EE 400
GRADUATION PROJECT

NEAR EAST UNIVERSITY
LEFKOSA

ELECTRIC & ELECTRONICS DEPARTMENT

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1995

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I- INTRODUCTION

In our theoretical education period, in the university it is very important to have practical works about our job, as it is the only bridge between real life and our education. So laboratories have an important aim in preparing students to their work. Combining theoretical with your experimental knowledge, and then adding experience to them make you a professional, in your job.

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ii- INTRODUCTION

In our theoretical education period, in the university it is very important to have practical works about our job, as it is the only bridge between real life and our education. So laboratories have an important aim in preparing students to their work. Combining theoretical with your experimental knowledge, and then adding experience to them make you a professional, in your job.

1- THE IMPORTANCE OF POWER SUPPLIES IN LABORATORIES

To have precise results while working in laboratories, at first you must be precise, and most important is your equipment must be precise. The errors of measurements, or supplies should not exceed the limits.

According to these points power supplies are one of the main units of the laboratories. They are main error sources in an experiment as the power is supplied by these equipment. In other words they are the starting point of errors.

In the light of these concepts, as an electronics engineer today, it will be good to examine a power supply, of course a laboratory model. I chose a very good model, easy to construct but so powerful as my graduation project EE400.

2- BRIEF DESCRIPTION OF THE PROJECT

The power supply that i have chosen is a good type as it has wide range of output with full function protection. This device have current fuse function with reset facility, have short-circuit protection, and have a cooler fan for heavy duty work conditions. This wide range of output makes possible to supply allow power rated circuit or to recharge a car battery with the same device. Also digital panel meters makes the measurements easily readable, this reduces the error percentage, made by the experimenter.
Another facility that differs this device from others is the stability under heavy load. Classical power supplies have current variation in order to stabilize the voltage. But our project subject hero cuts off the voltage as soon as the desired current is reached. This gives full protection for the connected device.
Another goodness of this supply is the construction costs. As it does not cost too much having these precise preferences, for an amateur, or professional it is a good choice for experimenters.
An AC output makes it more useful when needed to use AC directly, but of course in a constant voltage.

3- HOW IT WORKS (INTERNAL STRUCTURE)

In order to have a stable output power, in heavy load conditions the supply is designed with high tolerance equipment. Starting with a powerful transformer, a 30A bridge rectifier, a big powerful capacitor for filtering and at the end high power output transistors are chosen for heavy loads. If these tolerance limits are not chosen a problem of burning the loaded equipment will rise.

3 darglington output transistors are used in the supply. For example, taking into consideration that for a 5A output with current gain of 5, we need 1A of collector current for the second transistor. Again for a 1A current we need 50mA collector current for the third transistor with a current gain of 20.

To complete the protection against heavy loading, the cables used inside the supply connecting the transformer to rectifier and to the circuit is chosen as thick as 6-7 mm. This also reduces the heat loss in the cables.

The transformer with 27 volts AC output loads the rectifier and the filtering capacitor and a maximum of 35 volts DC output is obtained.

The output transistor behaves like a resistor when you want lower currents to the output. For example if you want 4A with 6 volts the rest must be used on the output transistor which is 4A with 29 volts and this makes 116W of power to be dissipated on the transistor of course standard case is not enough to take this much heat so the supply is equipped with a big cooler body made of aluminum and with a cooler fan. This easily can be seen that the power dissipated on the transistor is much more in lower potentials.

The equipment that used in the supply may differ from the list, this is not so important as the equivalent parts are used instead.

3.3- THE PROTECTION UNIT

As can be seen from the main diagram of the supply that the AC output has fuse protection only as it does not need more of this.
Once the DC voltage is obtained it is directed to a 0.3 Ohm resistor for measuring a voltage drop when loaded. This signal (difference) is used to decide when the protection will be active. A 27 Ohm resistor is put for enabling the resetting. As seen 0.3 Ohm resistor is also enough to have this control, because of loss of power, the internal cable resistance are much more important to have thick diameters. The main protection is obtained by a kind of a multivator with T2, T3. When the current limit is exceed, enough current flows from P1 to T2 to make it biased. This continues with the biasing of T3. Because of this from IN4448 the collector of T4 is taken to zero voltage. Because of this the series T5,T6,T7 is also taken to zero, deactivating the supply output.
This continues until the switch Ta is pressed. When the reset switch is pressed the voltage of protection unit is canceled resetting the whole supply unit . From T1 an indicating led shows that the problem is active until it is reset.

3.2- THE CONTROL AND REGULATION UNIT

The real voltage regulation is obtained by T4. From ZPD3 a reference voltage from the DC input is given to the emitter of T4. The regulation part is separated by the darlington array T5, T6 and T7. In order to minimize the equipment in design considerations an extra transformer is not used to regulate the voltage, as reference because in this case the regulation is referred from the earth so the range of 0-4V DC can not be used. This is because of the base-emitter voltage of 0.7 volt of T4 makes 4 volts.

The solution of using another zener diode is not the optimum solution because when you use a zener of 0.7 volts for example as a reference to T4, the regulation is less sensitive. So the zener diode used is the optimum one. In the reverse manner using a 7.5 V zener diode makes the usable range 8.7 to 34 volts DC.

4- TECHNICAL SPECIFICATIONS

220-240 V AC		input voltage
3 A		input current
25 V AC 3 A		AC output
4-34 V DC	3 A cont	DC variable output
	5 A max	
0.1- 5 A		DC output current
		Electronic current fuse protection with reset

Short Circuit Protection
Heavy Duty (Aluminum body + cooler fan)
Digital Display Easy Reading
Optimum Equipment Configuration, Easy Service
Sensitive Regulation to Output Power

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5- EQUIPMENT LIST

Transformer	220/24V, 6A
Rectifier	B 40 C 7500/5000
Filter Capacitor	10 000uF/40V
Transistor	2N 3772, 2N3771
Transistor	BDY 16B
Transistor	BC 141
Transistor	BCY 58 C
Transistor	BCY 78 C
Zener Diode	ZPD 3
Silisium Diode	IN4448
Potentiometer	100Ohm 0.25W linear
Potentiometer	5kOhm 0.25W linear

Resistors
27Ohm
100Ohm
560Ohm
680Ohm
1kOhm
2.2kOhm
10kOhm
1Ohm 5W

Capacitors
220uF/40V
47uF/40V
4.7nF
47nF
470pF

Digital Ammeter
Digital Voltmeter
Other mechanical equipment.

6- CONCLUSION

Building one of the important device of a laboratory, a power supply gives a lot of experience to the electronic engineers. Also to make precise measurements, or to experiment a device without overloading and burning it, and having a large variety of voltage and current output, can be very important to the engineers of electronics.

7- REFERENCES

-Funkschau electronic magazine (Germany)

-Elo electronic magazine (Germany)

-MC electronic magazine (Germany)

-Hilf, W : Nausch, A : m68, Teil 1 (Grundlagen und Architechur) Munchen

-Hunstman, C: Cawthran, D: The power concept Dez 1983

-Raven, J.G.: Berkhoff, E.J., Kraus, V.E.: Application of power supplies
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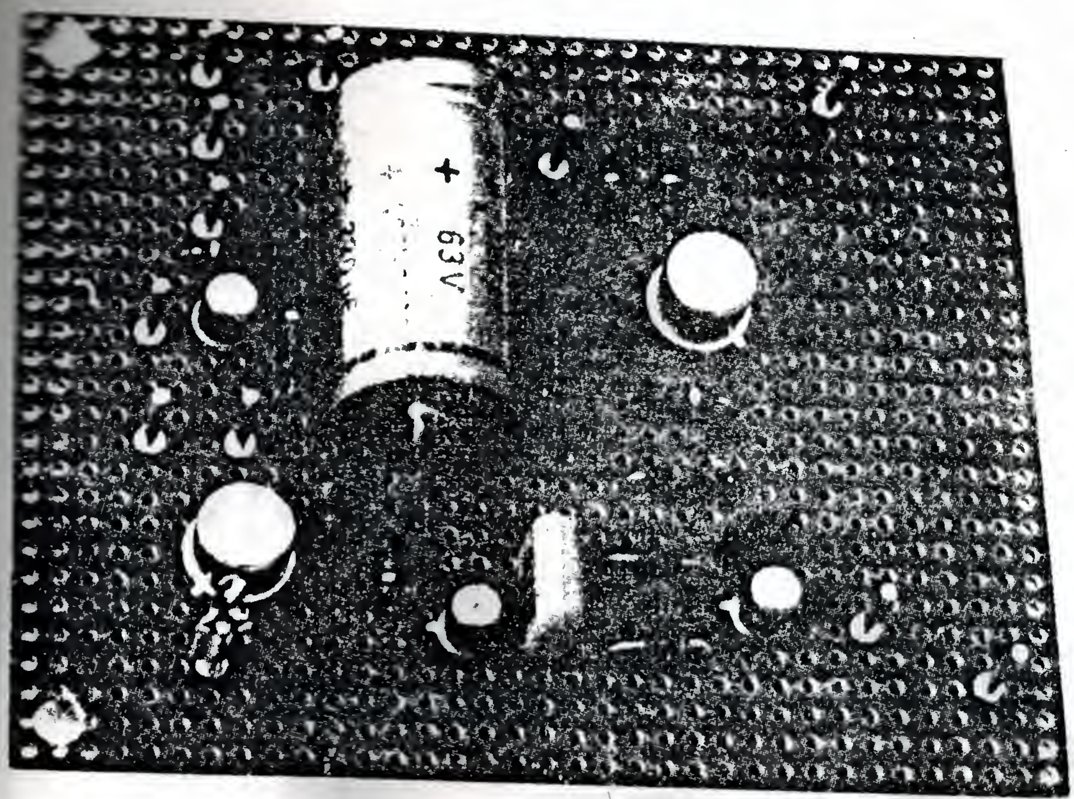

Figure 1- Supply and Regulation Circuit

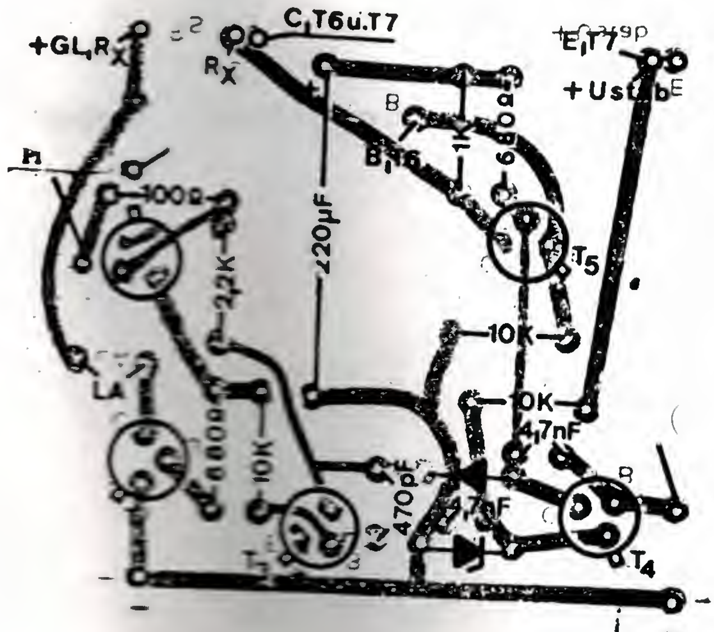

Figure 2- Circuit Board of Regulation and Protection Unit

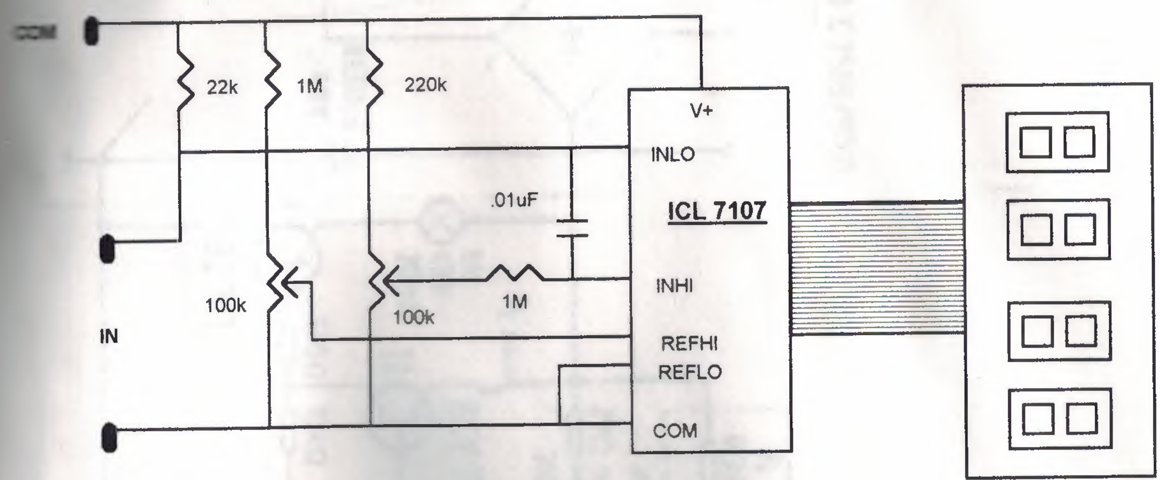

Figure 3 - The Diagram of the Digital Ammeter and Voltmeter

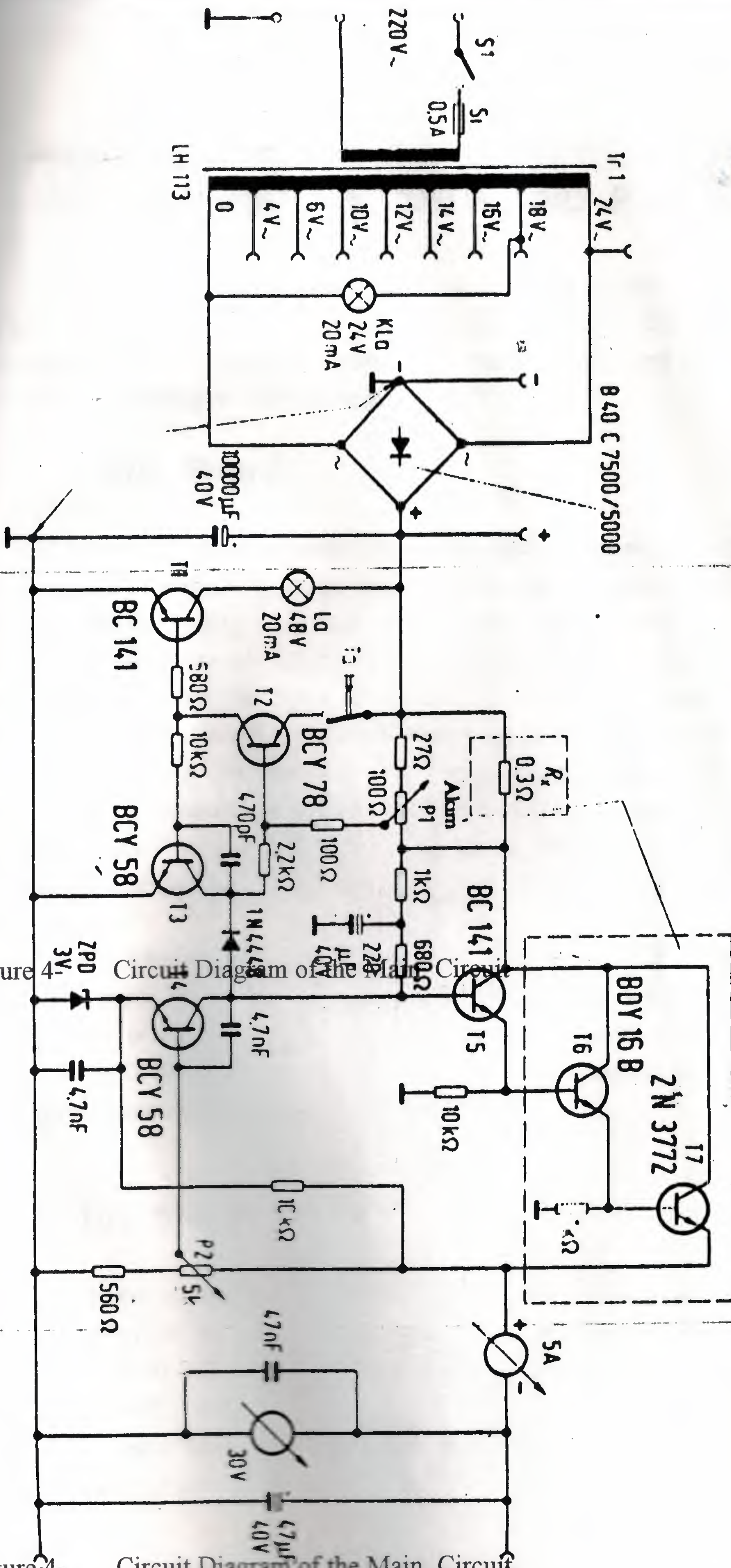

Figure 4- Circuit Diagram of the Main Circuit

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PRACTICAL GUIDE TO CONSTRUCTION ELECTRONIC CIRCUITS AND PROJECTS

There are several different ways of building electronic projects. The simplest by far is to use a printed circuit board. Other methods of construction include stripboard (verboard) , matrix board and tag strips. Each method has advantages and disadvantages.

1. Matrix Board

This is a phenolic material (like very hard cardboard) perforated in a grid pattern. It is a brittle material though quite strong dont bent it too much or it will fracture. Cutting it to size is a simple matter. Score along a line of holes with a pen knife or similar, clamp it along the score on the edge of a sharp corner, such as the edge of a bench or table, and bend or strike the overhanging portion sharply it should fracture cleanly along the score.

It can use it by inserting the components through the holes and making interconnections by joining the components across the back (non components side) of the board it all sounds a bit messy but it's surprising how quickly circuits can be assembled, and with a bit of care they look quite neat.

Another advantage of matrix board is that components and wiring can be placed exactly as shown on the circuit diagram. The main disadvantage is that the back of the board becomes a bit of a rat's nest if it try to built a complex circuit. Another minor drawback is that the finished job doesn't look like a totally professional job.

2. Tag Strips

Tag strips consist of a series of metal tags mounted on an insulating strip. The strips in turn are mounted on two or more further metal tags which are used to screw the whole lot down onto a chassis.

Component leads should never be wrapped more than three quarter way round a tag. If you wind them right round you'll have an awful job trying to remove them, if you need to.

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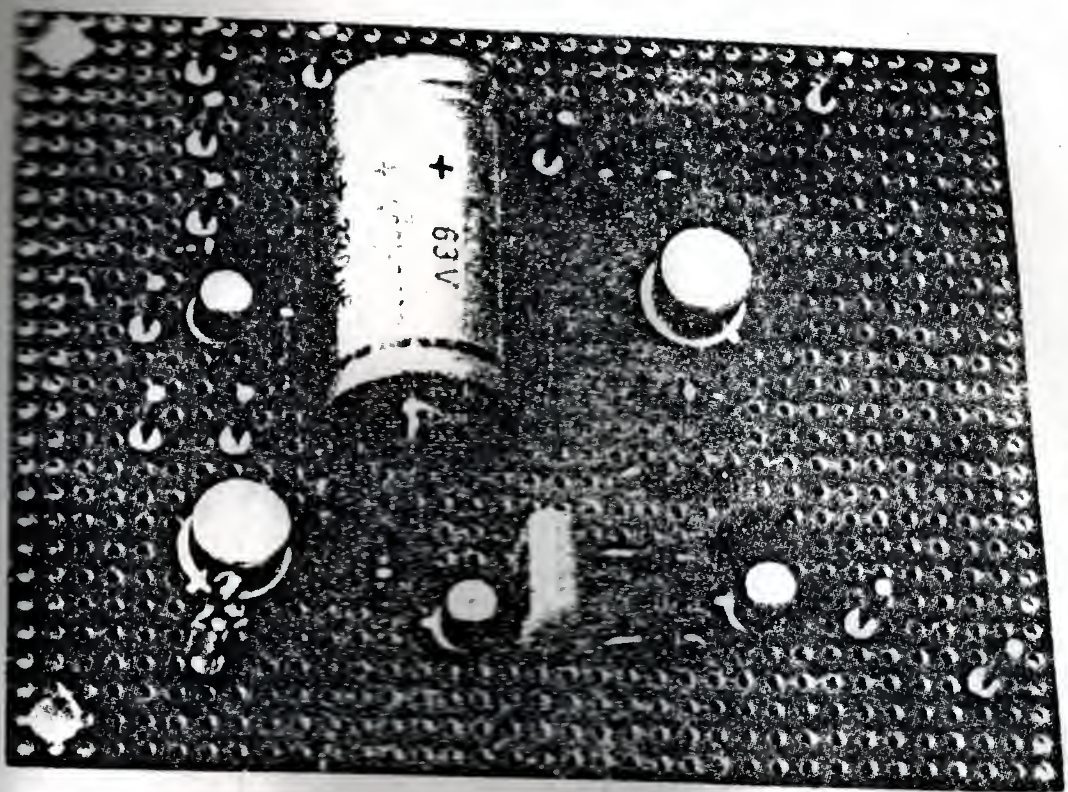

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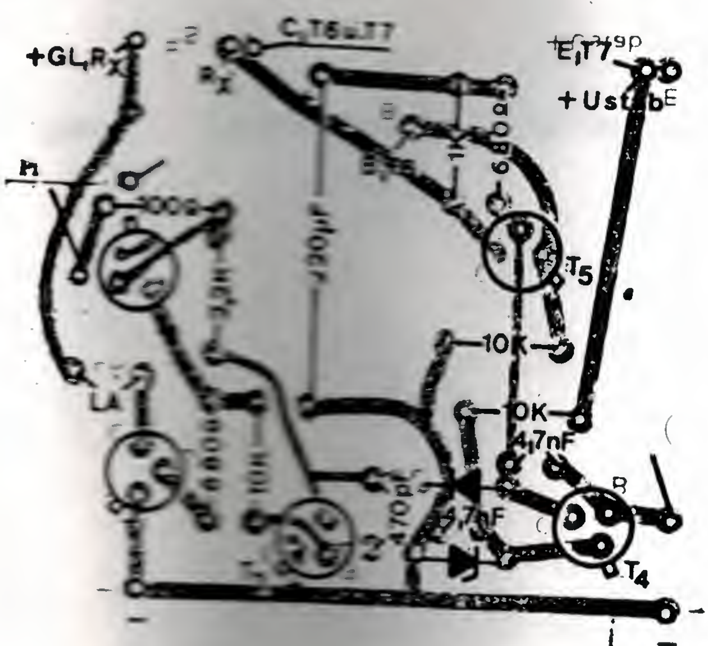

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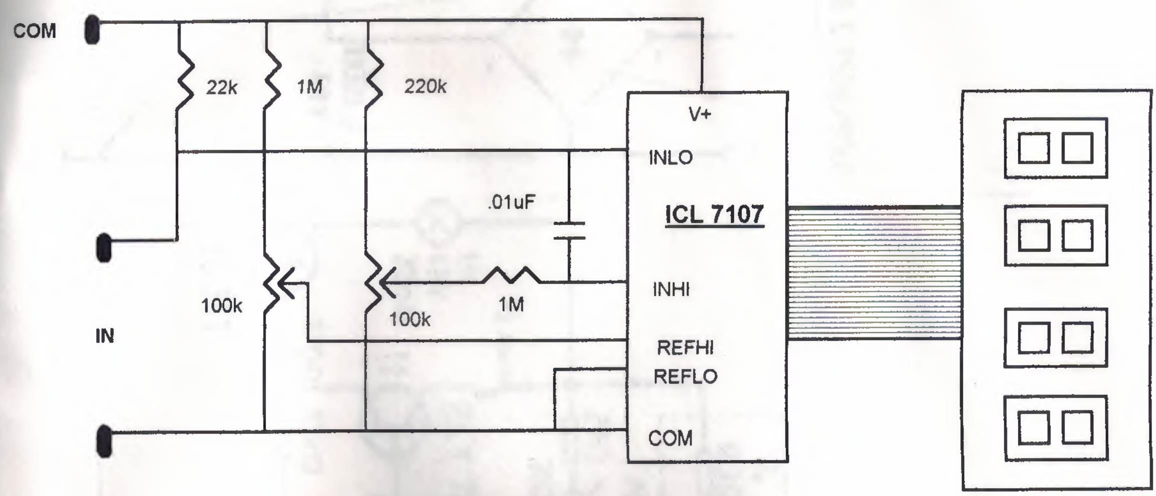

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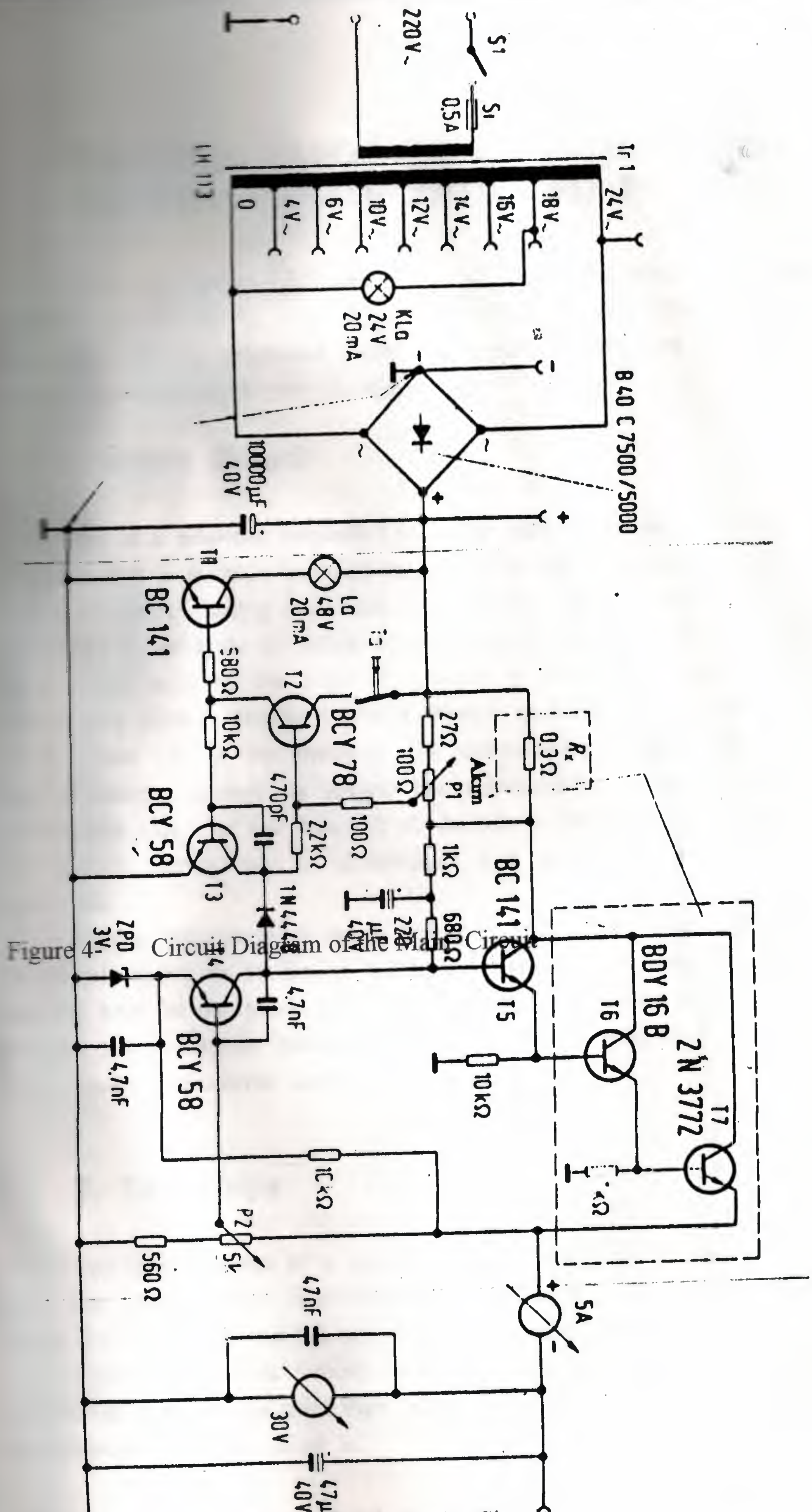

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Tag strip construction is quickly, cheap and simple but the method only suitable for small scale projects as intertag wiring is otherwise extensive and tedious. This method also wastes space.

3. Veroboard

This is made from a material similar to that used for matrix board, but with lines of copper (refers to as ' strips ' or ' tracks ') embedded in it. The strips are spaced 0.1" apart and the holes in the strips though which components are inserted, are also at 0.1" intervals.

Veroboard is easily obtainable in large pieces which can be used for a big job or cut down to suit a smaller circuit. It is simple to use and if the component layout is worked out in advance. It can result in a neat finished appearance. It is fairly easy to make mistakes, though. One important point to watch is that components which are not meant to be connected are isolated by cuts in the copper strip (these are easily made either with a suitable sized drill bit or with a special tool). A wise constructor will always check the layout against the circuit diagram to make sure that all components are in the right holes in the right holes, in the right strip, and that the leads of a transistor, for example, are only joined to those components shown on the circuit, and to no others. Two other points to note are that the loose copper which results from cutting the tracks is not joining adjacent strips, and that after soldering, no solder bridges have been accidentally made.

4. Printed Circuits

Printed circuit boards simplify electronic circuit building enormously.

The board material is made of phenolic resin or glass fibre with a thin copper sheet bonded to (generally) one face. Intercomponent wiring is formed by etching away the unwanted copper so that only the tracks and components mounting pads remain. Holes are drilled for the components which are then inserted through from the non - copper side and their leads soldered directly to the copper pads Printed circuit boards have a number of significant advantages over other methods of construction. The biggest is that mistakes are less likely to occur Most of the wiring is right there etched onto the board, and the drilled pattern is such that in many instances components will only fit the right way round. The finished article looks professional. It is how most professional equipment is made.

The disadvantages are that printed circuit boards are more expensive than other methods; there is also less personal involvement.

Most component suppliers stock PCB material for those who wish to make their own. It is not that difficult but may be messy and even dangerous, because of the powerful chemical used to etch away the unwanted copper.

5. Soldering

Good soldering is vital most of the problems. The following hints will aid it become adept at soldering.

x- Puchase a good quality iron with a rating between 15 and 25 watts.

x- Use only resin cored solder (60 / 40 tin lead content). Do not use acid flux.

x- A new, or worn iron will need tinning. To do this let the iron get quite hot and file the tip smooth to expose fresh clean copper. Quickly, before the copper has time to discolor, apply resin cored solder. It should flow all over the tip forming a shiny coating.

x- Keep the soldering iron clean. Wipe it frequently with a damp cloth or sponge.

x- Make sure the connection to be soldered is clean. Wax, frayed insulation and other foreign substances will result in interior joints.

x- With older components or copper wire, it will be necessary to clean and tin the individual components before soldering them together.

x- Attach the wires to be soldered. Do not make more than a half turn in a lead to be soldered; twisting makes subsequent removal difficult.

x- Heat the connection with the iron and apply solder to the joint.

x- Keep the iron on the joint until the solder just commences to flow on the connection. Too little heat results in a high resistance joint (known as a dry joint). Too much causes component damage and evaporates the tin component, again causing a poor joint.

x- Let the solder harden before moving the connection. Then check for a smooth bright joint. A joint that has been moved will have a crystalline appearance, may have a high resistance and will fracture easily.

6. Resistors

Resistors are fairly straightforward components. The value and wattage specified for a project, there's little that can go wrong. A color code chart is a handy guide if it is not completely familiar with how to read the value from the colored bands painted on the body of the component. Resistors are not polarized that is, it doesn't matter which way round put them in.

They can be damaged by clumsly handling. Don't bend the leads too near the body of the component, this can fracture the end or the main body the lead may even come right off. Don't apply excessive heat to the leads when soldering or hold the iron to the joint for too long. It is sufficient just to have the solder flow properly to make a good joint a little extra may do more harm than good.

In many instances the exact value of a resistor in a circuit is not too important and it can substitute a resistor one value up or one value down from that specified without causing any great change in a circuit's operating conditions. For example either a 2k7 or 3k9 resistor may be substituted where a 3k3 value is specified. Don't do this with high wattage resistors or high stability resistors (1% or 2%). A resistor having a smaller tolerance rating may always replace one of a greater tolerance rating of the same value. For example a 4k7, 10% resistor may be replaced by a 4k7, 5% type.

Similarly, half watt resistors may be substituted for quarter watt resistors provided they physically fit.

7. Capacitors

Capacitors come in a wide variety of shapes and sizes, types and ratings. The important thing to remember is that there are polarized and non - polarized types. Electrolytic and tantalum capacitors are polarized and it must take care which way round they are connected in a circuit. Al the others are non - polarized. Of the latter, mainly specify polyester and ceramic types. These are the most common. They may be inserted either way round.

A polarized capacitor always has some marking to indicate which lead is which. Many are made with a black stripe adjacent to the negative lead. Some have a ' + ' and a ' - ' sign near the respective leads. Always check that it have inserted or connected polarized capacitors the right way round. They won't work otherwise and that's about the worst that will happen in a battery operated circuit. A wrongly connected electrolytic in a mains operated circuit (even at low voltages) may very well explode !

In general capacitor values should be adhered to substitution is not recommended unless it is very familiar with the way a circuit works and the role of the particular capacitor. Voltage rating is important, particularly with electrolytic and tantalums. Never use a capacitor rated at lower voltage than specified. It can go upwards, though For example if a project calls for a 10 µF , 16 V type then a 25 V rated capacitor of the same value may be substituted.

8. Diodes

Diodes are polarized components. There is always a right way and a wrong way round. If the wrong way round it may well destroy the device. Fortunately, they always have some sort of mark identifying the cathode end . It may be a band around that end of the body adjacent to the cathode lead, or the body may be chamfered at the end We generally indicate on the construction diagram with our projects the polarity of any diodes. Alternatively, a small diagram may accompany either the circuit or the construction diagram showing diode body shapes and markings and how these relate to the diode symbol.

Any substitutes will usually be mentioned in the parts list accompanying a project or in the Bylines page. However, as diodes are generally rated in terms of voltage (maximum reverse voltage, not conducting), it is always safe to substitute a diode with one having a higher rating then specified never the other way around, and never substitute a silicone signal diode for a germanium signal diode.

9. Transistors

For most purposes a transistor is either the right one or it's not. It is rarely possible to substitute another type which some one may recommend as ' just the same ' though substitutes or equivalents may be mentioned in the parts list, or in Bylines.

A transistor can only be connected one way round, the right way !

The construction diagram or component overlay with a project will indicate which way the pins are to be inserted in a PCB. Connected incorrectly, there is a good change you will destroy the device when first switched on.

Incredibly, not all transistors of the same type number have the same pin connection. Sometimes a manufacturers may vary the pin connections of a type at different times ! Transistor pin connections and orientations are given in the construction diagram or component overlay.

Transistors (and diodes) may be damaged by excessive heat when soldering. Although, these days, it is no longer really necessary to use a ' heatsink ' (pliers or a special tool) when soldering small transistors leads a little care and speed when soldering is a good idea. Just get the solder flowing neatly over the joint ' wetting ' it properly, and things should be fine. Don't overdo it.

10. Integrated Circuits

Integrated circuits must be soldered in the right way round. They always have some identification usually in the form a small scallop in one end of the case or a small indentation adjacent to a pin at one end. They should be inserted as shown in our overlay drawings. Do make sure they are the right way round before soldering because once in they're very hard to get opt again.

Because this it's well worth while spending a bit more on IC sockets. These are plastic sockets which have identical pin connections to the IC and into which, in turn the IC is plugged. It's not always worthwhile because some IC 's are so cheap that the socket costs more than the IC, but they are worth considering for use with expensive devices.

Like transistors, most IC's are stronger than they look, but don't overdo the soldering, it is very easy to get a tinny solder ' bridge ' between the pins.

CMOS IC's are a bit different. These are very tough, once soldered in, but are a bit fragile until then.

They should be handled with care as they are easily damaged by quite small static charges. CMOS IC's are supplied inserted in a conductive plastic foam or foil-wrapped styrene block. Remove them carefully. Take care to pick them up with your thumb and forefinger grasping the ends of the package, not touching the pins. Make sure you have them correctly oriented before inserting them into a PCB.

When soldering CMOS IC's use an iron having an earthed tip and barrel. If you're unsure about these use a clip lead to connect the iron's barrel to the negative supply rail on the board. These measures ensure you don't ' blow ' CMOS IC's from either static or leakage currents.

Always leave CMOS IC's until last when assembling a project. Once removed from the packaging, insert them quickly and first solder those pins connected to the power rails, generally pins 7 and 14 for most 14 pin packages, but check the diagram beforehand. This ensures any static charges are dissipated by the other components.

11. LEDs

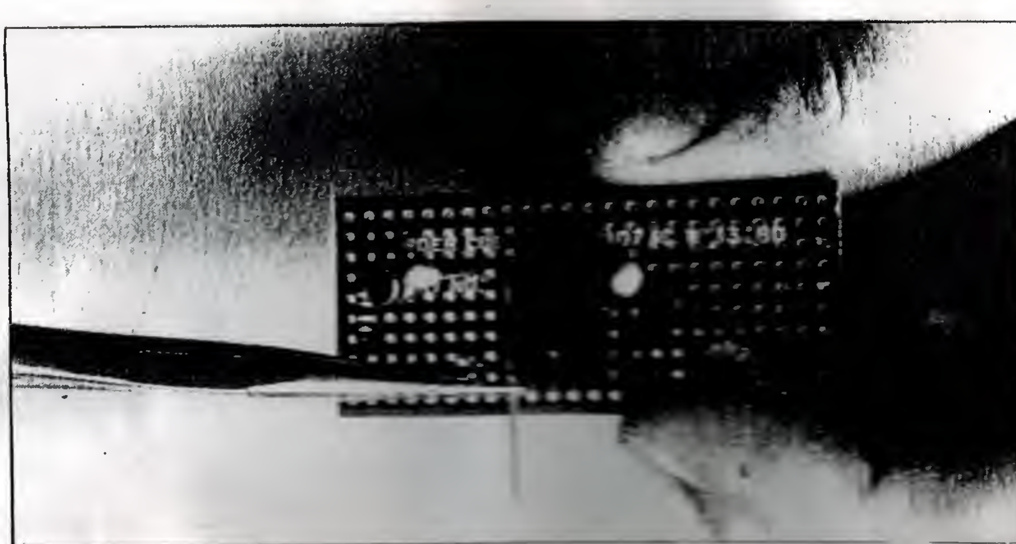
Light emitting diode are very handy little solid state indicators and for that reason are widely used. Common colors are red, yellow and green although orange are available and blue will be are availably shortly. Some are clear but glow red.

Being diodes they are polarized. There are not usually damaged if incorrectly connected, but they will not work. The polarity of the leads may be indicated in several ways. The most common is to have a flat section on the case adjacent to the cathode lead. Some have one lead shorter than the other, the cathode lead being shorter. LED's will last forever. We don't know of any that have worn out yet.

They must be used at the correct current rating and if this is exceeded.

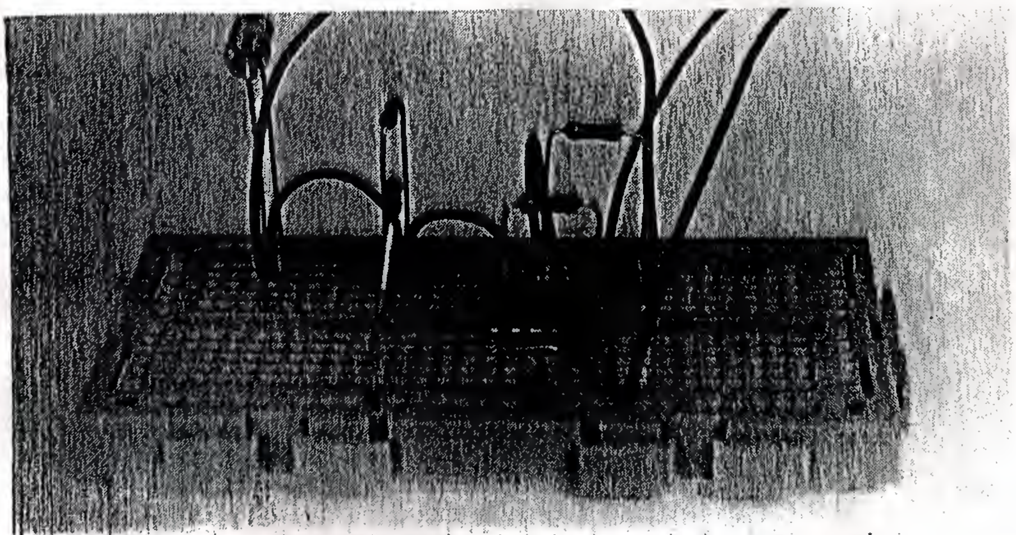
You will generally find a resistor connected in series with a LED in a circuit. Don't ever test a LED by connecting it across a battery. Best way to test one is to wire it into a circuit known to work.

Led connection diagrams generally accompany the circuit or component overlay with our projects.

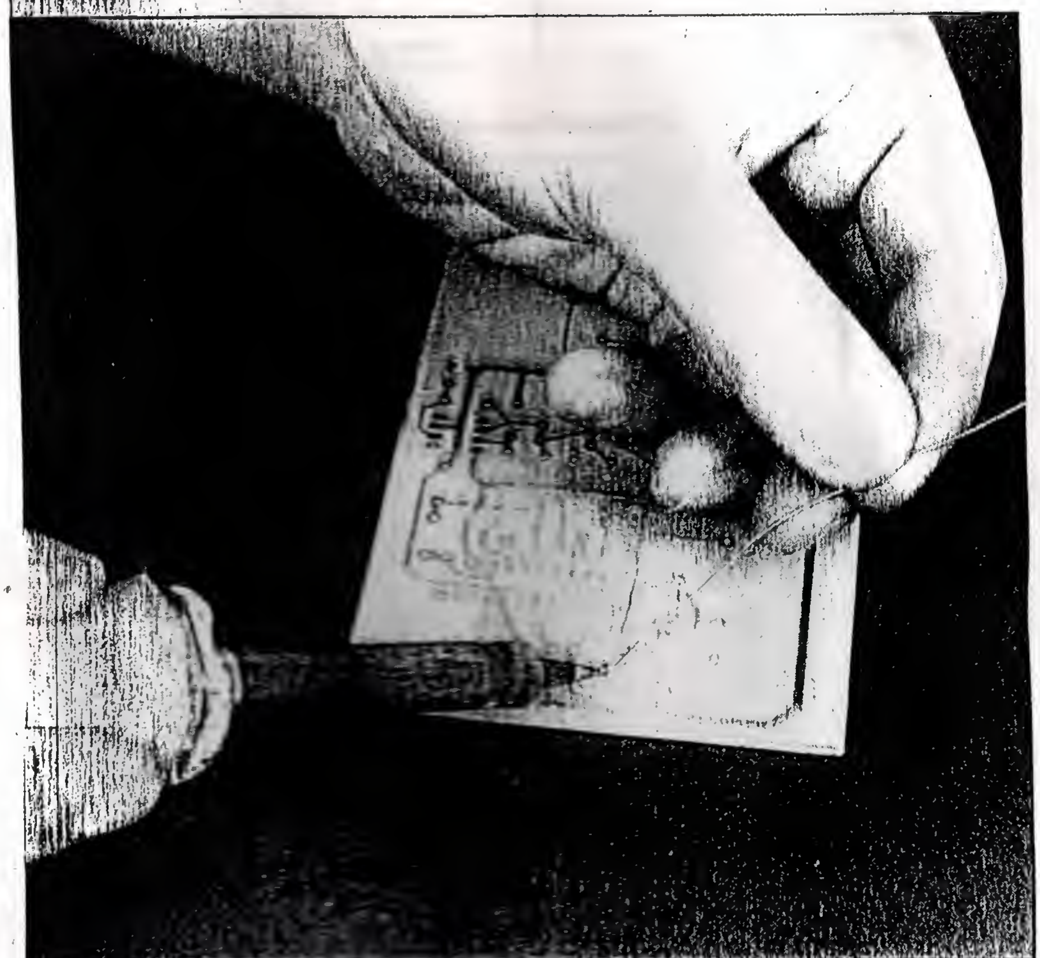


Assembling a circuit on matrix board.

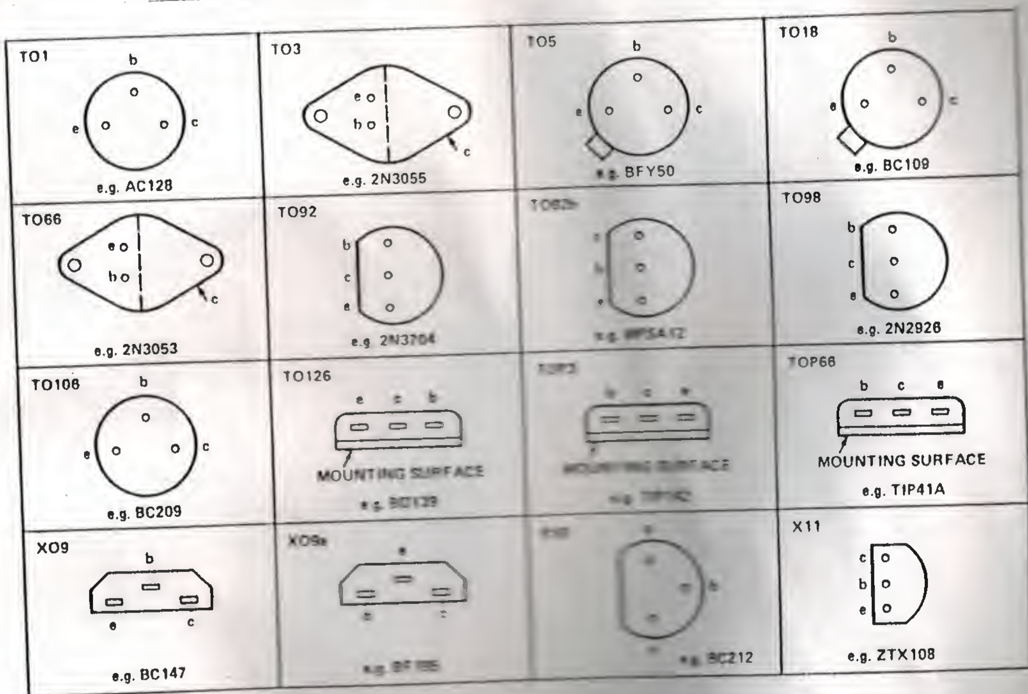
Bend it but don't break it.



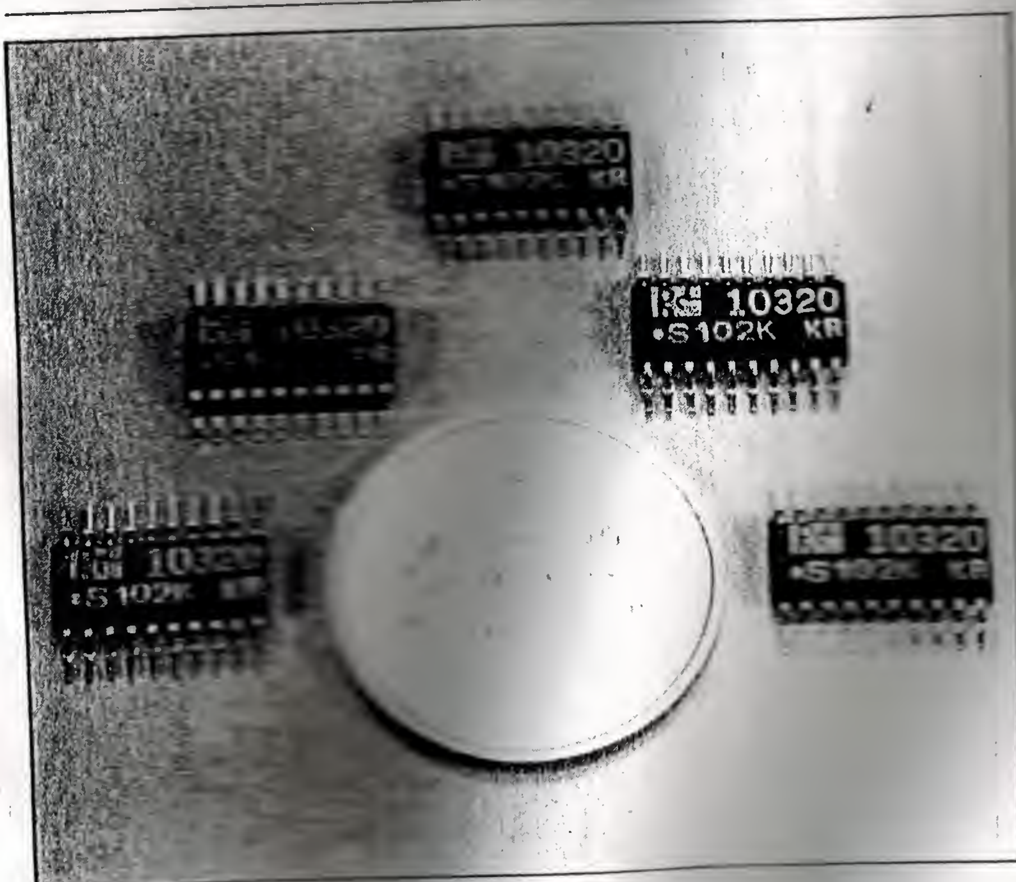
A modern 'breadboard' block — useful for prototyping a circuit but not for permanent use!



Soldering components onto a printed circuit board.



The pin configurations of some often-used transistors.



ICs continue to become smaller while packing in more functions.