914 PC Bot: In-flight refuelling

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A while ago I thought I would experiment with wireless power, so I bought a pair of huge 400turn, 0.5mm diameter electromagnets and turned them into a two part transformer. I successfully used the coils to taper charge some lead acid batteries.

I have now housed the wireless charger in an aluminium box (don't worry its all fused and earthed). I put it on a tripod so you can adjust the height of the power transmission coil. The other coil is mounted on the front of my robot at about the same height so docking can be accomplished when the two are facing each other.

I've run a few tests and have been was able to quick charge 914 robot batteries at 500mA when the two coils are close together.

The only issue is that although the coils can charge the battery the quiescent power consumption of the robot is such that to use the system effectively in its present state all robot systems would have to be turned off. I did some measurements into the electrical system on my robot and obtained the following results:

Condition	Current Draw	Power consumption (Watts)
Battery connected main power switch OFF	10mA – taken by solar charge regulator!	120mW
Main power switch On	230mA	2.76W
M3 power switch On	560mA	6.72W
Computer on	2.5Amps	30W
Computer+monitor	3.5Amps	42W

From the results you can see that even with the computer turned off current draw is still in the region of 500mA. Applying the inductive charger to the system under these conditions would not charge the battery, but would certainly reduce the loading on the battery.

Since the voltage from the charger is higher than that from the battery I anticipate power would come from the charger and therefore reduce the battery loading to somewhere around 60mA. At best the charger I made would "break even" with the battery. What is really needed is a magnetic field with somewhere in the order of 6-times the magnitude of my current system. I have had the following ideas about wireless inductive power:

1. **All systems shutdown pure battery charging.** This is the stage that I'm at the present time. It is possible to recharge the batteries of the robot but only when the robot is completely turned off. Without any further modification to the system an operator would have to manually turn the robot systems on again once the robot had finished charging. – turning the power on or off could also be accomplished automatically by using a microprocessor based system instead however see concept 1. As far as I'm concerned this is not the ideal but is low cost and very feasible at this instant in time.

2. **Pure In flight refuelling**. In this mode the charger would be such that it produces approximately 6 times the magnetic field strength of the present system. In this case the charger could not only recharge the batteries, but also provide power to the whole robot at the same time. As far as I'm concerned this represents the ideal situation because the robot's computer, sensors and drive systems would always be active. This means that the robot could be aware of its current state and its surroundings at all times and never actually need to shut down. During times of recharging the robot could run computer maintenance programs such as defrag, antivirus or other such software. If an unforeseen situation arose the robot could quickly move away from the charger and deal with it accordingly. This method will not be viable until I discover a magnet this powerful.

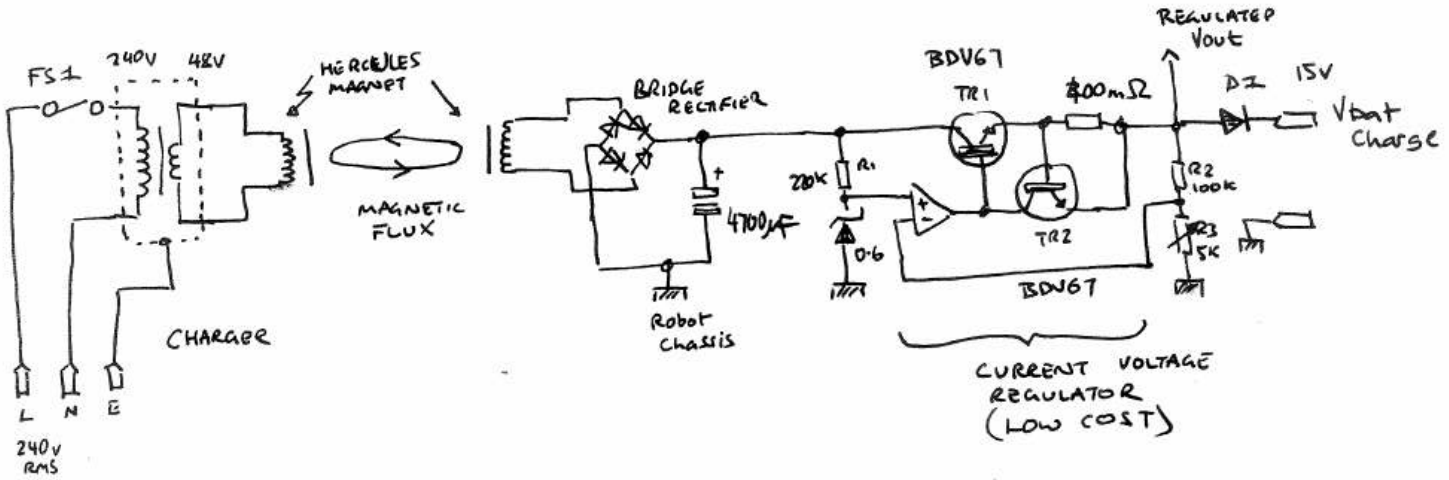
Current investigation

This is what the charging circuit looks like. I know I said I wouldn't wind any more coils, but I lied. The coil at the back is a homemade resistor. You can't buy 0.338Ohm resistor, so I resorted to making one.

I have opted to charge the batteries in my robot at a rate of about 0.1C. The charge rate or C as it is known, is a percentage of the nominal current capacity of a battery. In the case of the 914, there are two 9Ah batteries connected in parallel inside it, providing 18Ah of service therefore for this configuration 1C is 18.

At 20 degrees Celsius (ambient) it is recommended that lead acid batteries are charged at 0.1C or 1.8Amps, with a voltage of 2.275 to 2.5 volts applied to each of the 6 cells in the battery. This means that the battery should be charged with a voltage in the range of 13.65 to 15v DC. Obviously the higher the voltage the quicker the battery will charge.

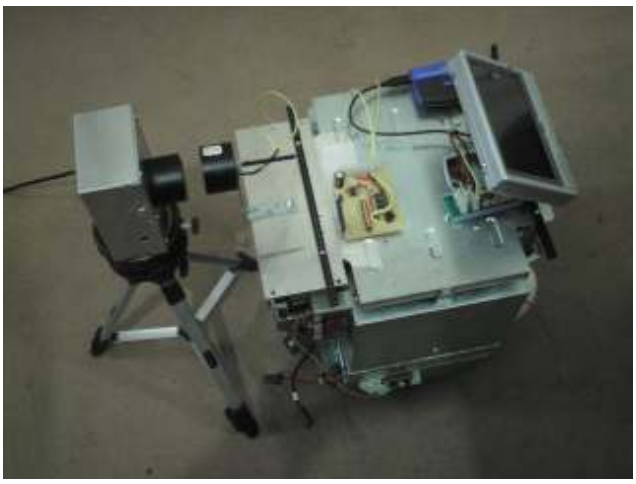
The following is the schematic of the wireless charger and this is how I am able to charge my robot wirelessly. The purpose of the following circuit is to safely charge the batteries on the robot without subjecting them to damaging conditions such as over voltage and over current.



Notes:- Charge rate ≃ 0.1C
Current limit 1.8A
Vcell = 2.275 → 2.5V
Vout = (12.6 → 16V) Range set to 15V nominal

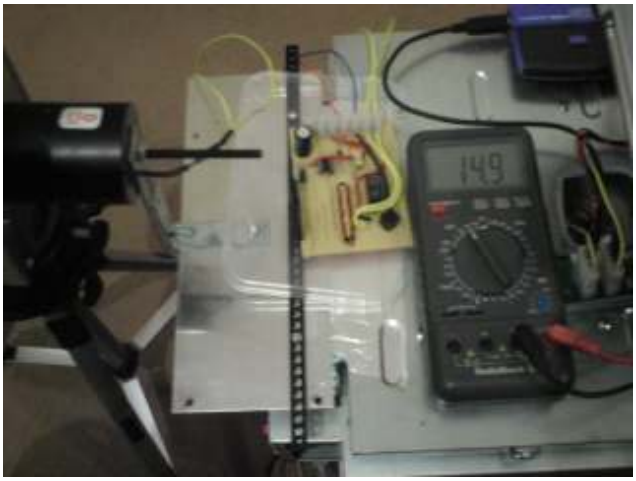
Constant Voltage Current limited Charger unit.

Here are some images of me using the charge regulator with the wireless battery charger:



The robot and the wireless charger, all switched off

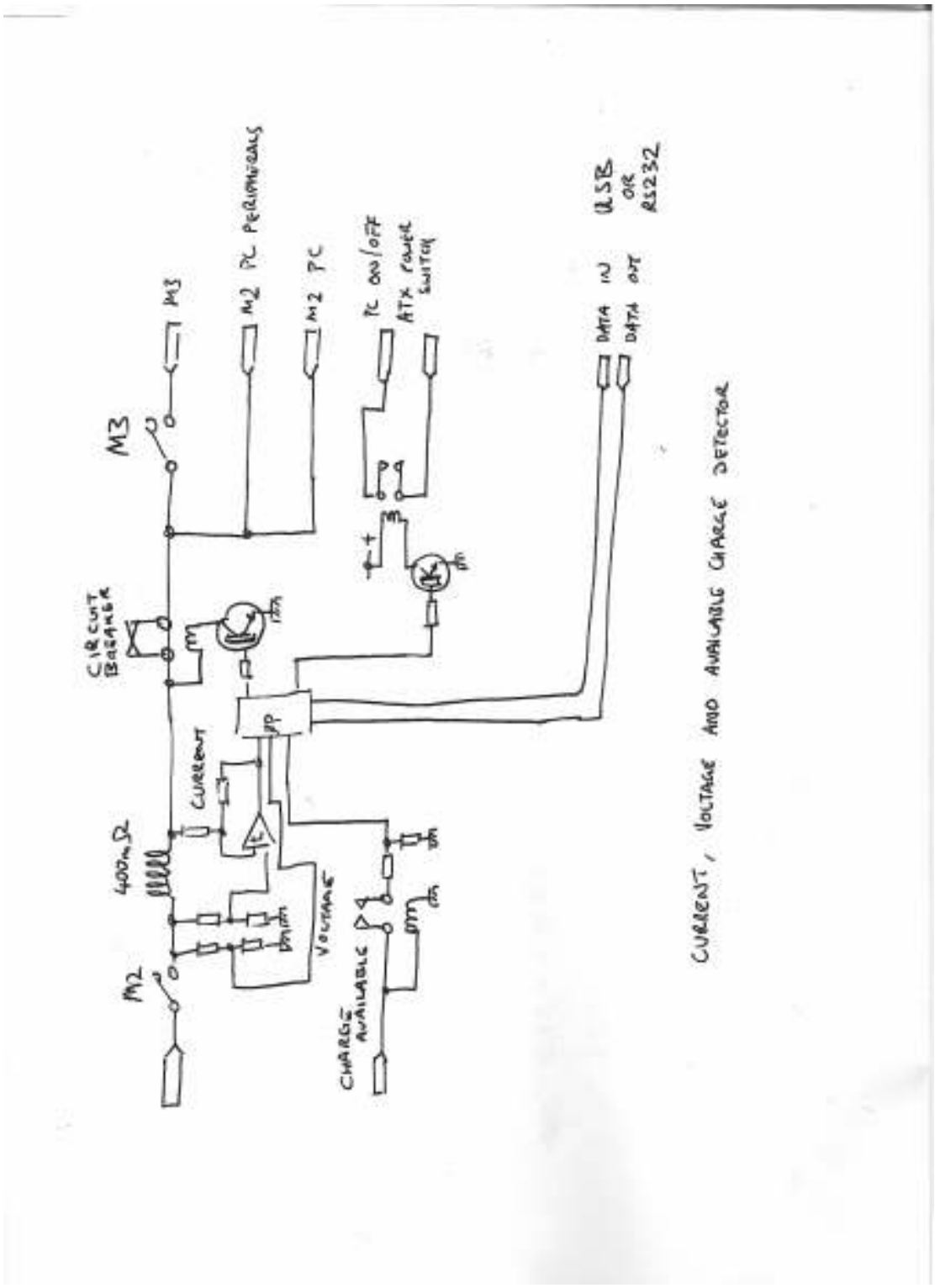
The robot and the wireless charger with a multimeter. Note that the reading is 0v because the coils are apart.



You put those coils together and up goes the voltage. As you can see it's permanently fixed at 14.9v. I designed my regulator such that you can increase or decrease the nominal output voltage if you really want to.

The next step

Don't forget although I can charge my robot batteries but only if everything is turned off. To overcome the problem of not putting enough energy back into the 914 I need to turn the computer, M2 and M3 boards off automatically. I haven't quite worked this out yet but this is what I've come up with so far:



There will have to be a standalone processor (with a relay) that communicates to the PC, it will be powered from the battery and located after the main power switch.

The processor system will detect that the robot is close enough to the charge coil and ask the computer to. The computer will shut down and by measuring the current from the M2, the processor will know when its quite safe to shut off both of the M2 boards. Then the processor will either monitor when the battery has had sufficient charge, or simply use a timer to determine when the batteries have had enough. Power will be turned back on to the M2 boards at this point. The only problem is getting the computer to turn back on once its all ready. There will need to be some method of shorting the switch contacts on the board to force the computer to boot.