to do is to operate the on/off lever till you can see the cage and disc through a hole in the base of the bellows, insert the tool and carefully test each leg of the cage by inserting the hook of the tool under the leg and pulling gently upwards, a broken leg will be obvious.
- NOTE: DO NOT pull hard on the cage because you may damage an otherwise undamaged cage, and if you do not have a spare you will have put yourself in a very embarrassing position.
- However if you are still not sure, then take it all apart, it is most important that the cage is in good condition. If you don't have the special tool, stop and make one.

If you have to take it apart to get at the cage, here is how:

- a. Having removed the bellows top plates as described above, undo four countersunk screws that you will see going through the bellows bottom plate, (sometimes there may be two screws and two nuts).

b. Lift off the bellows, bottom plates, seals and slide valve guide top half and place them all carefully on the bench. (Note the position of all the washers and plates in case you should drop everything).

c. Move the slide valve to one side.

d. Undo the two nuts that hold the bottom half of the slide valve block and the block that holds the cage.

e. Lift off this part, and there will be the cage. Note where the square washer is relative to the cage. (On top of it).

f. Inspect the cage for damage, don't remove it from where it is unless you really need to, this is because the disc is a close fit in the cage and unless it is all lined up just right you will trap the disc under the cage when replacing the block and give yourself a lot of extra work.

g. If the cage is cracked replace it, if you really are unable to get a new cage then glue it, but make sure the inside of the glued leg is quite smooth. Test the glued joint well before you re-assemble it.

h. When re-assembling it make quite sure that the disc is not caught under the cage before tightening everything up. You can check it is moving freely by putting a small magnet on a thin stick and lifting it with that.

i. Re-assembly is the reverse of the above sections. Make sure that all your seals are in the correct place.

j. Test the machine well afterwards, get yourself a stethoscope and put it to the block where the disc valve sits and listen, if the disc valve is free you should be able to hear it tinkling up and down as the bellows rise and fall.

8. Punctured or split bellows. The bellows in the Radcliffe is a very stout piece of rubber and under most conditions will last for a long time.

To change the bellows proceed as follows;

a. Remove the rear outer case.

b. Lift off the weights and place them to one side.

c. Slide the weight carrier back to pivot end of the arm, and secure.

d. Unscrew the screw that holds the weight arm to the bellows.

e. Lift up the weight arm and allow it to rest down the side of the machine.

f. Undo the bolt that holds the bellows plates together, you will need to grip the bellows plates quite tightly to undo it.

g. Take off the top outer bellows plate, and the inner plate, remember which one goes where. (The inner one has a nut welded on the inside).

h. Unscrew the four screws you will see at the bottom of the bellows.

i. Lift off the bellows and screws, place the screws to one side

j. Remove the lower bellows plate and fit it to the new bellows.

k. Reassemble in the reverse manner, remember that the weight arm stop on the lower bellows goes to the outside, that is the side of the bellows nearest the side of the machine.

l. Test for leaks after you have finished. To check for leaks put the full set of weights on and slide them to the top to get maximum pressure. Block off the patient 'Y' piece and cycle the machine with the manual handle so that the bellows drops off the cam and is trying to give the 'patient' a breath, the bellows should drop a little way then remain where it is, if there is a leak it will slowly drop down. If you suspect a leak look for it with soapy water.

9. Punctured breathing tubes. Replace or if the leak is near the end then cut off the leaking bit, cut the other two tubes to the same length and refit.

10. Breathing tubes badly kinked. Un-kink, if the kink is at the point where the tubes are attached to the ventilator, there should be a spring either inside or outside the tube to prevent it kinking, if this is missing replace it. This is called an anti-kink spring and helps to support the tubes. It should be about 150 mm long.

11. Leak in expiratory mechanical valve. Strip down and clean, replace any defective parts. This is a major job, check for other faults before attempting this, for example check the screws on the front that the push rods press against, these may be out of adjustment. (See part 9 in the next section.) If you really do decide that you have to do it, you will need to remove the whole of the bellows unit to gain access to the valve gear.

12. Bellows separated from the top plates.

It is possible to put gas under pressure into the machine whilst the machine is not running. This will inflate the bellows, but because the inspiratory valve is closed, they will go on and on inflating.

Should they inflate too much the bellows will be pushed out from its position between the two top plates either completely or partially.

The first complaint from the anaesthetist, assuming that he hasn't spotted the problem, will be that the tidal volume to the patient is getting less. If the bellows has come right out then there will be a big leak and the patient will not be inflated.

PARTIAL LOSS OF POSITIVE PRESSURE.

1. Small leaks at one of the taper connections. Remove taper and gently reform it with a soft hammer.

2. Punctured bellows or breathing tubes. Replace or repair if you are desperate, replacement is preferable. With the bellows you would have to be very desperate to try to repair one, it really

should not be done, IF you have to make sure that you get a new bellows as soon as you can and fit it.

3. Leak at patient end connection. Replace the connection if it is badly damaged or repair. (Of course it may simply be that it is not pressed on to the patient connection tightly enough).

4. Leak at one of the valve seats. Strip down, clean, replace sealing washers. (See section 11 above).

5. Leak at the bellows slide valve (p.n.a. and c.p.a only). To get at this strip down as for inspecting the inspiratory cage, re-grease with a suitable grease. As you take this apart take careful note of where all the plates and washers go.

6. Leak at top clamping plate of positive bellows. Tighten the bolt that clamps the two bellows top plates together.

7. Cracked moisture trap. Replace with another trap or a rubber or cork bung if you do not have a new trap, remember, however, that if you do not have a water trap there and a humidifier is in use to let out the excess moisture at regular intervals.

8. Pressure tube from pressure gauge disconnected. Re-connect, check that the tube is clipped in place and is not being rubbed by anything as the machine operates.

9. On the P.N.A. Radcliffe, that is the one with the ON/OFF lever on the top, that the push rods are free to move and are correctly adjusted. If you look at the front of the machine you will see the two push rods coming out of the two blocks that the patient tubes and the water traps are connected to. Around these is a chrome metal 'U' shaped piece of metal that goes around them and then back into the machine. On this are fitted two screws and lock-nuts, as you operate the lever on top so this moves in and out, when it is in the two screws press the push-rods in to operate the valves and keep them open, when it is out, that is the lever is in the ON position, the screws are clear of the push rods and they are free to move in and out as the valves open and close.

If these screws are not adjusted correctly they can be pressing one or both of the push rods thus not allowing the valves to close properly and giving you a slight leak. Whilst on the subject of the adjustment of these two screws, if there is difficulty in inflating the patient when using the bag and with the levering the anaesthesia position, it may be that the screws are not adjusted correctly and not pressing on the push rod enough.

PRESSURE GAUGE NOT STEADY WHEN PRESSURISED.

1. There is no damping screw in the tube to the pressure gauge. Note. This is most often a brass wood screw with the head cut off and a screwdriver slot cut in the top, it is then screwed about 25 m.m. or so down the tube at the pressure gauge end.

2. There is excessive water in the patient tubes. Caused by the humidifier, the pressure gauge may also not be returning to zero and showing a slight residual positive pressure.

DIFFICULTY CHANGING GEAR OR SLIPPING GEARS.

1. Gear cable not adjusted correctly. Adjust using the screw adjuster near the gearbox. When you have got the adjustment correct, put a little spot of paint on the adjuster this stops any chance of it coming loose.

This is how to test that the gear cable is adjusted correctly: When the gear lever is midway between respiration rates of 13 and 16 and between 20 and 25 on a 4 speed gear box, red drive knob and between 16 and 21 on the 3 speed gear box, red drive knob, the gears will be in neutral, so that nothing will happen, the motor will turn the gearbox but the final drive to the main cam will not be moving.

2. Cable broken. Replace. If you have difficulty getting one of these try a bicycle repair shop they may have something that you can alter to suit your needs.

3. Brake bracket pressing too hard on brake pads. Adjust so that it is just enough to give the main cam a smooth movement.

4. Gear cable stretched. Adjust using the screw adjuster near the gearbox. (see section 1 above) When you have got the adjustment correct, put a little spot of paint on the adjuster this prevents the chance of it working loose.

5. Gear adjusting links tight. This is the little length of chain and a rod going from the adjuster to the inside of the gearbox. Sometimes this will get stuck with old grease and dust. Undo the adjuster so that the chain is free, then apply a light oil as far inside as you can reach, as you do this work the chain to and fro until it feels free. Re-assemble to the adjuster and adjust to get the neutral position in the correct place. Test to see if there is any improvement. NOTE. Do not unscrew the chain and rod, it is connected through the gearbox to another rod on the other side, it can be a fiddle to get them joined again.

6. Gearbox damaged. Strip down the gearbox and repair if it is possible (see section on noisy gear box).

PROBABLE CAUSES OF LOSS OF NEGATIVE PRESSURE.

1. Large capacity lungs-over 1 litre, (negative pressure would not show on gauge).

2. Leak in negative bellows. Replace the bellows; repair may be possible if you are desperate. As I said in a section above, it is not a good idea to try to repair a bellows except under dire circumstances, and you should then get the correct bellows and fit it as soon as you can.

3. Badly seated disc valve on the expired air outlet due to dirt or grease on the seat. Remove the front panel, strip down and clean.

4. Valve disc trapped under plastic gate. Strip down and re-assemble correctly.

5. Leaking expiratory valve or inspiratory valve. Strip down and clean valve seats, replace-sealing washers, re-grease. (see part 11 in the section on loss of positive pressure).

6. Bent yolk arm (the machine has been operated by hand or motor with the lever in the bag position, you will know if you are doing this as there will be a bang as the negative cam tries to push down the negative yolk). Strip down and straighten the yolk, to straighten it proceed as follows.

- a. Remove the front panel.
 - b. Remove the rear case.
 - c. Undo the nut and bolt that holds the negative bellows to the negative yolk. Put them in a safe place.
 - d. Undo the nut and bolt that holds the negative link wire to the yolk, this will be found near the base under the gearbox. Leave the nut and bolt with the link wire.
 - e. Look for the pivot point of the yolk and you will see a pin passing through the yolk from the side by the gear cable adjuster.
This pin is held in place by two screws, one at each end of the pivot pin. It is quite obvious which they are, loosen these off and with a pair of pliers pull the pin out, lay it in a safe place.
 - f. Pull out the yolk arm through the front.
 - g. Straighten it and then replace it in the reverse order from above. Remember to tighten the two screws holding the pivot pin.
 - h. Test to see that the negative cam rolls over the bearing correctly.
 - i. Replace the covers.
7. Moisture trap off the negative bellows, or a cracked trap. Refit or replace, if you don't have another get a rubber or cork bung to block the hole.
 8. Humidifier pipes disconnected. Re-connect, secure with clips if you think that they may come off again.
 9. Leak in patient circuit tubes. Replace or repair if you don't have any more tube on hand if the leak is at the end snip an equal amount off each tube.
 10. Negative control knob slipping back. Tighten the two nuts on the back of the knob,
 11. Negative spring broken or stretched. Replace, or if stretched and you do not have a replacement snip off some to make it the correct length.
 12. Jammed or stretched cable. Free or replace as required.
 13. Loose cam on spindle. Tighten, the tightness of these cams should be checked on every service.
 14. Faulty pressure gauge. Repair or replace.
 15. Kinked expiratory patient tube. Straighten, if the kink is where the tube joins the ventilator, there should be a spring on the outside of the tube or sometimes on the inside to prevent this happening. If there is not fit one, it should be about 150 mm long.

16. Restrictor blocked in pressure gauge tube. This restrictor is to be found in the pressure gauge tube near to where it is connected to the pressure gauge.

17. Negative bellows soft. Replace them.

18. Negative base block choked, causing excessive wear on cam or bending of the negative yolk. Take apart by undoing four screws under the base, removing the front panel and lift clear, clean and replace.

19. Broken negative cable. Replace, you should be able to buy something suitable from a bicycle repair place.

20. Broken negative link wire. This wire runs from the end of the negative yolk, underneath the gearbox and via the rest of the linkage back to the negative control knob. You will probably find that the eye where the screw goes through to hold it on to the negative yolk arm is broken. If you do not have the official replacement, it can be replaced with a home made one made from a suitable diameter of wire made to the correct length.

21. Roller and chain in need of lubrication. Remove the front panel, you will see it to the right of the negative bellows block fixed to the base. Apply a few drops of oil and work the wheel to and fro.

MACHINE STOPS FOR NO APPARENT REASON.

1. Drive knob has become disengaged. Push it back in. Check the adjustment of the click spring. This is the little copper strip screwed on to the drive knob; it has a little bend in it that locates in a groove cut in the drive shaft.

DO NOT over-tighten this as you WILL strip the threads in it.

The test for the correct adjustment of this click spring is this, Get the drive knob in a position so that it is fully engaged in the gear teeth, pull it out slightly so that the bend in the click starts to come out of the groove in the drive shaft then let it go, if it is correctly adjusted it should pull itself back in. If not then adjust it till it does.

2. Gear cable stretched allowing gear to slip in to neutral. Adjust the cable if the stretch is not too great; replace cable if there is no adjustment left. When you have the adjustment correct apply a drop of paint to the adjusting lock nut to stop it vibrating loose.

3. Faulty electric wiring or fuse. Replace or repair as required. If it is the fuse that has gone check to see that there are no faults that might cause this to happen. If it goes again check even more deeply for possible faults.
The fuse should be a 7 amp one.

4. On the older machines the tumbler switch has accidentally switched off. Switch on. If this has happened before, make a metal guard to go over the switch so that it doesn't happen again.

5. On P.N.A. Machines that have the on/off lever on the top of the case, that the lever has been moved so that it is no longer pressing the micro-switch. This will be because the operator has not pushed the lever in correctly, or that it has been knocked out accidentally.

6. On the P.N.A. Machines, that is the ones that have a lever on the top of the case that turns the machine on when it is running on the mains, there is a micro switch that is pressed by the on/off lever, now you will see one reason given in section 5 above why the machine stops. It can also be that the micro switch has moved relative to the lever, opposite to the case above. This could be because the micro switch is not screwed down properly, or because the metal cover on to which the switch is mounted is not tightly screwed to the base of the machine, in this case tighten up the four screws that hold it in place.

7. The cogs on the two drive shafts have become seized to the shafts, this can be caused by too much oiling, the cogs have oilite bearing pressed in which should not need oiling, you should take them apart now and again and clean the shaft, should you have to oil, use any type of light motor oil, some oils leave behind a sticky deposit, in time this can close the gap between the shaft and the cog and then seize up completely. If this has happened check the battery motor casing to see that the strain caused by the stopping has not moved it out of position or damaged the tie rods.

MACHINE WILL NOT START.

1. Machine not plugged into the mains or connected to 12-volt battery.
2. Switch not turned on.
3. Machine humming but nothing happening, bobbin not pushed home properly.
4. Everything plugged in and turned on, will almost run without the bobbin in and with a little help. Motor start capacitor faulty. Replace, make sure that you use the correct value.
5. Gear box in neutral.
6. Broken chain.
7. Blown fuse.
8. No local electricity. Check supply with meter.

THE MACHINE STOPS, WILL NOT START OR HESITATES WHEN RUNNING ON THE 12-VOLT MOTOR.

There is a possibility that this is caused by worn or faulty brushes in the motor. However as the 12 volt motor is not used a great deal in most of these machines the chances are that the brushes will be all right, still its worth knowing about and should you use the motor a lot then it may be the cause.

If this happens you should first check all the obvious possible faults, for example;

- a. That the wires to the motor are connected correctly.
- b. That the ON/OFF switch is working correctly.
- c. That the motor is not so stiff from lack of use that it will not turn (measuring the current should point you to this fault).

d. That your 12-volt battery is not flat, and is properly connected. These are the main ones that spring to mind.

Having checked for these, then there is a possibility that there is a problem with the motor brushes.

This is how to check and replace them if it is required:

- a. Remove the front and rear covers.
- b. Remove the steel cover over the 12-volt battery motor by undoing the two small countersunk screws on the side above the gear change cable, you will have to lift the weight arm to get it out. Place the screws in a safe place along with the cover.
- c. Move the weights to the top of the arm.
- d. Undo the small cross head screw that holds the access cover on to the rear of the motor.
- e. Undo the small screw that holds the wire of the brush to the motor. Take care not to drop the screw in to the motor. Lift clear the leg of the brush retainer, and lift the brush out.
- f. Inspect the brush and connection for damage and wear, replace it if you have a new one and you think that it may be faulty. Replace the cover.
- g. Working through the front of the machine do the same with the other brush, this may be more difficult as you can't really see what you are doing.
- h. Having replaced or at least inspected the brushes, connect it up to a 12 volt motor and test.

FITTING A NEW 12-VOLT MOTOR.

Should you have to replace the 12-volt motor it is really quite easy proceed as follows;

- a. Remove the outer front and rear covers.
- b. Unscrew the wires to the motor from the block, (a pair of white and red wires, two black wires on the older machines.)
- c. Remove the cover plate over the motor, (two screws).
- d. Undo the two bolts holding the motor in place.
- e. Lift the motor out backwards, disengaging the two drive cogs from the chains.
- f. Take off the two cogs and the spacer and fit them to the new motor.
- g. Take one of the red and one of the white wires and cut them to the correct length, bare the ends and twist them together. Repeat this for the other pair.

As far as I know you will not get a new motor with just the two black wires.

h. Connect the pairs of wires to the leads of a 12-volt battery charger and switch on the charger, look to see which way the drive shaft is turning, looking at it from the end it must

revolve clockwise. (If it is going anti-clockwise the teeth will not engage in the drive dogs).

i. Once you are happy with the direction, crimp the wires in to an electrical eye or solder them together.

j. Replace everything in the reverse manner to removing it, test it for current consumption as outlined before.

MACHINE SQUEAKS FOR NO APPARENT REASON.

There is one main reason for the regular squeaks of a Radcliffe.

Inside there are the two brake blocks on the inner end of the gearbox, these stop the cam moving around in an irregular manner, these blocks rub on a metal plate and as they are close to one of the chains can, after a while become oily, it is these that are squeaking.

The blocks can be cleaned with a degreaser or rubbed down with a file.

On the subject of brake blocks for the Radcliffe, the older machines, which often were painted white as opposed to silver hammer finish of the current production, have a smaller brake block than the new type, now as far as I know you can't buy the small blocks anymore, a great shame because the old type are much better than the new ones, they have what looks like brass bits embedded in them and as a result seem to last much longer.

Note, new brake blocks being supplied are now of the older type with the brass looking bits imbedded in them, check your brake block bracket after fitting these and running for a while they wear a groove in it quite quickly.

What you have to do to change them if you have a broken one, I have never had to do it but I should think that you could, is to cut down the larger ones to fit.

If the blocks are really badly worn, it may be that it is the counter- sunk screws that are rubbing against the brake bracket, if it has got to that stage then the machine can't have been serviced for a long while.

UNUSUAL NOISES.

1.Noisy motor. (12 Volt)

Before you start this you will need to connect your multi-meter into the circuit to measure the current that you are drawing, it will give you a good idea how free the motor is.

a. Remove the rear outer cover of the ventilator.

b. Then the cover plate over the battery motor.

c. Then loosen the two tie rods that hold the outer casing of the motor together just a little.

d. Then take hold of the motor gearbox and move it slightly, by doing this you can often stop the motor making so much noise. Anyway adjust this till the motor is as quiet as possible and the meter is showing as low a current as you can manage, the lower the current the better the motor is running. Sometimes whilst doing this you will stall the motor, get a screwdriver and put it in to the slot in the end of the motor nearest the gearbox, and flick the plastic fan blades you can see, this will often start it again. If the motor is tight it will draw about 5 or 6 amps, stalled it will draw a lot more but when it is running smoothly it will only draw about 2 to 3 amps.

e. Re-tighten the tie rods but do it carefully as you can make the motor noisy again if you do not do it evenly.

NOTE !!!!!DO NOT leave the motor in a stalled condition with the electricity turned on for long, the wires and the motor will get very hot.

For removal of 12-volt motor see above.

2.Noisy Motor, Mains If you think that it is the mains motor, you can adjust the tie-rods but it is more difficult to get at. You may have to remove the negative bellows to get at it properly. There is one noise that you may get from the mains motor that has a specific cure, that is a noisy rear bearing.

This will start to be apparent when there is a little extra load on the motor, as, for example when you add extra weights to the weight arm. It will be noticed as a rapid ticking noise when the motor is under load, not very loud but noticeable even with the case on, the sort of thing that the anaesthetist will complain about having noticed it when things are quiet in the theatre. To check this you will have to remove the negative bellows but first remove the front panel and the rear case, look in to the front of the machine at the rear of the mains motor, there you will see around cover plate about 30 m.m in diameter, held on by three small cross head screws.

Put the machine, with the back against a wall and then with the screwdriver press on the plate, the noise should be less as you press.

Now you will have to remove the negative bellows, proceed as follows;

a. With an Allen or hexagonal key and a small spanner remove the nut and bolt that holds the negative bellows to the negative yolk arm, put the screw, nut and a star washer in a safe place.

b. With an Allen or hexagonal key remove the four bolts holding the negative block on to the base, these are underneath the base and a little difficult to get at owing to the cross bar passing across them. put the screws in a safe place.

c. Lift and twist the bellows and with a flat long bladed screwdriver undo the screw that holds the earthing wire to the block. put the screw in a safe place.

d. Lift the negative bellows out of the front of the machine, take care not to lose the brass bush in the securing point of the bellows. lay this to one side along with the screws.

e. With a cross head screwdriver remove the three small screws holding the cover plate in place, as you undo the last screw put a finger on the plate as it will try to spring out. Put the screws and plate to one side in a safe place.

As well as the plate you will find a spring washer, it is the spring washer that is causing the problem, on the only occasion that I have had this problem this spring washer had broken and was thus not pressing on the bearing as it should, replacing the spring-washer solved the problem. It is possible that the spring washer may lose its tension and have the same effect, in both cases you will have to replace the washer. I must say that I do not think that this will be a common fault. If when you have got the plate and the washer off you try to start the motor it will make the most terrible noise.

f. Replace the spring washer, and the plate and screw it in to place.

- g. Replace the negative bellows and block, do not forget to replace the earth lead to the block.
- h. Re-attach the negative yolk arm, not forgetting the brass bush at the top of the bellows.
- i. Test the operation of the negative bellows, and that the noise has gone from the motor.
- j. Replace the covers and give the machine a final test.

Should you find that you are unable to cure the noisy motor then it will have to be replaced, to take it out proceed as follows;

- a. Remove the front and rear outer covers.
- b. Remove the negative bellows by undoing four Allen screws underneath the negative block, and the earth wire attached to the block.
- c. Undo the earth wire of the motor, the motor wires in the main junction box at the rear left of the machine, do a drawing of where the wires go to assist you in replacing them afterwards, and the cable clamp below the gear box.
- d. Undo the four bolts that hold the motor to the base.
- e. Loosen the 12 volt motor right off so that the drive chains are slack.
- f. The motor is withdrawn through the front of the machine, this is done by twisting and lifting, you may think that it won't come out but it does.
- g. Replace the new motor in the reverse manner.
- h. Line it up, and then do up the bolts gently. Refit the rear cover and check that the drive spindle will sit on the shaft correctly without rubbing the case, once you are happy do up the bolts fully.

3.Noisy gearbox.

Not a common fault, the firm say change the gearbox, in any case if you don't have a spare or are unable to get or buy one, try the following.

- a. First try lubricating it in case it is dry, put a few drops of oil into the gearbox through the filler hole in the body of it, no better?
- b. At this point it is best to remove the gear box from the machine, it makes it much easier to work on.
- c. Now try to get a degreaser inside to clean it out, what happens is that over the years oil gets put in and slowly evaporates leaving behind a sticky deposit, allow the degreaser to do its job and then let it evaporate and then re-lubricate, still no better?
Now you are really going to have to get keen and strip down the box.
Most people say you shouldn't do it as they are not easy to take apart, but this is not true, the only problem is that you probably won't be able to get any spares for it.
- d. Remove the gearbox from the machine, if you have not done so already, if you have another that is broken then you may be able to make one good one out of the two.

Look at the fig B and photograph at the back for an exploded view of a gearbox, work slowly and carefully and make sure that you know how to put it back together, if you can't cure it, a noisy box is better than none. Once inside you should soon be able to see the problem and with luck have to part to cure it, it may be that a good degreasing and re-lubrication will cure your troubles.

- e. Refit repaired gear box back in to the machine and test.

4.Noisy valve roller bearings. This will be a regular 'clonk' twice during each cycle, once on inspiration, once on expiration. It is caused by the roller bearings on the end of the inspiration and expiration valve operating pistons falling off the cam lobes to quickly. What has happened is that the grease that was put in to the pistons when the machine was made has gradually been lost and the piston is being pushed out by the return spring to quickly.

Another possible cause is that the pistons have been lubricated with an ordinary light oil and over the years this has caused the grease to be thinned down and lost.

This noise has no effect on the operation of the machine, it just makes an irritating noise.

The solution is to repack the pistons with grease, any fairly thick grease will do.

I think that it is impossible to do it without removing the whole of the valve assembly, so if you are removing the valve assembly to check the valve seats, this is the time to do it.

Light oil may be put on the roller bearings, but try to keep it only on the rollers, do not put it on the pistons behind the bearing.

To remove the valve assembly to repack these pistons with grease, or to check the valve seats proceed as follows;

- a. Remove the front and rear outer casings.
- b. Unscrew the bellows from the weight arm bracket.
- c. Remove the two large bore tubes that go to the valve block that the bellows sits on.
- d. Remove the bracket that supports the valve block, and the block as a complete unit.
- e. Remove the patient tubes and water traps.
- f. Remove the small plate at the front of the machine which has two cut outs in it and through which the outer covers of the valve push rods pass.
- g. Remove the large bore tube that goes from the expiratory valve to the respirometer block.
- h. Remove the earth tag attached to the valve assembly.
- i. Mark the main chain and cog wheel on the end of the shaft with the small cams on it, this is so that you can re-assemble them in the correct relative position when the time comes.
- j. Undo the four nuts and bolts that hold the valve assembly in place, and pull it out through the rear of the machine.

Once you have the whole valve assembly on the bench in front of you it all becomes quite easy.

To repack the pistons, undo one of the screws that hold them to the base plate, swivel them to one side and withdraw the pistons, do one at a time so that they do not get mixed up, once re-greased push it back into place and test that it moves freely.

Re-bolt them to the base.

Once the pistons have been done you might feel that the valve rubbers need looking at, this is the time to do it, however if there is no sign of a leak I would suggest that you leave them alone, you may cause trouble by disturbing them.

Should you decide to look proceed as follows:

a. Undo the three screws holding the two halves of the valve housing together and pull clear.

b. Unscrew the long hexagonal nut you can see once the housing has been separated. Remove the washer and the rubber valve.

c. Inspect the valve seat for damage, replace the rubber seat as required.

Re-assemble the valve housing, not forgetting the sealing washer. Once you are happy with the whole of the valve assembly, refit it into the ventilator in the reverse manner in which you took it out.

5.A rumbling noise as the roller bearing on the weight arm rolls over the main cam.

This is caused by the surface of the main cam being damaged.

a. Remove the outer rear cover.

b. Take off the weights.

c. Undo the screw holding the weight arm to the bellows.

d. Inspect the bearing to see that it is running smoothly. Lubricate it or replace it as required.

e. Inspect the cam, you will probably find that it is rough. Take a fine file and smooth it down, then get some wet and dry sandpaper or steel wool, and rub it till the surface on which the bearing runs is quite smooth, lastly polish the surface with some metal polish.

As to what caused it to get rough it may be that the bearing is not running smoothly, or that you have recently put a new bearing on and put it on the wrong way around, the bearing is tapered as you can see, the thinner end must go on the side nearest to the bellows.

It might be that the bearing is not set properly, there is an adjustment to move it a short distance up or down the arm.

Set it so that it tracks properly across the cam, turn with the handle while you watch the movement.

OTHER PROBLEMS.

1.Main cam not moving smoothly.

a. Due to worn or oily brake pads.

b. Roller bearing under the weight arm damaged or needing lubricating.

c. Badly adjusted brake bracket.

d. Brake shoes and gear box out of position relative to the main cam.

This last fault is not very likely, however if you do think that that is the trouble it is as well that I tell you how to correct it, you can get in to an awful mess if you are not careful.

Before you try to cure the last reason, first check the other three.

a. If the brake blocks are oily or broken. They must be replaced or cleaned, to clean the oil off either use a solvent or gently file the surface off clean.

b. Roller bearing under the weight arm damaged or needing lubrication. Remove the weights, slide back the weight holder, undo the screw that holds the weight arm to the bellows assembly, lift it up and let it down to rest at the side of the machine.

Remove to roller bearing, note where the washers go and which way round it the bearing sits. Clean it out really well with a degreaser and then re-lubricate it.

If that does not work and you have a new one fit that one. If you do not have a new one perhaps you have a scrapped off machine that you can take one from.

Be sure that you put it in the correct way around, this is most important because if you put it round the wrong way it will damage the main cam.

For those of you that didn't make a note of which way round it goes when you took it off, this is the way: – The narrow end goes near the bellows.

c. Badly adjusted brake bracket. See if the brake bracket is set correctly, if you think that it may not be, you have to resort to the hammer to cure it, slacken off one of the screws that hold the brake bracket on, not too much but just enough, so that it is able to move, then take a hammer and gently tap the bracket down a little, this will increase the pressure on the brake blocks and will often cure the problem.

Only do it just enough otherwise you run the risk of over stressing the bracket and causing it to eventually split where it is bent.

Re-tighten the screws.

Next check that the brake blocks touch the bracket at the right moment, this will be just as the weight arm roller is about to fall off the main cam.

If not, see if the break block reaches the brake bracket before or after the weight arm drops off the main cam.

Let me explain what you are doing at this point and what you will be doing to correct it.

What you want to do is to alter the position of the brake blocks relative to the weight arm falling off the main cam, this is so that the blocks are doing their job at the right moment.

Now the brake blocks are fixed to the gear box and the gear box held in this relative position to the main cam by the cog on the end of it, and its position on the chain that connects the main cam the inspiratory and expiratory cams and the gear box.

So what you need to do is to move the gear box cog a few teeth forwards or backwards along this chain, this has the effect of altering the relative position of the brake blocks to the main cam.

To do this you have to undo this chain, move the cog around by the correct amount and reconnect the chain.

To carry on from where I left off above,

This will tell you if you have to move the cog wheel on the gearbox forward or backwards relative to the chain that goes around the main cam.

Remember that it is not likely to be more than two of three teeth out.

It is important that you get this sorted out before you start otherwise you will give yourself a lot of extra work.

Now go through the following stages;

a. Put the hand operation handle in place so that you can turn things slowly.

b. Remove the brake bracket and put it to one side.

c. Turn the hand operation handle until the joining link on the main chain between the gear box and the main cam is between the cog on the hand operation shaft and the gear box cog, that is running vertically at the back of the machine.

d. With a screwdriver, push off the joining link securing clip, it should push off in the direction that the chain travels. It may well fly off unexpectedly, so keep an eye on where it goes. Now comes the difficult part.

e. Take apart the joining link without dropping the two ends of the chain.

NOTE>>>>>>>> take care that the main cam does not fall around and pull the chain out of your hand. It is most important that you do not drop the chain, this is because the relative positions of the main cam, the inspiratory and expiratory cams, and the gearbox do not alter, otherwise the timing will all be wrong.

f. The end of chain which passes under the hand operation cog can be laid gently down. (this is the lower of the two in your hands), this will give you a free hand.

g. Now lift up the piece of chain that you have in your hand lift it clear of the gear box cog, with your free hand move the gearbox forwards or backwards by the number of teeth you decided upon at the beginning, lay the chain back down on to the cog.

h. Get the joining link and fit it to the upper half of the chain, pick up the lower half of chain and holding the upper half still, rejoin the two halves of chain.

g. Replace these curing clip, make sure that you fit it the right way around, that is you push it on in the opposite direction to the direction of travel of the chain.

h. Replace the brake bracket and test the machine. If you have judged the adjustment correctly the job is complete, if not you will have to do it again.

2.Negative cam worn.

Take a fine file and clean it up as it probably won't be that damaged, even in quite a damaged state it should still work, if necessary replace it. If this is the case then there is a fair chance that the roller bearing is not running free or that the negative yolk arm is bent and the cam is rubbing on that.

3.Negative cam unable to depress the bellows, due to clogged bellows block.

Remove the Block and clean it out.

4.Bent negative yolk. Straighten. (see section on possible cause of loss of negative pressure for the cause of this). This is best done out of the machine, it is not difficult to remove, proceed as described in section 6 – Probable causes of loss of negative pressure.

5.Chain rubbing on the case. Adjust the gearbox position and tighten the chains correctly.

6.Chains too tight or too loose. Adjust by slackening the hub nuts and moving the gearbox forwards or backwards as necessary.

To adjust the driving chain only, slacken the battery motor securing bolts and raise the motor or lower it as required by tightening or slackening the adjusting screw through a hole in the cover plate for the battery motor. Re-tighten the motor securing bolts, the nut towards the back of the machine will skid around as you try to tighten it, hold it with a spanner or put a large screwdriver in as the flat of the nut comes around to hold it still.

7.Drive knob rubbing on the case. adjust the motor to bring the driving knob central.

To do this remove the rear outer case, slacken off the motor securing bolts, move the motor in the required direction refit the rear case to check correct positioning.

When it is correct Re-tighten the bolts.

8.Grease on expiratory valve disc. Clean the disc, when replacing take great care not to trap the disc under the plastic cage.

9.Battery motor cover vibrating on battery motor. bend the cover enough to stop it vibrating.

10.Too much horizontal play on the weight arm at the pivots. Remove one of the pivots and put a washer on the spindle, replace the pivot, lightly oil the pivots.

11.Negative spring rubbing on the base. lightly lubricate it.

12.Negative bellows trapped on negative control support. Bend the edges of the bellows plate downwards a little.

13.The Anaesthetist complains that the patient is not getting the Oxygen / Anaesthetic gas supplied.

The Oxygen/ Anaesthetic gas is put in to the machine bellows by the chrome tubing connection marked OXYGEN on the top or the front at the right hand side of the machine, this pipe goes from this connection to a point below the inspiratory disc valve.

It may be that the pipe inside has fallen off inside or perished, this pipe goes from this connection to a point below the inspiratory disc valve.

Replace the pipe or refit it as required, and put on a cable tie or some other means of securing it.

14.The hand operation handle will not engage properly.

This is more than likely to be caused by damage to the roll-pin in to which the slots in the end of the handle engage in. Look inside the tube and you will see the pin, the edge has probably been lifted up.

Tap out the pin, you may have to cut the pin if it is bent to come out of the hole.

Replace the pin with a new one, it need not be a roll pin, any pin that is not going to fall out will do, even a nut and bolt, make sure that it is not too wide to fit the slot of the handle.

15.Respirometer will not operate.

a. Check that the ON/OFF switch on the respirometer has not moved to the OFF position. The lever can be reached with a small screwdriver down between the steel plate on top and the respirometer.

b. The respirometer is faulty. Remove from the machine. To do this remove the front case panel, remove the top steel plate around the respirometer and the ON/OFF lever. Undo the clamps that hold it in place, and wriggle it off the connectors. Repair it as in the section on respirometers.

Replace in the reverse manner.

This description refers to the P.N.A. Radcliffe, (P.N.A. stands for positive, negative, anaesthesia.).

There is now a newer version of the P.N.A. or rather an updated and simpler version called the R.P.4, it is very much the same inside except that it doesn't have the negative bellows.

The normal one doesn't have the Bag/anaesthesia position that the P.N.A. has, but I have seen a version of the R.P.4 that has on the front a switch that does the same as the P.N.A, that is stop the motor and leave the valves open so that a bag can be used for manual inflation.