A Simple Self-Acting Spark Erosion Machine

Introduction

This machine has been designed with the requirements of the Model Engineer in mind, requiring minimum financial outlay, straightforward construction and little electrical knowledge.

Its main use is envisaged to be the removal of broken drills or taps, but it can also be used to create holes of any shape in any conductive material, including hardened steels.

Its mode of operation differs from typical industrial machines and many previous designs based on similar principles which have been published in model engineering magazines. As is normal in industrial use, the work is submerged in a bath of paraffin so that the sparking between tool and work takes place without the presence of air, so avoiding oxidation (burning). The paraffin also aids dispersal of erosion debris. Fire risk appears to be minimal, but precautions should be taken such as having a fire extinguisher available.

In operation the tool is connected to a capacitor charged to about 60 volts so that an arc discharge occurs when it contacts the workpiece. The discharge and recharge currents pass through a solenoid coil, which applies a lift force to the tool raising it from the workpiece and extinguishing the arc. Whilst the current continues, recharging the capacitor, the lift force holds the tool plunger against an upper stop until the current ceases when the discharge capacitor is fully recharged. The tool plunger then falls under gravity until the tool contacts the workpiece again, and the cycle repeats.

Construction

Drawings of the prototype are attached. Most dimensions are not critical and can be changed to suit materials and thread sizes that happen to be available. It is important to ensure that the tool plunger slides freely in the bearing block, and that the armature does not contact the bore of the solenoid, causing friction. The solenoid and tool assembly must be mounted so that it can be held at an adjustable height above the work, whilst being electrically isolated from the work. The drawings show this being achieved by interposing sheet plastic material between the tool/solenoid assembly and its stand, and sleeving the securing screws with insulating material.

The drawings show an anti-rotation stop fitted to prevent rotation of the tool as it oscillates vertically. This is unnecessary if it is only intended to make circular holes or remove taps, etc.

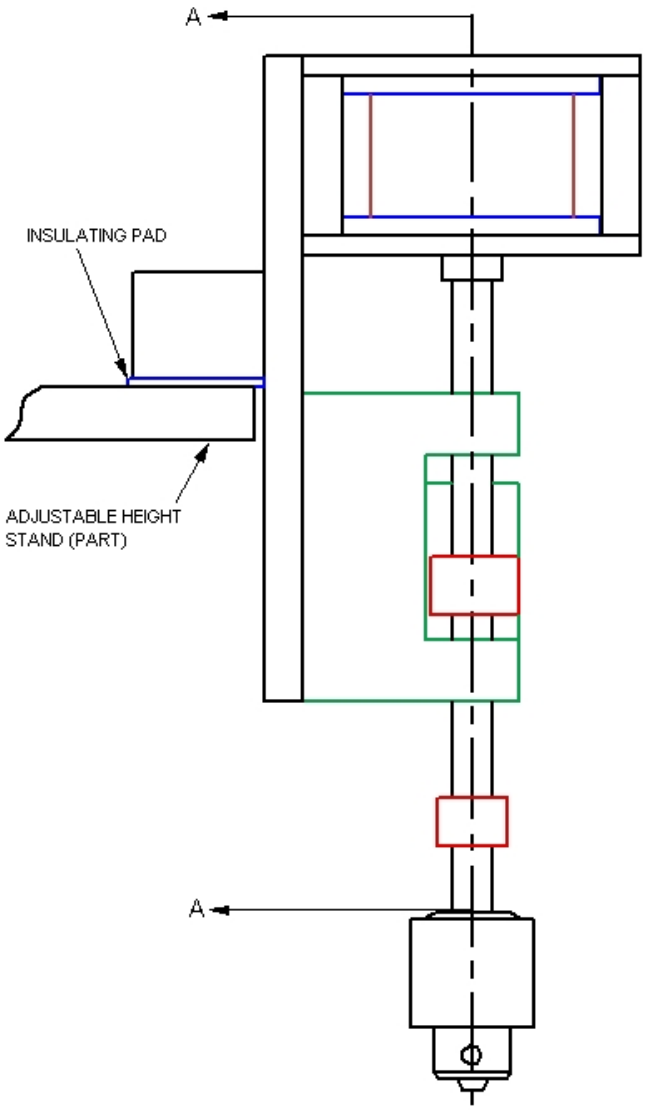
The electrical components are available from suppliers such as RS Components, and should not cost more than about £25 total. The 7 ohm resistors should be capable of dissipating 10 watts, so are likely to be wirewound types. Note that the discharge current from the discharge capacitor through the tool/workpiece is quite large, so wire cross-section should be at least 4 sq. mm.in this part of the circuit and terminals should be adequately sized. The cable to the tool must, of course, be flexible.

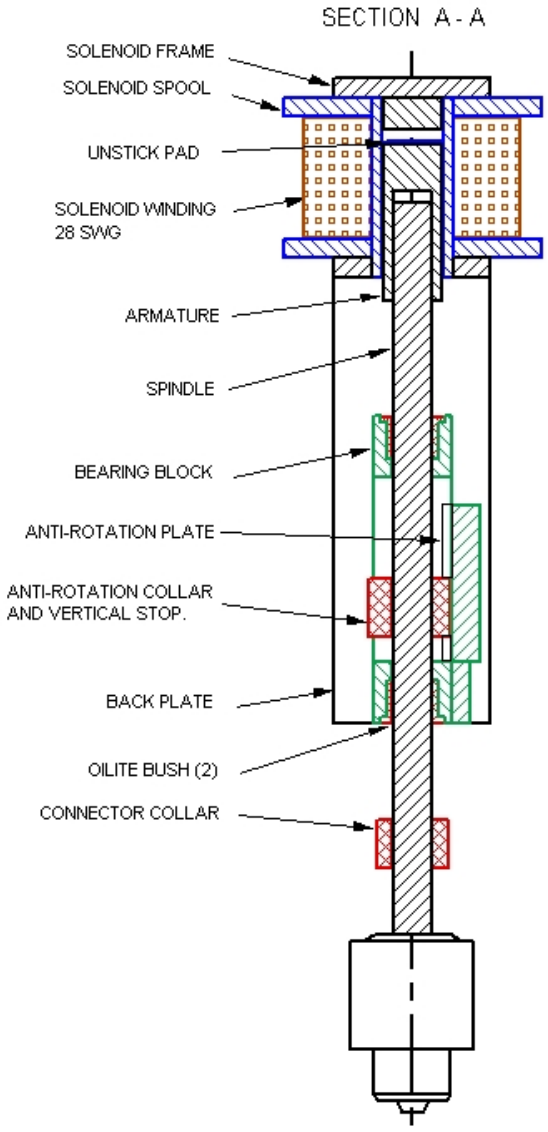
Operation

Tools are normally made from copper, but brass is also suitable. Hollow (tubular) tools are ideal as they minimise the amount of metal to be removed. Set the height of the solenoid/tool assembly initially so that the tool rests on the work with about 3 mm lift available before hitting the upper stop, then switch on. Repetition rate should be about 20 per second. If deep drilling is needed it will be necessary to lower the solenoid/tool periodically to maintain the lift height which affects the repetition rate.

Derek Lynas 2008

SPARK EROSION MACHINE GENERAL ASSEMBLY





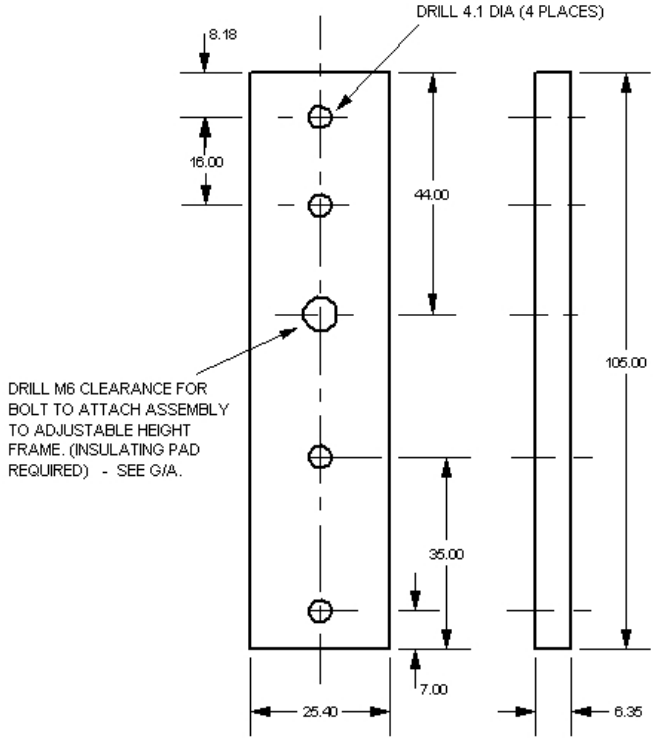
MATERIALS

- STEEL
- PLASTIC
- BRASS / BRONZE
- ALUMINIUM

BEARING BLOCK AND BACK PLATE

BACK PLATE

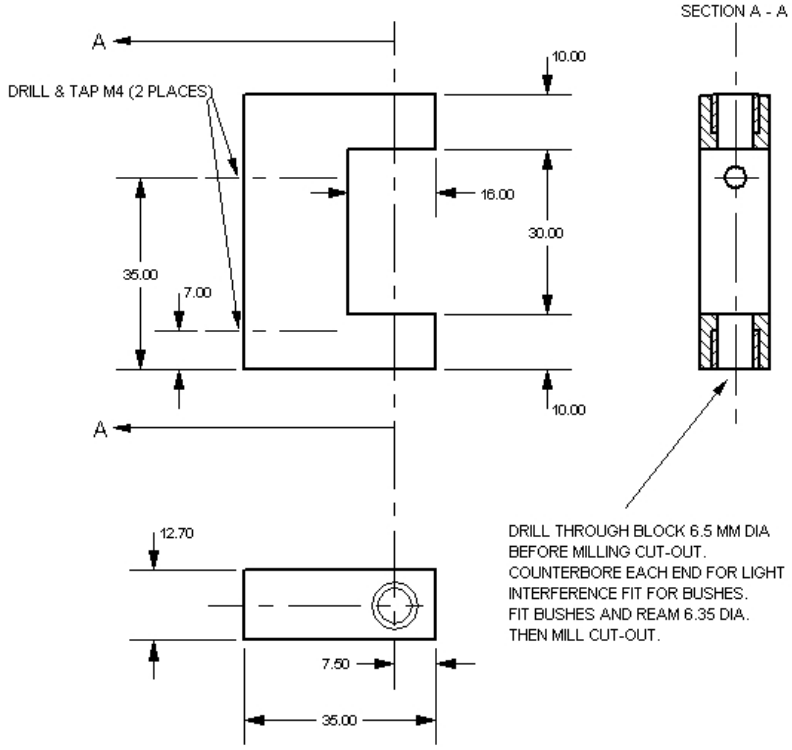
MATERIAL: BRIGHT MILD STEEL



BEARING BLOCK

MATERIAL: ALUMINIUM
BUSHES: BRONZE OR BRASS

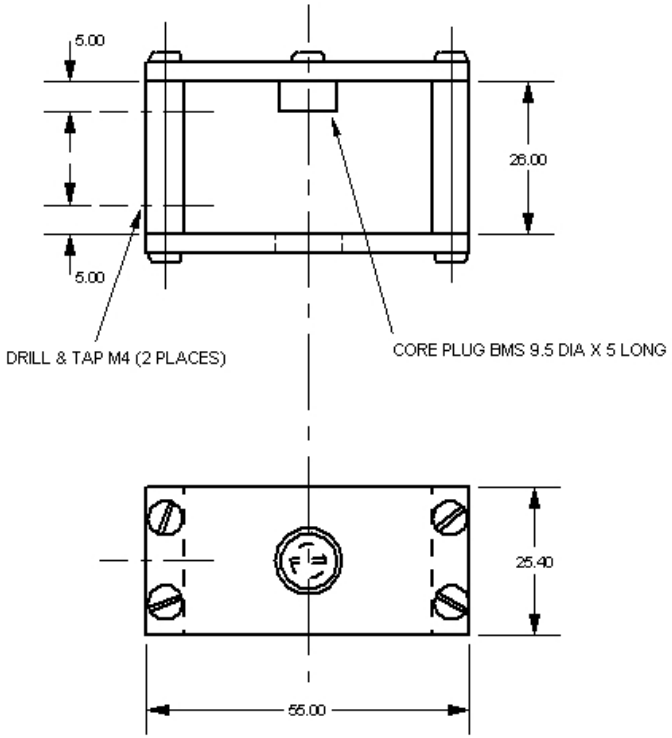
OR: MAKE FROM BRASS AND DO NOT FIT BUSHES



SOLENOID FRAME AND SPOOL

FRAME

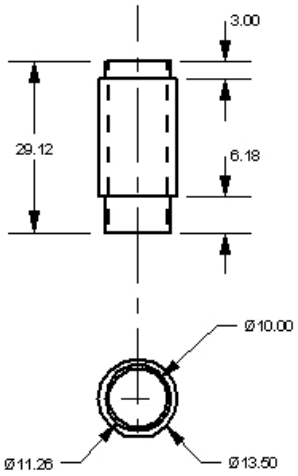
FABRICATE FROM BMS FLATS
TOP & BOTTOM 1" X 0.125"
ENDS 1" X 0.25"
USING M3 SCREWS



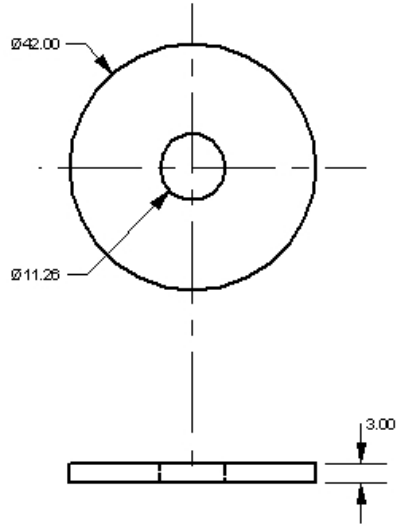
SPOOL

MATERIAL: TUFNOL OR PERSPEX

BARREL



FLANGE (2 OFF)

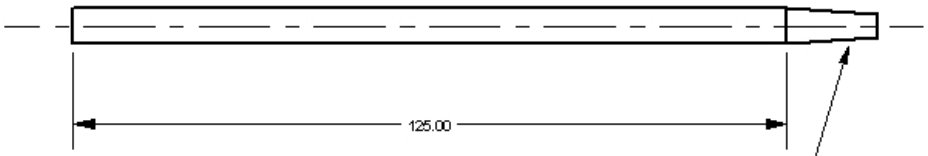


ASSEMBLE USING ARALDITE
WIND WITH 28 SWG ENAMELLED COPPER WIRE
TO A COIL O/D OF 35 MM. (APPROX. 1500 TURNS)

PARTS FOR SPINDLE ASSEMBLY

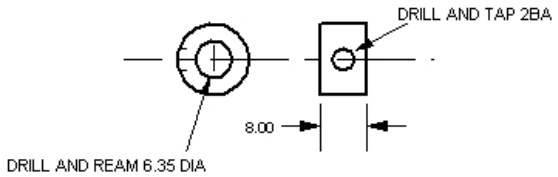
SPINDLE

MATERIAL: SILVER STEEL 6.35 DIA



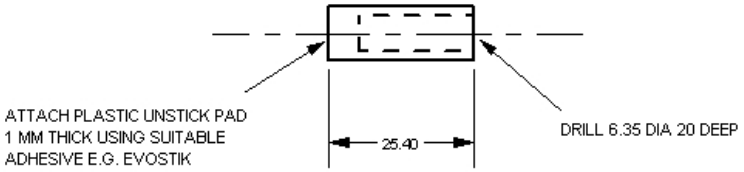
CONNECTION COLLAR

MATERIAL: BRASS 12.7 DIA



ARMATURE

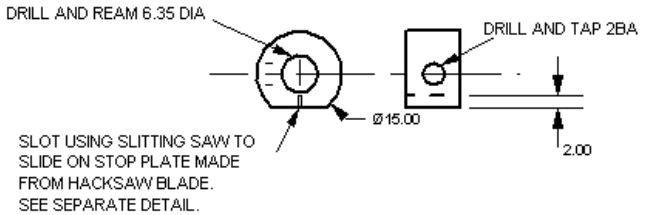
MATERIAL: BRIGHT MILD STEEL 9.5 DIA.



CLEAN BORE THEN PRESS ON TO PLAIN END
OF SPINDLE, USING LOCTITE TO SECURE.

ANTI-ROTATION COLLAR

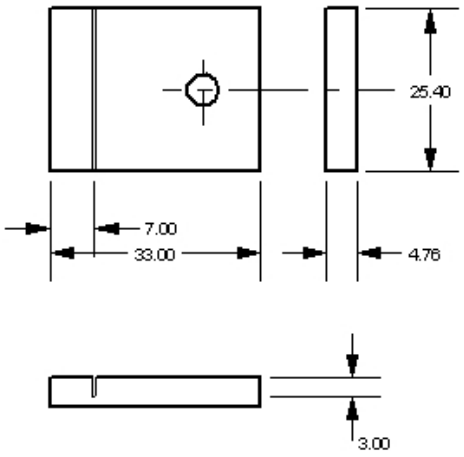
MATERIAL: BRASS



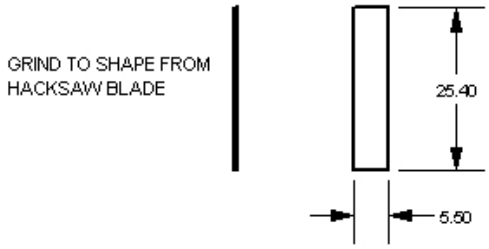
ANTI-ROTATION STOP DETAIL

STOP PLATE BLOCK (1)

MATERIAL: ALUMINIUM

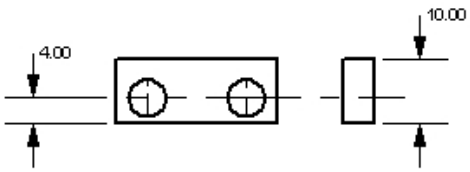


STOP PLATE (2)

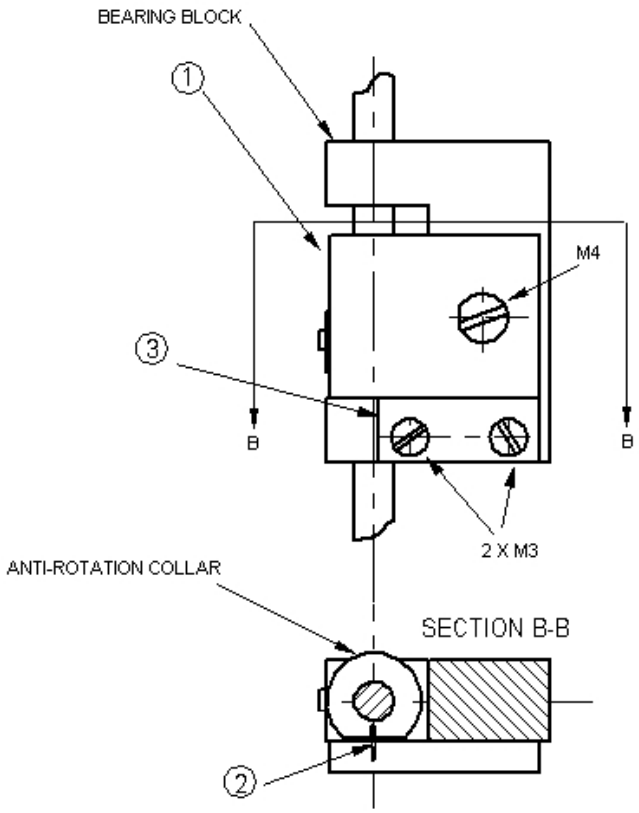


ALIGNMENT BLOCK (3)

MATERIAL: ALUMINIUM

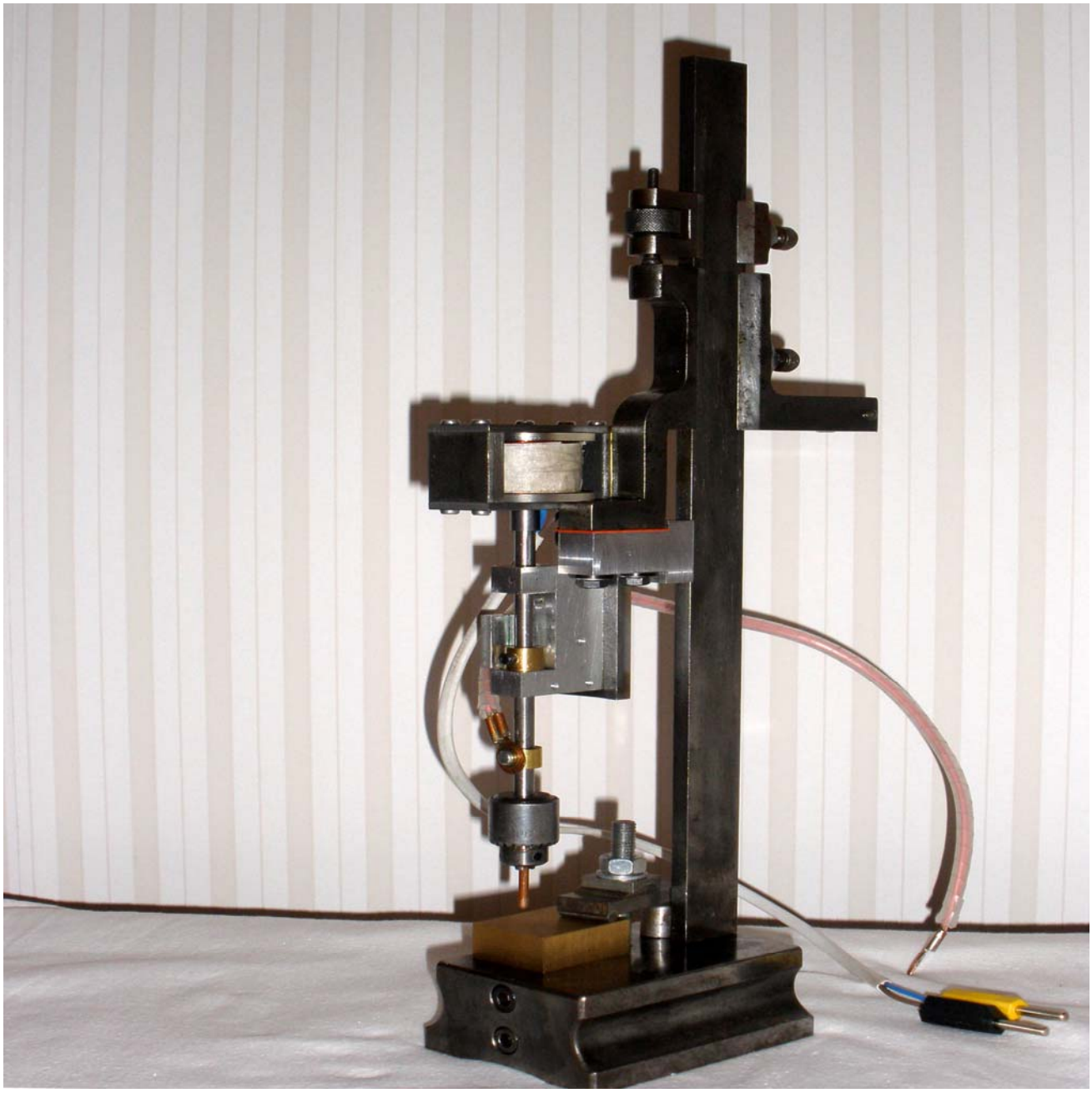


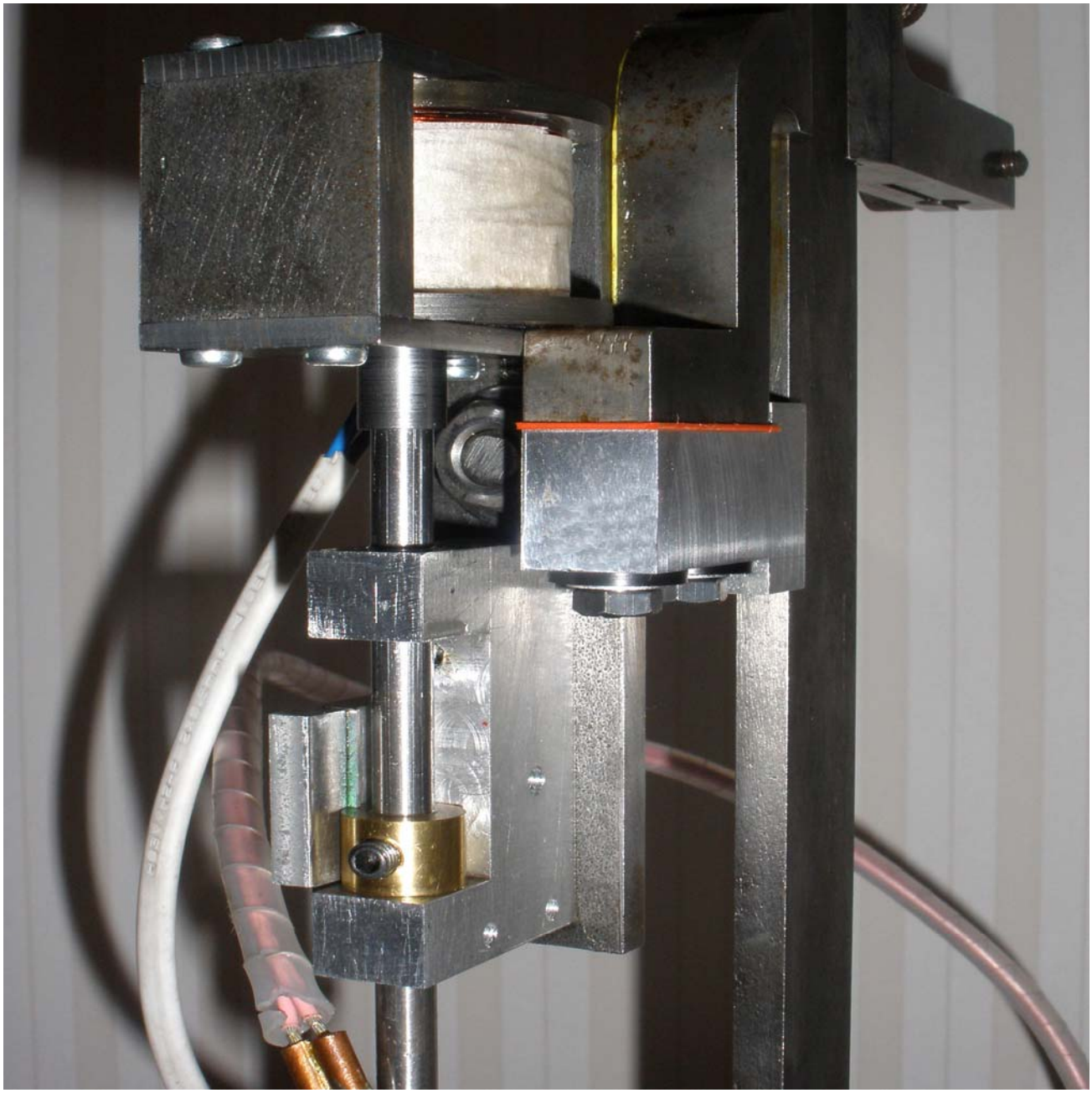
ASSEMBLY

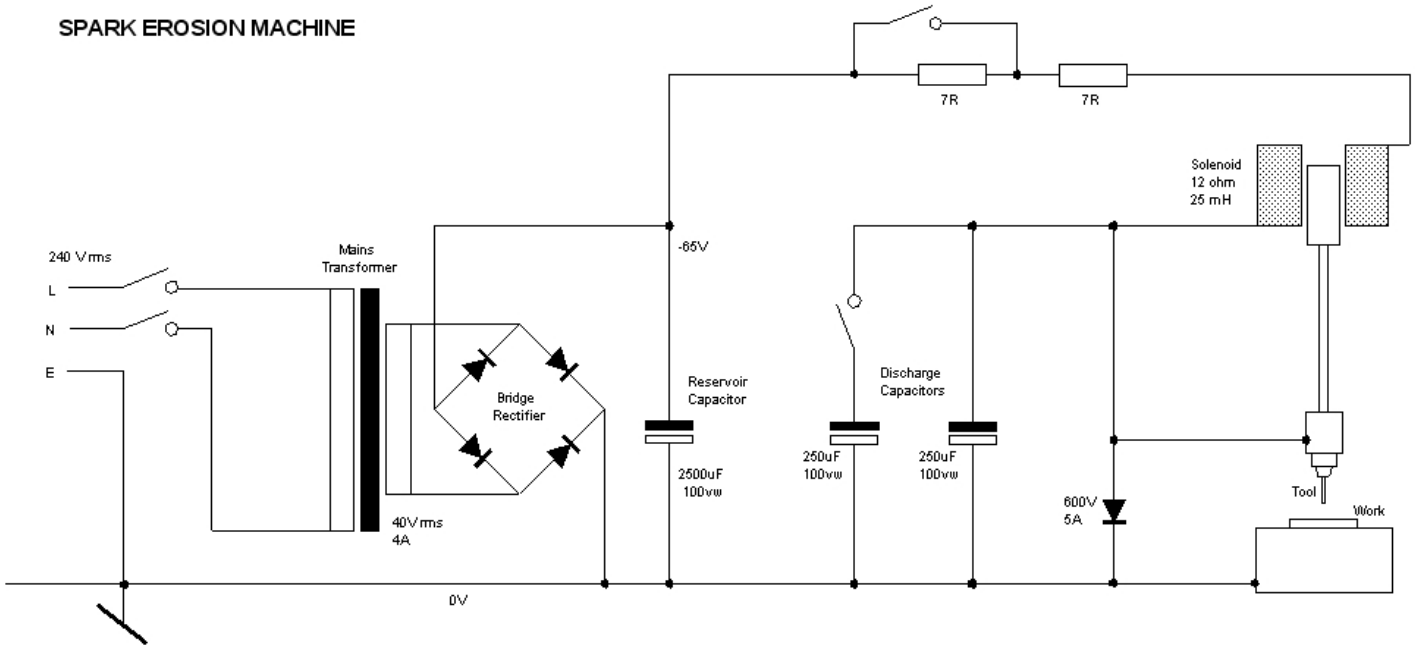


FIX STOP PLATE INTO STOP PLATE BLOCK USING ARALDITE. ENSURE SLOT IN ANTI-ROTATION COLLAR IS CLOSE SLIDING FIT OVER STOP PLATE.

DRILL SCREW CLEARANCE HOLES IN BLOCKS LARGE ENOUGH TO ALLOW POSITIONAL ADJUSTMENT.
FIT STOP BLOCK AND ALIGNMENT BLOCK LOOSELY TO BEARING BLOCK. THEN ADJUST ALIGNMENT BLOCK SO THAT ANTI-ROTATION COLLAR SLIDES FREELY ALONG STOP PLATE AND TIGHTEN ALIGNMENT BLOCK SCREWS.
THEN SLIDE STOP BLOCK TO ENSURE ALIGNMENT OF STOP PLATE AND ANTI-ROTATION COLLAR SLOT, AND TIGHTEN STOP BLOCK SCREW.







Operation

1. Assuming the discharge capacitor is fully charged, so current is zero, and the plunger/tool assembly is falling freely.

2. Breakdown occurs when the tool contacts the work, and the discharge capacitor discharges rapidly through the tool/work contact.

3. As the discharge capacitor voltage falls, current starts to flow from the reservoir capacitor through the resistor and solenoid.
   We have to assume that the arc resistance is much lower than that of the resistor and solenoid so that the capacitor discharges almost completely.

4. The recharge current through the resistor and solenoid generates a lift force, raising the plunger and tool, and breaking the arc path.
   The lift continues until the rising voltage on the discharge capacitor reduces the charging current below that required to support the plunger/tool assembly.
   The upward momentum of the plunger/tool assembly causes it to continue to rise until it eventually stops and then commences to fall freely.

5. Meanwhile the discharge capacitor continues to recharge over the slower part of its exponential rise to the voltage on the reservoir capacitor.
   This recharge current, whilst insufficient to support the assembly, does still affect its motion to some extent.

6. Eventually the plunger and tool fall far enough to re-establish tool - work contact, and the cycle repeats.

Note: Experience has shown that the switched 250uF capacitor and 7 ohm resistor are unnecessary and can be deleted.

Spark Eroder Main Electrical Components

Item	Description	Quantity	RS Part No.	Price, £
1.	Transformer, 50V, 50VA	1	504-329	9.60
2.	Bridge rectifier, 200V, 1.7A	1	261-491	1.05
3.	Reservoir capacitor, 2200 mfd	1	180-2122	5.41
4.	Discharge capacitor, 250 mfd	1	839-044	2.92
5.	Series resistor, 6R8, 15W	1	160-433	1.94
6.	Suppression diode, 100V, 1A	1	348-5397	0.06
7.	Switches and connectors			3.00

Approx. total cost £20.98