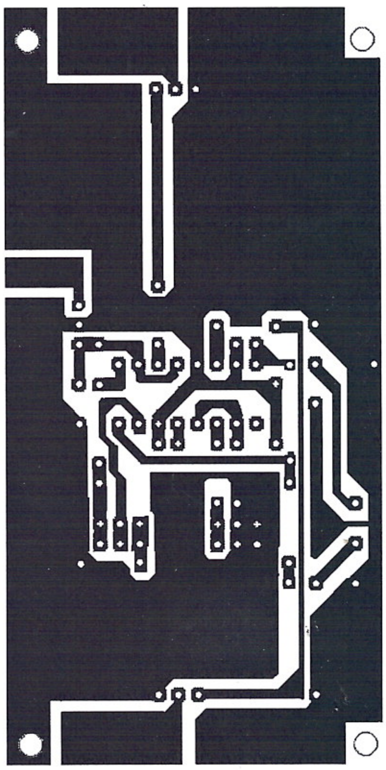
A L Z I C H T - S P E C T R U M

Talking Flames.			
1989 Version 1.1			
1.2			
2015 Version 2.0			

Reference numbers

A 6620-240 wit-weiss-blanc-blanco-white
A 6620-242 rood-rot-rouge-rojo-red
A 6620-244 geel-gelb-jaune-amarillo-yellow
A 6620-245 groen-grün-vert-verde-green
A 6620-246 blauw-blau-bleu-azúl-blue

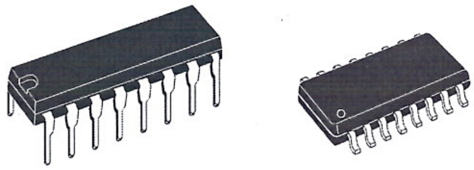


![ST logo]

SG2525A
SG3525A

REGULATING PULSE WIDTH MODULATORS

- 8 TO 35 V OPERATION
- 5.1 V REFERENCE TRIMMED TO ± 1 %
- 100 Hz TO 500 KHz OSCILLATOR RANGE
- SEPARATE OSCILLATOR SYNC TERMINAL
- ADJUSTABLE DEADTIME CONTROL
- INTERNAL SOFT-START
- PULSE-BY-PULSE SHUTDOWN
- INPUT UNDERVOLTAGE LOCKOUT WITH HYSTERESIS
- LATCHING PWM TO PREVENT MULTIPLE PULSES
- DUAL SOURCE/SINK OUTPUT DRIVERS

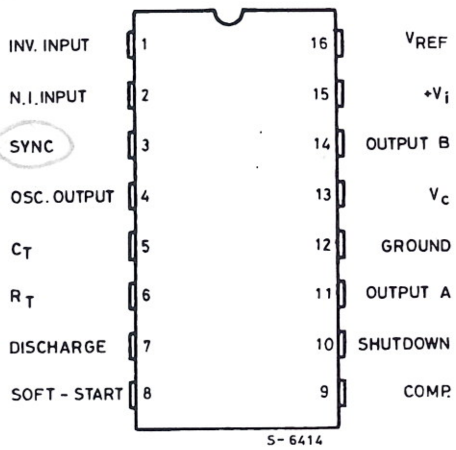


DIP16 16(Narrow)

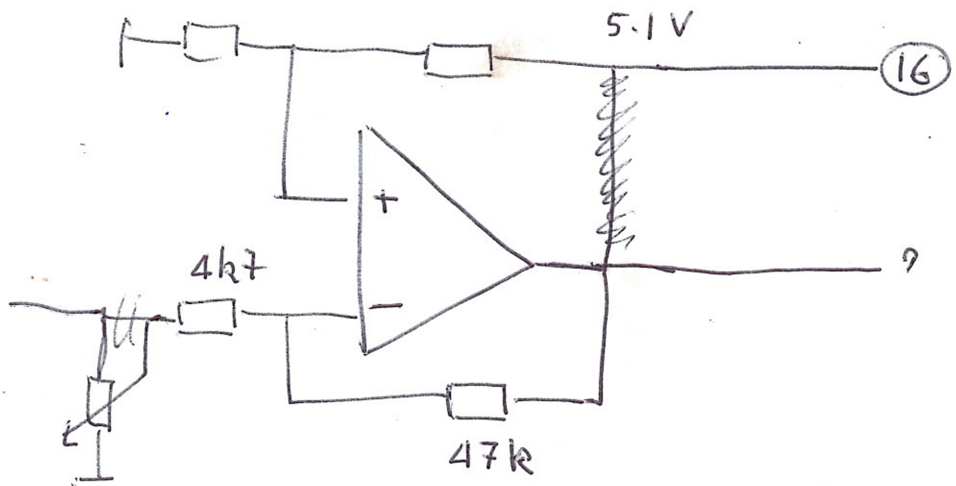
DESCRIPTION

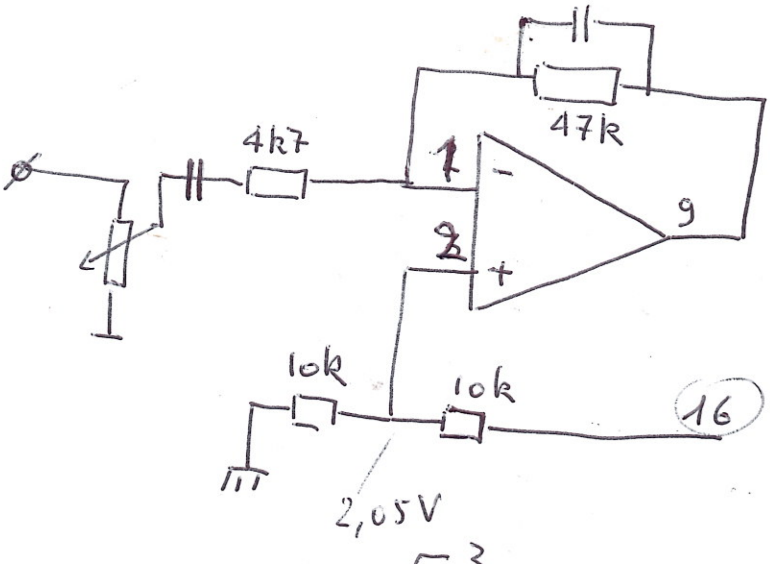
The SG3525A series of pulse width modulator integrated circuits are designed to offer improved performance and lowered external parts count when used in designing all types of switching power supplies. The on-chip + 5.1 V reference is trimmed to ± 1 % and the input common-mode range of the error amplifier includes the reference voltage eliminating external resistors. A sync input to the oscillator allows multiple units to be slaved or a single unit to be synchronized to an external system clock. A single resistor between the C_T and the discharge terminals provide a wide range of dead time ad- justment. These devices also feature built-in soft-start circuitry with only an external timing capacitor required. A shutdown terminal controls both the soft-start circuity and the output stages, providing instantaneous turn off through the PWM latch with pulsed shutdown, as well as soft-start recycle with longer shutdown commands. These functions are also controlled by an undervoltage lockout which keeps the outputs off and the soft-start capacitor discharged for sub-normal input voltages. This lockout circuitry includes approximately 500 mV of hysteresis for jitter-free operation. Another feature of these PWM circuits is a latch following the comparator. Once a PWM pulses has been terminated for any reason, the outputs will remain off for the duration of the period. The latch is reset with each clock pulse. The output stages are totem-pole designs capable of sourcing or sinking in excess of 200 mA. The SG3525A output stage features NOR logic, giving a LOW output for an OFF state.

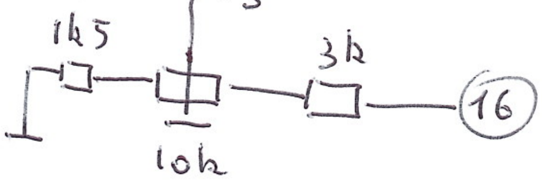
PIN CONNECTIONS AND ORDERING NUMBERS (top view)

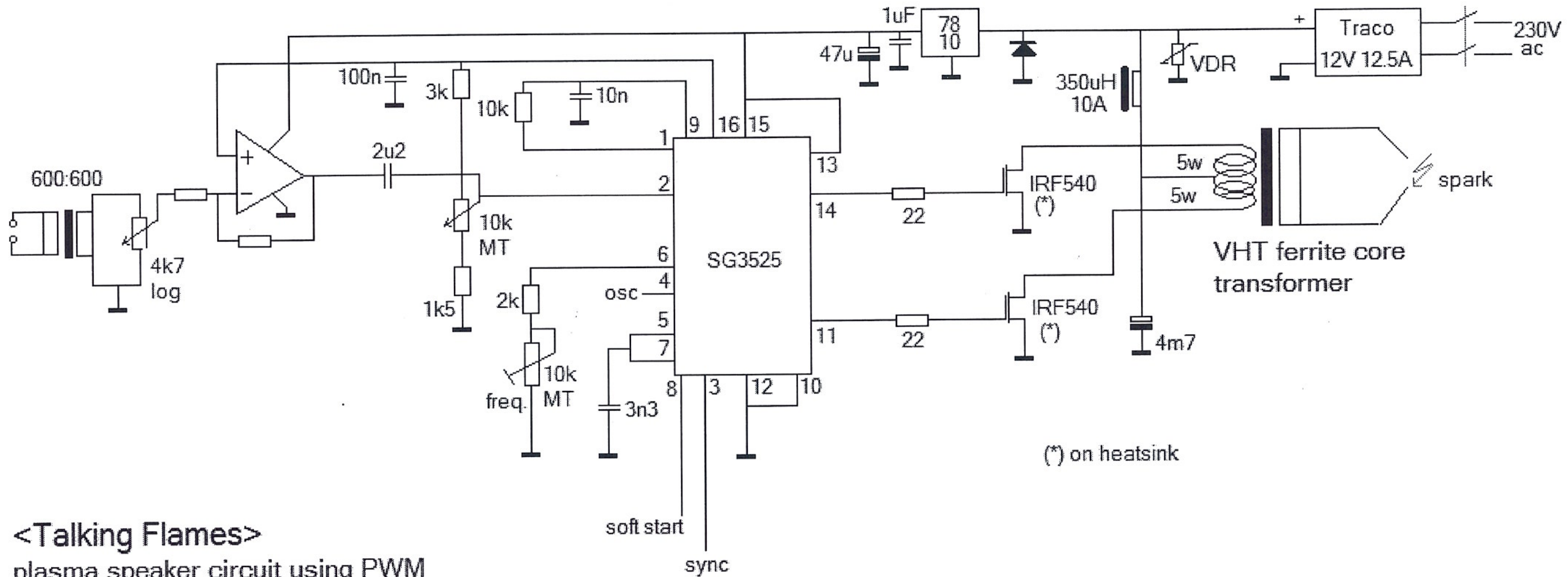


Type	Plastic DIP	SO16
SG2525A	SG2525AN	SG2525AP
SG3525A	SG3525AN	SG3525AP


5.1V
16
+
4k7
−
47k
7


47k
4k7
1
−
2
+
9
10k
10k
16
2,05V

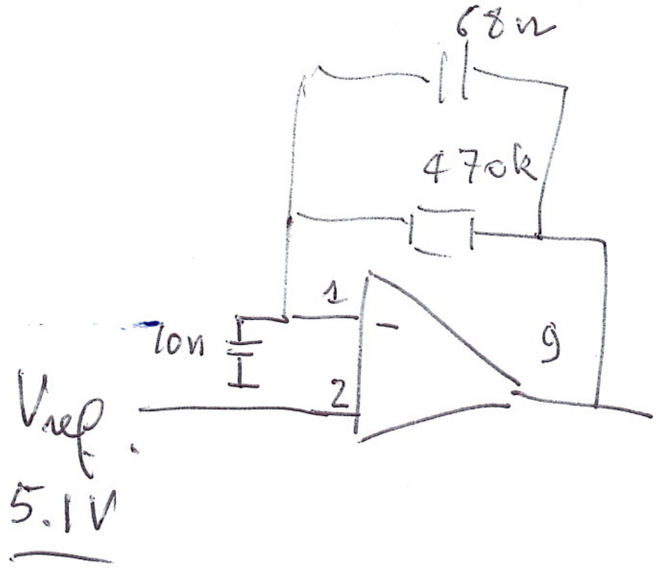

3
1k5
3k
16
10k

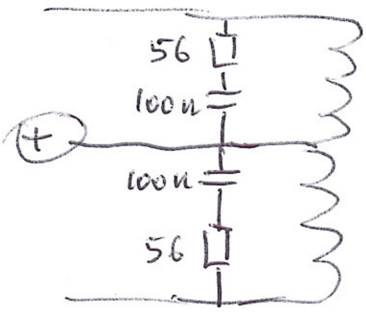


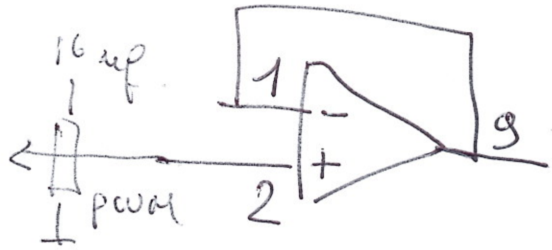
<Talking Flames>

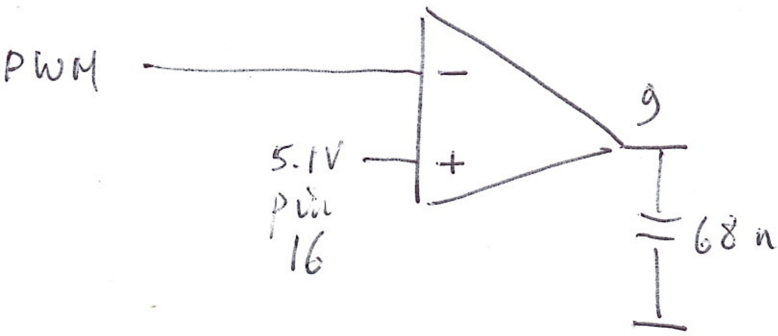
plasma speaker circuit using PWM

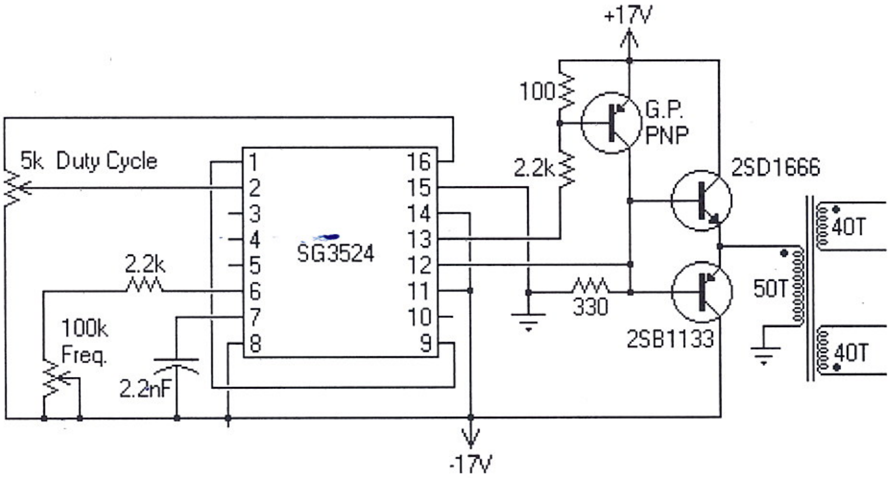
last revision: 05.11.2015


68n
470k
1
10n
9
2
Vref
5.1V


56
100n
+
100n
56


16 uF
1
9
PWM
2

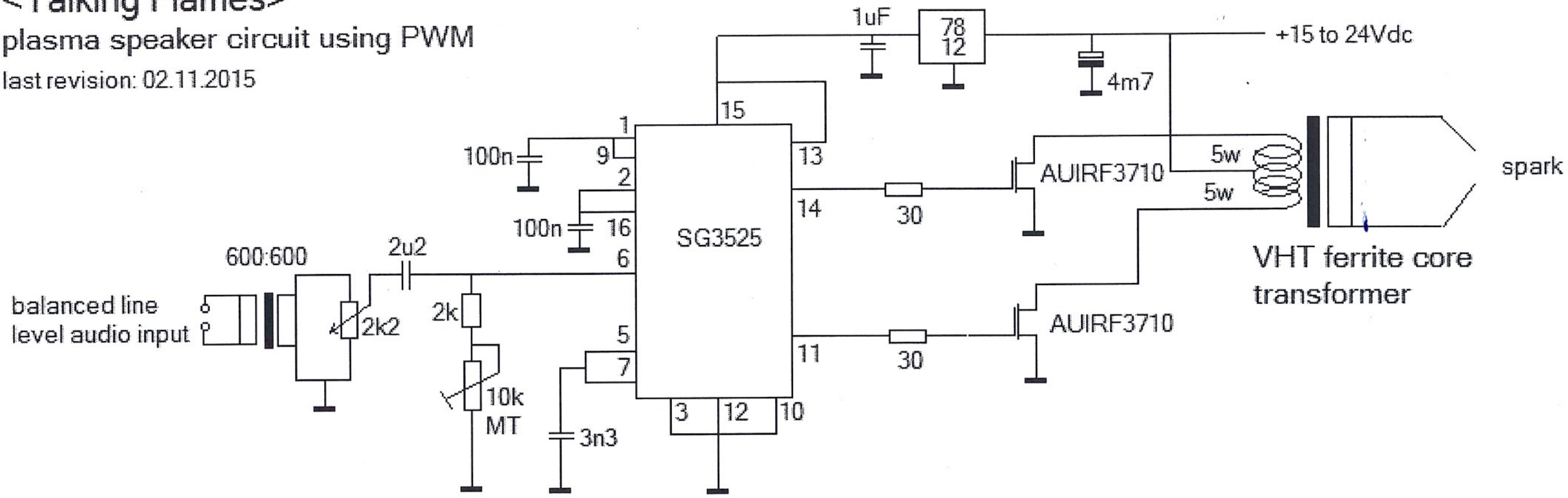

PWM
9
5.1V
pin
16
68n


+17V
100
G.P.
PNP
2.2k
2SD1666
5k Duty Cycle
1
2
3
4
5
6
7
8
16
15
14
13
12
11
10
9
SG3524
2.2k
330
2SB1133
40T
50T
40T
100k
Freq.
2.2nF
-17V

<Talking Flames>

plasma speaker circuit using PWM

last revision: 02.11.2015



TRACO POWER

INSTALLATION INSTRUCTIONS

TXL 100/150 Series Switching Power Supply

Order Code	AC-Input Voltage Range	Output Power max.	* DC-Output 1	DC-Output 2	DC-Output 3	Recommended Circuit breaker
TXL 100-3.3S	88 – 264VAC Universal Input	87.5 Watt	3.3V / 25.0A			10A (Characteristic C)
TXL 100-05S		100 Watt	5.0V / 20.0A			
TXL 100-12S		100 Watt	12.0V / 8.5A			
TXL 100-15S		100 Watt	15.0V / 6.8A			
TXL 100-24S		100 Watt	24.0V / 4.5A			
TXL 100-48S		100 Watt	48.0V / 2.1A			
TXL 100-0512D		100 Watt	+5.0V / 12.0A	+12.0V / 5.0A		
TXL 100-0524D		100 Watt	+5.0V / 10.0A	+24.0V / 3.0A		
TXL 100-0521T		100 Watt	+5.0V / 12.0A	+12.0V / 5.0A	-5.0V / 1.5A	
TXL 100-0522T		100 Watt	+5.0V / 12.0A	+12.0V / 5.0A	-12.0V / 1.5A	
TXL 100-0533T		100 Watt	+5.0V / 12.0A	+15.0V / 3.0A	-15.0V / 1.5A	
TXL 100-0534T		100 Watt	+5.0V / 12.0A	+12.0V / 3.0A	+24.0V / 2.0A	
TXL 150-12S		150 Watt	12.0V / 12.5A			
TXL 150-24S		150 Watt	24.0V / 6.3A			
TXL 150-48S		150 Watt	48.0V / 3.2A			

* Output 1 adjustable by potentiometer with a screwdriver.

Total output power must not exceed specified max output power.

Input current:	@ Vin=115VAC	@ Vin=230VAC	Power Consumption	@ Vin=115VAC	@ Vin=230VAC
➢ TXL 100	1.65A typ.	0.95A typ.	➢ TXL 100	135 Watt typ.	130 Watt typ.
➢ TXL 150	2.10A typ.	1.10A typ.	➢ TXL 150	190 Watt typ.	180 Watt typ.

Output Voltage Adjustment range: (Only single output models)	±10%
Operating temperature range: Natural Air Convection Cooling	-10°C – +70°C max -13°F – +158°F max
Output Power Derating:	above +45°C → 2 %/K (TXL 100-xx Power Supplies) above +50°C → 2.5 %/K (TXL 150-xx Power Supplies) above 113°F → 2 %/K (TXL 100-xx Power Supplies) above 122°F → 2.5 %/K (TXL 100-xx Power Supplies)
Storage temperature range: Non operating	-10°C – +75°C max -13°F – +167°F max
Connections:	Screw type terminal COMBICON. Recommended tightening torque 0.5 to 0.7Nm (4.5 to 6.2lb.in.)
Terminal for wiring:	Y or Ring shape recommended (max. diameter = 8.0mm)
Case material:	Aluminium base and nickel plated steel cover
Mounting inserts:	M3 x P0.5 7 different places; 3 on the side and 4 on the bottom.

TRACO POWER

Safety Instructions:

- Before installation read these instructions carefully and completely. This installation instruction cannot account for every possible condition of installation, operation or maintenance. Further information can be obtained from your local distributor's office or from the product data sheet, which can be downloaded, from the Internet at www.tracopower.com/products/txl.pdf.
- The power supplies are constructed in accordance with the safety requirements of IEC/EN60950 and UL 1950. They fulfil the requirements for CE-compatibility and carries the CE mark. They are UL and cUL approved.
- Before any installation, maintenance or modification work ensure that the main switch is switched off and prevented from being switched on again. Non-observance, touching of any live components or improper handling of this power supply can result in death, severe personal injury or substantial property damage. Proper and safe operation is dependent on proper storage, handling, installation and operation.
- Compliance with the relevant national regulations (in the USA, Europe and other countries) must be ensured. Before operation is started the following conditions must be ensured:
  - Connection to mains supply in compliance with national regulations (VDE0100 and EN50178).
  - By use of stranded wires, all strands must be fastened in the terminal blocks. (Potential danger of contact with the case)
  - Power supply and mains cables must be sufficiently fused.
  - The non-fused protective earth connection must be connected to the FG terminal (Protection class I).
  - All output wires must be rated for the power supply output current and must be connected with the correct polarity.
  - Sufficient cooling must be ensured.
- ***Never work on the power supply if power is supplied!*** Risk of electric arcs and electrical shock, which can cause death, severe personal injury or substantial property damage.
- **Warning:** Hazardous voltages and components storing a very substantial amount of energy are present in this power supply during normal operating conditions. However, these are inaccessible. Improper handling may result in an electric shock or serious burns!

  Do not open the power supply until at least 5 minutes after it has been disconnected from the mains on all poles.
  - Only trained personnel may open the power supply.
  - Do not introduce any objects into the power supply. The output voltage adjustment potentiometer may only be actuated using an insulated screwdriver.
  - Keep away from fire and water

Installation Instructions:

- This power supply is designed for professional indoor systems. In operation the power supply must not be accessible. It may be installed and put into service by qualified personnel only.
- Do not operate without PE connection! To comply with EMC and safety standards (CE mark, approvals) the power supply must be operated only if PE terminal is connected to the non-fused earth conductor.
- The correct mounting position for optimal cooling performance must be observed. ***Do not cover any ventilation holes.*** Leave a fee space of minimum 50mm (2in.) above and on the sides of the power supply. Observe power derating. (see our TXL data sheet)
- The internal fuse is not accessible, as it may not be replaced by the user. If this internal fuse has blown, the power supply has an internal defect and, for safety reasons, must be shipped to the local distributor. In case this internal fuse has to be replaced in the field, replace only with same type and rating of fuse for continued protection against risk of fire.
- ***Recycling:*** The unit contains elements that are suitable for recycling, and components that need special disposal. You are therefore requested to make sure that the power supply will be recycled environment friendly at the end of its service life.

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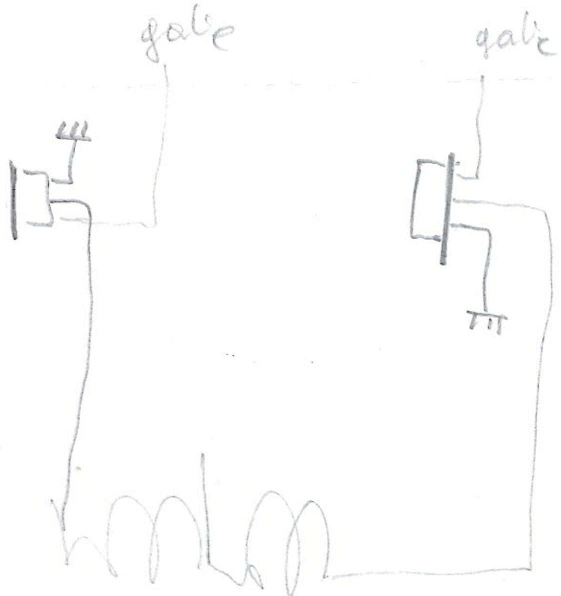
Plasma Speaker 3

pcb : 02.11.2015
PCB_Plasma3.gif

sch : talking_flames_002.gif

IRLR 2905 ⇒ V_{GS} : <2V !

IPB072N15N3



Δ 13022,57

1706 02/11 +8 € Gelt

1708 ✓ F1522

1710 03/11 -250 €

Σ 12772,57

Onkost

Hoogspanningskoskaak 20 €
Neon transfo's . 2 50 €

IRFP250 — TO 247
200 V
$R_{ds\,on}$ 0,085 Ω
I_D 30A
86 ns

IRF540 — TO220 150W
100 V
$R_{ds\,on}$ 0,077
I_D 28A
53 ns

Mosfets:

(also used in <Fa> and <Aeio>)

AUIRF3710

$V_{ds} = 100V$

$R_{ds} = 18m\Omega$ 160W

$I_D = 59A$

[10V gate

77ns

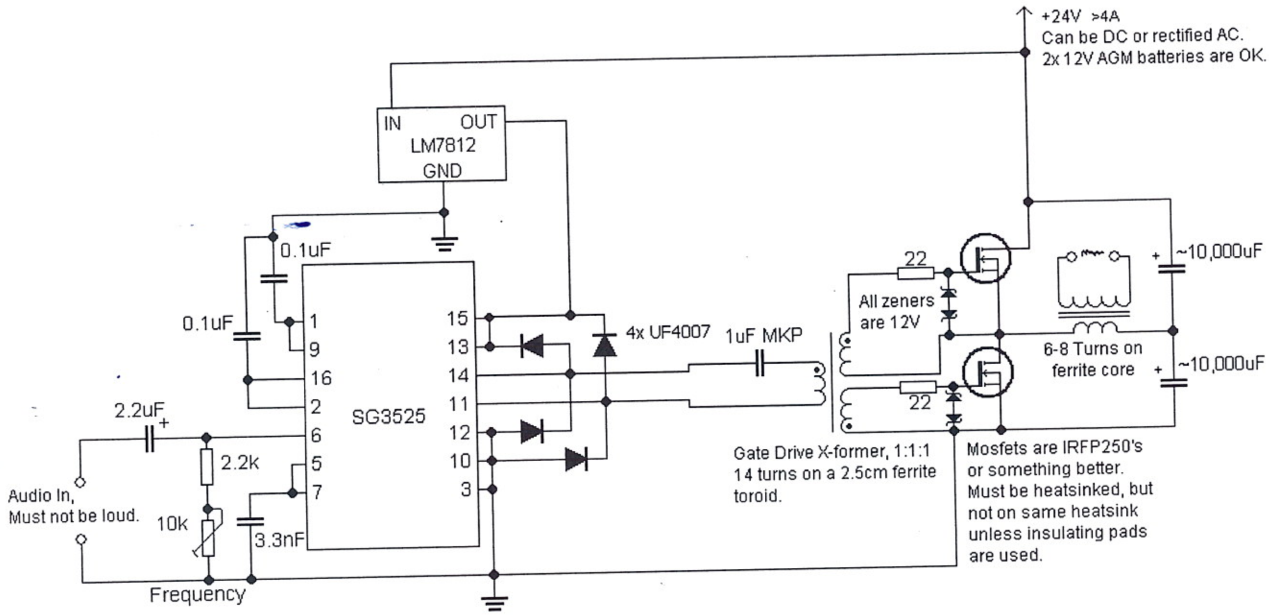
IRF1310N

$V_{ds} = 100V$

$R_{ds} = 36m\Omega$

$I_D = 42A$ 160W

56ns



http://teravolt.org/Plasma_Speaker_2.htm

Δ = 19795,77

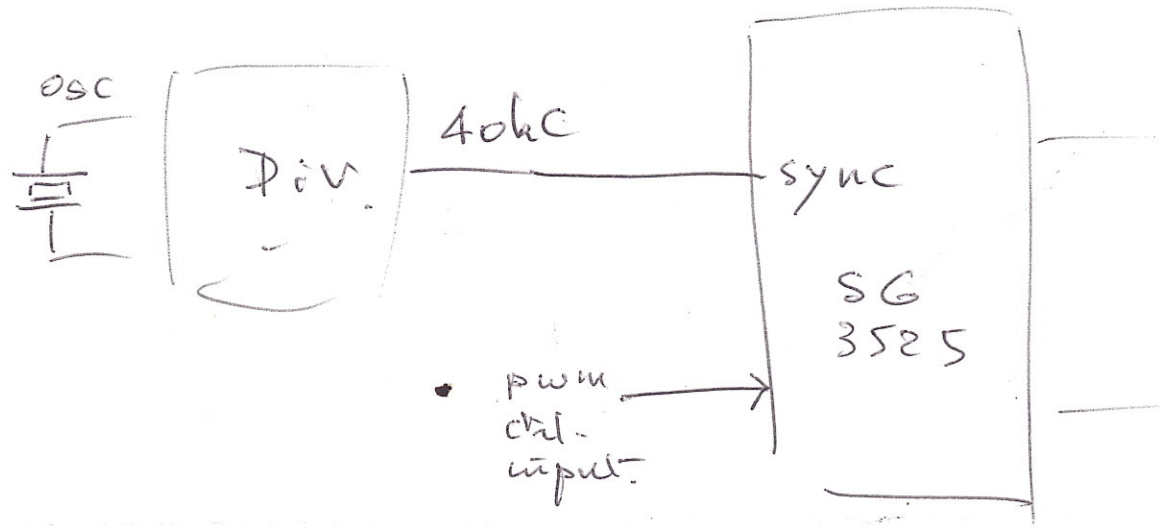
δ = 13347,29

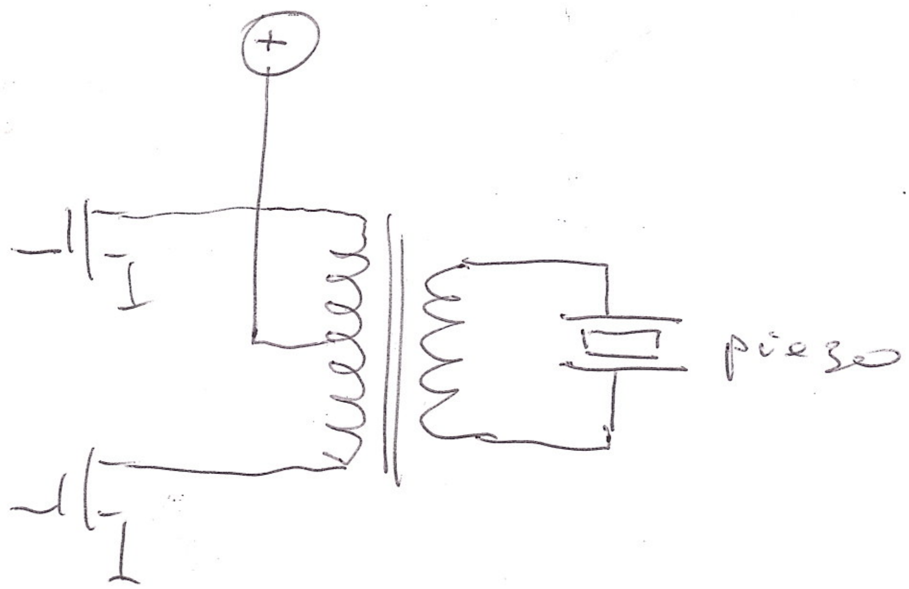
δ = 13259,29

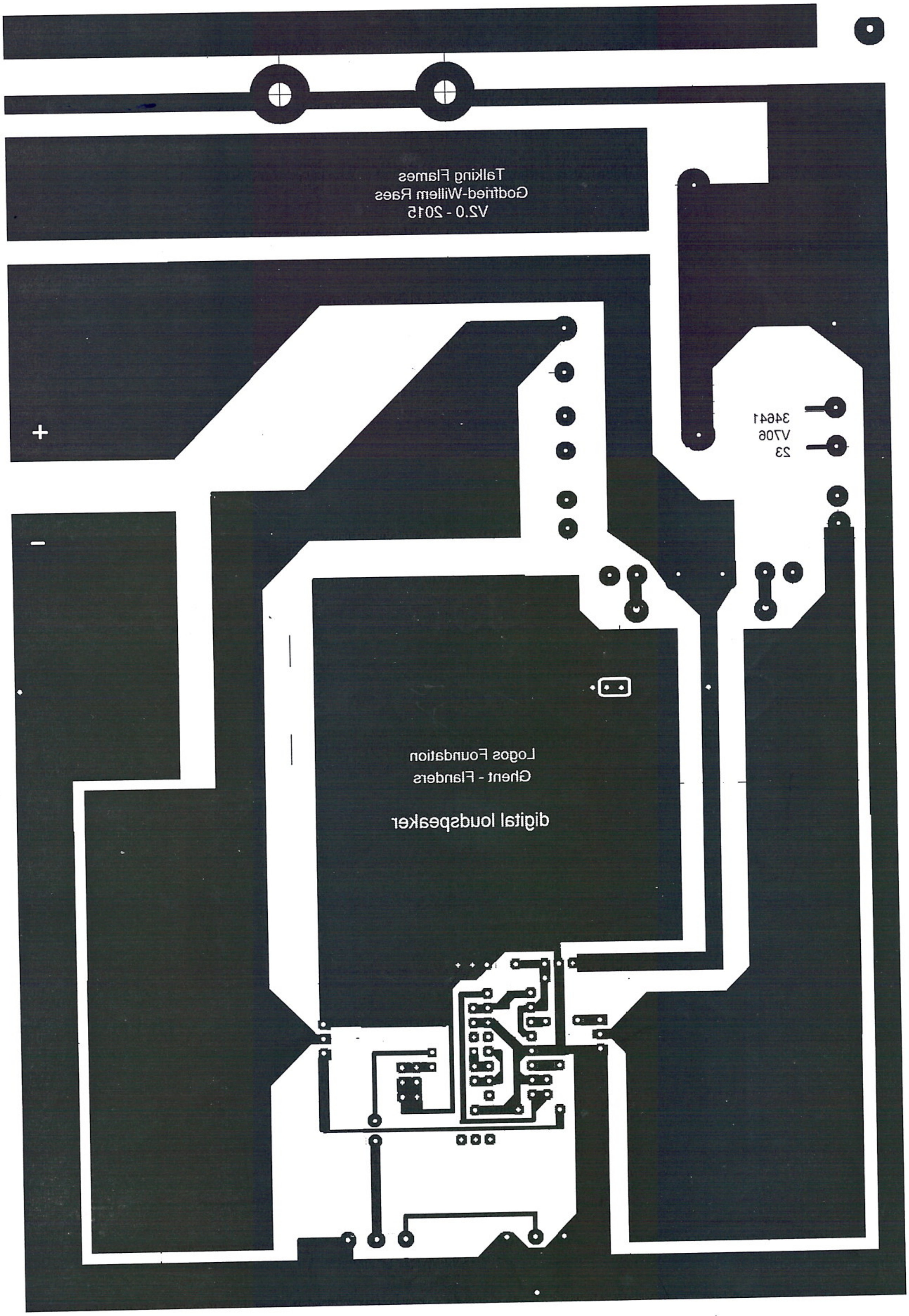
δ = 13014,57

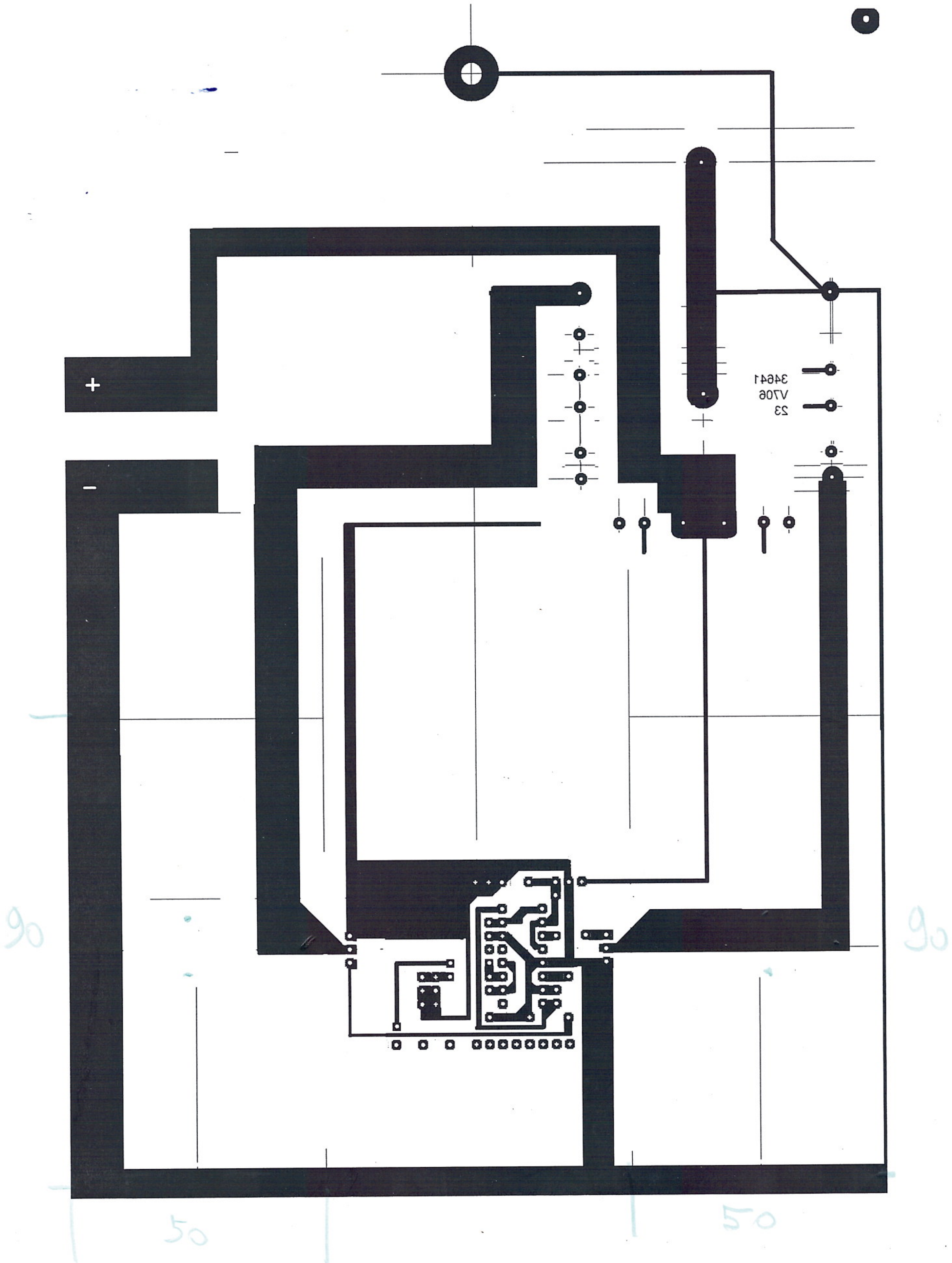
EP31

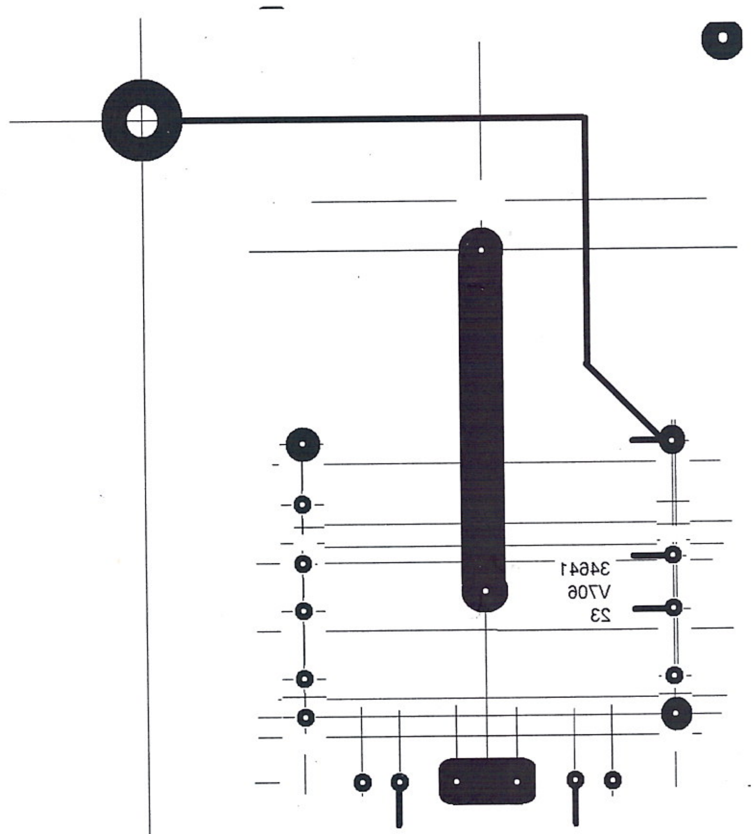
40kc PWM generator.





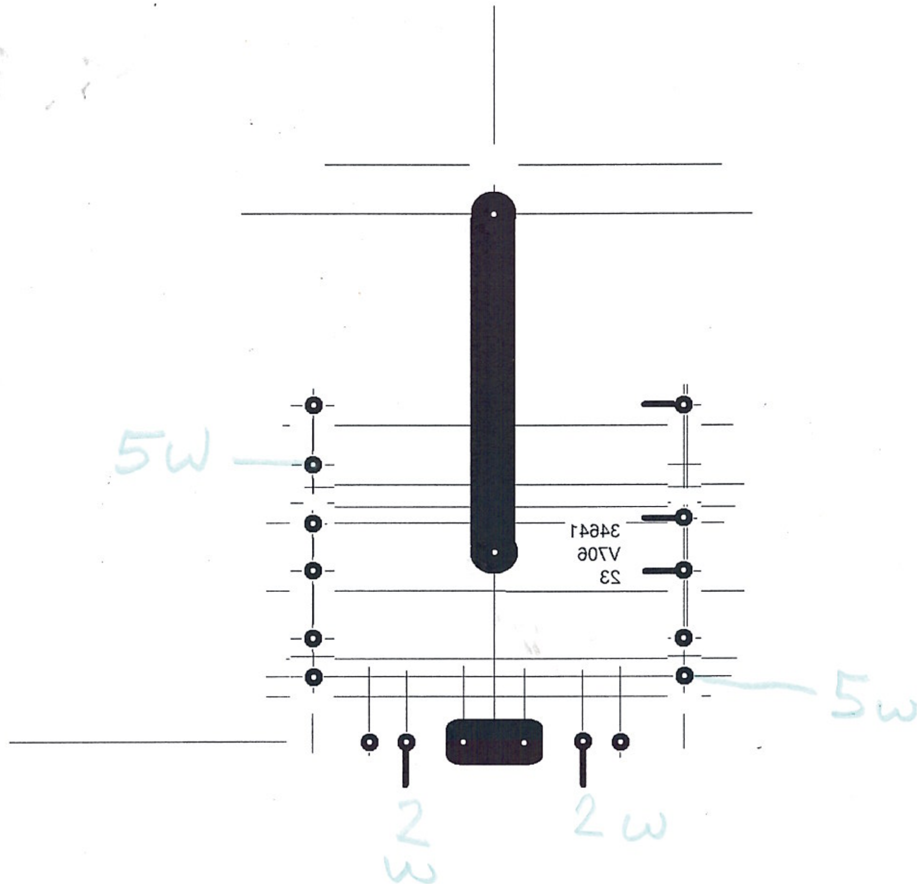

Talking Flames
Godfried-Willem Raes
V2.0 - 2015
+
-
Logos Foundation
Ghent - Flanders
digital loudspeaker


+
−
90
90
50
50

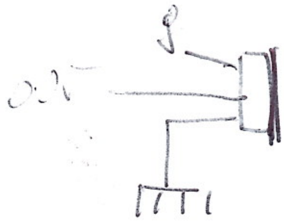


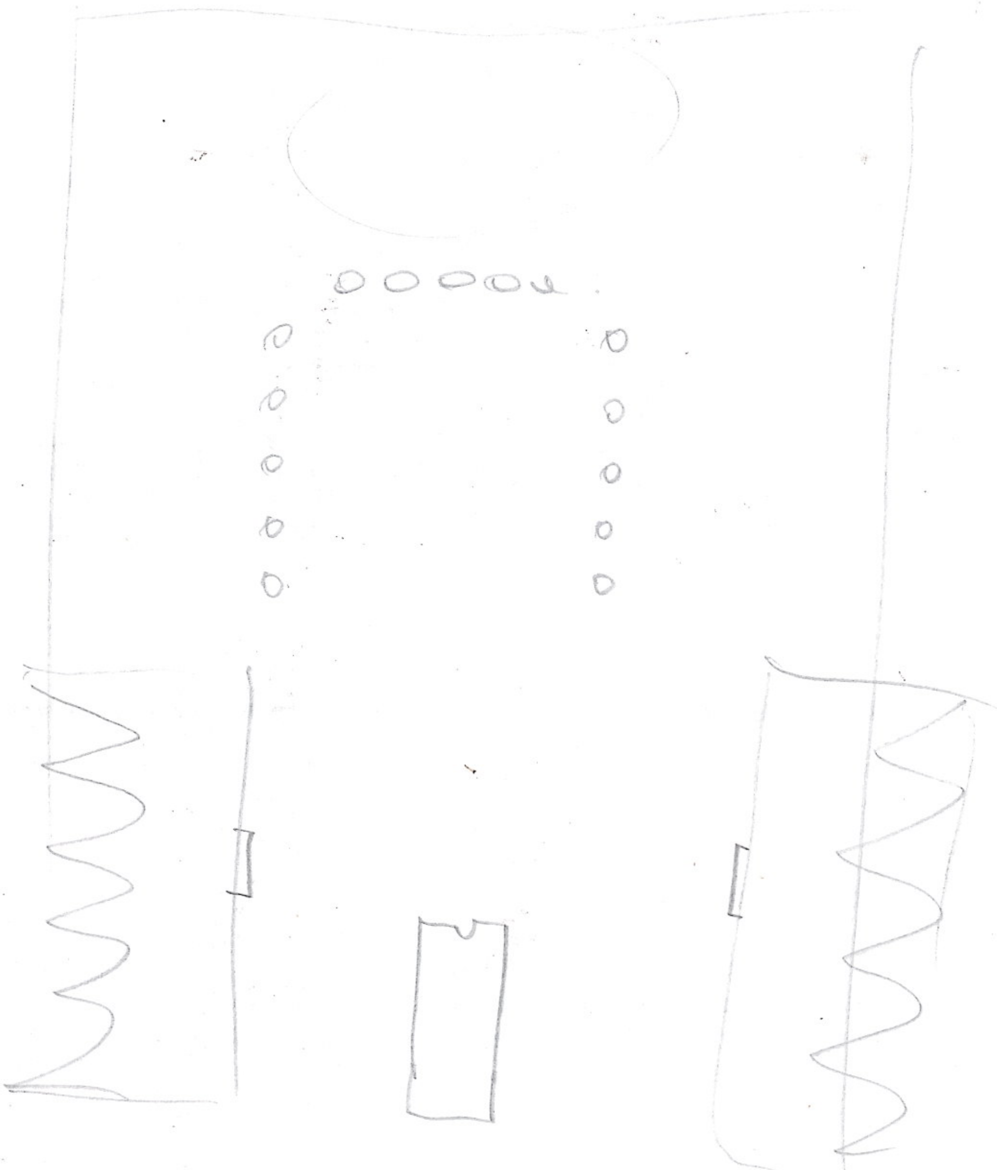
100 x 220

233 x 160



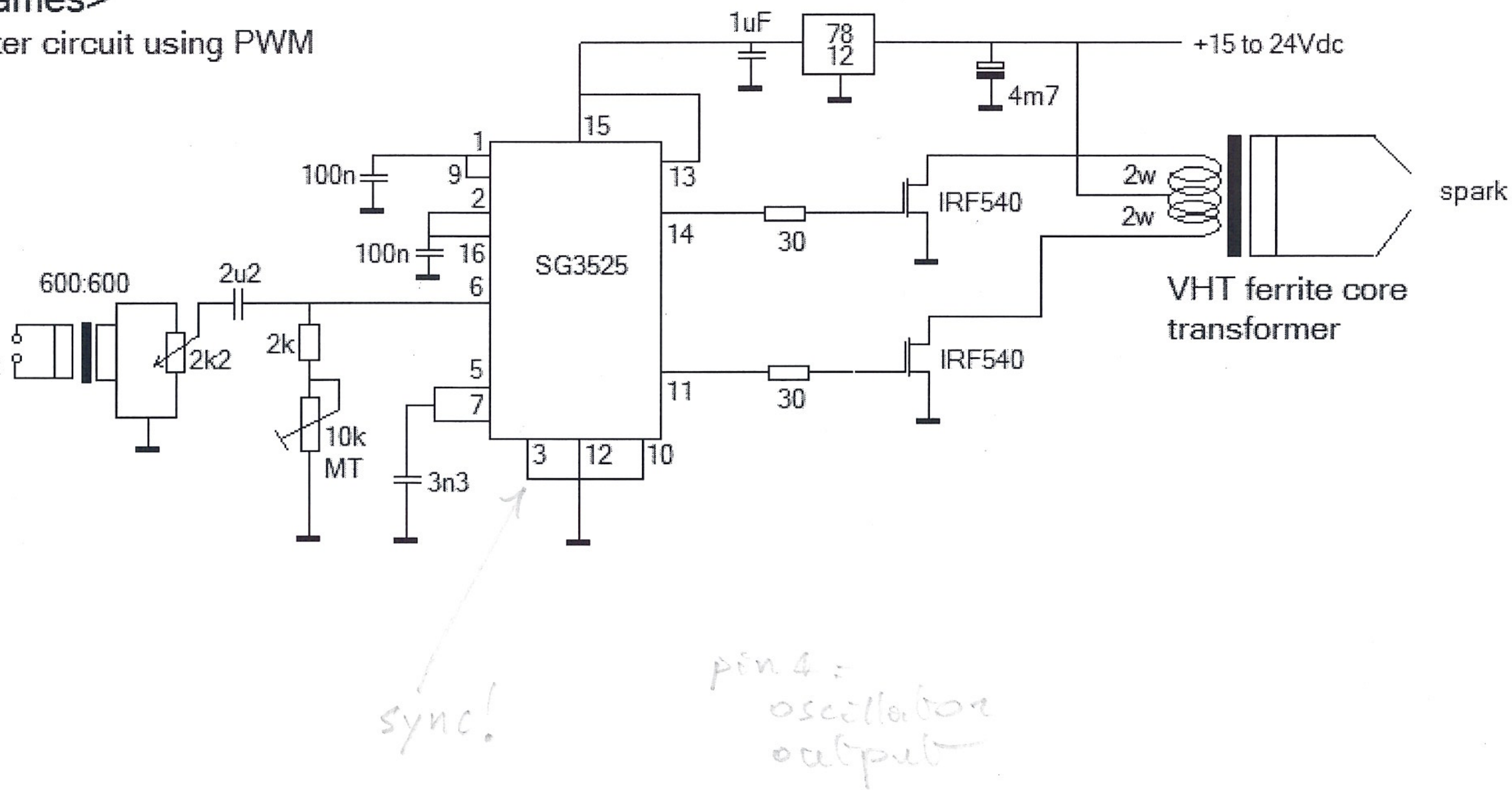
$\frac{12,4}{20} = x$

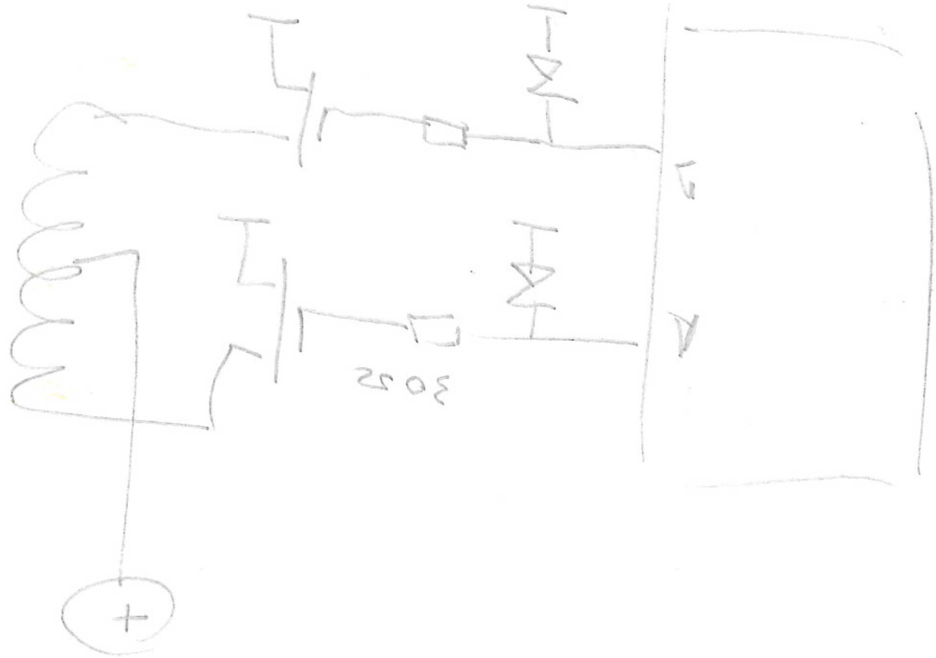


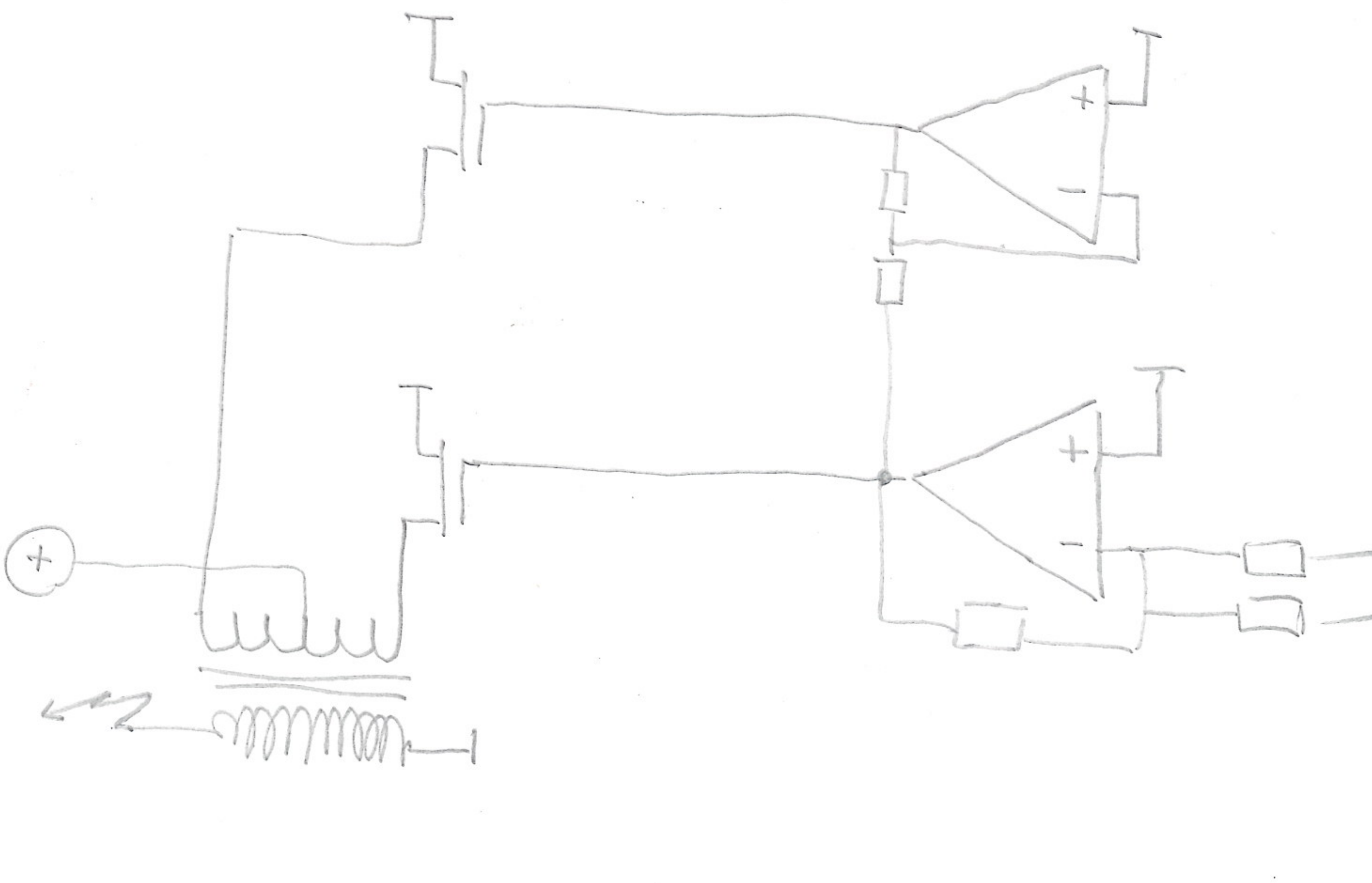


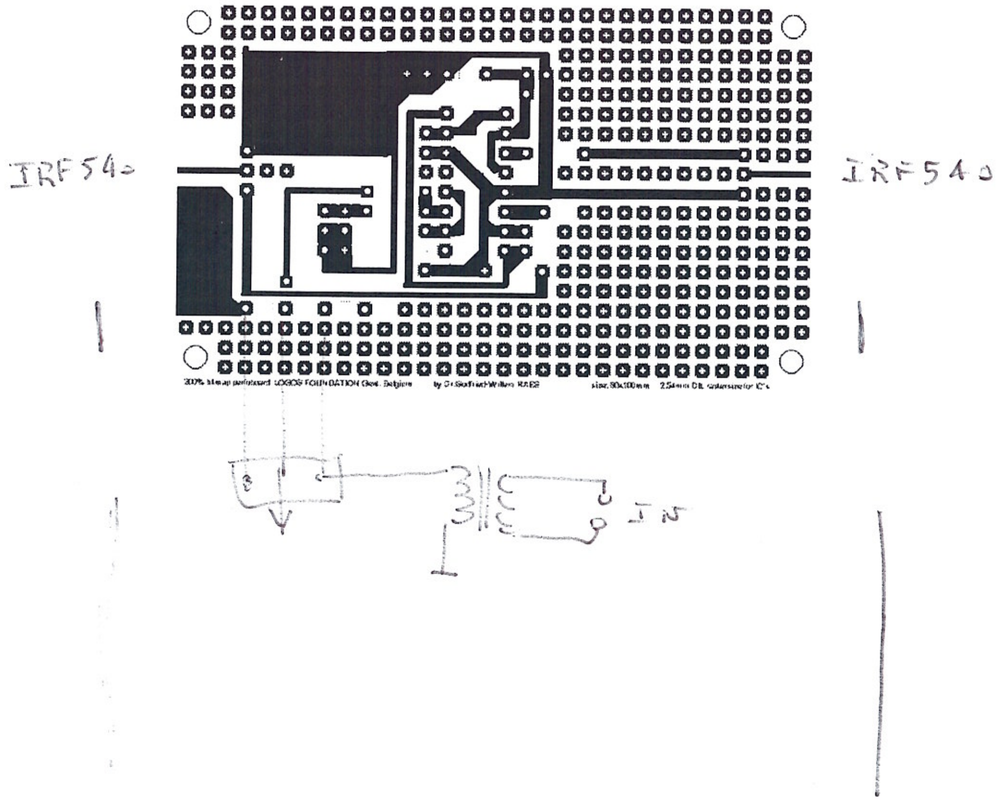
<Talking Flames>

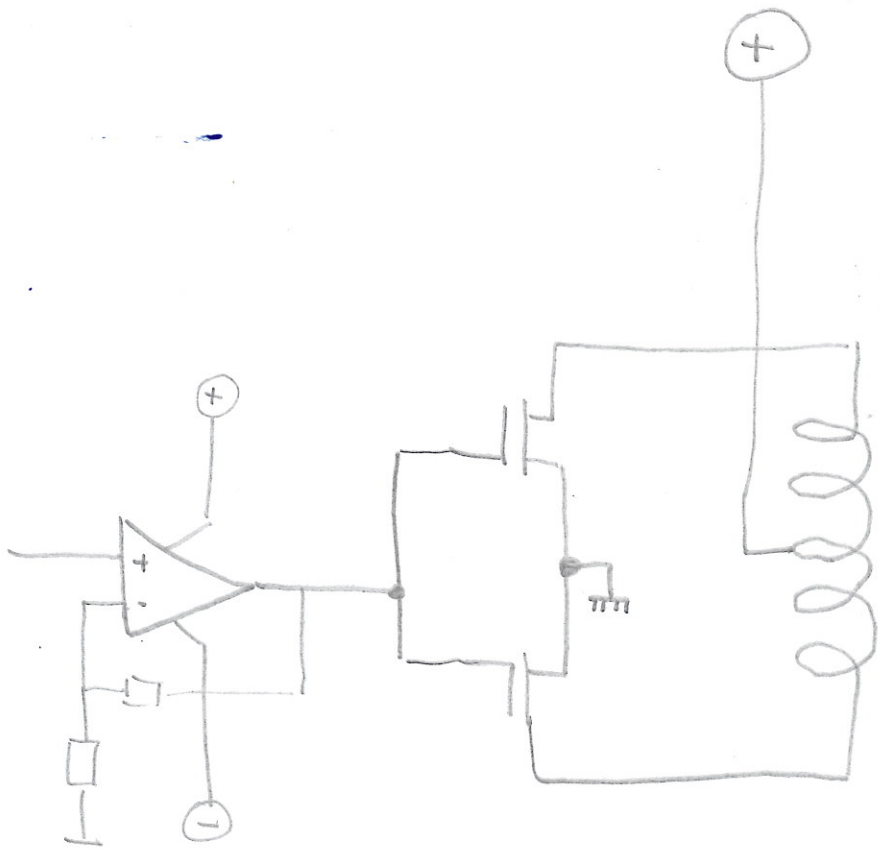
plasma speaker circuit using PWM

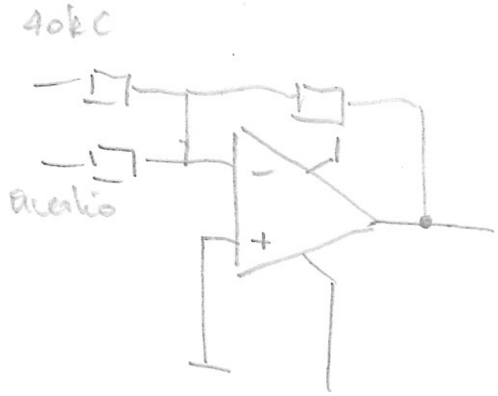


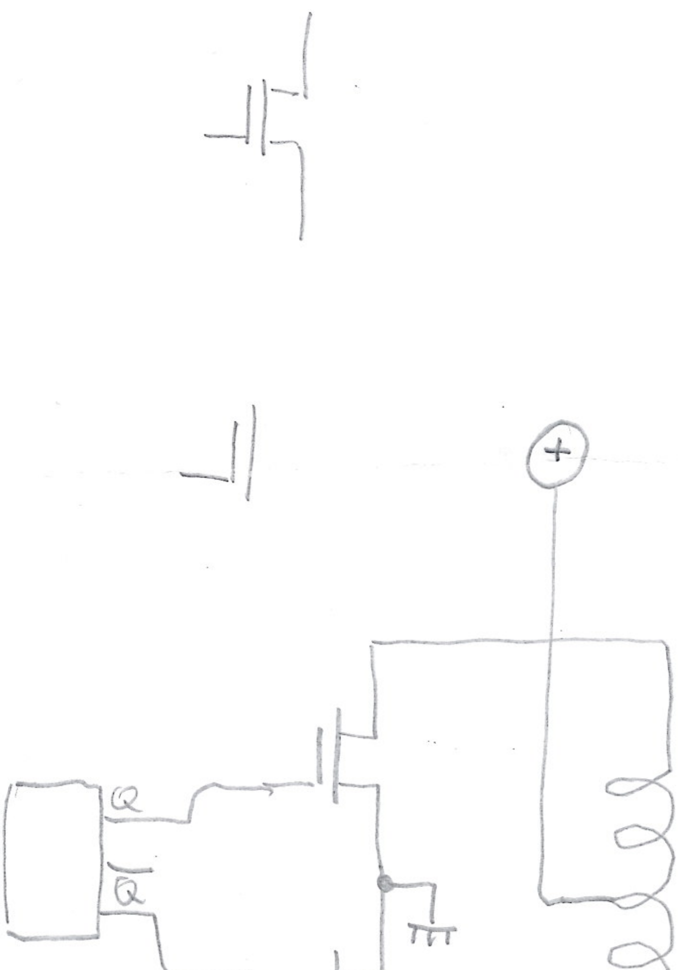




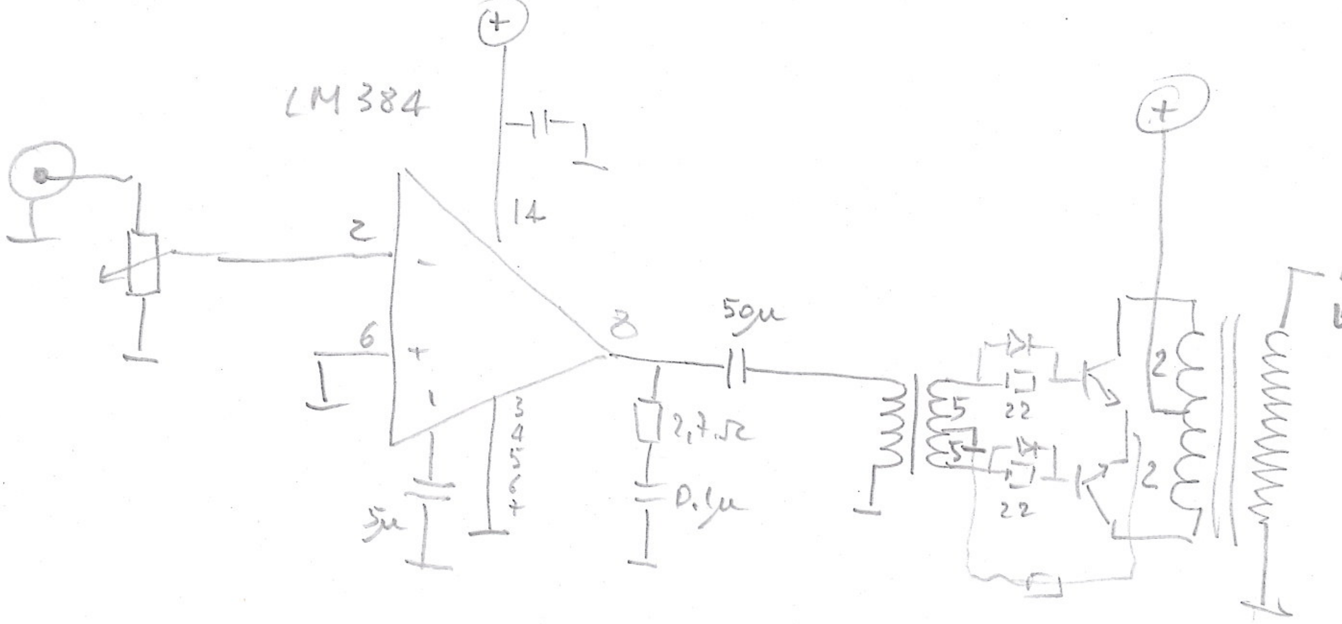

IRF540
IRF540
LOGOS FOUNDATION Gent, Belgium
IN



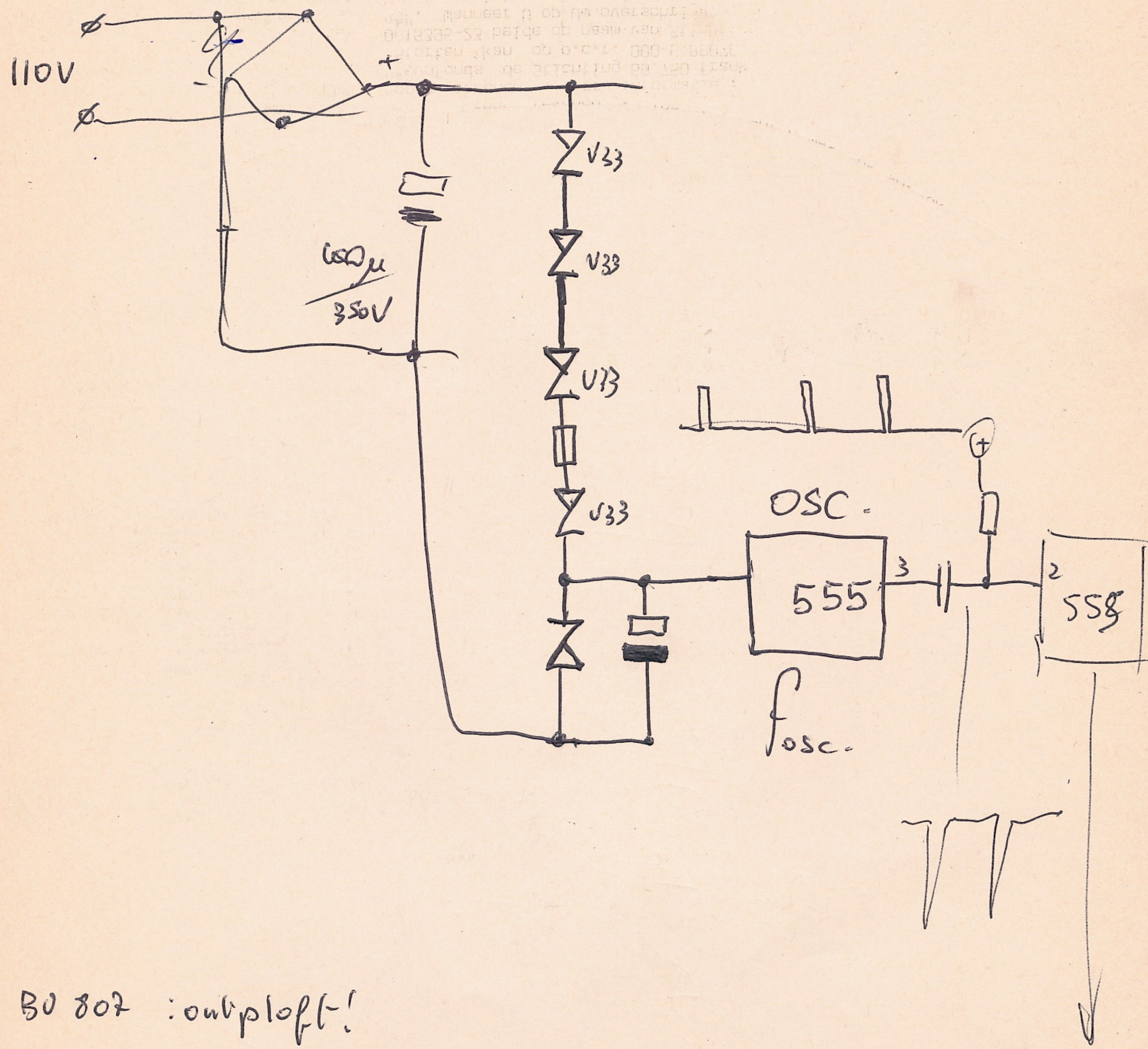

40kC
Audio


Q
$\overline{Q}$
+

PWM schakelingen



LM 384
14
2
6
8
1
3
4
5
6
7
5µ
50µ
2,7 Ω
0,1µ
22
22
2
2



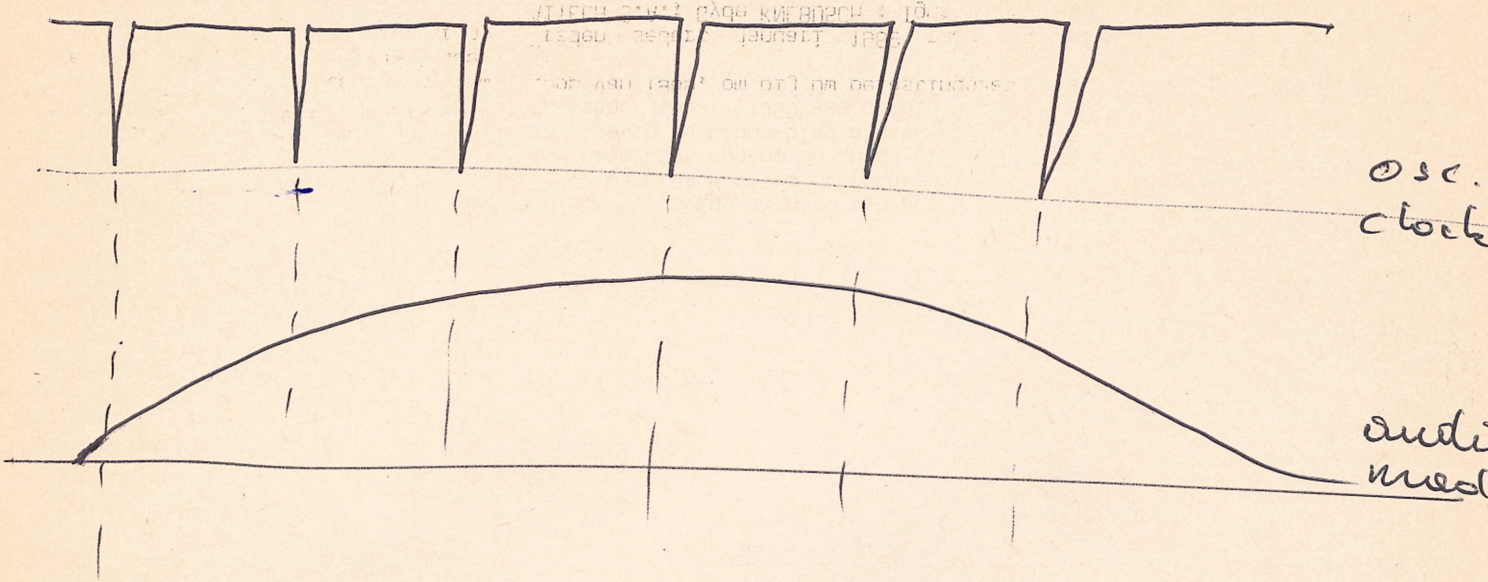
BU 807 : ontploft!

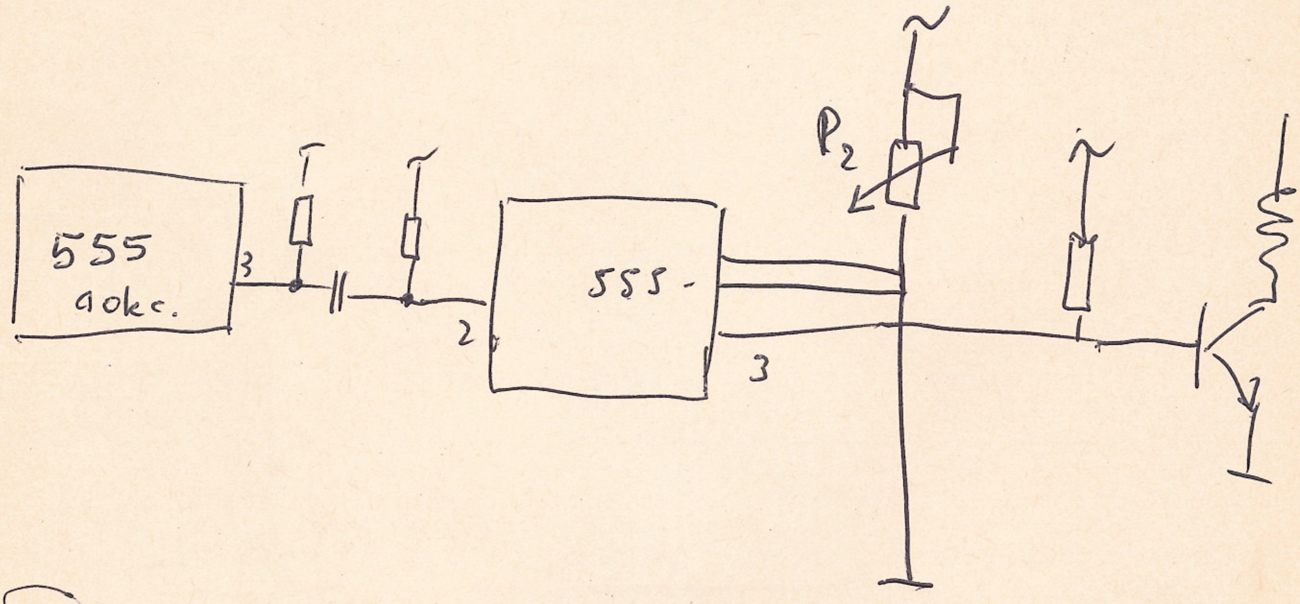
↳ Darlington!

8A / 60W.

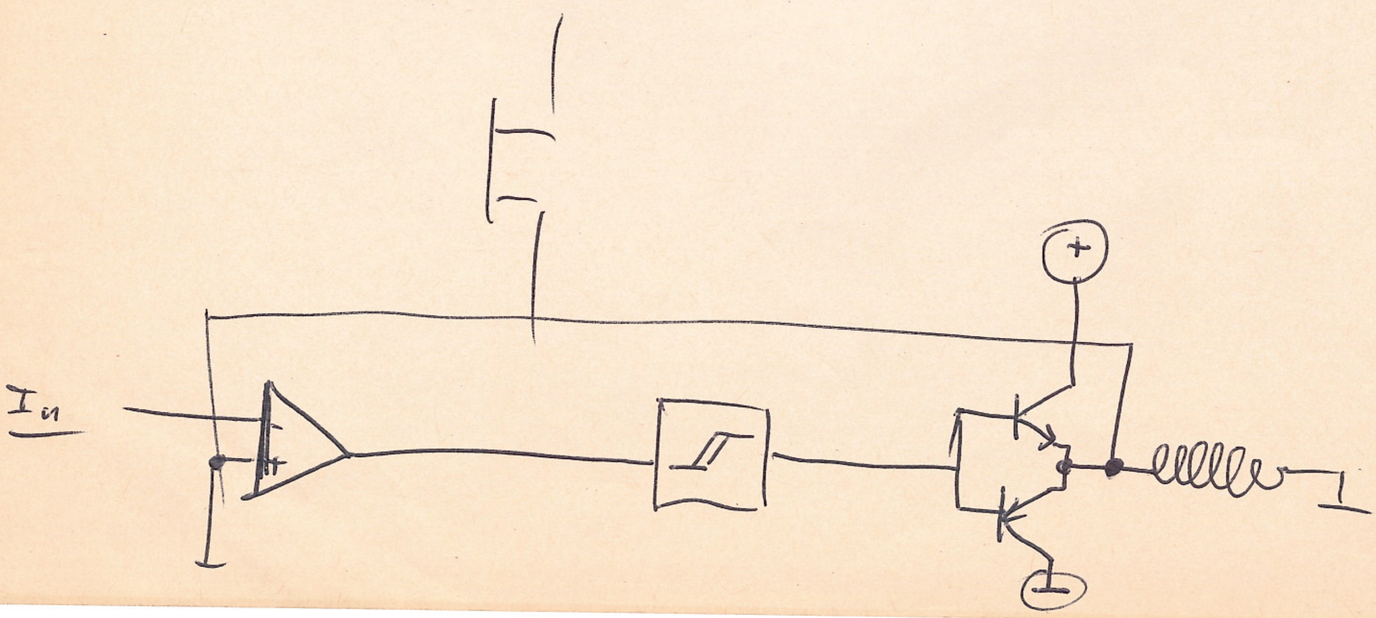
PWM

$f_{max} < \frac{1}{f_{osc}}$

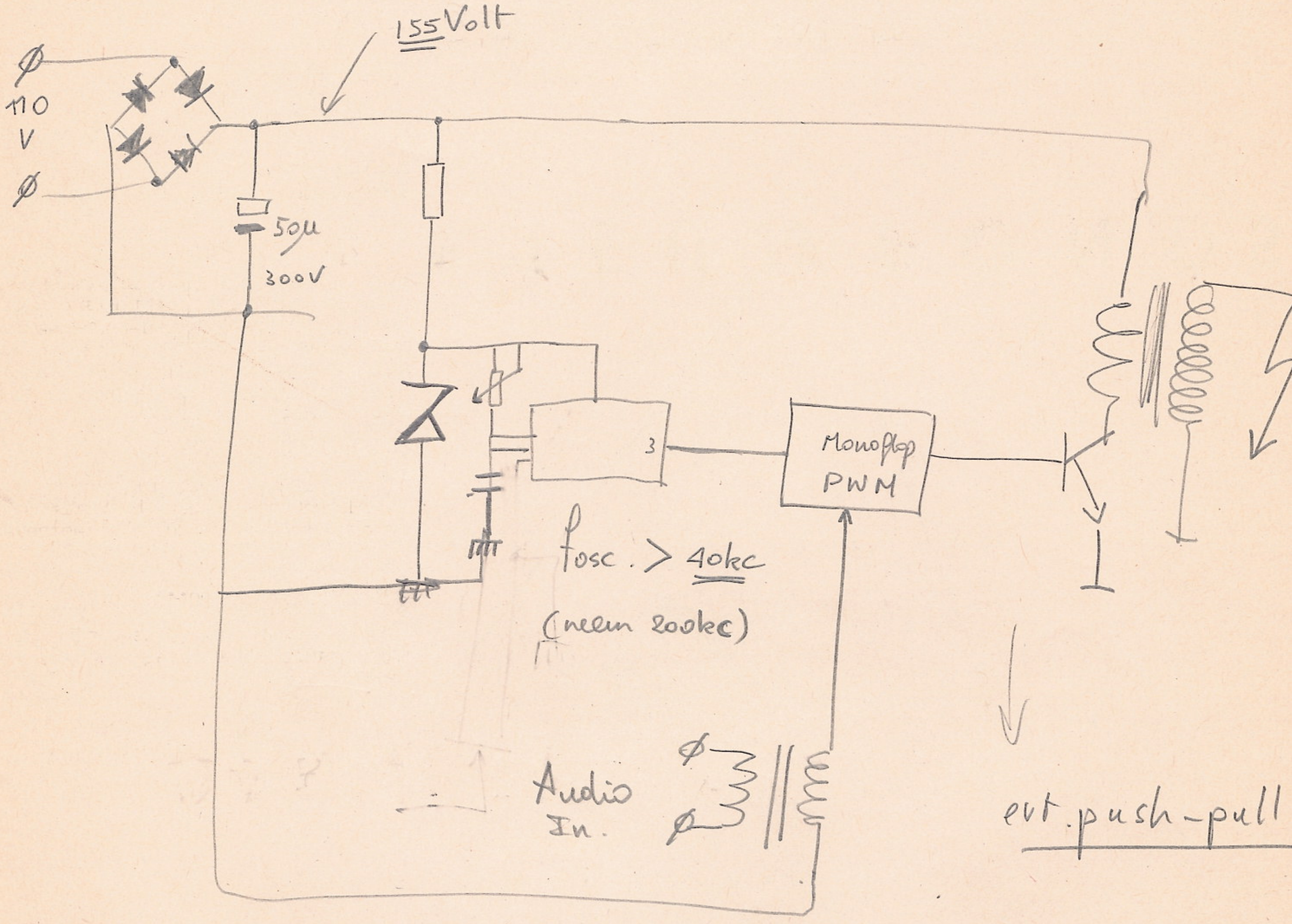




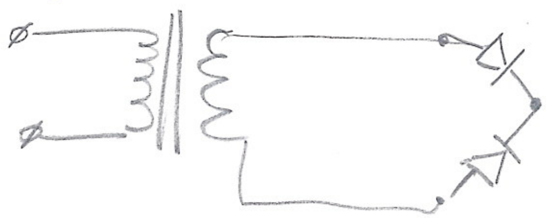
duty cycle : 1 – 95%

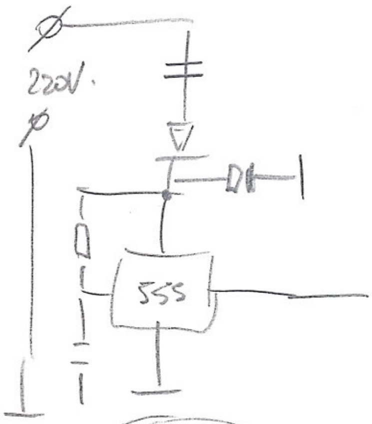


Principe schema
met gevoede plasmaspeakers

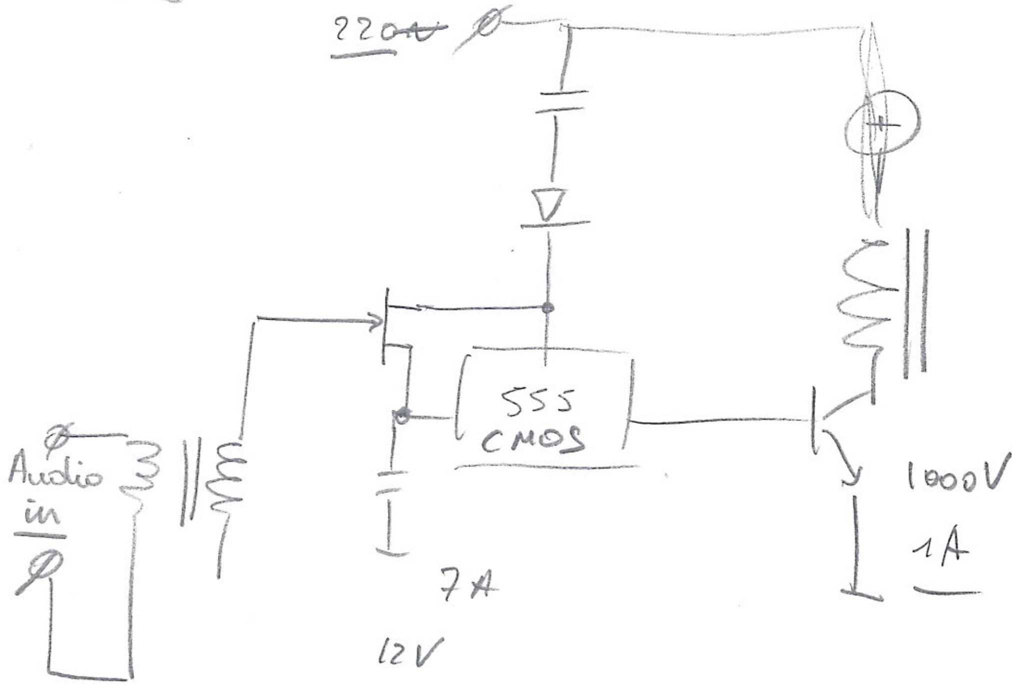


12 V = 10 wdp.





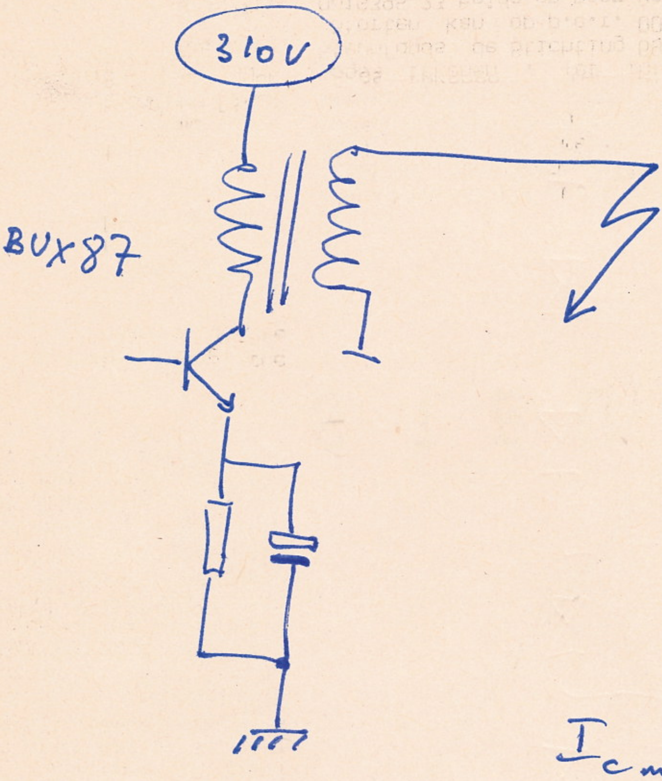
Duty cycle



Pid: 8A / 12V

= 96Watt

⇒ Noodig: 12Volt (regelbaar) —— 16Ampere



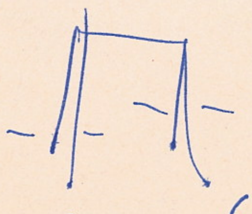
$I_{c\,max}$: 0.5A.

peak (2ms) : 1A.

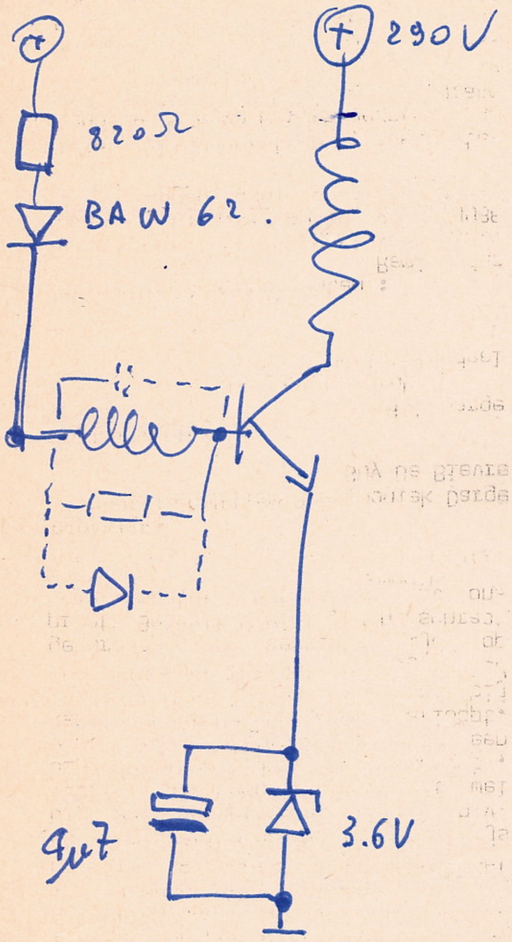
$P_{max.}$ = 20W

I_b = 20mA. & I_c = 200mA

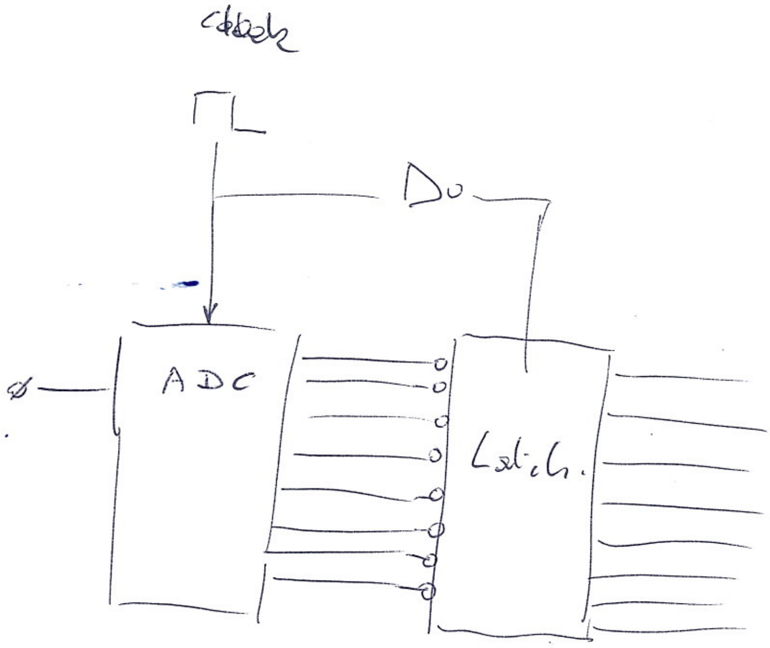
$\Rightarrow V_{ce_{sat}} < 1V$



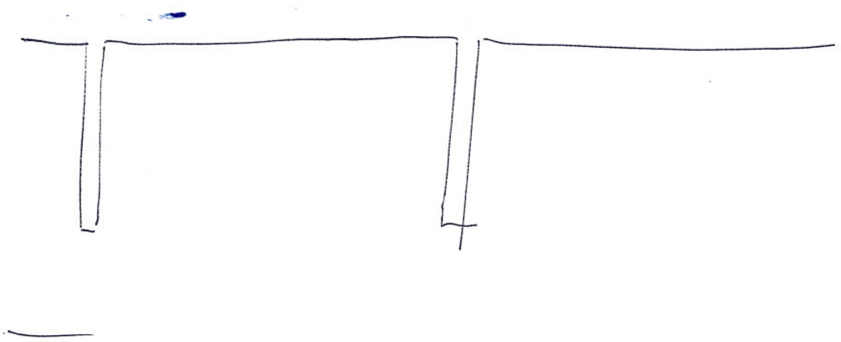
0.4µs !



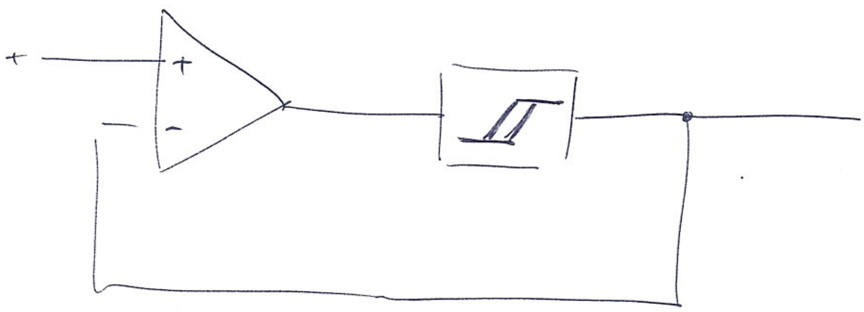
414
579

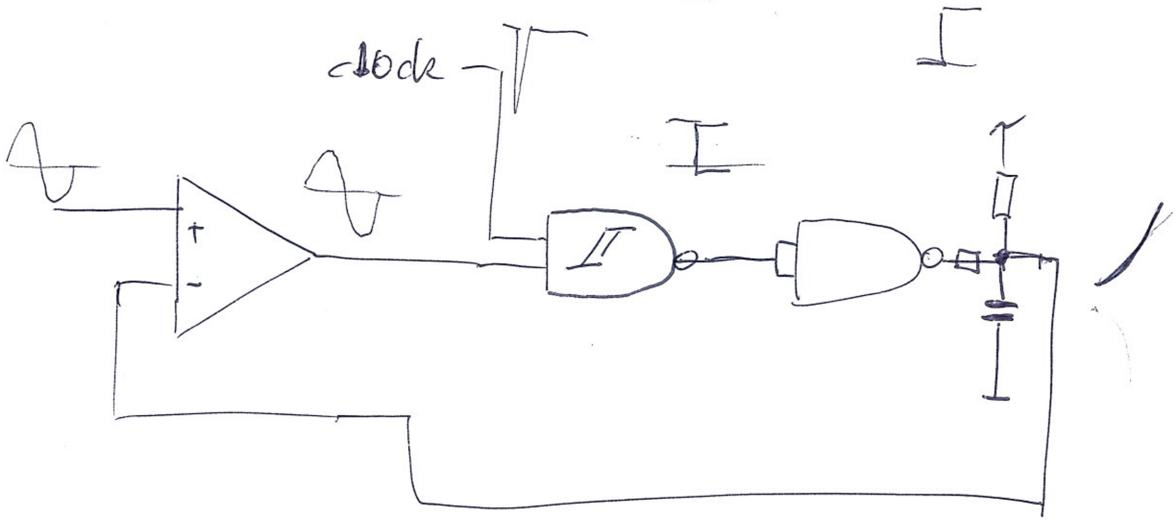


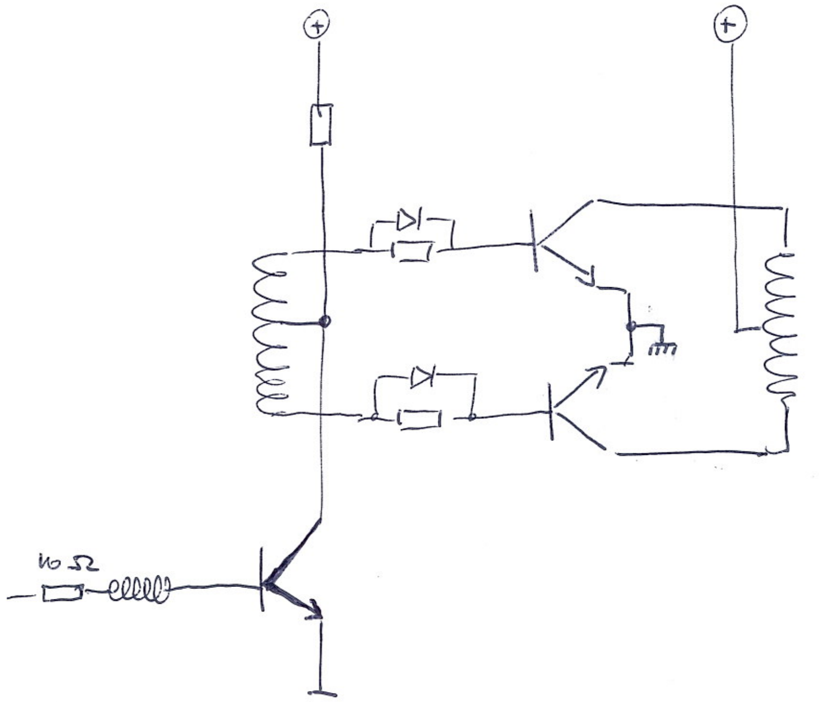
$$8780 - 978 = 7802$$



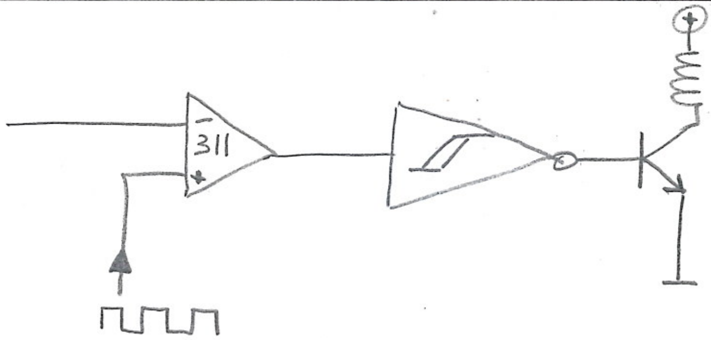
P_{max} = 50% DC !

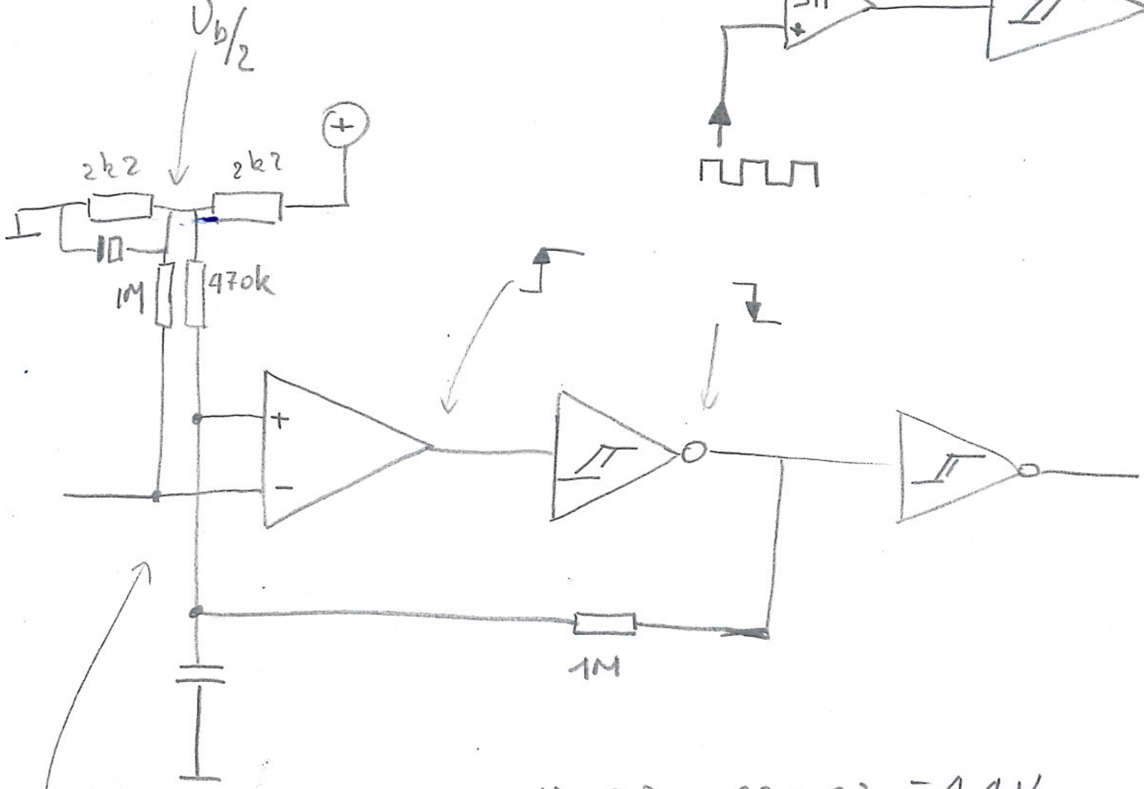






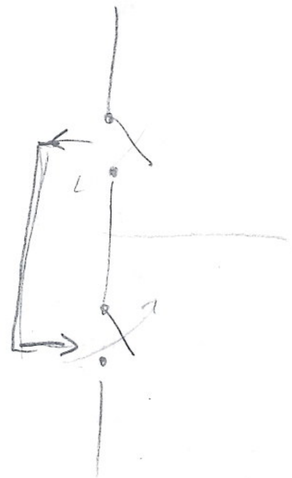
10µs

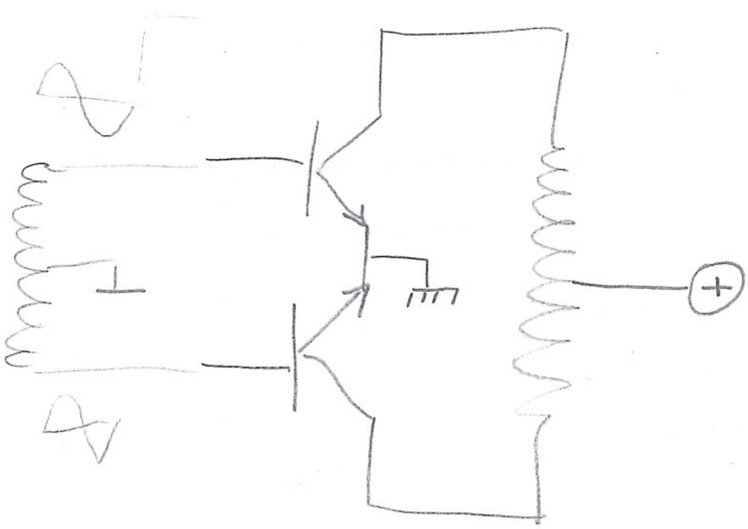


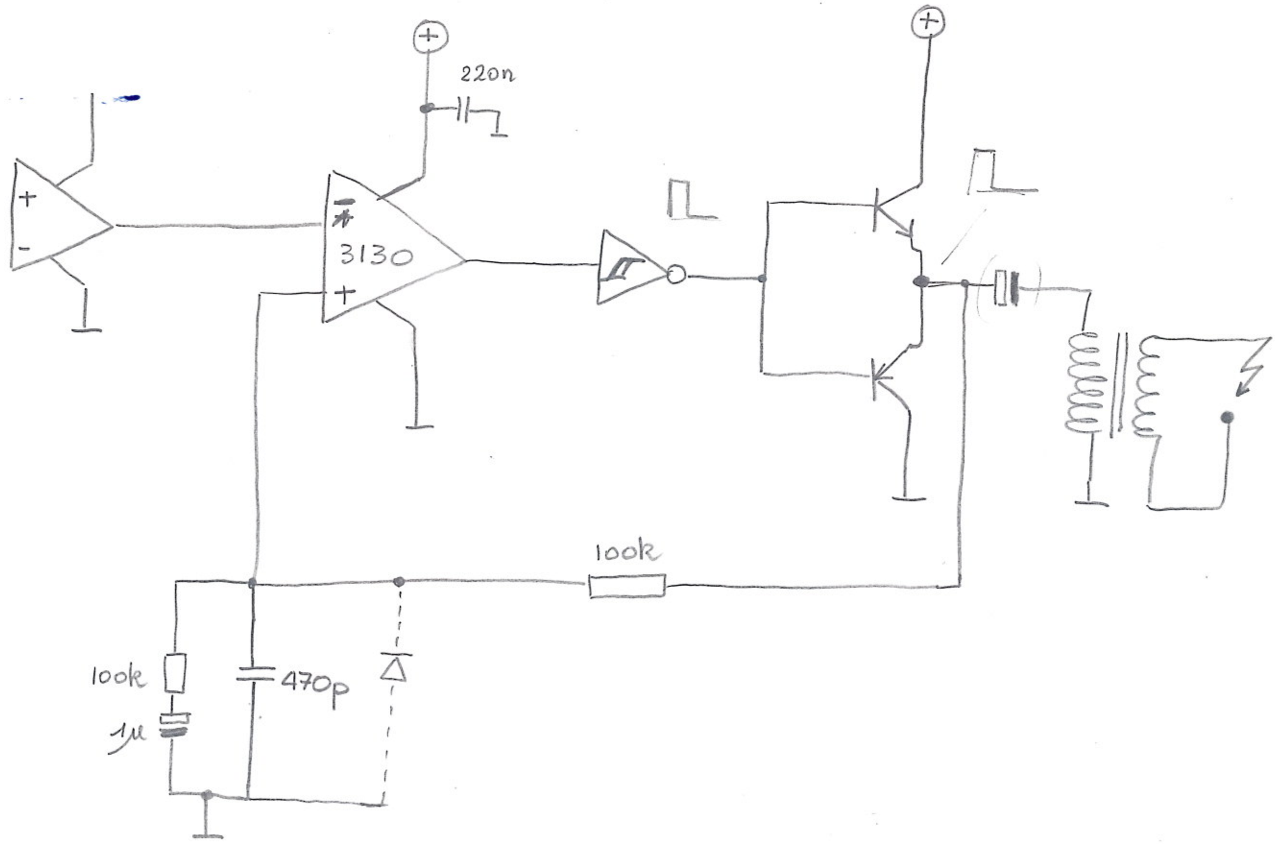


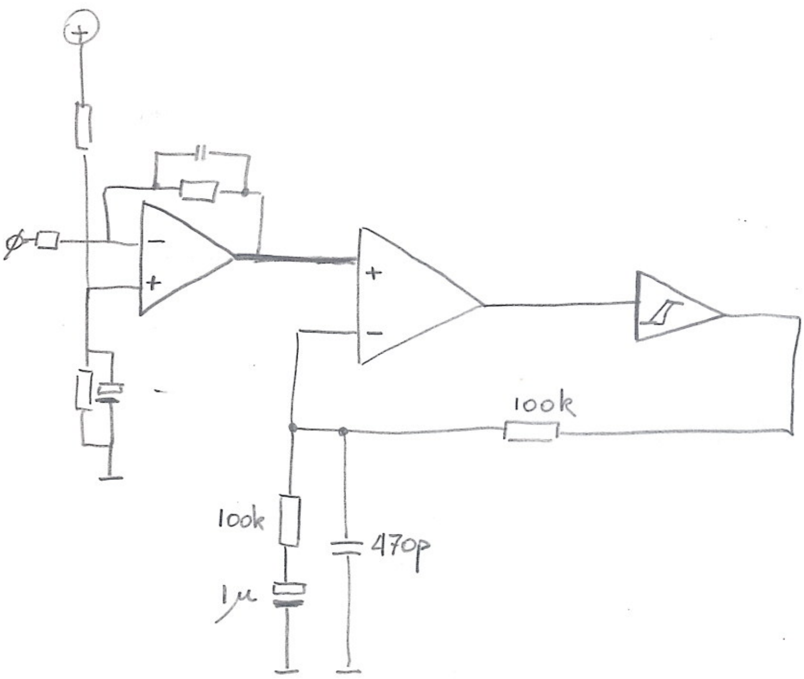
$U = IR = 22 \times 0{,}2 = \underline{4{,}4V}$

beide ingangen op $\frac{U_b}{2}$!! in rust!









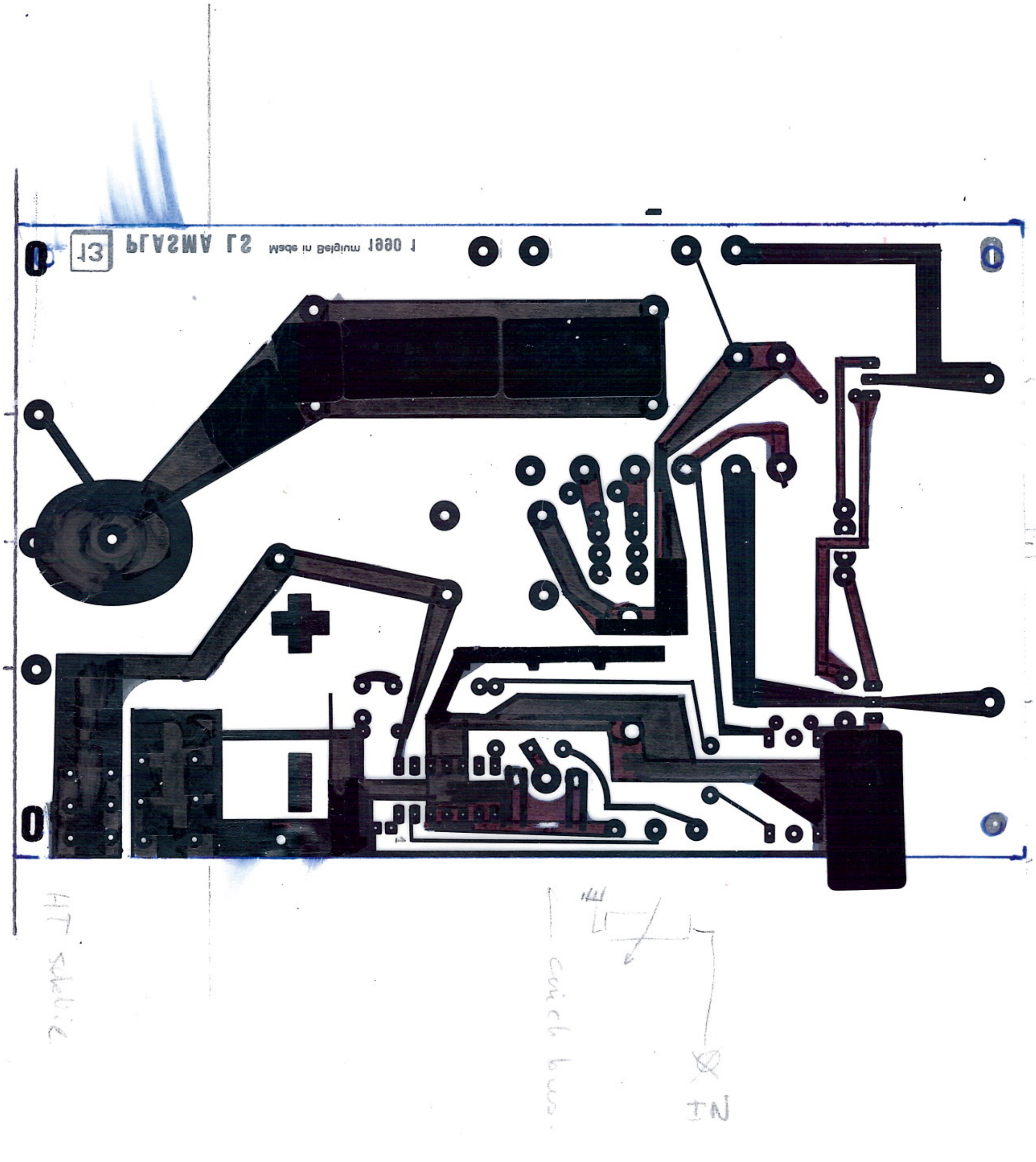
H3 : Klienten

H4 : FiN

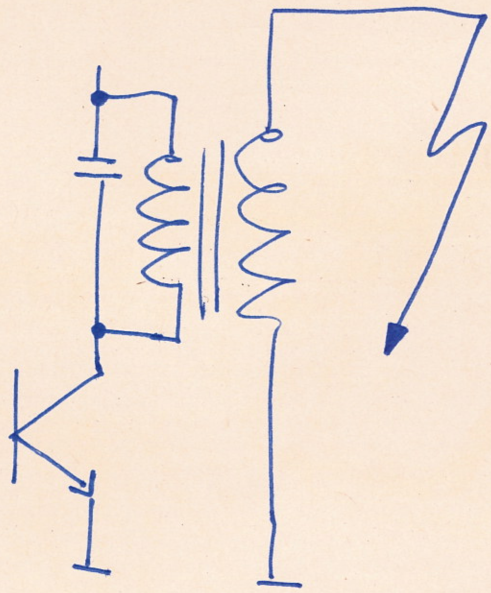
Brasilie

1989

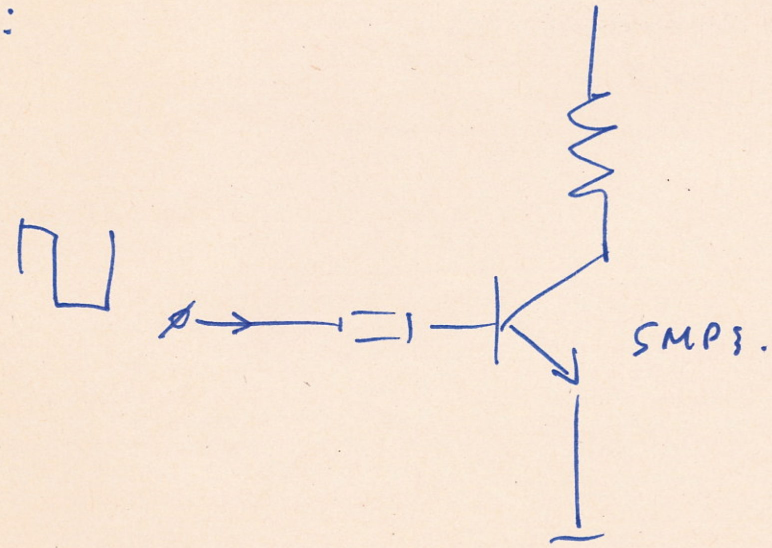
Plasmamachines

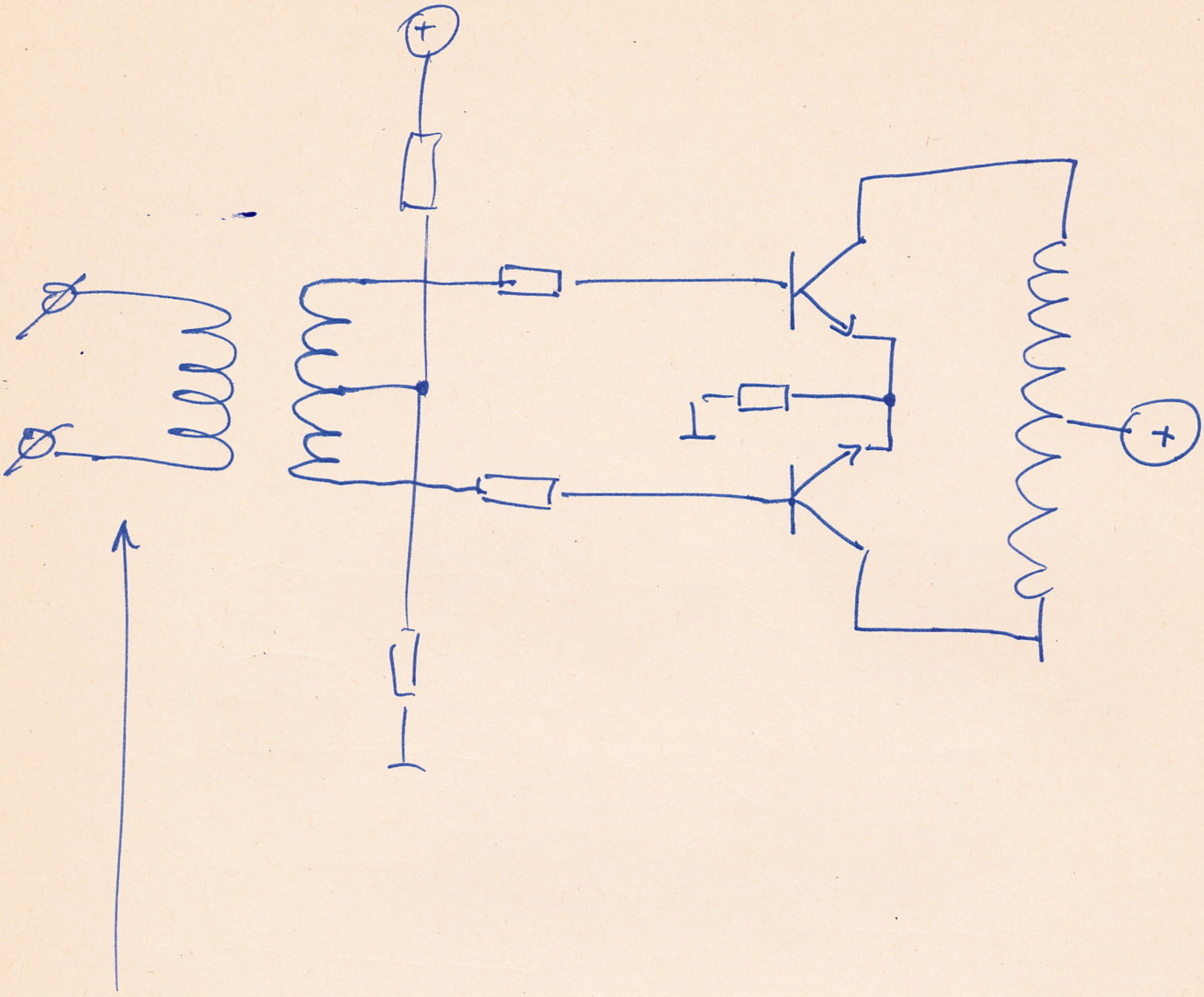

13
PLASMA LS
Made in Belgium 1990

Simple Tesla generator:

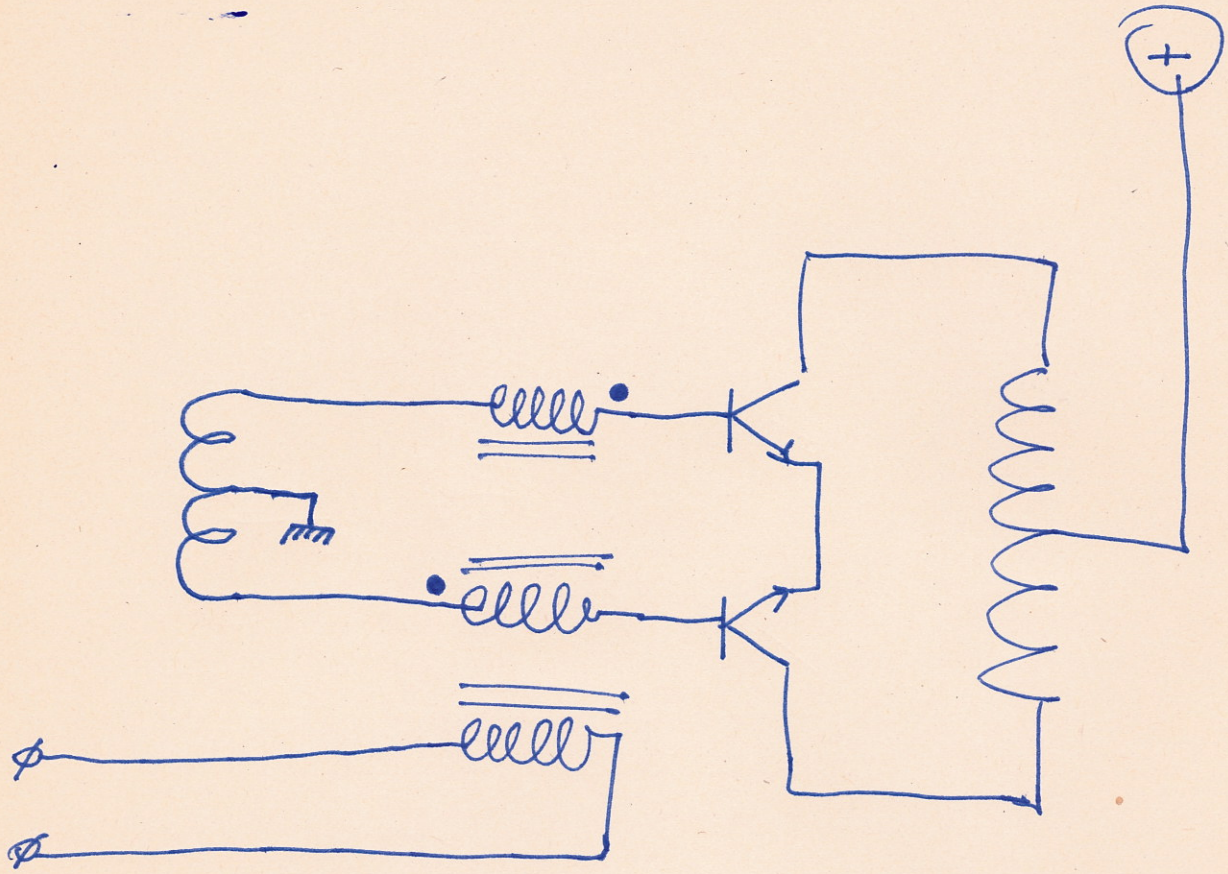


Test:

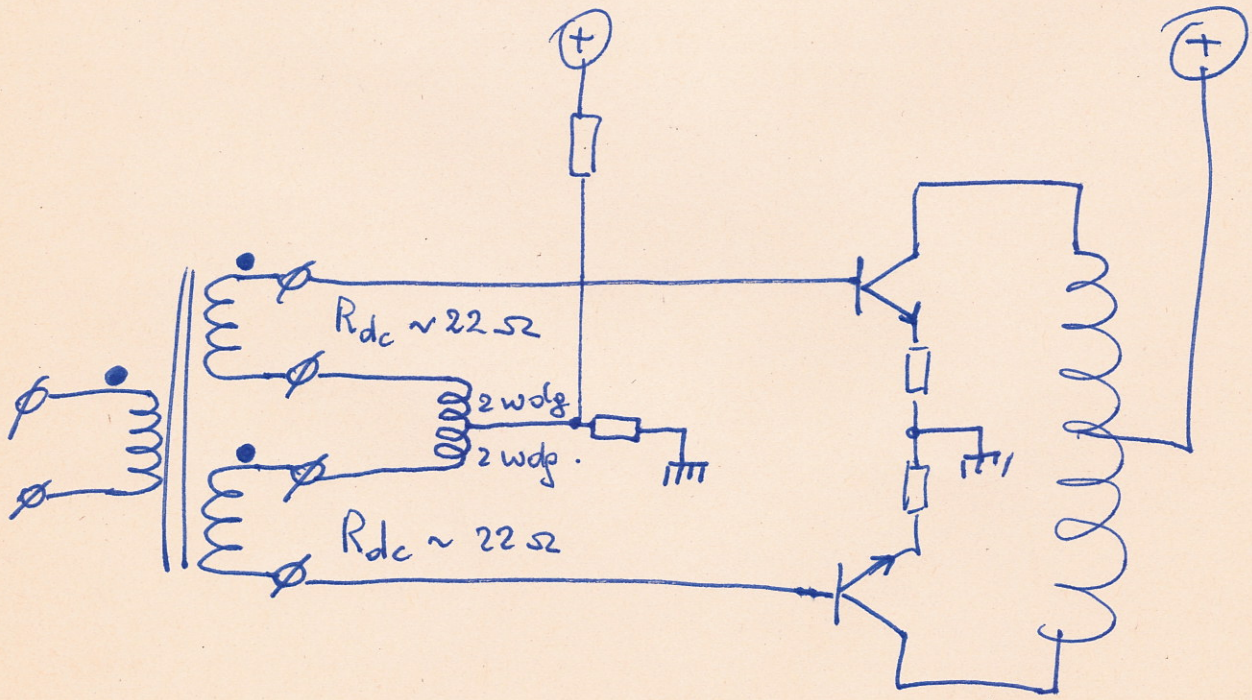




$U_{in} = U_{bias} + U_{signaal}$.

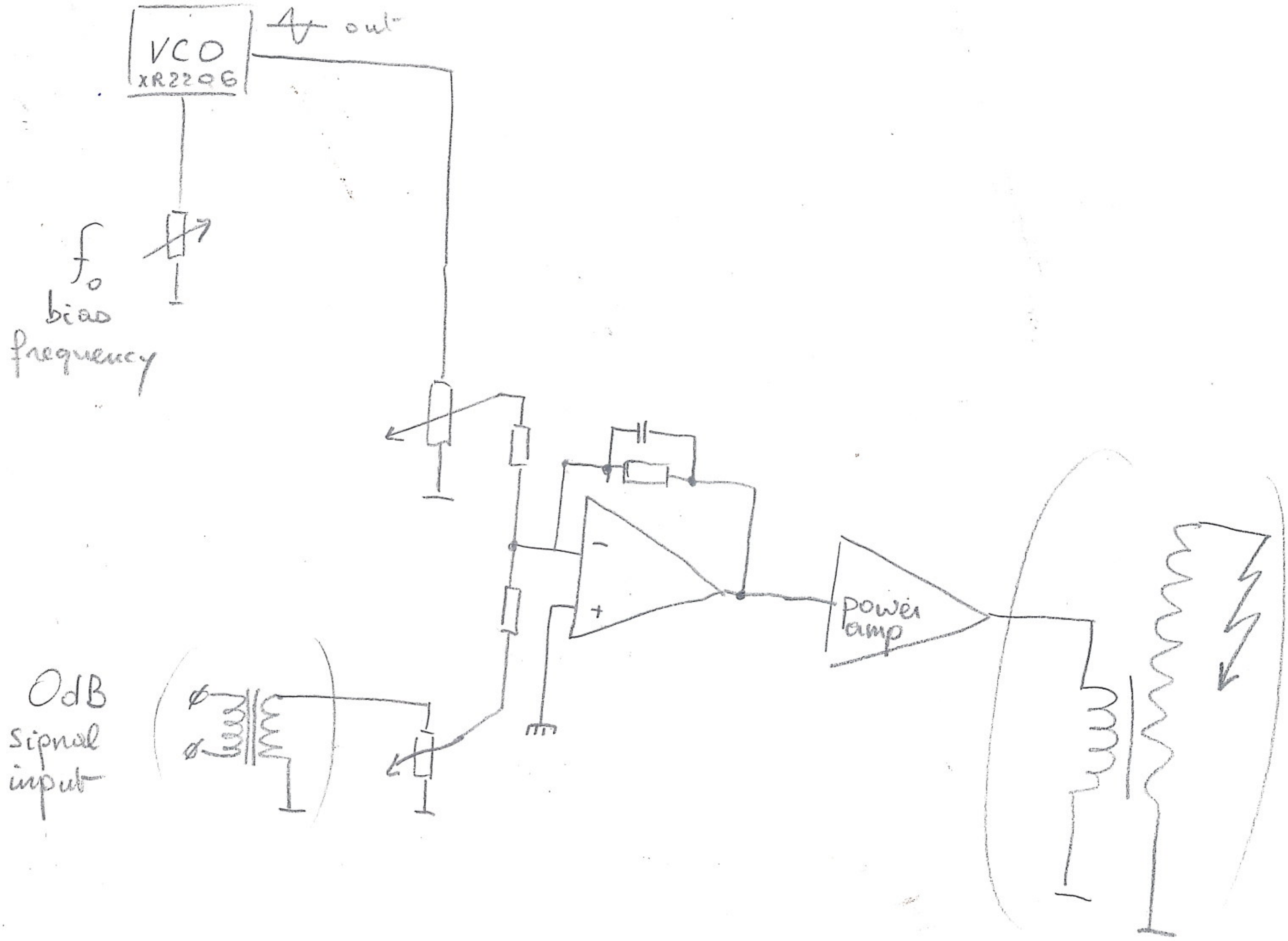


+

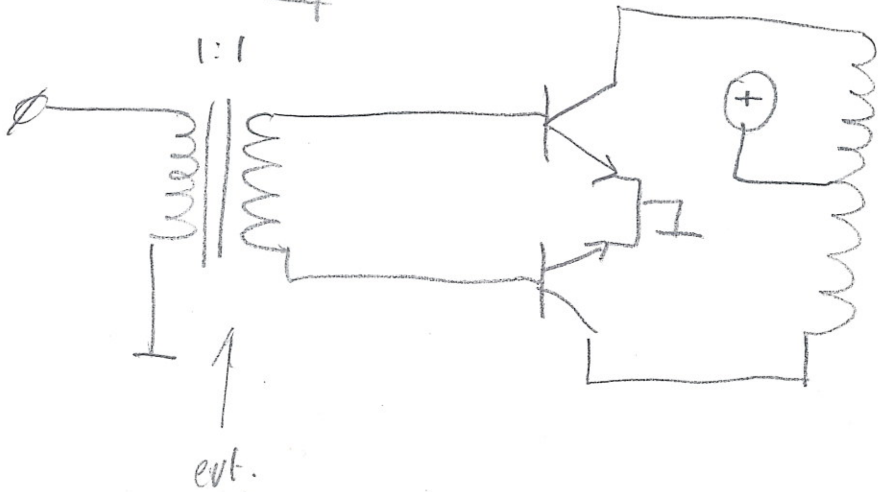


+
+
$R_{dc} \sim 22\,\Omega$
2 wdg
2 wdg.
$R_{dc} \sim 22\,\Omega$

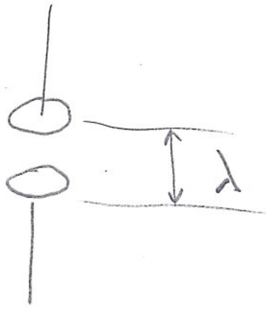
Vlamspeakers.



Galvanische Scheiding!



414
579



21/09/90

$\frac{s}{\frac{m}{s}}$

$v = 340\ m/s$

$f = 200\ kHz$

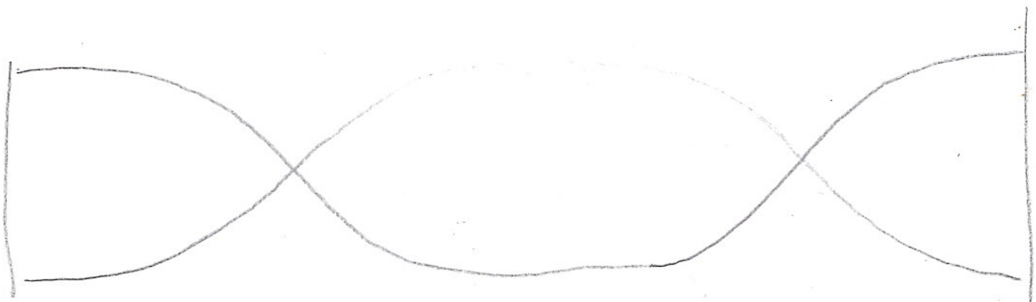
$T = \frac{1}{f} = \frac{1}{200kHz}\ s = 5 \mu s$

$\lambda = \frac{T}{v} = \frac{5 \mu s}{340 m/s}$

$= 340 \frac{m}{s} * T s = 1,7\ mm$

$\frac{3}{\frac{6}{2}}$

0	0	1	1
1	1	0	6
0	1	1	3
2	6	5	

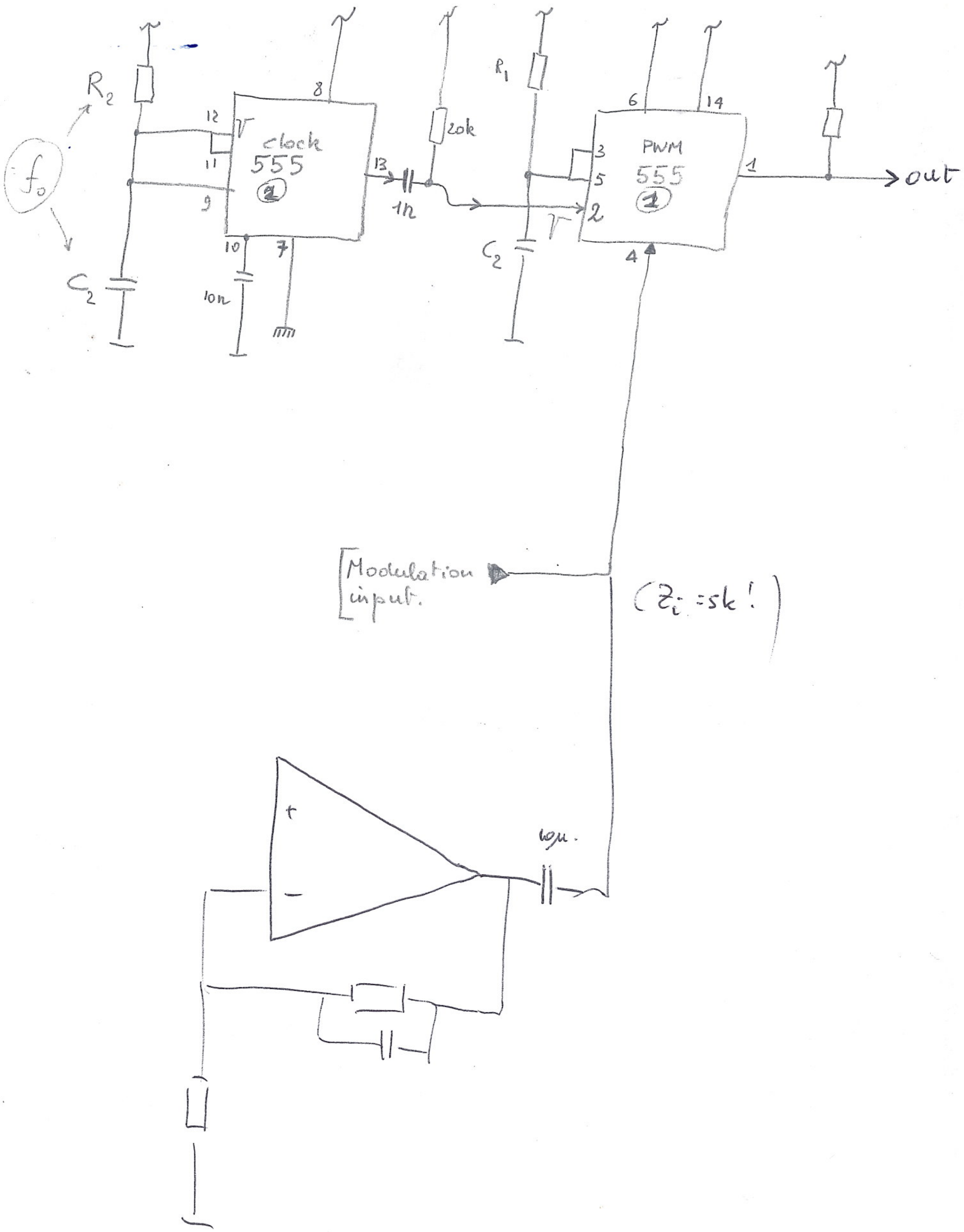


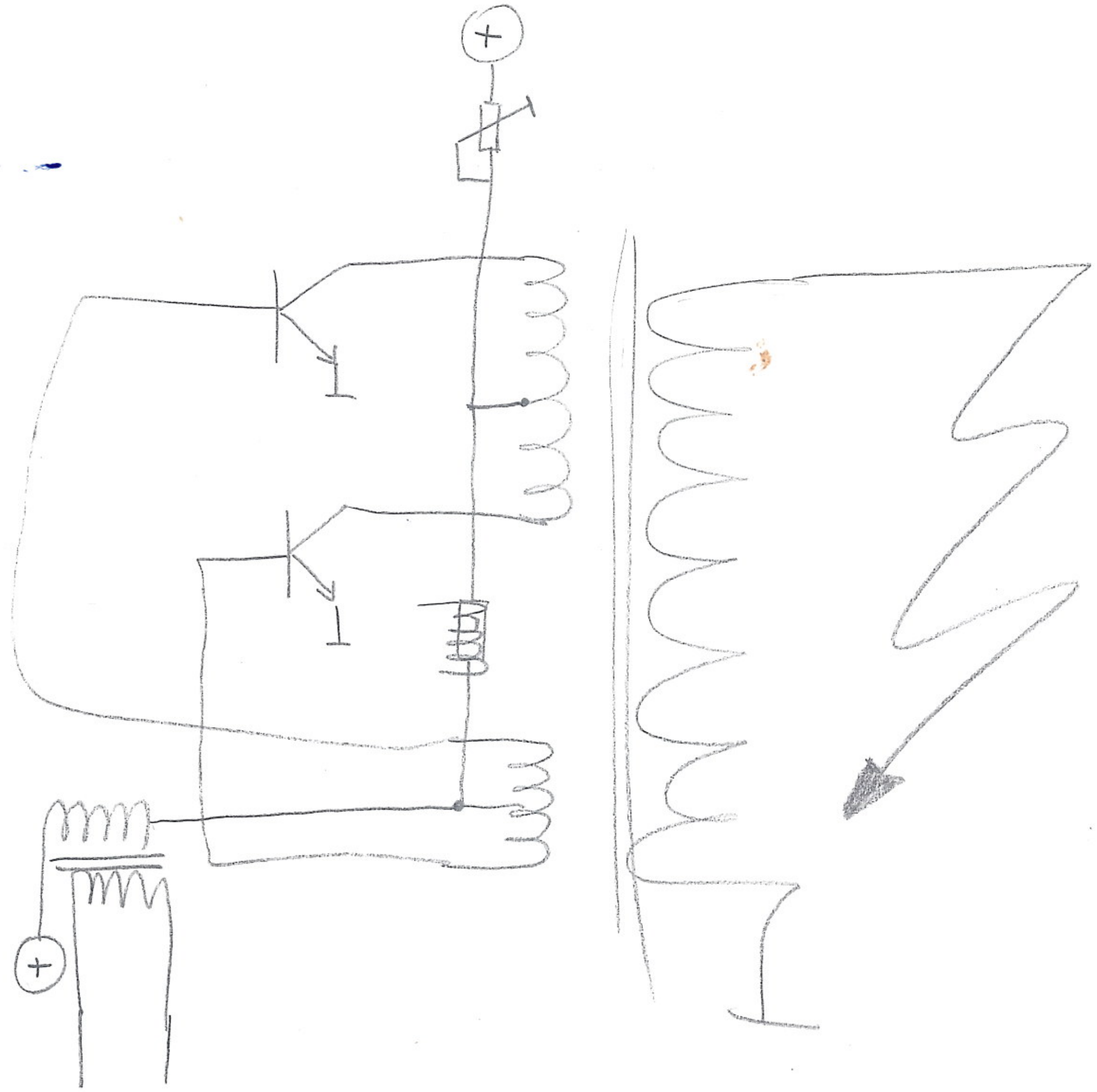
λ

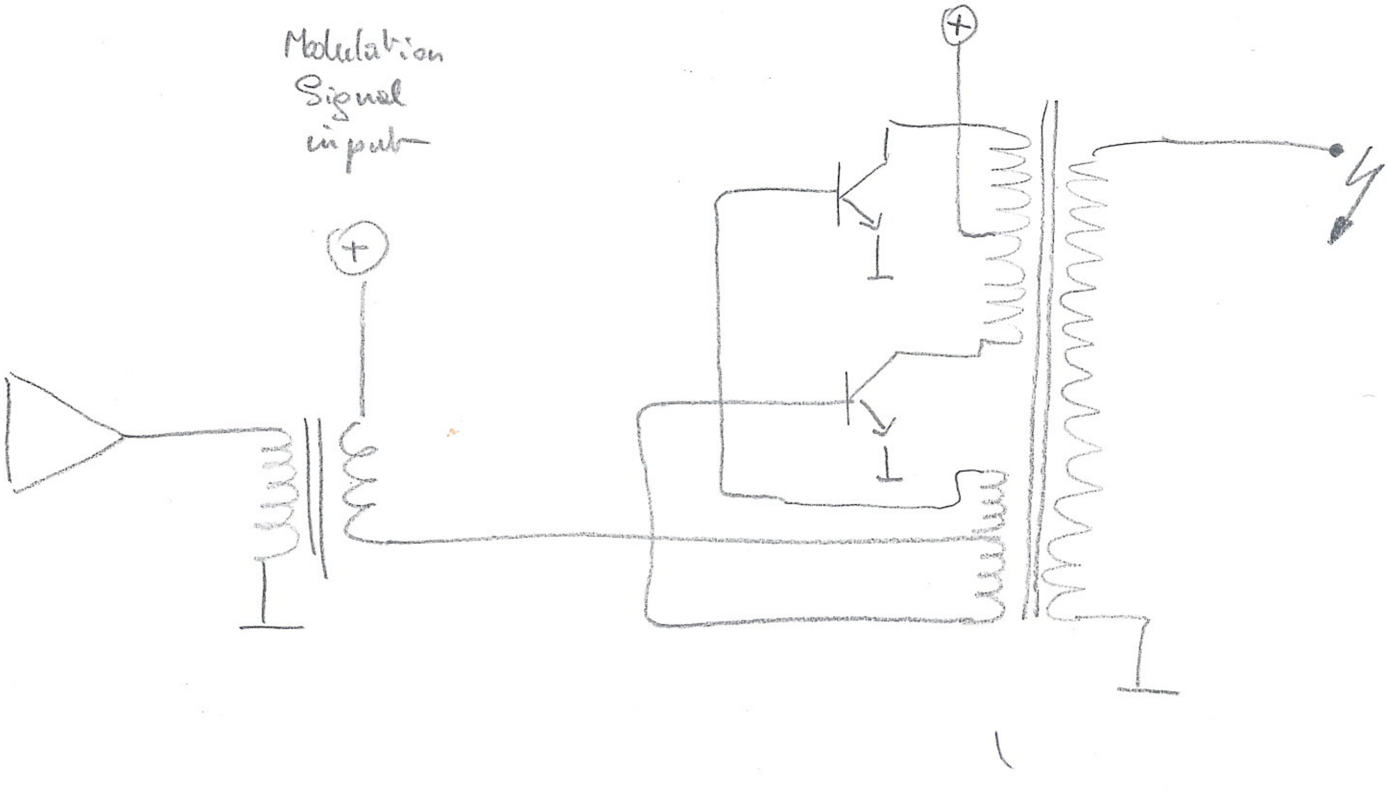
132
450
582
582
1164

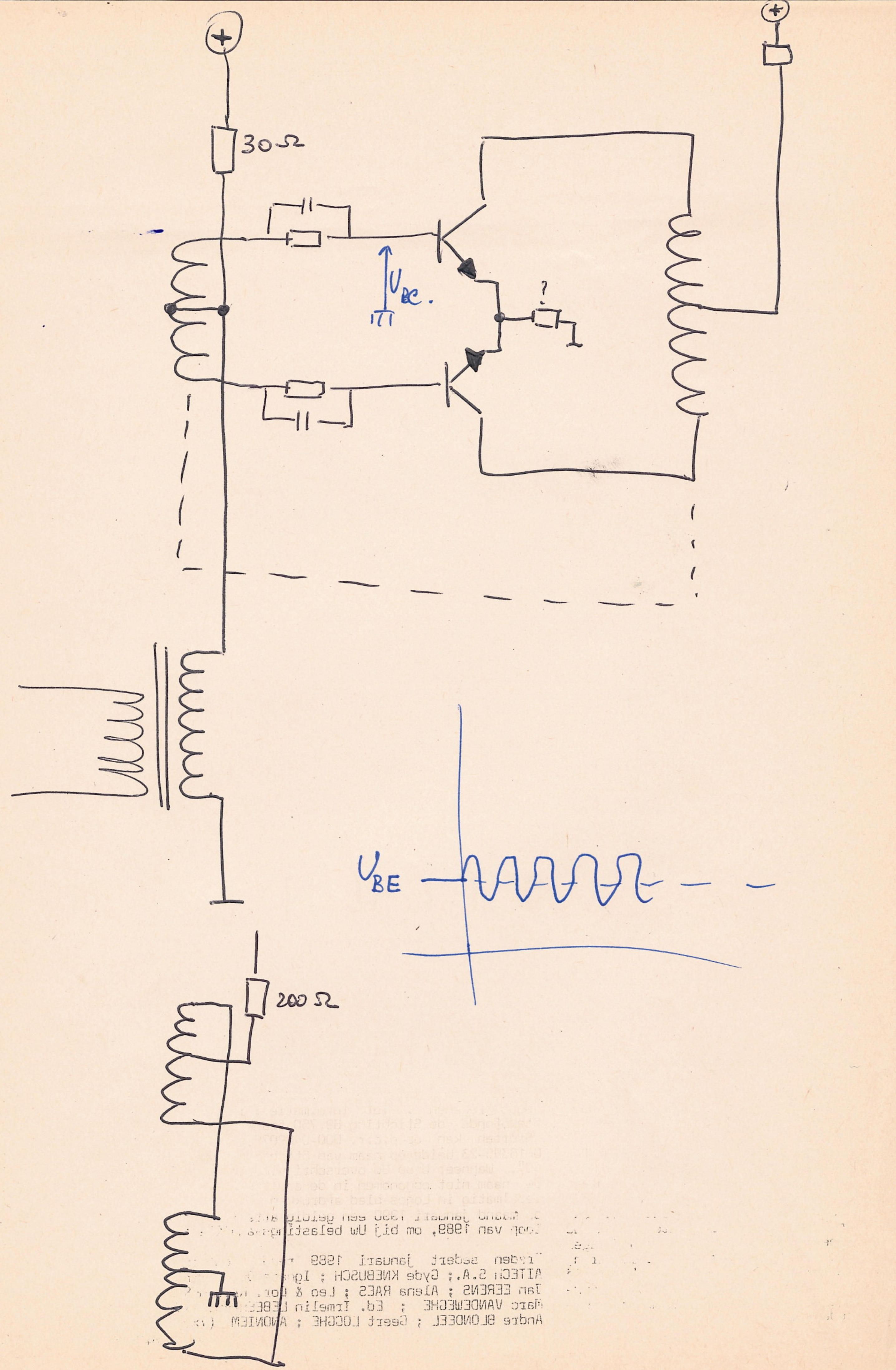
Puls-width-modulator (for plasmaspeakers)

[2 555 IC] (dubbele 555)




Modulation
Signal
input



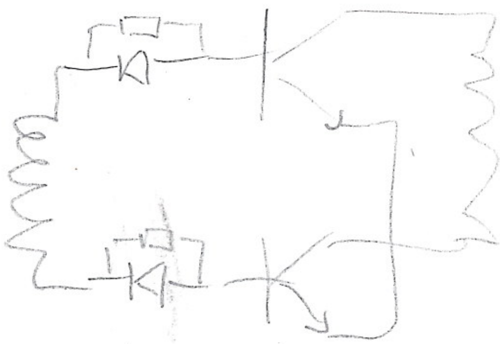

+
30 Ω
U_BE.
?
+
U_BE
200 Ω

Relatie publiek.

⇒ inzicht in mot. der kunst is essentieel.

Nieuwe muziek is "elitair" — zoals overigens alles wat progressief is.

Port ∅ must have pull-ups (ok)



Echte ernst is elitair. Echte ~~plezier~~ humor eveneens. Wat er rest ~~zijn~~ is banaal.

Alberto Moravia 17/01/90 ok.

BUS98 20A/800V

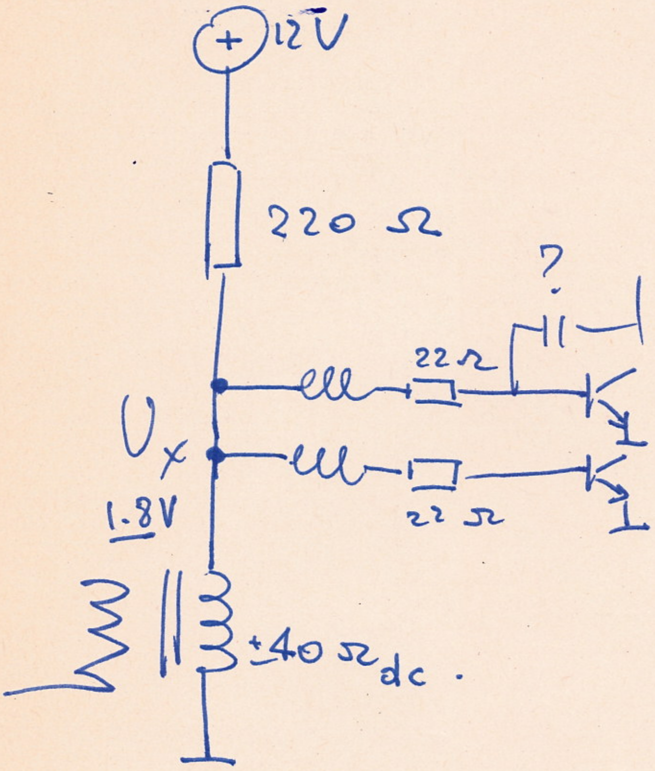
MJ10022 10004 10A/ Darlington

Elite of exclusief

- PL 75
- RM 42

12 tpi

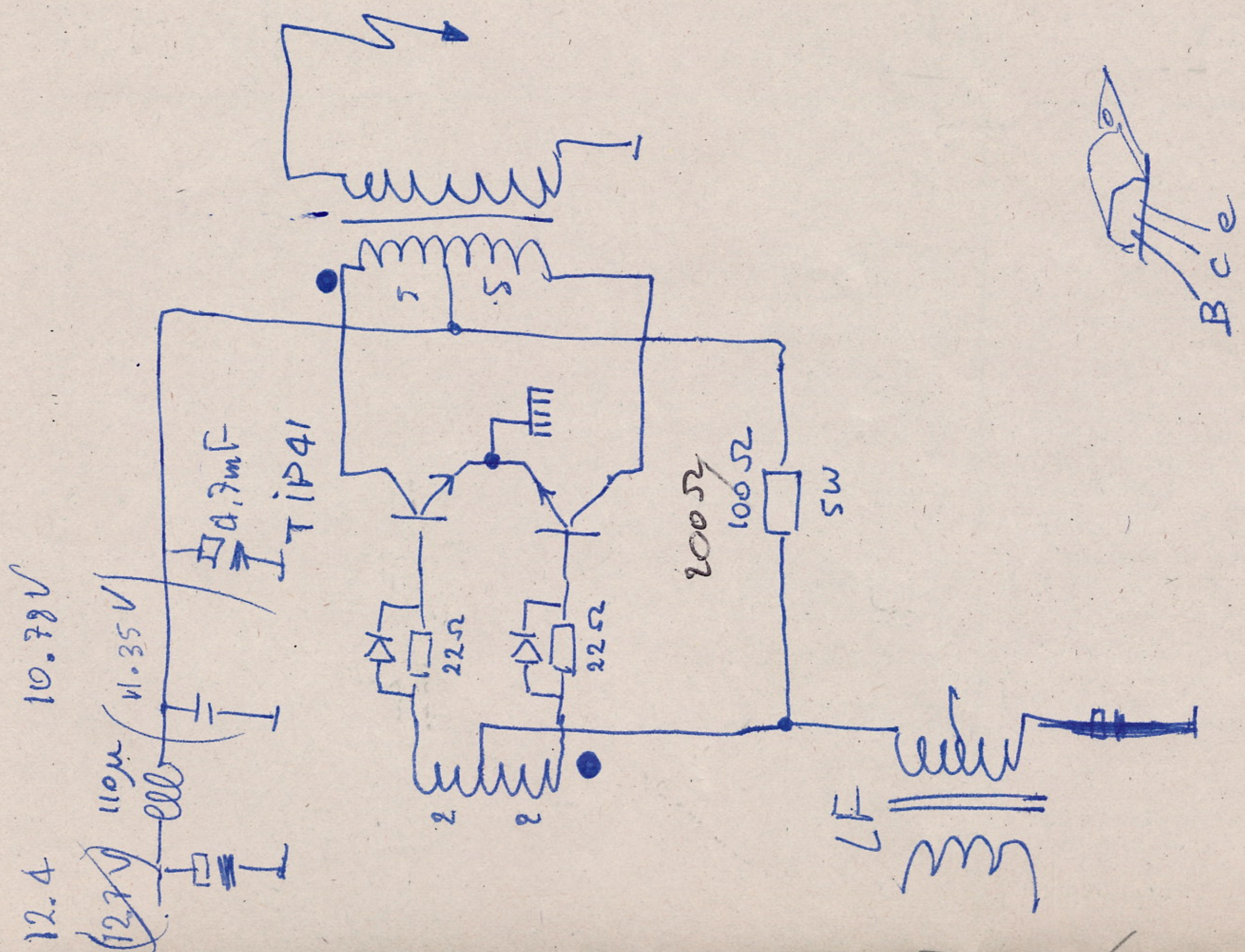
Basisstroominstelling DC.



$$I_{max} = \frac{12}{230\,\Omega} = \underline{52\,mA}$$

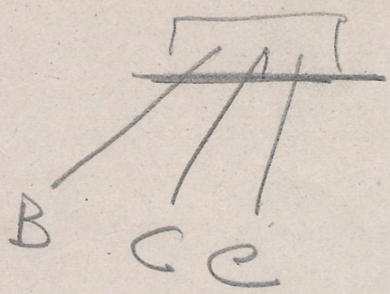
$$\frac{260\,\Omega}{12V} = \frac{40\,\Omega}{U_x}$$

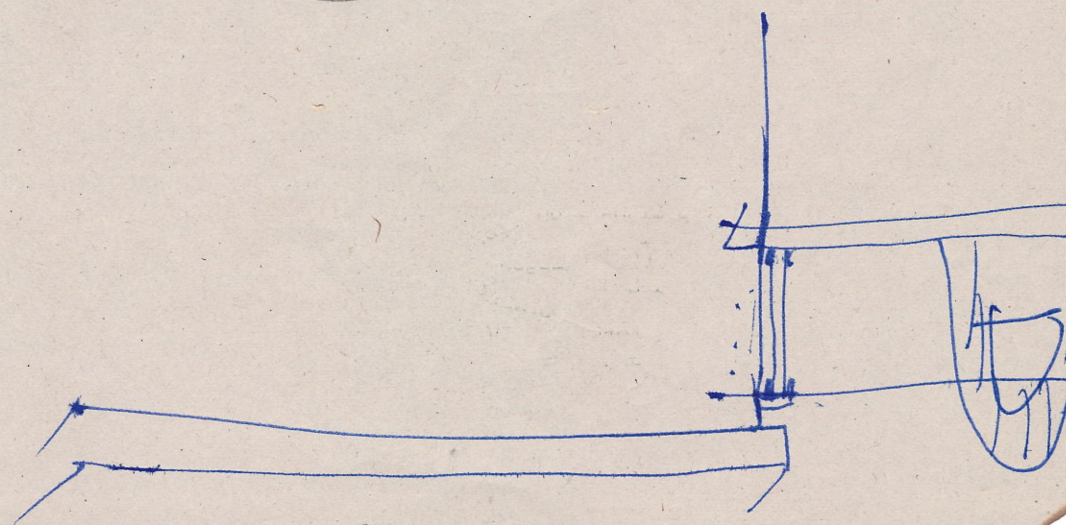
$$U_x = \frac{12 \times 40}{260\,\Omega} = 1{,}8\,V$$

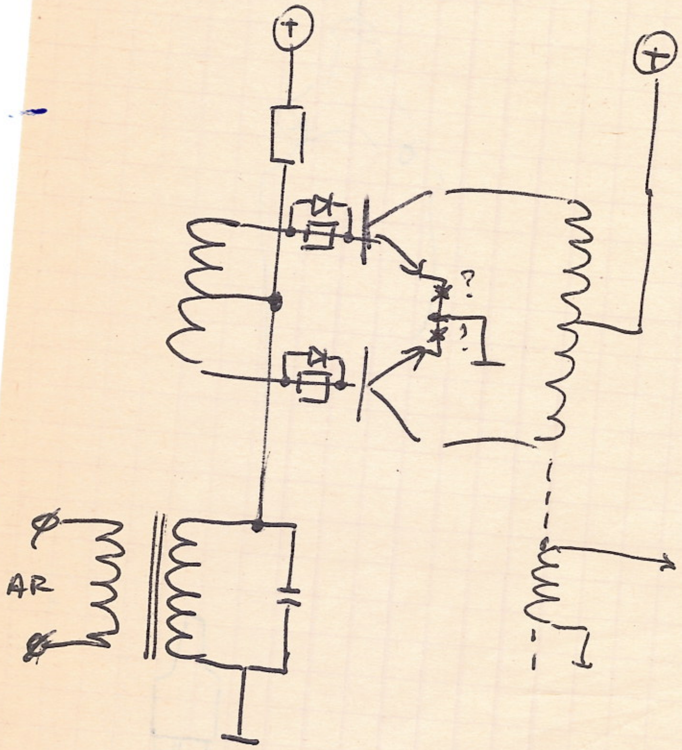


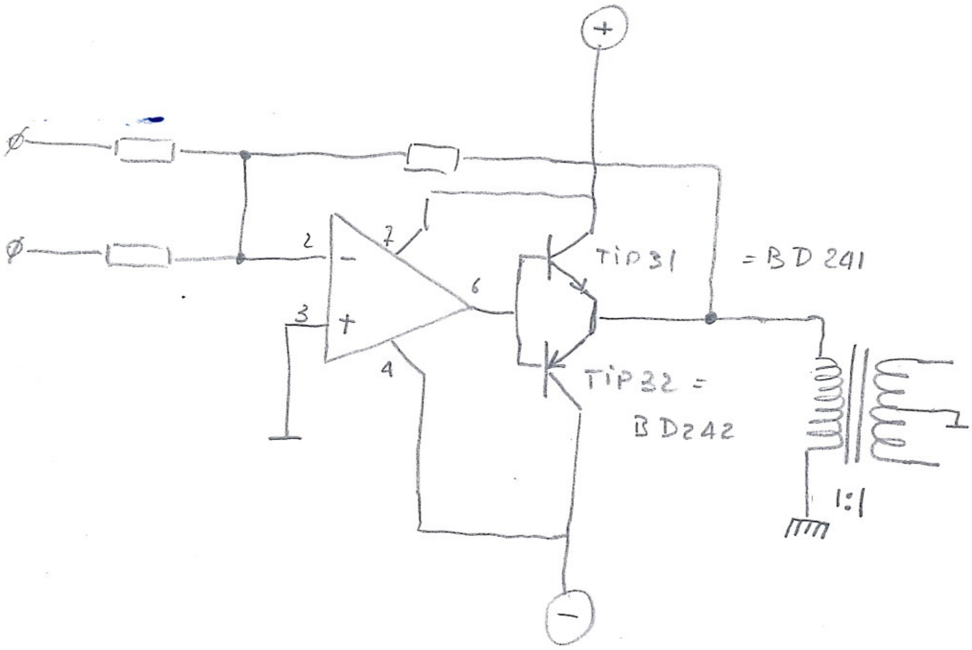
TO220 / 221 A

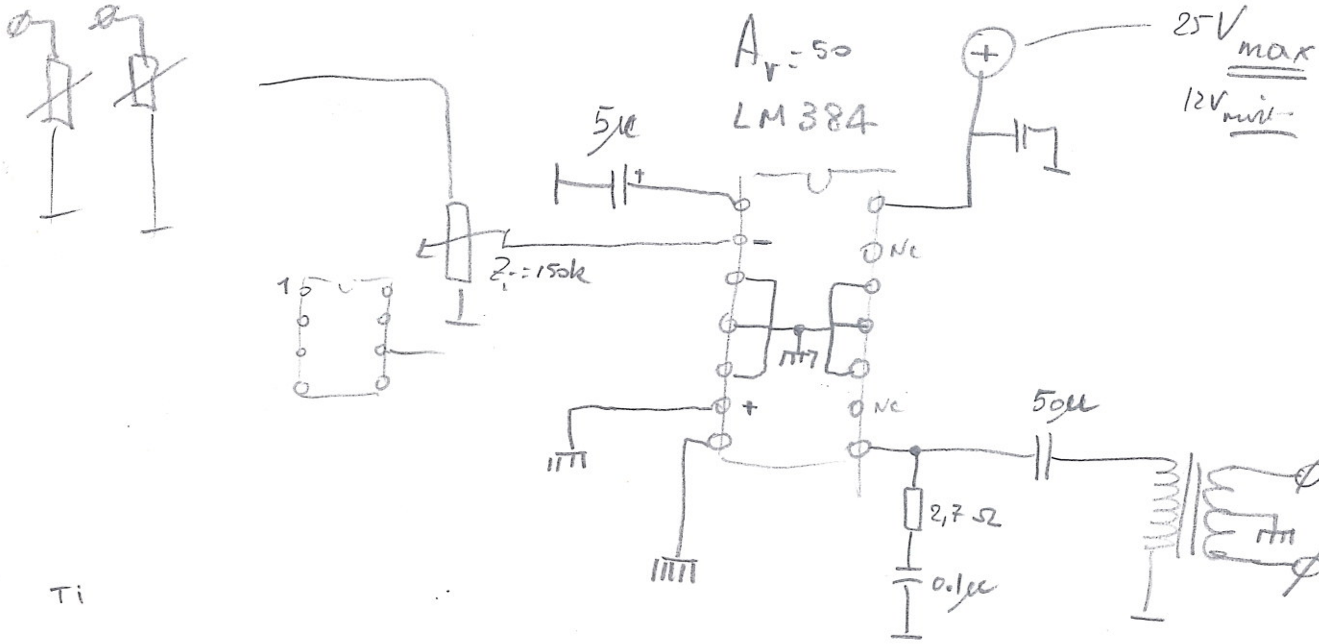
TO220





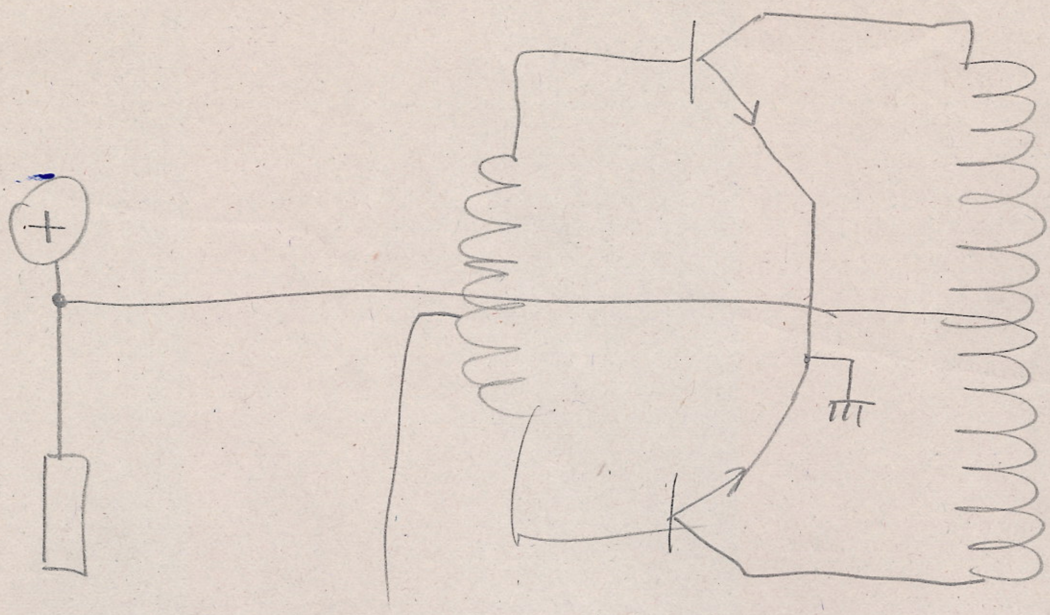

+
+
?
AR

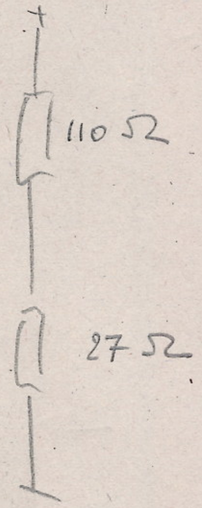




Ti

TiP 120 60V/5A NPN PNP = 125.





Darlingtons.

TIP 112 100 V / 2A / 50W

TIP 120 60 / 5A / 65W

?. BDX65B 100V / 10A / 125W
Darling.

= TIP 142

THE PLASMA MACHINE

You can control the very basic forces of nature with your finger tip! Direct the flow of plasma and harness the unknown!

By Robert Iannini

☐PLASMA IS OFTEN CONSIDERED TO BE THE FOURTH STATE of matter. It consists of atoms that are ionized and it demonstrates peculiar effects unlike the other three forms of matter—solid, liquid, and gas.

The Plasma Machine is a device that demonstrates the presence of a plasma produced by high-frequency, high-voltage, electrical discharge through a low-pressure gas. The plasma created produces a visible and bizarre lighting effect that is totally different than any other presently existing phenomenon. Columns of pinkish and purplish plasma are attracted to external influences, such as fingers and other objects, when placed on or near the display container. Those columns of plasma light span the entire length of the display container, dancing and writhing with a tornado type effect. Balls of plasma and *fingers* are created and controlled by simply touching the container. That effect cannot be effectively or justifiably described in words. The effect can only be appreciated when actually observed.

The Plasma Machine is intended for display purposes such as advertising, conversation piece, novelty decoration, special effects, etc. The device can also be an educational, science-fair project demonstrating plasma controlled by electrically and magnetically induced fields. Special materials treated by a controlled plasma beam can also be realized.

What It Is

The Plasma Machine consists of a low-powered, high-frequency, high-voltage generator that is somewhat like the high-voltage circuit in a television receiver. The generator produces a voltage with the necessary parameters for obtaining the described plasma effect. The generator uses a circuit consisting of transistors that rapidly switch current through a winding on a ferrite core of a high-voltage, resonant transformer (similar to a TV flyback transformer). Power for the transistors is obtained from a step-down transformer and rectifier combination.

A clear, glass container or jar of suitable size is evacuated to a low gas pressure of less than 2 *torrs* and uses the metal cover as a convenient discharge element. The metal cover of this container also provides an excellent low-cost approach to constructing a home-made or laboratory model without expensive glass-blowing facilities. The display jar has provision for depressurizing and then being permanently sealed. Again, the metal cover of a pickle jar makes an excellent choice because a piece of copper capillary can be soldered directly to it, forming a good vacuum-tight seal and allowing pinching-off for sealing. Should the display container require the vacuum to be restored, the pinched capillary tubing is opened for connection to the vacuum system.

The display jar is mounted on a suitable stand that houses the high-voltage generator beneath it. The entire assembly resembles a water cooler. To some, it looks like a gumball machine. Refer to Fig. 1.

The following instructions show how to assemble the Plasma Machine that is capable of generating a plasma *tornado*. That phenomenon uses nature's fourth state of matter to produce the effect. While the Plasma Machine doesn't do anything really useful, with the exception of deodorizing putrid air, it does demonstrate an interesting display of that form of energy. Several local pubs in the area have purchased those units assembled and ready to use. They place them on the bar, or other appropriate location, and allow the customers to control the plasma tornado using their fingers, hands, pencil points, etc.

Science Fair buffs can look to the Plasma Machine as an exciting, visual display of electronics and plasma in action. It could be a sure winner if you are the first in your school to display it.

The plasma is inside a glass enclosure (the pickle jar) and

The plastic enclosure fits neatly over the assembled bracket assembly. The enclosure is a No. 10 planter found in most variety stores. A hole is cut in the bottom to fit the PVC extender tube (EXT1) snugly. All of the electronics is safely covered so that observers can approach the Plasma Machine and touch the display jar without fear of a high-voltage shock.

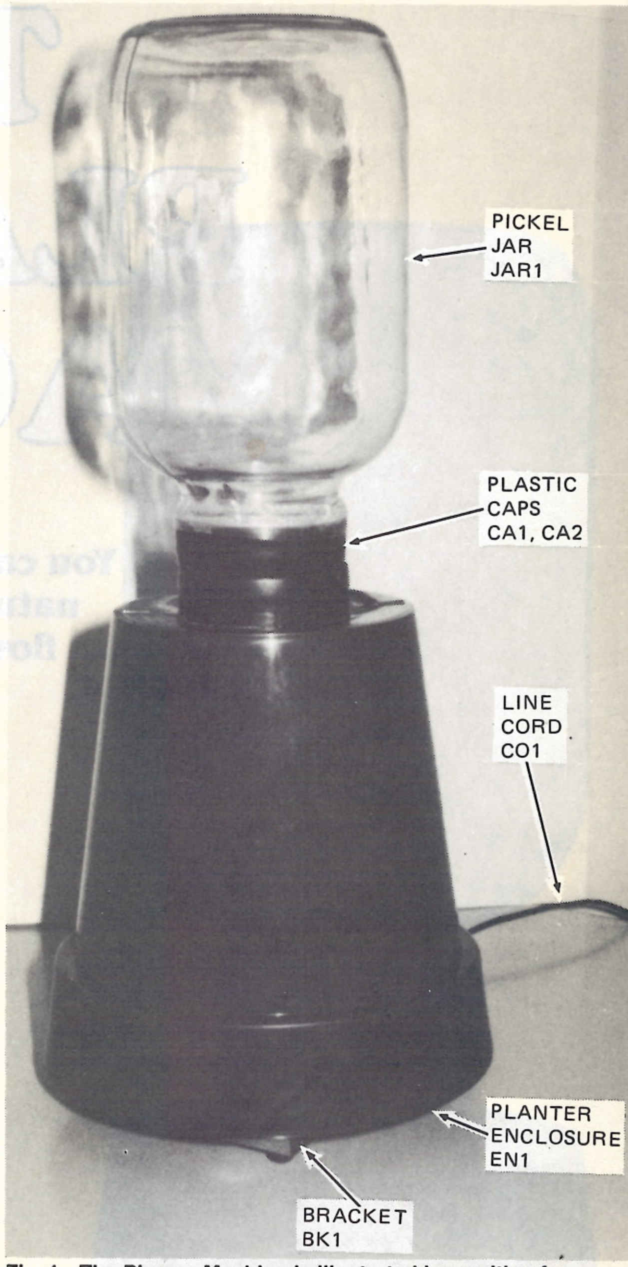


Fig. 1—The Plasma Machine is illustrated here with a few of its basic parts identified. Always keep in mind that the pickle jar (JAR1) contains a large evacuated volume so that it always should be handled with care.

resembles a tornado shape of glowing and swirling plasma. It dances and jumps to anything brought near it and is highly visible even in normal fluorescent lighting. That sensitivity to any external capacity creates many bizarre and seemingly striking effects. The plasma also can light up a fluorescent lamp when brought near the glass enclosure, without any wires or connections of any kind.

The Plasma Machine is an extremely interesting conversation piece and is unlike anything else that most people have yet seen. Its theory is very basic, but yet it still seems to amaze most people, who do not understand it.

Theory of Operation

An evacuated, glass jar is sealed and pumped down to 1-3 torrs of pressure. A metal cap seals the jar and serves as an electrode for charging the remaining thin gas mixture. The voltage applied to the cap is at a potential of 10- to 20-thousand volts of high-frequency AC at 15 to 30 kHz.

The ionization of the thin gas causes current to flow, creating the plasma discharges within the glass jar. One may visualize the device in the following manner: The conductive gas forms one plate of the capacitor inside the jar. The glass envelope of the jar is the insulating dielectric with the outer air serving as the other plate of the capacitor. Any conducting object brought near the jar now only enhances the conductivity of the outer plate and appears to draw the plasma flow to the point of contact. The vacuum will vary along with the physical parameters of the jar, and can be adjusted to enhance the type of discharge desired.

The evacuated pressure level, where the plasma discharges are best viewed, is critical. Increases in pressure above that level will create a broken wisp effect and a decrease will broaden the discharge path within the glass jar, making it less pronounced. Further variances from the above will eliminate the discharge completely.

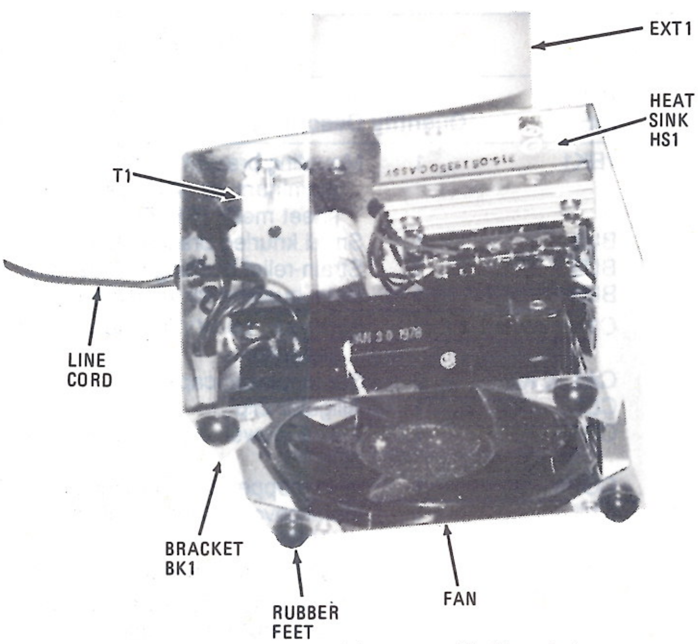
The effect of where conduction of a gas peaks at a certain pressure is known as the Townsend Effect, and it becomes an important factor in the design of vacuum systems where medium-to-high voltages are encountered. The basic Plasma Machine does not require any gas other than the existing atmosphere rarefied by evacuation to obtain a decent display.

Other colors and effects are limitless when the builder chooses to charge the Plasma Machine with other gases or combinations of gases. For example: Evacuate the jar and then place a balloon filled with helium over the input port. Open the valve and let the helium in. Now, evacuate the jar and the bulk of the residual gas will be helium.

Another technique is to place a few ounces of dry ice in the jar. Allow the jar to exhaust into the atmosphere until all of the ice sublimates. Do not permit internal pressure to build up in the jar. The carbon-dioxide gas that the dry ice emits will displace most of the nitrogen and oxygen in the jar. Again, evacuate the jar, leaving mostly carbon dioxide behind. Nitrogen gas is easy to obtain from tanks used by welders, hospitals, telephone company, etc.

Gas contained in tanks are at very high pressures. Take special care to allow the gas inserted into the glass jar to bleed out freely so that the internal pressure of the jar is only slightly above normal air pressure, and never higher. The best way to do that safely is to place a rubber or plastic hose inside the jar and let the nitrogen come in quickly with the cover off the jar. Then, as quickly as possible, remove the hose and clamp on the cover practically in one motion.

Do not use cooking gas, propane, pure oxygen, or other gases that support combustion. They can produce an ex-



Looking up into the bottom of the assembled bracket you can see the fan installed. It blows upward providing a cooling stream of air against the heat sink immediately above it.

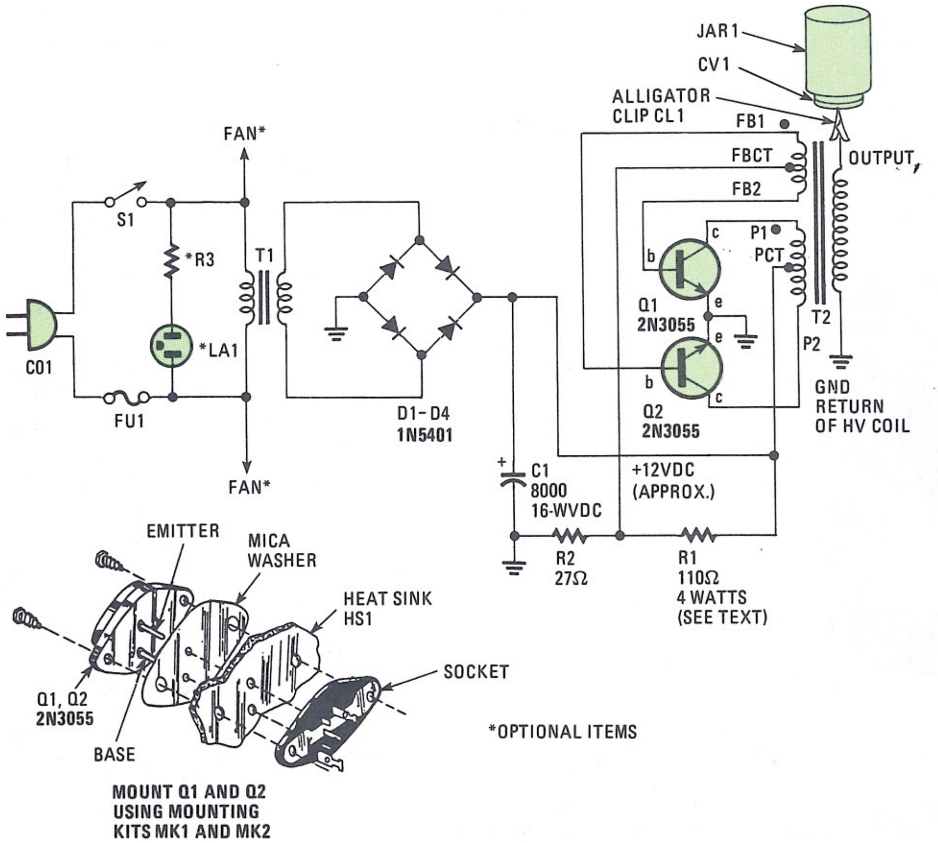


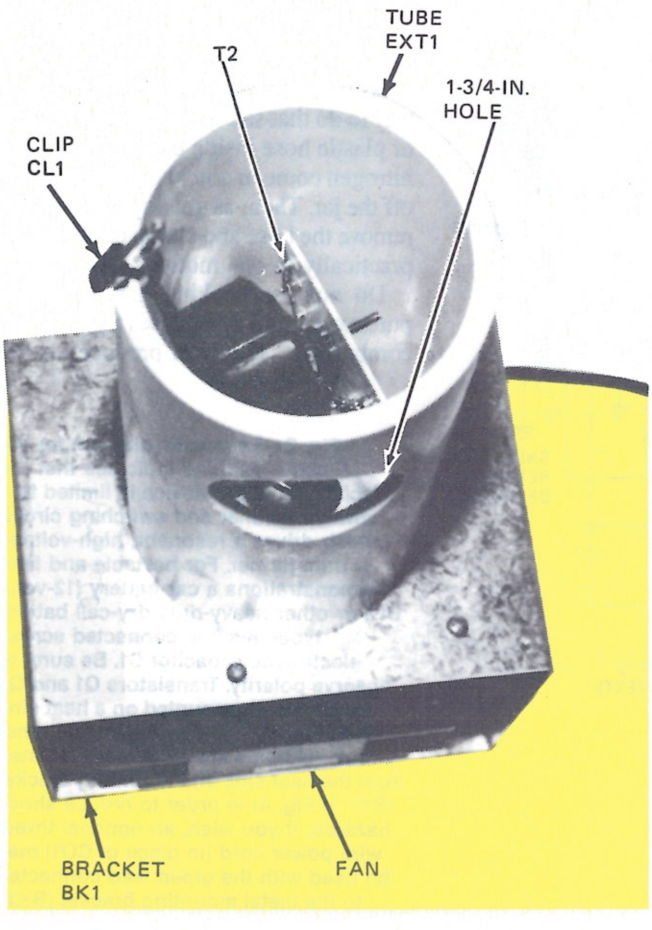
Fig. 2—Schematic diagram for the Plasma Machine indicates that the electronics of the device is limited to a fullwave rectifier and switching circuit which drives a resonant, high-voltage transformer. For portable and field demonstrations a car battery (12-volts DC) or other heavy-duty dry-cell battery types may be connected across electrolytic capacitor C1. Be sure- to observe polarity. Transistors Q1 and Q2 are physically mounted on a heat sink (HS1 in Fig. 4). The transistors and other circuit elements are electrically isolated from the heat sink and mounting bracket (BK1 in Fig. 4) in order to reduce shock hazards. If you wish, an optional three-wire power cord (in place of CO1) may be used with the green lead connected to the metal mounting bracket (BK1).

PARTS LIST FOR THE PLASMA MACHINE

Part No.	Quantity	Description
†BK1	1	Mounting bracket made from #22 aluminum or #24 galvanized sheet metal ($12.50)
BU1	1	Small knurled brass nut
BU2	1	Strain-relief bushing for line cord
BU3	1	½-in. bushing for wires from T2
C1	1	8000-µF, 16-WVDC electrolytic capacitor
CA1, CA2	2	3½-in. plastic caps
CL1	1	Alligator clip
CO1	1	2-wire power cord with molded plug
COP1	1	⅛-in. copper capillary (tubing)
CV1	1	Metal cover to 1-gallon display jar (JAR1)
D1–D4	4	1N5401 3-A, power-rectifier diode
EN1	1	Large plastic enclosure made from #10 plastic planter
EXT1	1	PVC extender tube, 3½-in. OD × 7-in.
*FAN1	1	Rotron fan, or similar muffin type
*FU1	1	1-A fuse with fuse holder
HS1	1	Dual TO3 transistor heat sink
†JAR1	1	Display jar (1-gallon) to fit metal cover (CV1) with rubber seal—pumped down to 1.5 mm (torr) air ($24.50)
*LA1	1	NE51 neon lamp with wire leads

Part No.	Quantity	Description
MK1, MK2	2	Transistor mounting kits for TO3-case
†PV1	1	⅛-in. brass petcock and fitting
†Q1, Q2	2	2N3055 NPN power transistor
R1	2	Use two 220-ohm, 2-watt, 10% resistors in parallel to form one 110-ohm, 4-watt, 10% resistor
R2	1	27-ohm, ½-watt, 10% resistor
*R3	1	100,000-ohm, ¼-watt, 10% resistor
*S1	1	SPST toggle switch
SW1, NU1	as req'd	6-32 screws and nuts, ¼- to ½-in. lengths
SW2	2	6-32 1-inch screws
SW3	3	#6 ½-in. self-tapping screws
†T1	1	117-volt AC to 12-volt AC, 3-A power transformer
†T2	1	Ferrite, TV, resonant high-voltage transformer
TE1	1	7-lug terminal strip with end terminals providing mounting legs
WN1, WN2	2	Small wire nuts
WR1	24-in.	#18-AWG, vinyl-insulated wire
WR2	24-in.	#24-AWG, vinyl-insulated wire

†Available separately from Information Unlimited
*Optional—see text.
A complete kit on certain individual parts—$85.50. Order from Information Unlimited, Box 716, Amherst, NH 03031.



Looking down into the PVC tube (EXT1) you see the high-voltage transformer T2. The alligator clip is connected to the transformer's high-voltage output lead. The clip (CL1) connects to the cap of the display jar (JAR1) that rests on top of the tube.

plosive atmosphere. Refer to the section in *Special Note on Different Gases*.

It is interesting to mention at this time that the acetic acid given off by the curing of RTV cement produces a white plasma display.

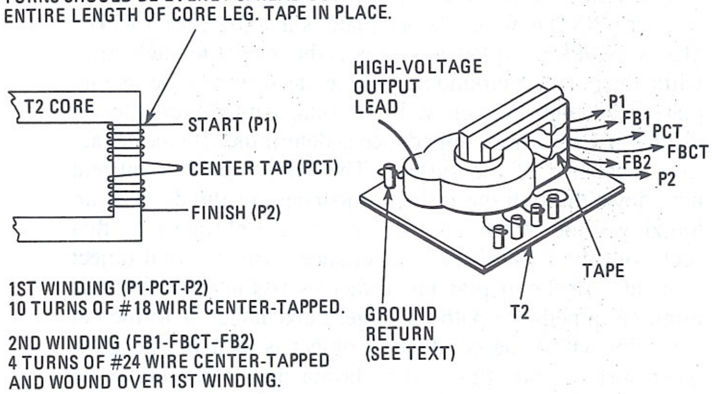
Circuit Description

In the following discussion, please note that the symbols used to identify electrical and mechanical parts are not in conformance to the universal convention used by **Hands-on Electronics** and the electronics industry. No change was made to those symbols in the preparation of this text, so that the parts identification will coincide with supplier of the kit. Refer to the Parts List.

Power is obtained by polarized plug (CO1) and is fused by (FU1) before energizing the primary winding of the transformer (T1). Refer to Fig. 2. Switch S1 controls the power and serves as an on/off switch. The neon lamp (LA1) is lit when power is applied to the primary winding of the transformer. Resistor R3 limits the current through the neon lamp so that it will not destruct. Parts S1, R3, and LA1 are optional in that the line cord can be pulled from the AC outlet to disconnect the Plasma Machine. (*The editors prefer the use of the parts.*)

Transformer T1 steps down the 117-volt AC power line to 12-volts AC where diodes (D1–D4) rectify the voltage to a positive, pulsating, DC voltage. Refer to Fig. 2. That voltage

Fig. 3—The text gives complete details on adding the two new windings to the resonant, high-voltage transformer T2. That transformer is typical of the high-voltage transformers found in consumer solid-state TV receivers. Each winding should be evenly spaced and done neatly. The primary-winding terminals are marked P1, P2, and PCT (CT for *Center Tap*). The feedback winding terminals are marked FB1, FB2, and FBCT.



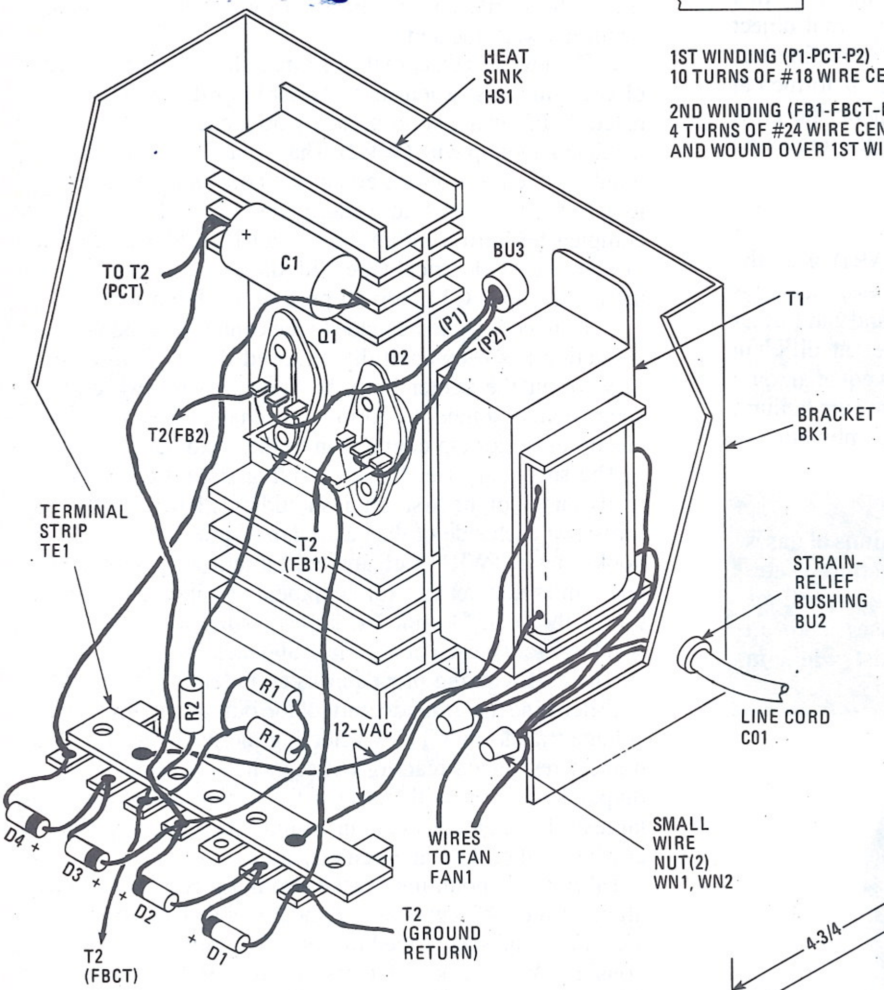
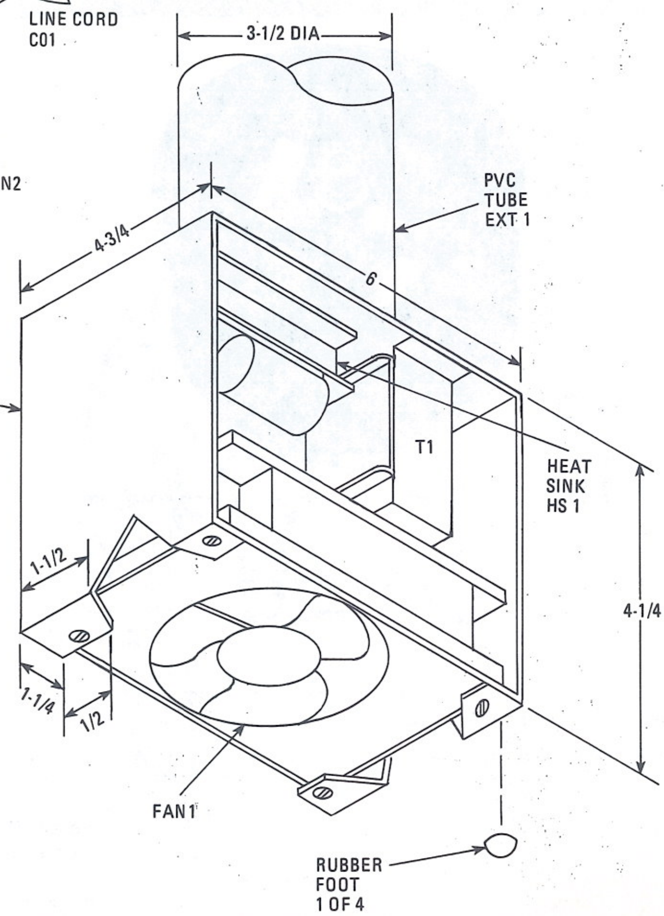


Fig. 4—Here are two views of the metal mounting bracket (BK1) with the various circuit parts and other items attached to it. You could fabricate you own bracket, but before you do obtain the plastic enclosure that you will use. Then, the bracket is designed to fit inside the enclosure, provide mounting space for the circuit elements, and offer a safe, insulated container for the high-voltage transformer inside the PVC extender tube (EXT1). The fan may be considered optional should the Plasma Machine be used for short periods only. Nevertheless, the editor strongly recommends the inclusion of the fan in the design, because once the device is running you'll spend many minutes, if not hours, watching and playing with it.



is filtered by electrolytic capacitor C1 (8000- to 10,000-µF, 16-WVDC) to 10- to 14-volts DC.

The collectors of the transistors (Q1 and Q2) alternately switch the 12-volts DC to the primary winding of the resonant, high-voltage transformer (T2) at a period determined by the circuit's resonant frequency. Transistor base drive is obtained through the base winding and emitters' return resistor (R2). Resistor R2 is made from two 220-ohm, 2-watt resistors connected in parallel, that combination provides 110-ohms with the capability to dissipate 4 watts. The 27-ohm resistor (R1) and the usual unbalance in transistors start the oscillator. The resonant, high-voltage transformer (T2) now produces a stepped-up, high-frequency voltage. The output of high-voltage transformer (T2) is now connected to the discharge electrode (CV1) which is the metal cover of display jar.

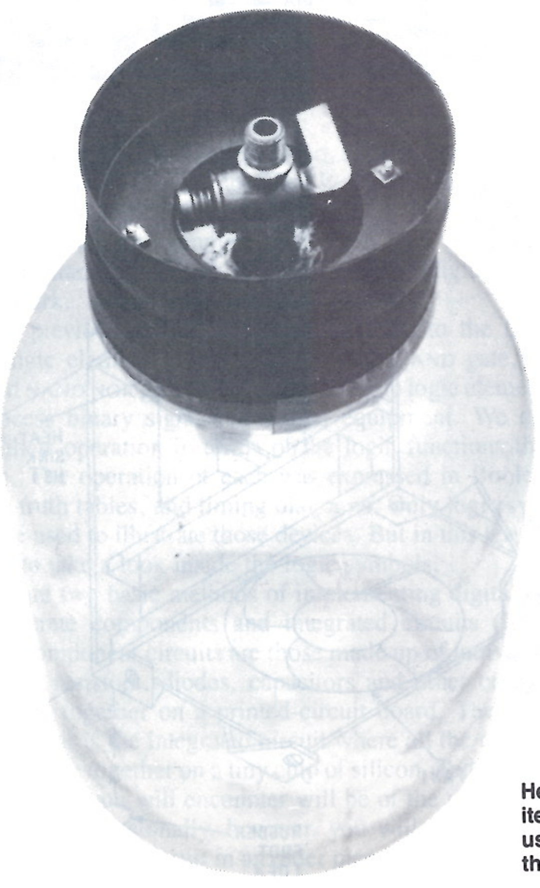
The highly-conductive, rarified atmosphere inside the display jar (JAR1) now acts as one plate of a large capacitor. The glass wall of the display jar serves as the insulating dielectric, while the outer air around the display jar serves as the second plate. The high-frequency, high voltage now encounters a discharge path whose impedance is determined by the capacitive reactance of the system. The high-frequency current now flows through the inside atmosphere of the display jar, ionizing some of the gas, thus creating a plasma path that seeks out the path of least impedance. Any external object brought near the display jar surface assists in providing this minimal impedance path. A larger capacitance is formed at the point where the conducting object is near on the glass outer surface and attracts the plasma due to the increased capacity effect.

Special Note on Different Gases

The Plasma Machine glass display jar (JAR1) uses the spectral and conductive property of rarified air as a vacuum is drawn down. A variety of effects are possible and can further be enhanced by the admission of other gases at different pressures. The combinations are many with an equal amount of different display phenomena. Suggested gases are helium, neon, carbon dioxide, krypton, argon, or any combination of those relatively inert gases.

CAUTION!

Do not use explosive gases and combinations of gases such as hydrogen, fluorine, chlorine, methane, etc. Always use inert gases. Observe all safety precautions when using high vacuums. Never use gases from an aerosol spray can. Check with a chemist when in doubt.



Here is the display jar assembled and evacuated. The black item on top of the display-jar cover is made from two plastic caps used to provide a joining grip between the display jar and the PVC extender tube (EXT1) on which it rests.

Assembly Steps

Lay out all the parts and materials required to assemble the Plasma Machine on a work surface along with the tools you would expect to use.

1. Rework high-voltage transformer (T2) as shown Fig. 3. Two new primary and feedback windings are added to the flyback transformer (T2) that connect to the driver transistors (Q1 and Q2). Those windings are hand-wound on the bottom leg of the ferrite core where the original two-turn filament windings were located.

2. Remove and discard the original filament winding. In its place, wind first a ten-turn, center-tapped winding (designated P1-P2) using approximately 30 inches of #18 or larger insulated hookup wire (WR2). That is easily accomplished by winding five turns at one end of the core and then twisting a loop in the free end before adding the second five turns. The complete ten-turn winding should then be held in place with a turn or two of electrical tape with the two ends (P1, P2) and the center tap (PCT) loop all protruding. Refer to Fig. 3.

3. Connection can be made to the center-tap loop when the insulation has been carefully removed. If it becomes necessary to cut the center loop, be sure that the two ends are scraped and joined to form a mechanical as well as an electrical center tap connection to the winding.

The secondary (feedback) winding should be wound directly on top of the first, but it should only have a total of four turns-two each side of the center tap. Wind two turns of #22 hook-up wire (WR1), pull and twist a center-tap loop (FBCT) and wind the other two turns. Tape that winding in place on top of the first. Do not let the center tap loops of the two windings touch each other. Mark all leads as indicated in Fig. 3. The coil-winding procedure is complete.

Determine the ground return of the output winding of high-voltage transformer T2 by selecting the pin or lead with the highest resistance reading between it and the high-voltage output lead. You will detect a finite resistance that is the largest. Do not consider an infinite-resistance reading as anything other than an open circuit.

Fabricate a mounting bracket from a piece of #22 gauge aluminum or #24 galvanized sheet metal (BK1 in Fig. 4B). The shape and size of the bracket will depend on the external housing. When a kit of parts is purchased, the bracket is fabricated to fit the housing. The bracket must be large enough to hold components shown in Fig. 4.

There are three holes located on a 3.25-inch diameter circle 120-degrees apart for securing the PVC extender tube (EXT1). Be careful not to interfere with the other components. Final assembly may be made easier by first securing the PVC extender tube (EXT1) to the mounting bracket (BK1) with three self-tapping screws (SW3).

Fabricate the PVC extender tube (EXT1) from a 7-inch length of 3½-inch, schedule 40, PVC pipe whose actual outside diameter is 3½-inch. The extender tube is necessary in the design of the Plasma Machine. It allows proper clearance of the jar cover from other metal parts in the device, because the cover is at a very-high voltage being connected directly to transformer T2.

Use a hole saw to cut a 1¾-inch diameter hole with its center located two inches from what will be the top end of the PVC extender tube. That hole is used to gain access into the extender tube so that the alligator clip (CL1) from high-voltage transformer T2 can be connected to the plasma tube using the shortest possible lead between the clip (CL1) and the high-voltage transformer (T2). See Fig. 5.

Assemble transformer T1 to the mounting bracket (BK1). Then attach the terminal strip (TE1) to the heat sink. It might be necessary to drill two holes between the first and second fins. Remove burrs from the heat sink in the area of the transistor mounting holes and mount transistors Q1 and Q2 to the heat sink using transistor mounting kits (MK1 and MK2) as shown Figs. 2 and 4.

Complete the wiring following the details in Figs. 2 and 4. The leads to high-voltage transformer T2 should be long enough so that the transformer will be about one inch off the surface of the bracket. See Fig. 5. Check your work carefully.

CAUTION:
High voltages are dangerous to your health and they can kill you!

(Continued on page 101)

A rear view of the bracket assembly with the electrical parts in place and the PVC extender tube (EXT1) installed. The 1¾-inch hole in the extender tube is not visible in this view.

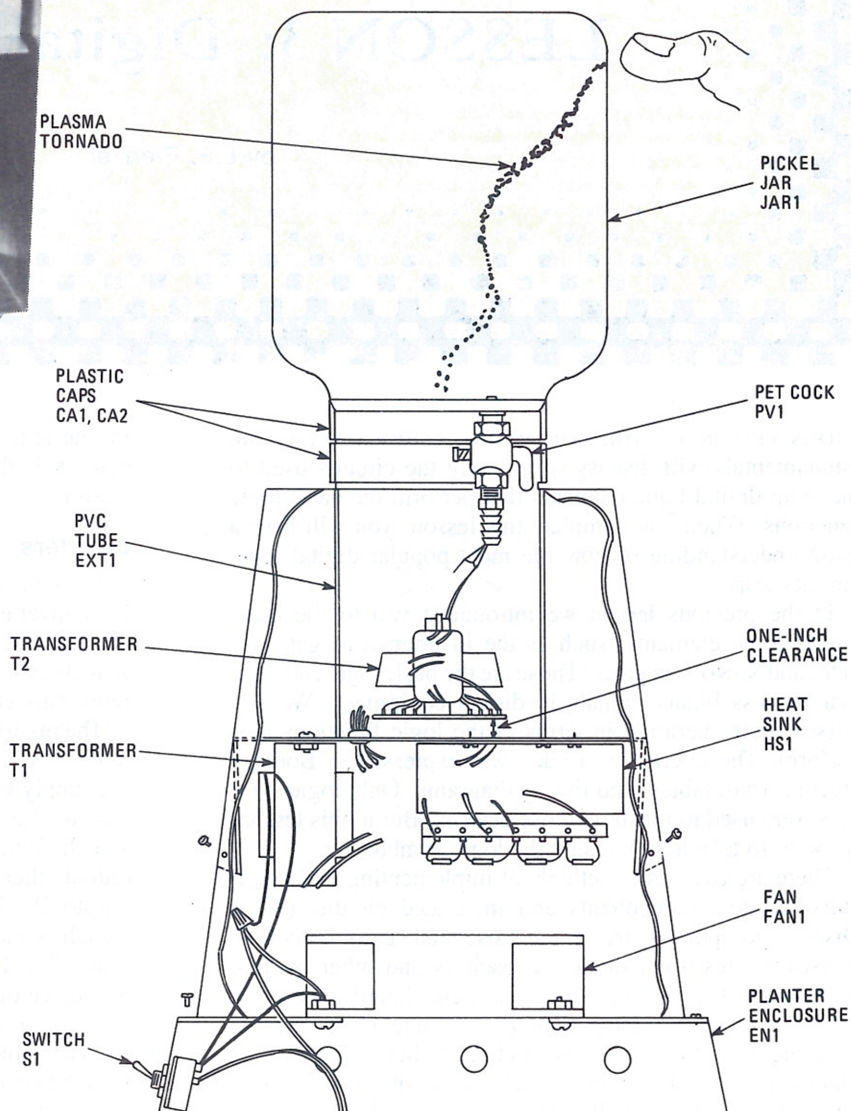


Fig. 5—Here's Superman's view of the Plasma Machine—we've added the call outs to identify the parts. High-voltage transformer T2 should be kept about one inch above the top surface of the mounting bracket (BK1). To do that the high-voltage lead with alligator clip attached is kept to a length so that the transformer *hangs* in the correct position. As an option to that design you may want to add some PVC pipe scraps to the bottom of the PVC extender tube (EXT1) to serve as insulating spacer material. Those scraps will keep the transformer from falling to the bracket and provide the necessary spacing. The PVC material is highly resistive to the high-voltage AC. The diagram does not show a fuse location. To include a fuse in the circuit, break the lead between the power cord and switch S1, Then install in that circuit gap a fuse holder that can mount on the plastic enclosure (EN1) next to toggle switch S1.

DIGITAL FUNDAMENTALS

Now you will discover the operation of inverters and gates, or gates and how to use logic gates. You get an insight to digital integrated circuits small-scale integration (SSI) to very-large scale integration (VLSI). And, we test your knowledge.

LESSON 3: Digital Circuits

by L.E. Frenzel

THIS LESSON OF THE CONTINUING SERIES ON DIGITAL Fundamentals will discuss specifically the circuits used to make up digital logic elements that perform the basic logic functions. When you complete this lesson, you will have a good understanding of how the most popular digital logic circuits work.

In the previous lesson we introduced you to the basic digital logic elements, such as the inverter, AND gate, OR gate, and NAND NOR gates. Those are the basic logic elements that process binary signals in digital equipment. We discussed their operation in terms of the logic functions they perform. The operation of each was expressed in Boolean algebra, truth tables, and timing diagrams. Only logic symbols were used to illustrate those devices. But in this lesson, we want to take a look inside the logic symbols.

There are two basic methods of implementing digital circuits: discrete components and integrated circuits (IC's). Discrete-component circuits are those made up of individual transistors, resistors, diodes, capacitors and other components wired together on a printed-circuit board. The other type of circuit is the integrated circuit where all the components are made together on a tiny chip of silicon. Today, most digital circuits you will encounter will be of the integrated-circuit form. Occasionally, however, you will run across a discrete-component circuit in an older piece of equipment or in one requiring some special or simple function. We will discuss both IC's and discrete-component circuits in this lesson.

Inverters

Let's begin our discussion with the circuits used to make a logic inverter. We will talk about simple discrete-component circuits first and that knowledge will easily translate to integrated circuits. For our discussion here, zero volts or ground represents a *binary 0* and +5-volts DC represents a *binary 1*.

The main element in an inverter circuit is a switch as shown in Fig. 1A. The switch is connected in series with a resistor to the supply voltage. A binary input signal controls the operation of the switch. The binary output appears across the switch. When the input is binary 0, the switch is open. The output, therefore, is +5 volts or binary 1 as seen through resistor R1. The circuit does invert. If the input is binary 1, the switch is closed. Current flows through the switch and resistor R1. The output is 0 volts or binary 0, because the resistance of the switch is near zero.

A common bipolar transistor can be used as the switch to form a simple inverter as shown in Fig. 1B. A transistor works well in that application, because it can be turned off so that no current flows through it or so that the transistor can be turned on to act as a very low resistance and current flows through it.

THE PLASMA MACHINE

(Continued from page 57)

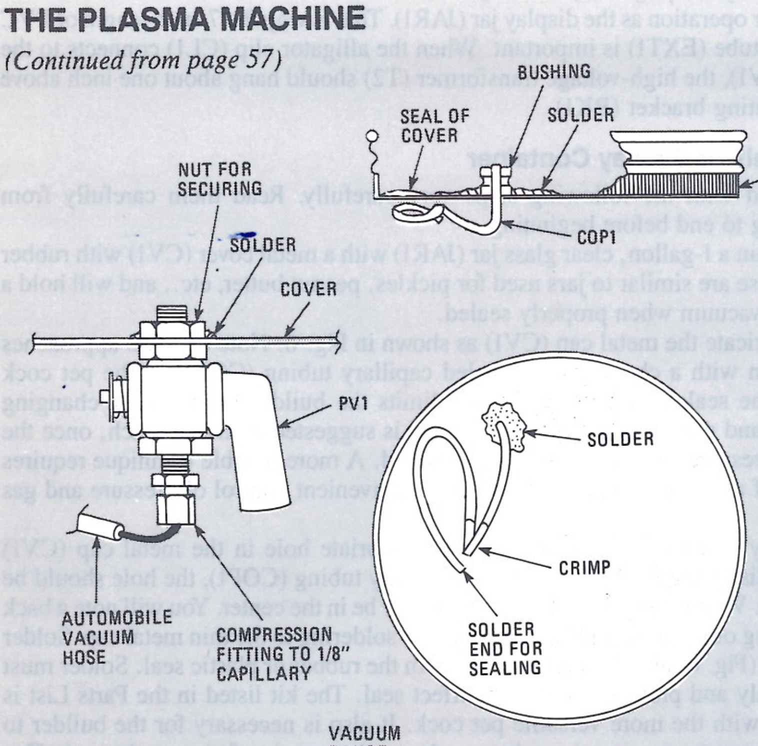


Fig. 6. It is reasonable to assume that most electronics hobbyists do not have a vacuum source or pump at home that can go down to 1-mm of mercury (approximately 1 torr). Most Plasma Machine builders will obtain the display jar direct from the supplier in the Parts List. In that case the display jar (JAR1), cover (CV1), and pet cock (PV1) come as an assembled unit with the interior evacuated to the desired vacuum. However, for those few who do have a vacuum source available, the details in the drawings are important. The Plasma Machine may be powered with high voltage as the display jar is evacuated to 1 to 2 torrs. Ordinary automotive vacuum hoses may be used since they will provide adequate electrical insulation. Nevertheless, observe extreme caution in the vicinity of the Plasma Machine, and do not touch unless the power is turned off. Once the plasma tornado comes into view as the pressure drops, select the vacuum level that offers the brightest display with a well defined plasma column. Whenever you apply heat to the cover for soldering purposes, be sure *not to damage the rubber or plastic seal* on the covers' inside-top edge.

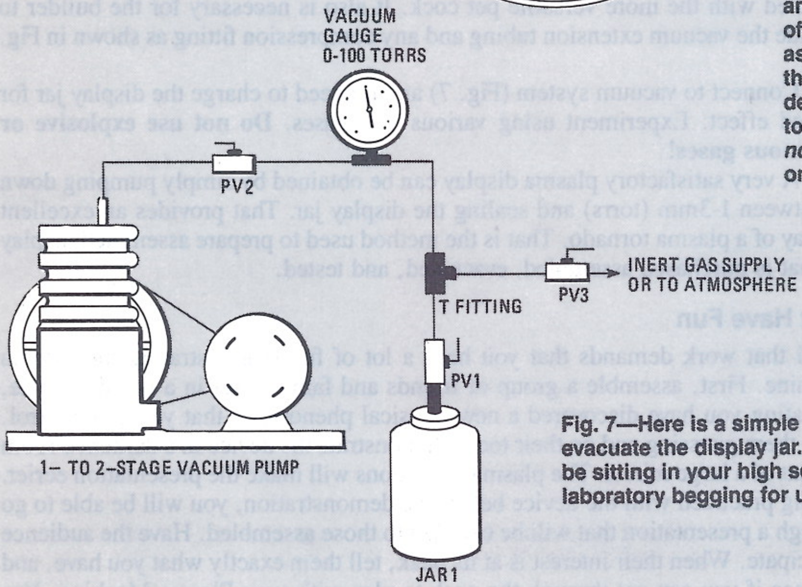


Fig. 7—Here is a simple vacuum setup that can be used to evacuate the display jar. All the items for this setup may be sitting in your high school's or college's physics laboratory begging for use. Speak to the instructor in charge.

Powering Up

Plug the AC line cord into an outlet and set S1 to on. Power is applied to step-down transformer (T1). An electrical arc of nearly 1-inch may be drawn from the high-voltage lead of transformer T2. Use a long, clean glass rod to bring a grounded wire to the alligator clip (CL1). Have a second person ride the power switch so that power would be disconnected immediately in case of smoke, overheating, or other disaster. Once an arc is drawn and proven to be stable, remove the lead and glass rod. Leave the power on for several minutes, then turn it off. Immediately check for excessive heating of the transistors. If continuous use is anticipated, it will be necessary to cool the heat sink and components with a fan (FAN1) as shown in Figs. 4 and 5. The circuit does have a tendency to run hot.

The human body acts as an antenna when in contact with any metal part of the Plasma Machine and an annoying burning sensation will occur. To avoid that effect, cover any and all metal parts including the toggle lever of switch S1 with a piece of plastic tubing. Cover any exposed screw heads with high-voltage putty, or a dab of RTV cement.

Fabricate the plastic enclosure (EN1) as shown in Fig. 5 to mate with power-supply assembly diagrammed in Fig. 4. Also shown is a method of mounting an optional muffin fan (FAN1) for cooling. Note: About ten ⅜-inch-diameter ventilation holes are punched or drilled in the lower base area. Another method to increase air circulation by the fan is to raise the base with rubber feet, keeping the housing about one inch above the tabletop.

The enclosure shown and supplied with the kit is a large plastic planter available through most garden and florist shops. Obtain a #10 standard plastic pot, or equivalent.

Positioning of the high-voltage transformer is important

(Continued on page 102)

(Continued from page 101)

for proper operation as the display jar (JAR1). That is why the 7-inch length of PVC extender tube (EXT1) is important. When the alligator clip (CL1) connects to the cover (CV1), the high-voltage transformer (T2) should hang about one inch above the mounting bracket (BK1).

Assembly of Display Container

Proceed with the following steps very carefully. Read them carefully from beginning to end before beginning.

1. Obtain a 1-gallon, clear glass jar (JAR1) with a metal cover (CV1) with rubber seal. Those are similar to jars used for pickles, peanut butter, etc., and will hold a medium vacuum when properly sealed.

2. Fabricate the metal cap (CV1) as shown in Fig. 6. Note that two approaches are shown with a choice of the sealed capillary tubing (COP1) or the pet cock (PV1). The sealed capillary technique limits the builder from readily changing pressure and gas mixtures. That technique is suggested as an approach, once the desired pressure and mixtures are determined. A more flexible technique requires the use of a pet cock, which allows more convenient control of pressure and gas mixtures.

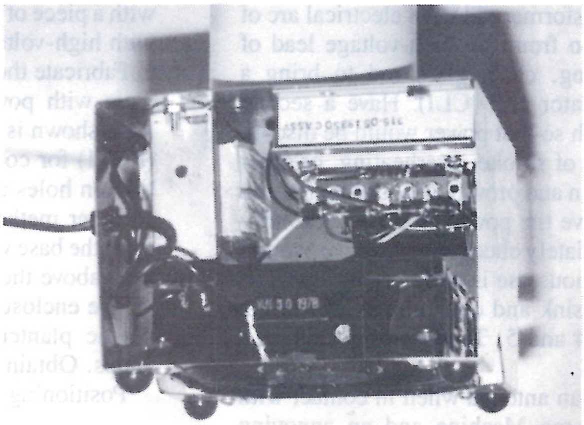
3. Very carefully punch or drill an appropriate hole in the metal cap (CV1) without distorting it. When using the capillary tubing (COP1), the hole should be off center. When using the valve, the hole may be in the center. You will note a back up bushing or nut to provide surface area for soldering to the thin metal cap. Solder as shown (Fig. 6) and be careful not to burn the rubber or plastic seal. Solder must flow evenly and provide a vacuum-perfect seal. The kit listed in the Parts List is supplied with the more versatile pet cock. It also is necessary for the builder to provide the vacuum extension tubing and any compression fitting as shown in Fig. 6.

4. Connect to vacuum system (Fig. 7) and proceed to charge the display jar for desired effect. Experiment using various safe gases. **Do not use explosive or poisonous gases!**

5. A very satisfactory plasma display can be obtained by simply pumping down to between 1-3mm (torrs) and sealing the display jar. That provides an excellent display of a plasma tornado. That is the method used to prepare assembled display jar that is purchased assembled, evacuated, and tested.

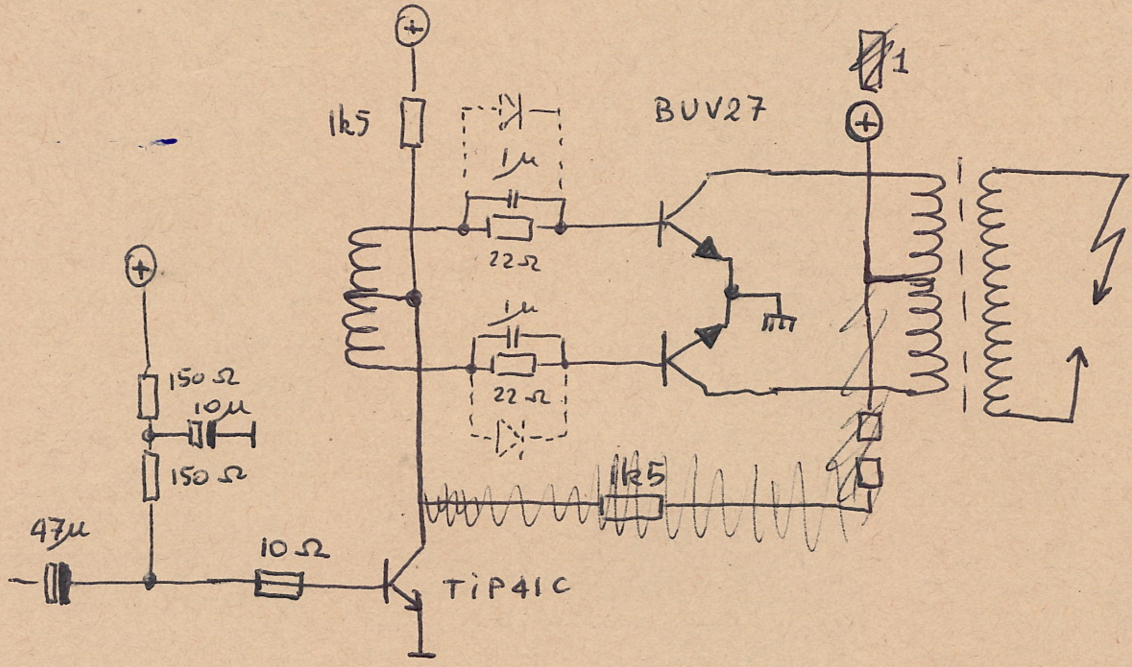
Now Have Fun

All that work demands that you have a lot of fun demonstrating the Plasma Machine. First, assemble a group of friends and family. Act in a mystical style, indicating you have discovered a new physical phenomena that you can control. Keep them guessing and on their toes. Demonstrate the device in a darkened room in front of a large mirror. The plasma reflections will make the presentation eerier. Having practiced with the device before the demonstration, you will be able to go through a presentation that will be exciting to those assembled. Have the audience participate. When their interest is at its peak, tell them exactly what you have, and then see if you can get through the pack to play with your Plasma Machine. You may have to practice some crowd-control tactics. If that's your problem, we made your day! ■



Realizing the amount of metal work that goes into this project, consider following the author's layout to the letter. In fact, it is suggested that you obtain the parts in kit form. Refer to the Parts List.

Vlamboog
& plasma speakers



Sic

Transistorgegevens

TO220 – types:

TIP120 : darlington

60V – 5A – 65Watt

= BD267
BD 645
BD 697

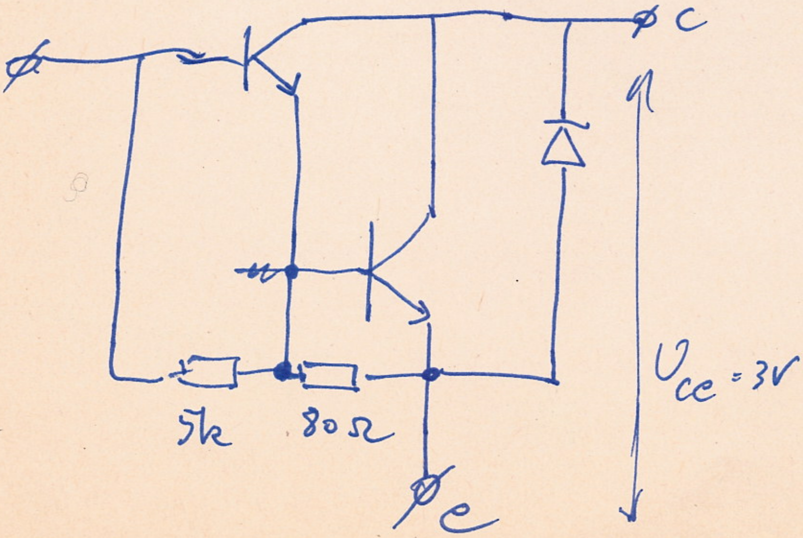
TIP130 : darlington.

60V – 8A – 70Watt

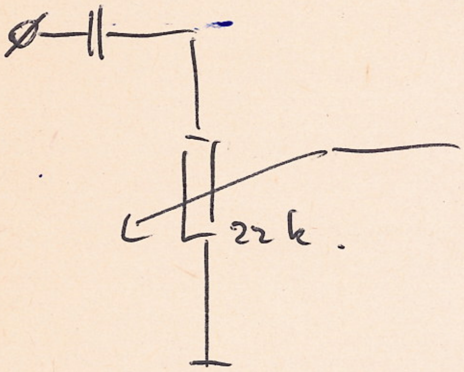
TIP140 : 60V – 10A. – 125Watt.

↳ brede TO220 !

= BDX65 (A/B) – MJ3000 of MJ3001



I_b max = 200mA



f_c

−6dB $\quad Z_c = 22k.$

$$Z_c = \frac{1}{2\pi f C_1} = 22k.$$

$$2\pi f C = \frac{1}{22000.}$$

$$C = \frac{1}{22000 \times 2\pi f} = 36 . 10^{-9}$$

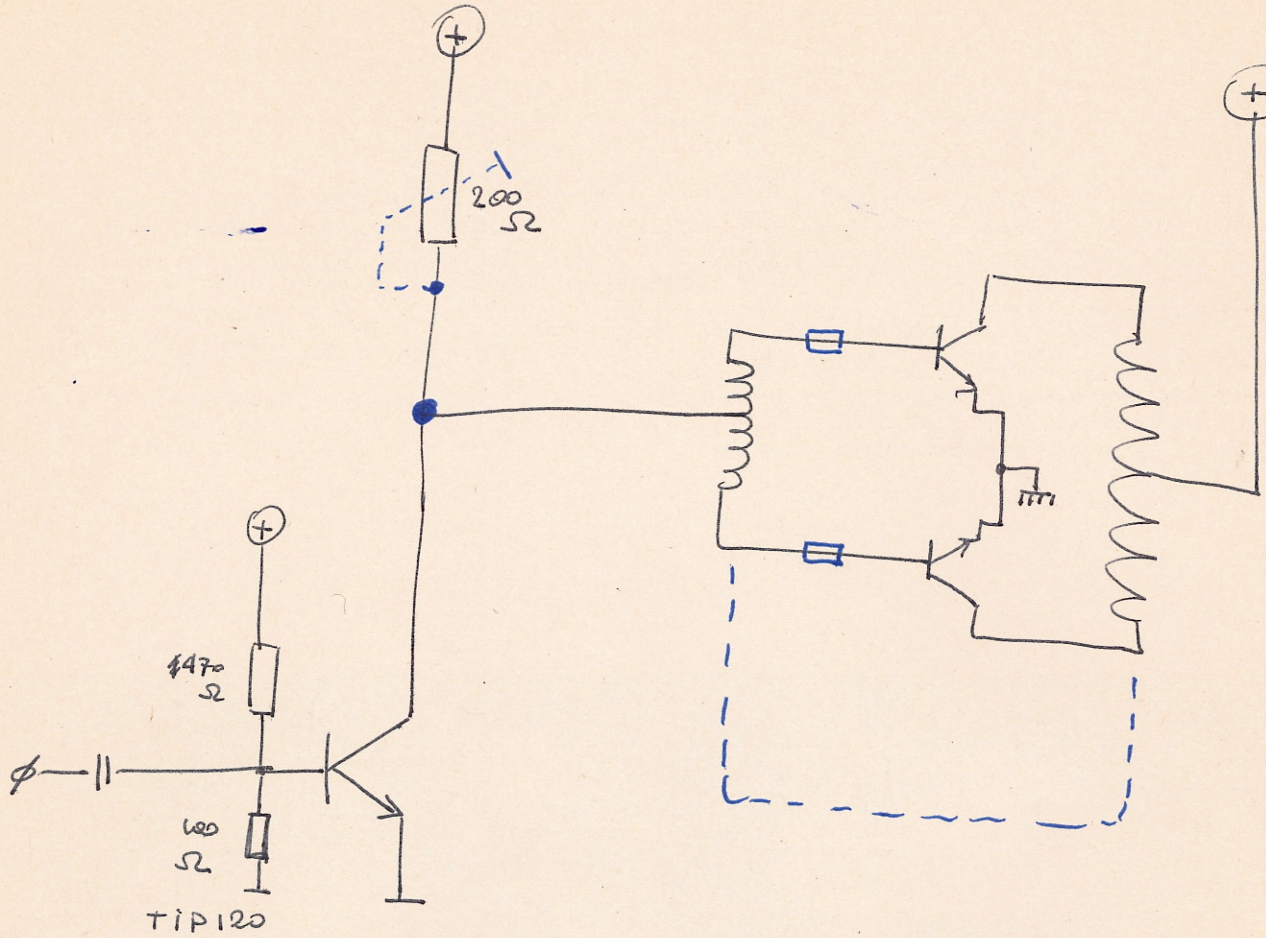
36nF

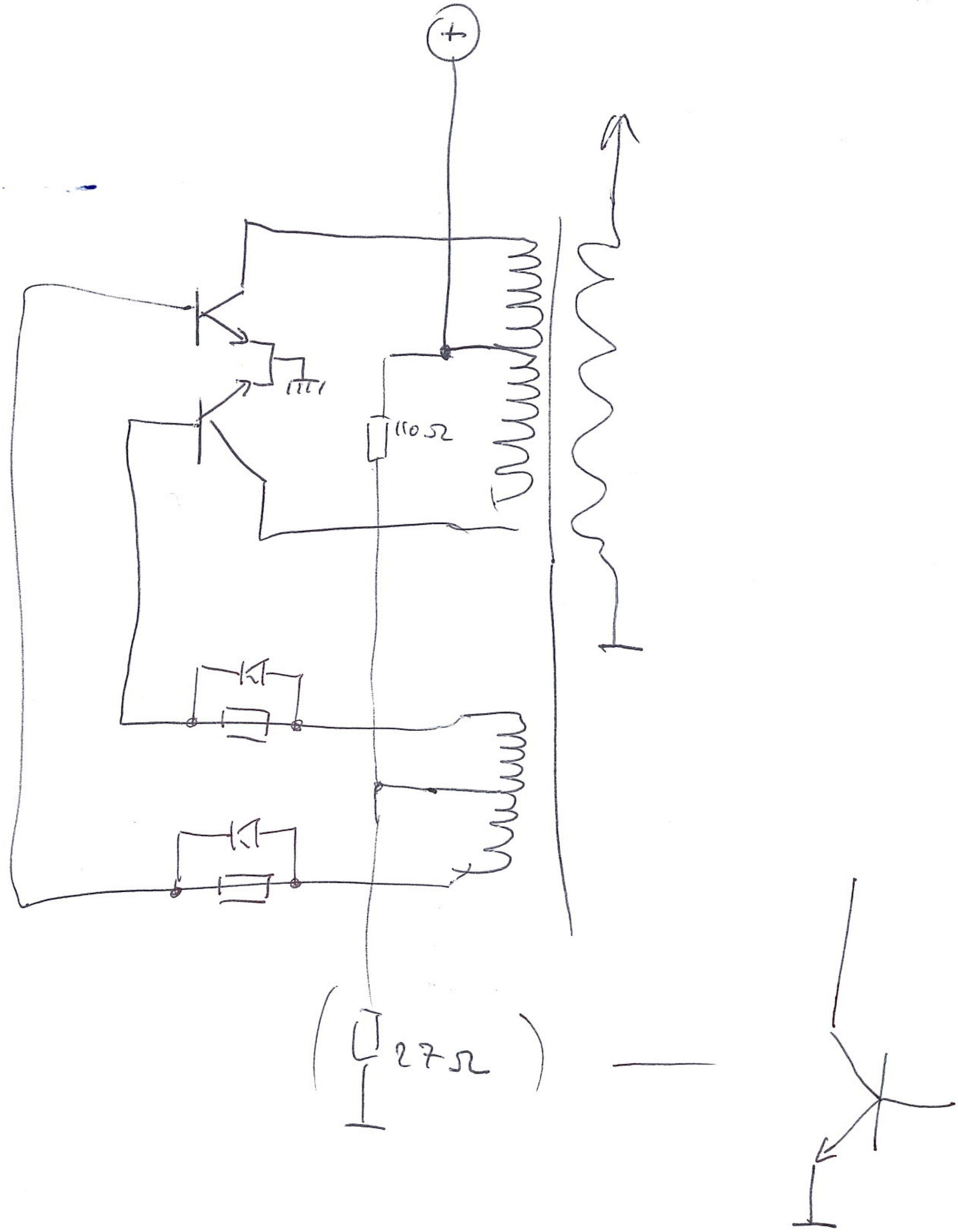
If $C = 0.1\mu$

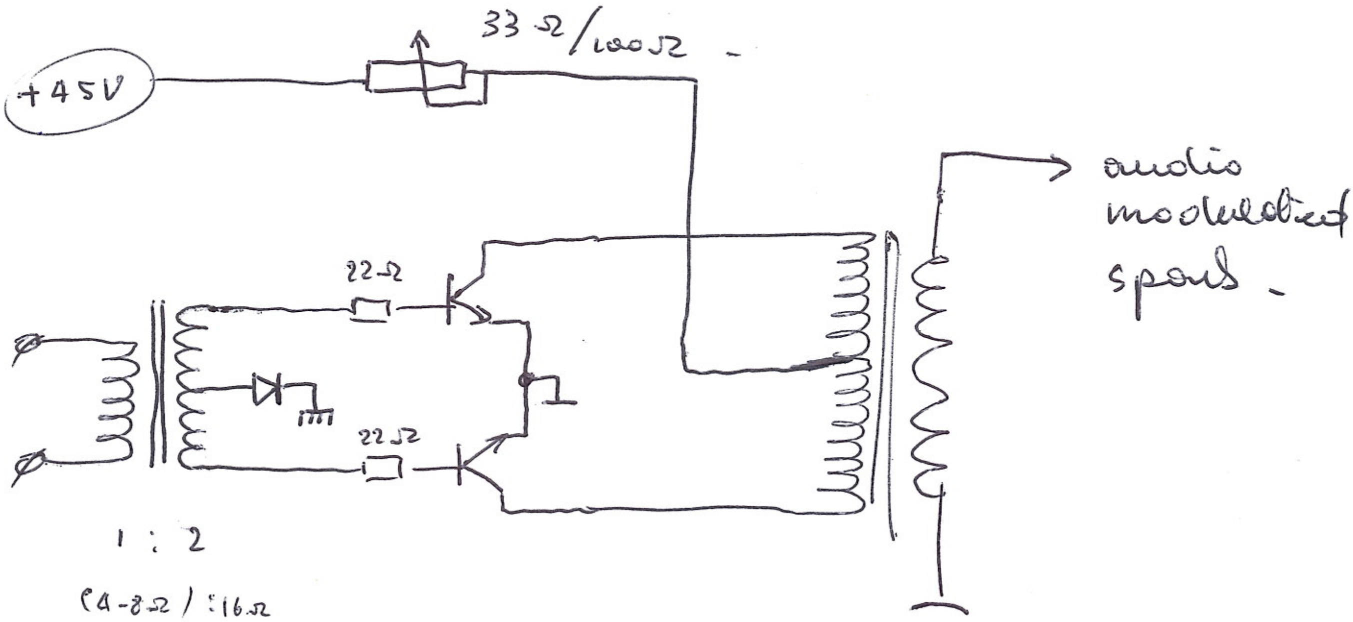
Then $f = \frac{1}{22000 * 2\pi * 0.1 . 10^{-6}} = 72 Hz$

Paul DeMarinis. Hij werkt haast uitsluitend met

werk. Dat is ook waarom ik graag stemmen gebruik die




+
110 Ω
27 Ω

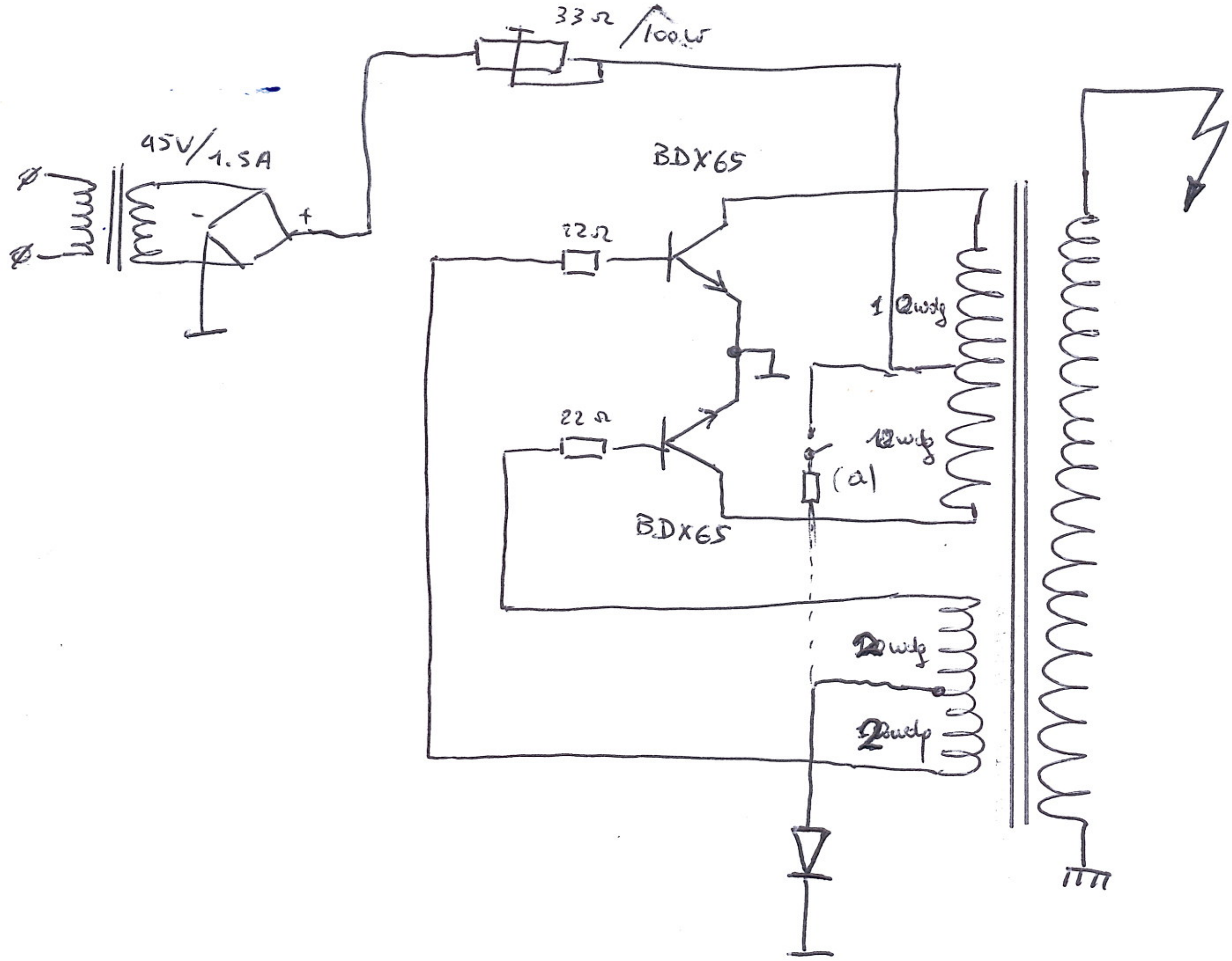


1 : 2

(4-8Ω) : 16Ω

use transistor output transformer.

Zelfoscillerende schakeling:



a) press to start up!

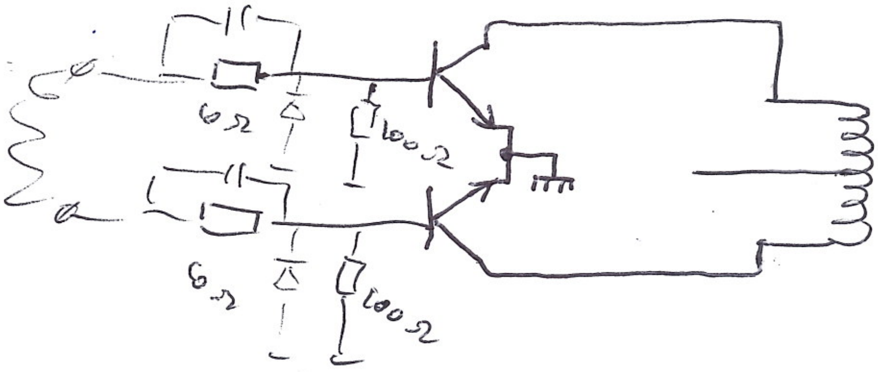
R = ± 100 Ω

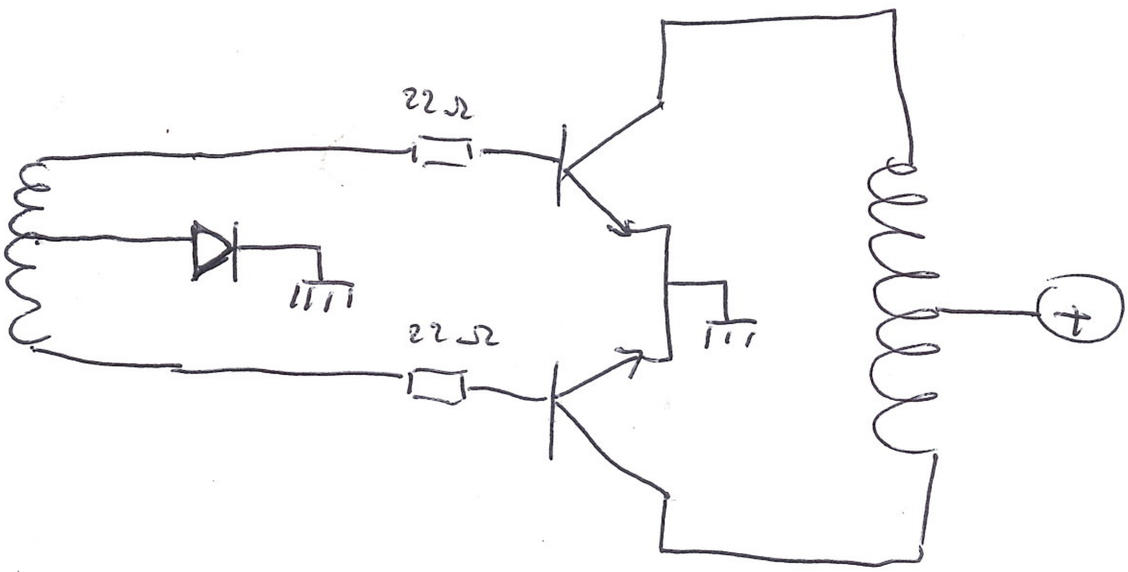
Werkb.

24/12/89.

C-amp.

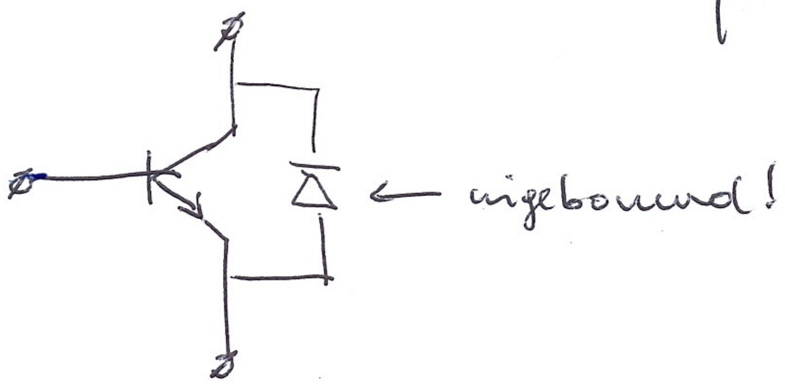
BDX65B





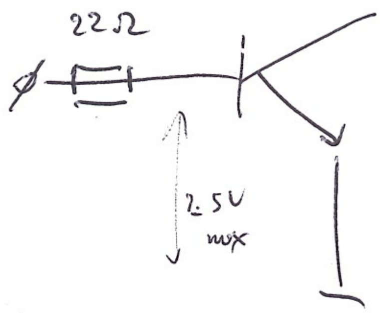
BDX65

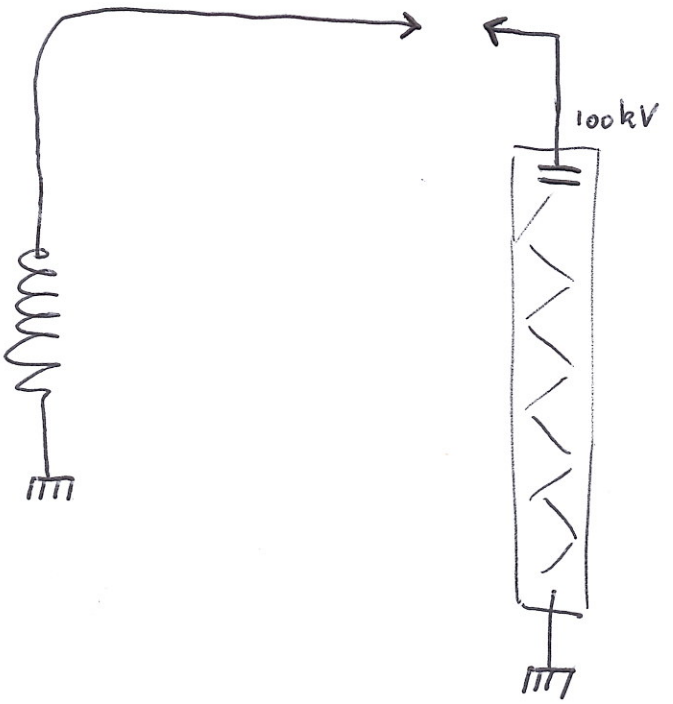
Darlington.



$I_{b\,max} = 200\,mA$

$U_{b\,max} = 5\,V$

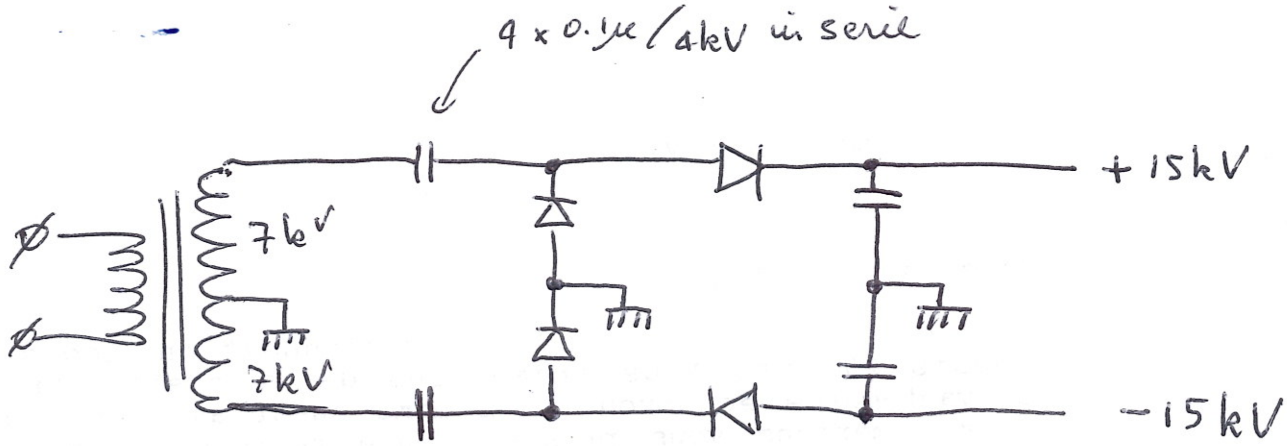



100kV

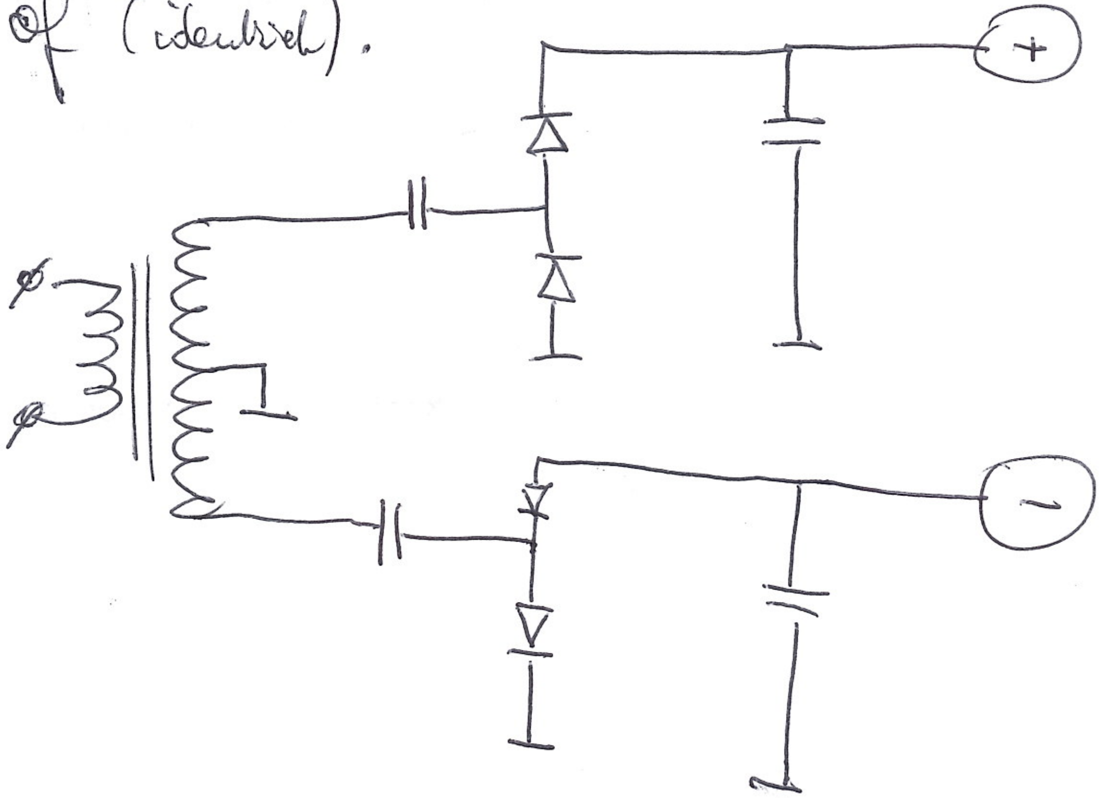
$I = \frac{45kV}{10^7}$ 4,5mA. $P = \frac{U^2}{R} = 202W$ 30kV.

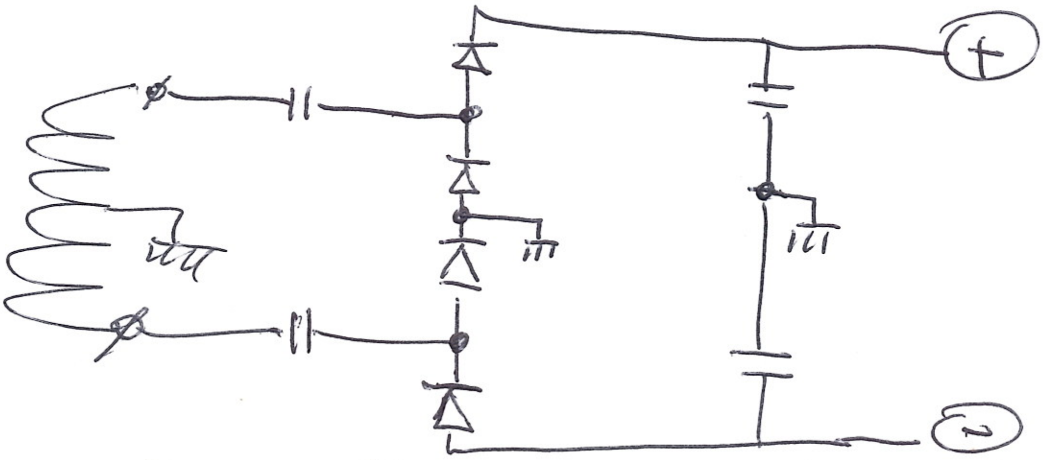
10MΩ

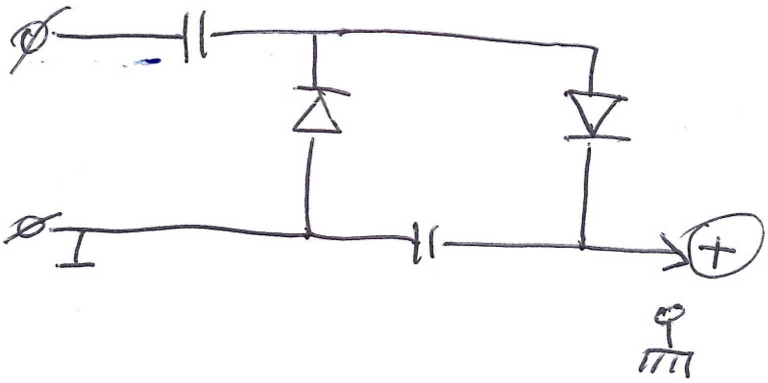
verdubbelaar.   P = 202W !

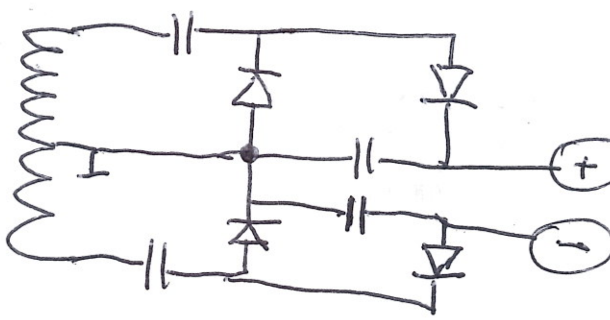


of (identiek).

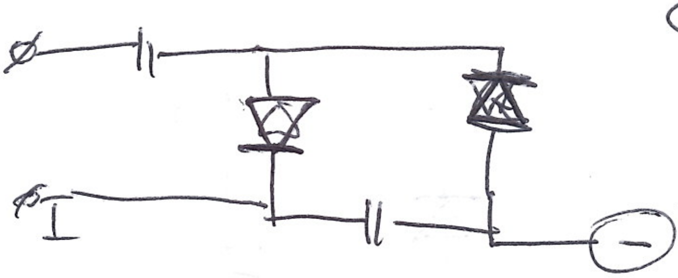


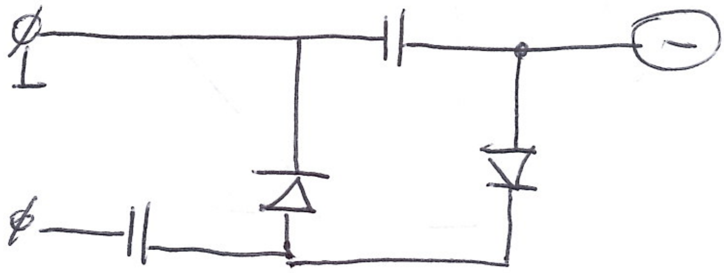


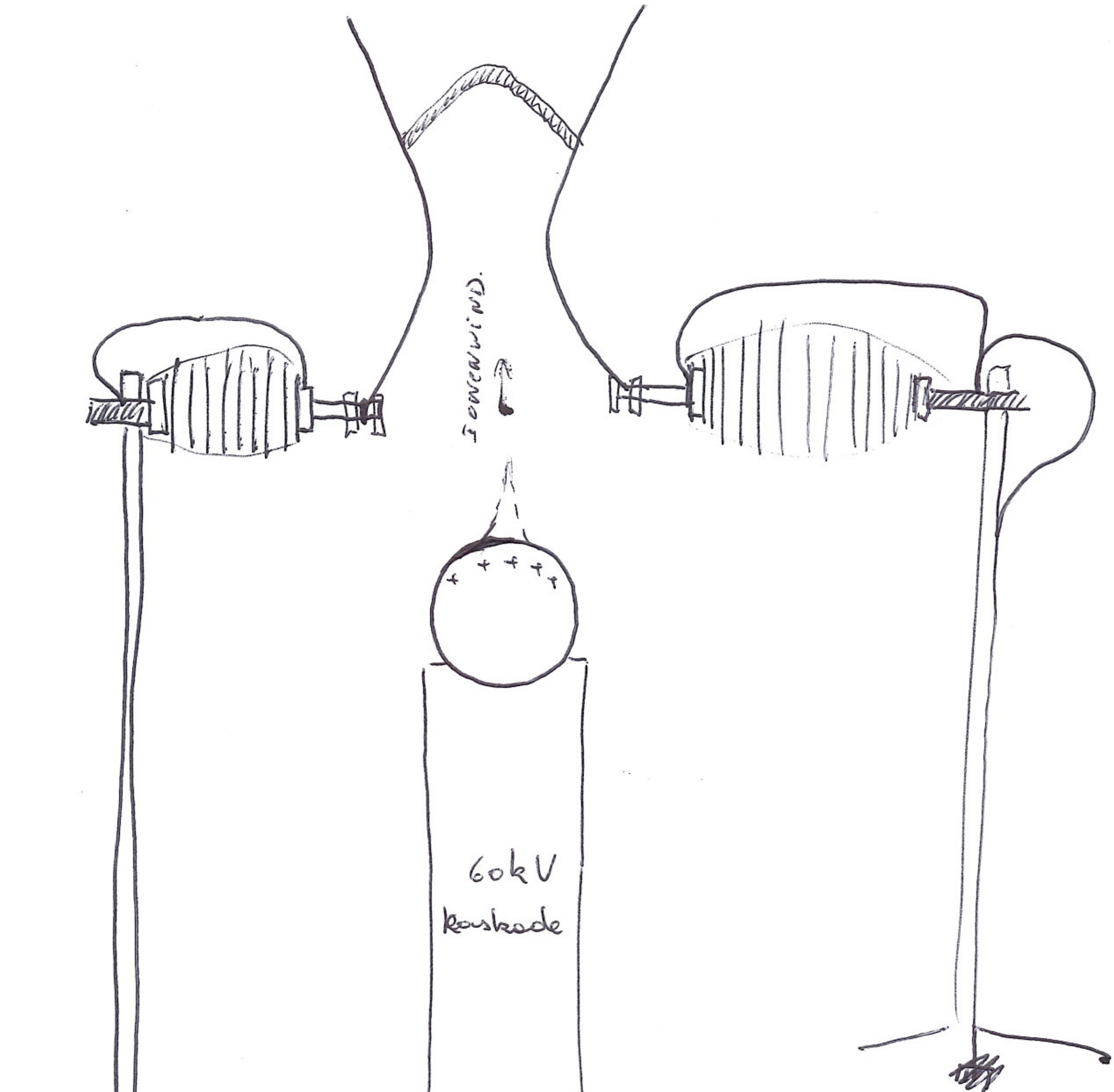




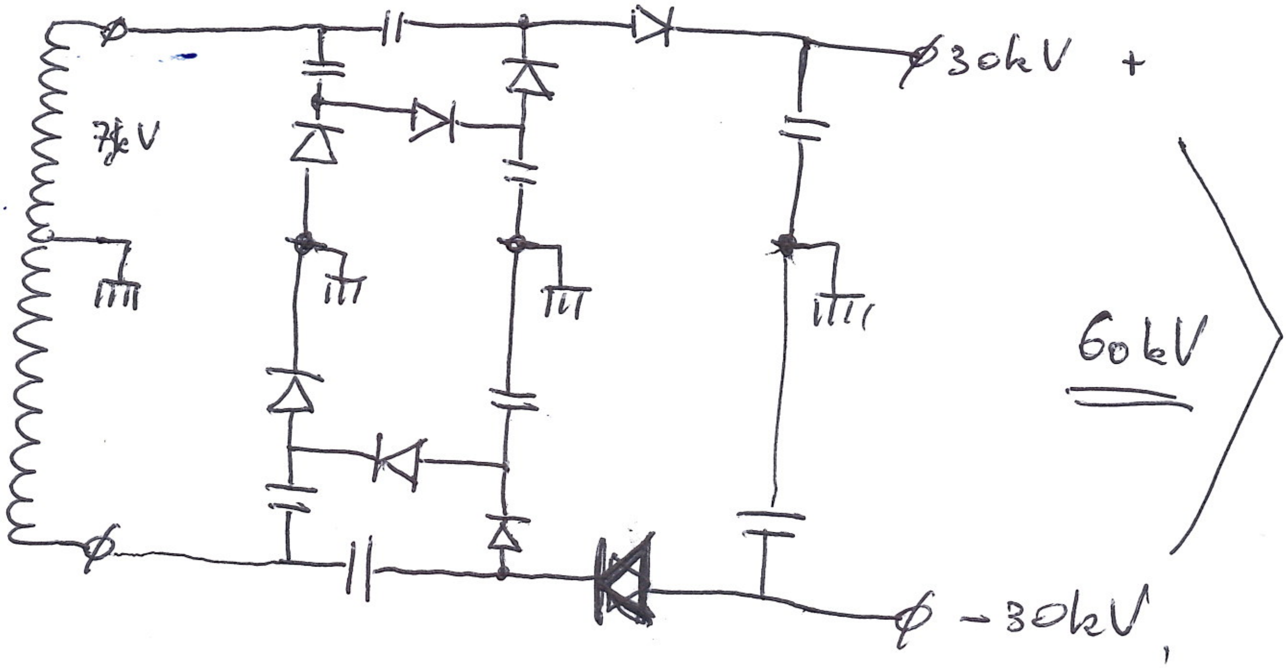
нер:



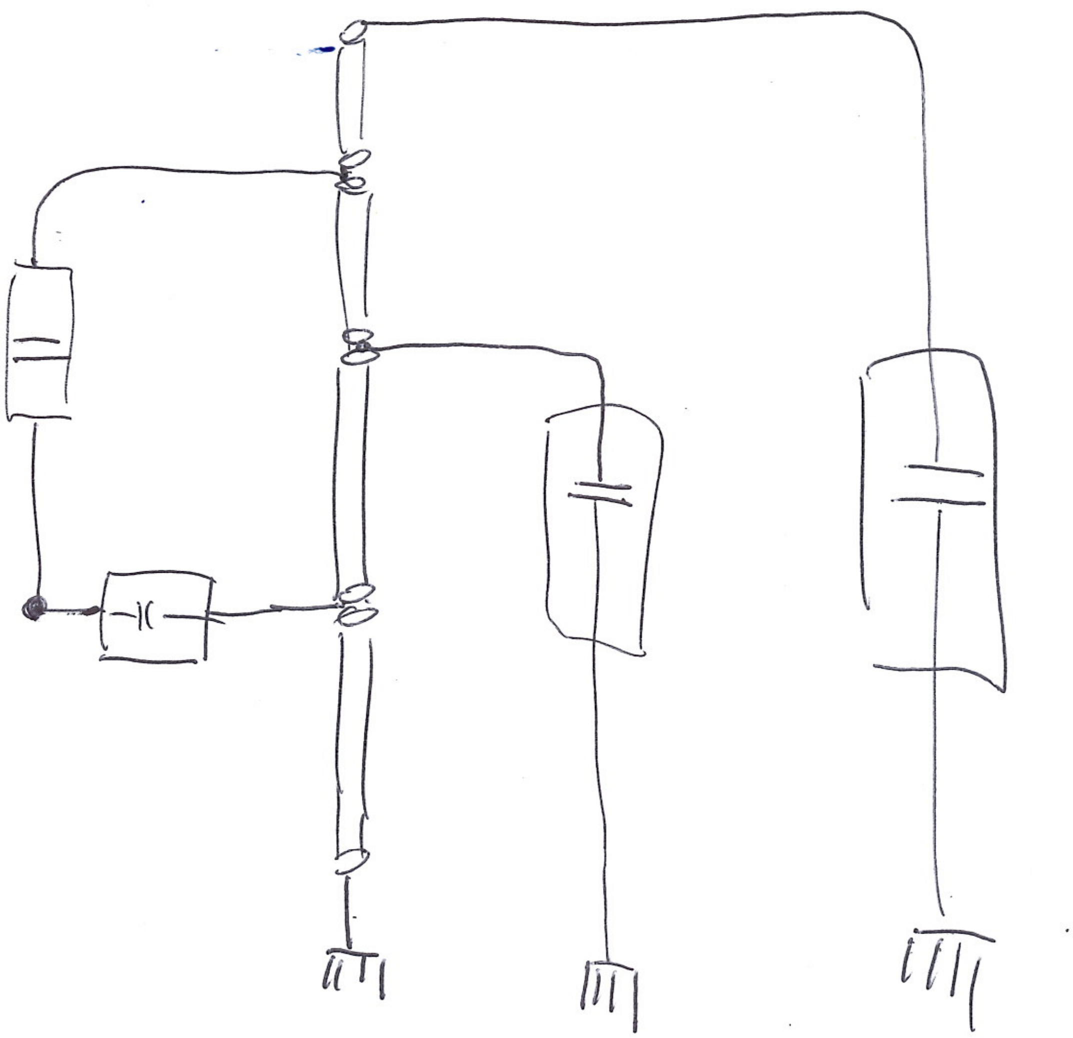


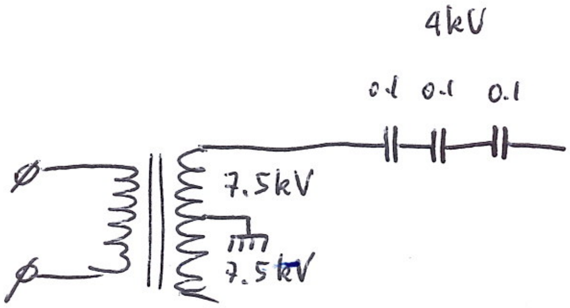


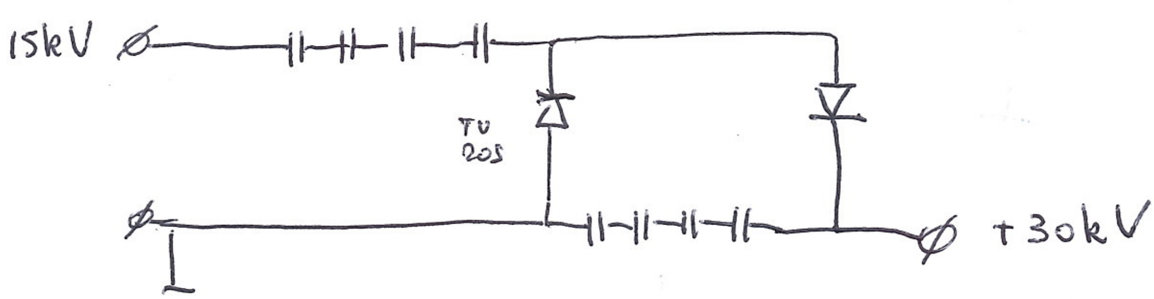
Ionenwind.
60kV
Kaskade
15kV input.

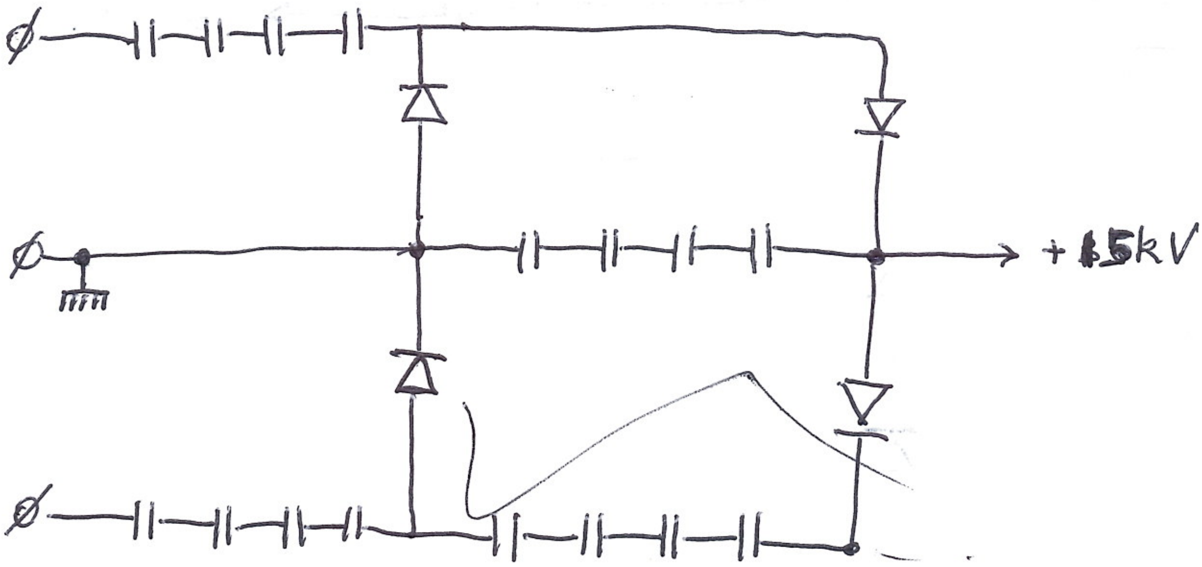

7kV
30kV +
60kV
-30kV

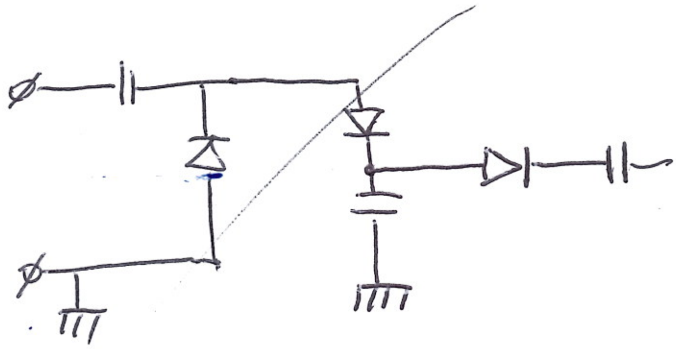
layout

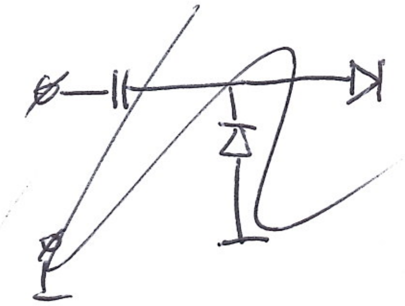


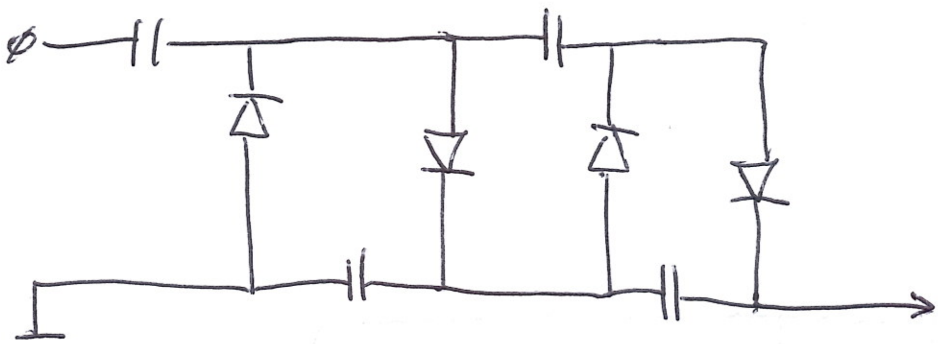

4kV
0.1 0.1 0.1
7.5kV
7.5kV

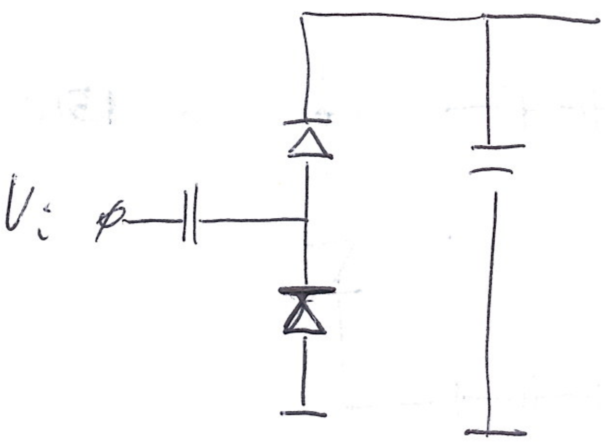

15kV
TV
20S
+30kV

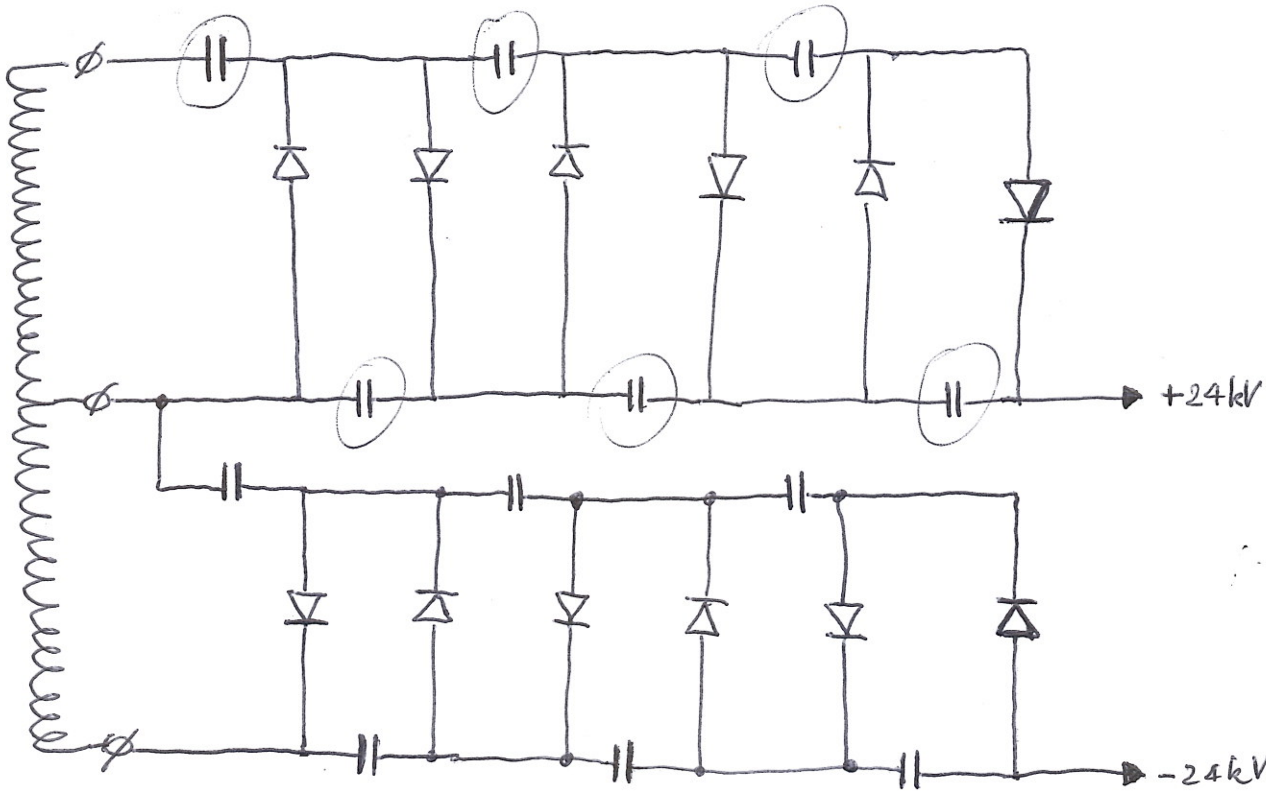

+15kV






30kV.


2 Vi
Vi

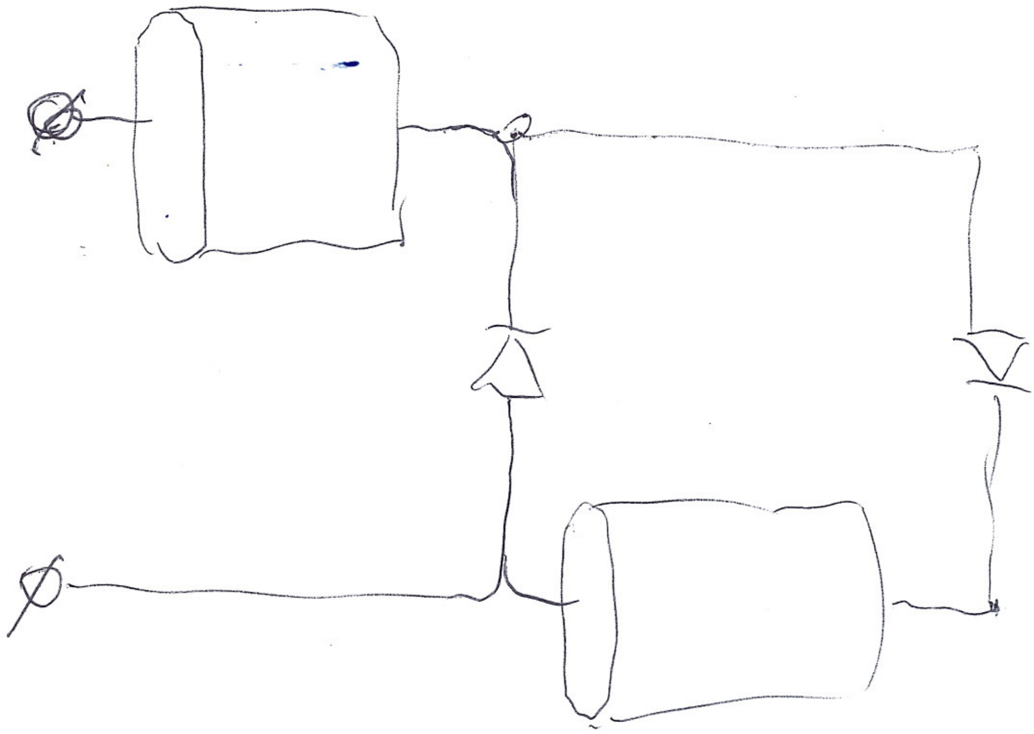


Buizen:	GY501	35kV	– 1,7 mA.
	EY86/87	27kV	40mA.
	EY51	17kV	80mA.
	DY30	30kV	17mA.
	DY51	15kV	40mA.
	DY80	23kV	60mA.
	DY86	27kV	40mA.

+V209.

?BY476 (16kV diodes)

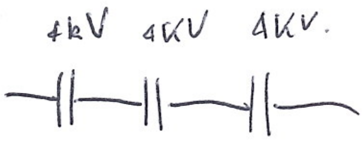
BY478 27.5kV



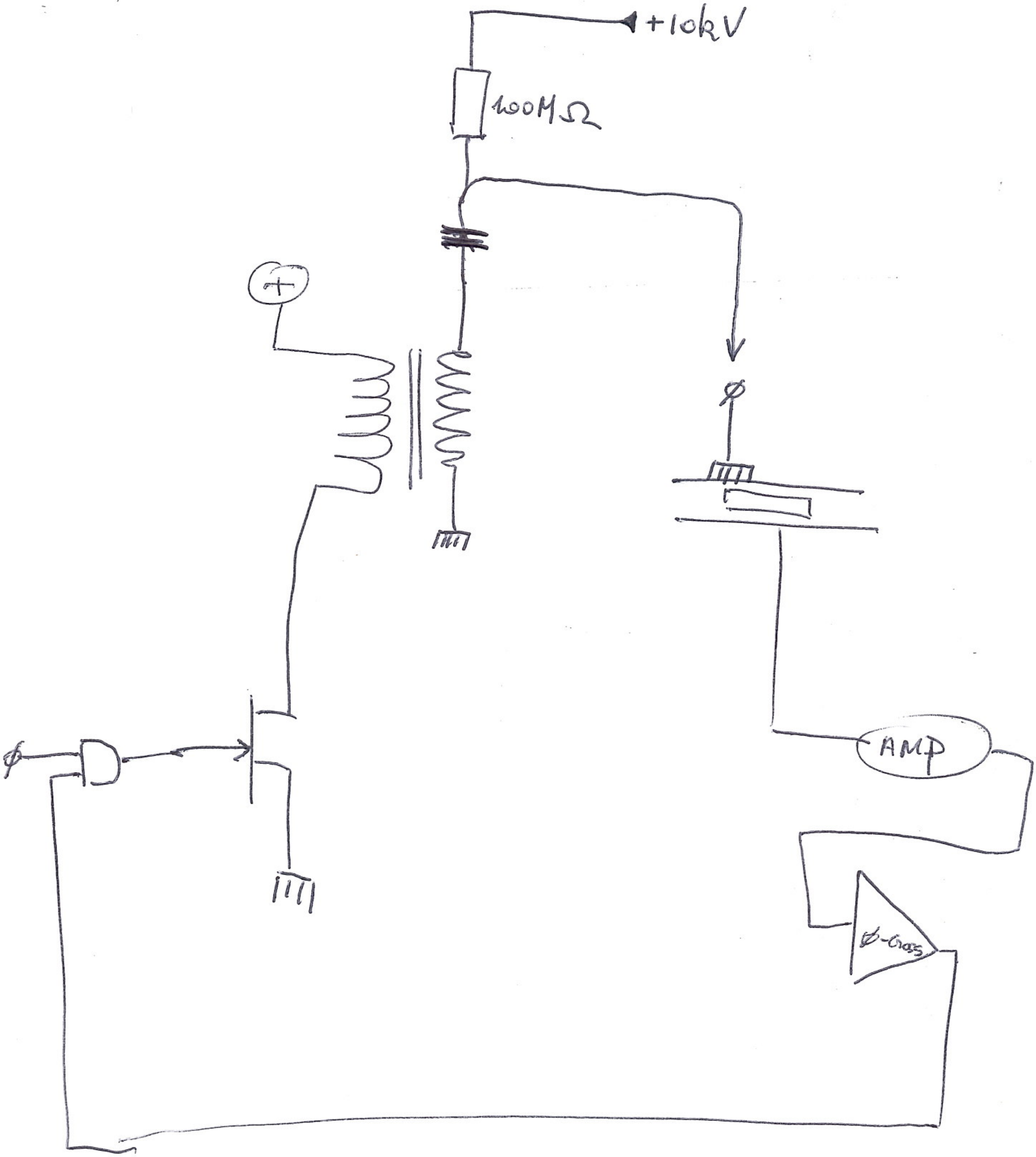
17 × 0,1μ   4kV

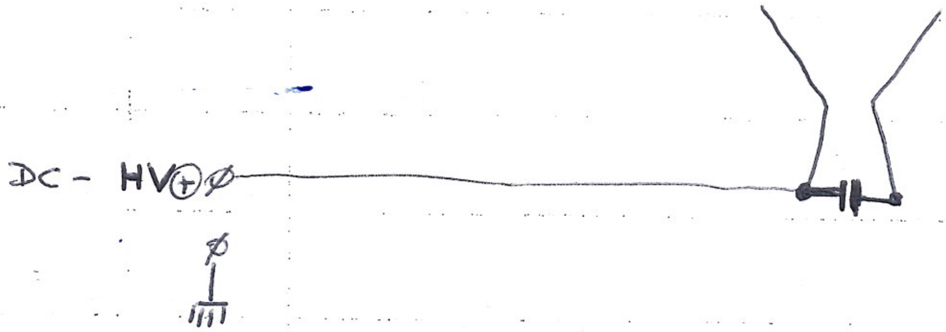
6   C's   per   cascade.

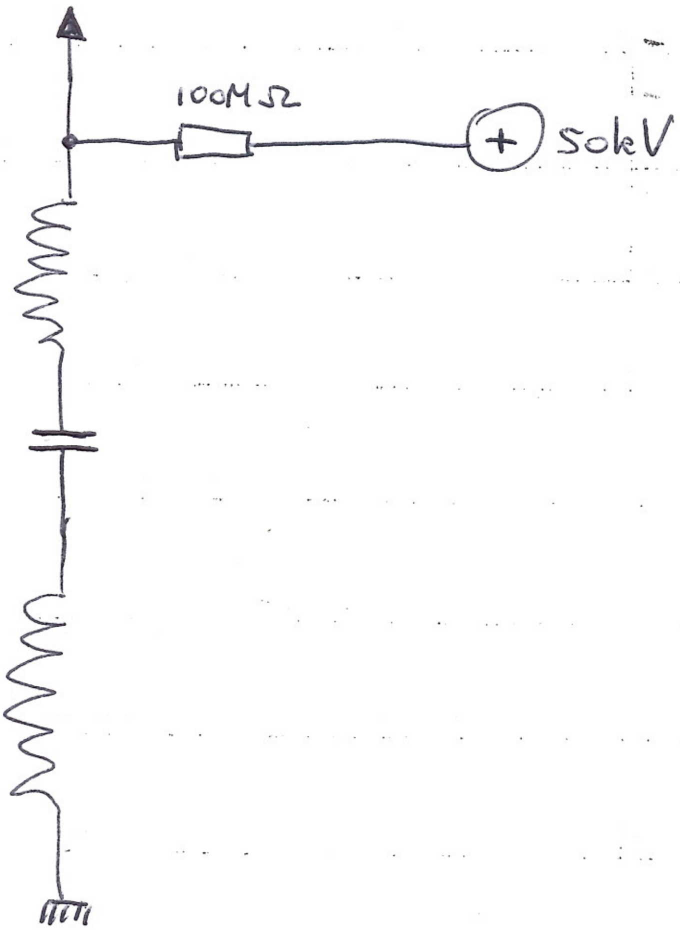
⇒



VCO : AD537

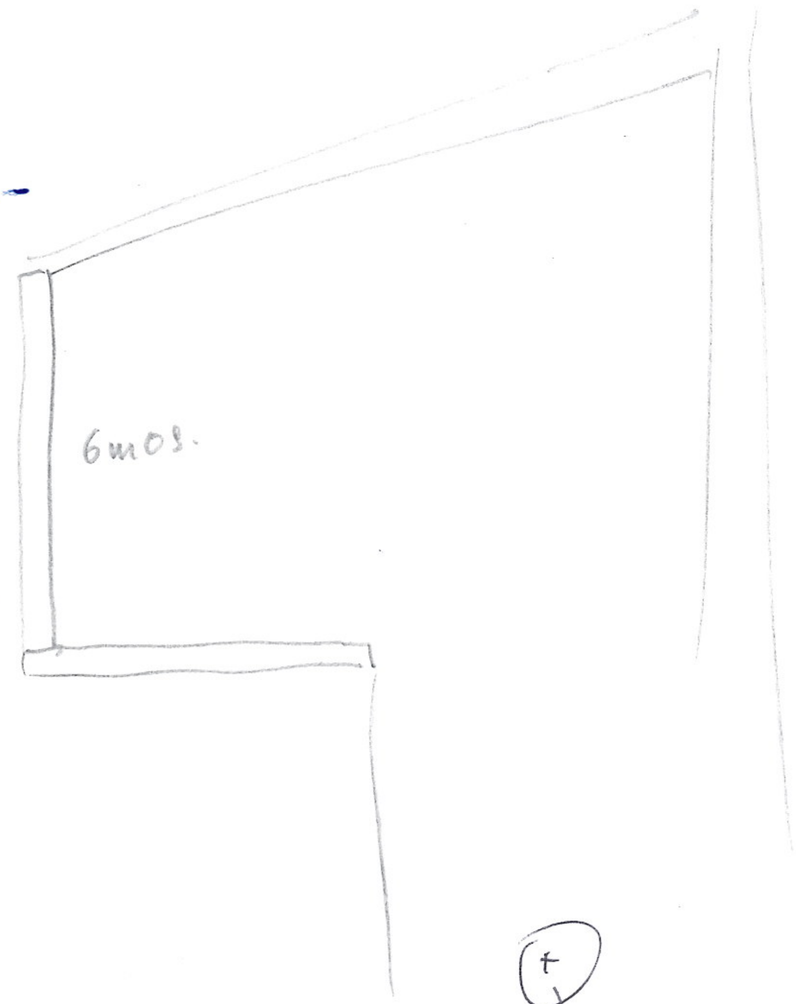


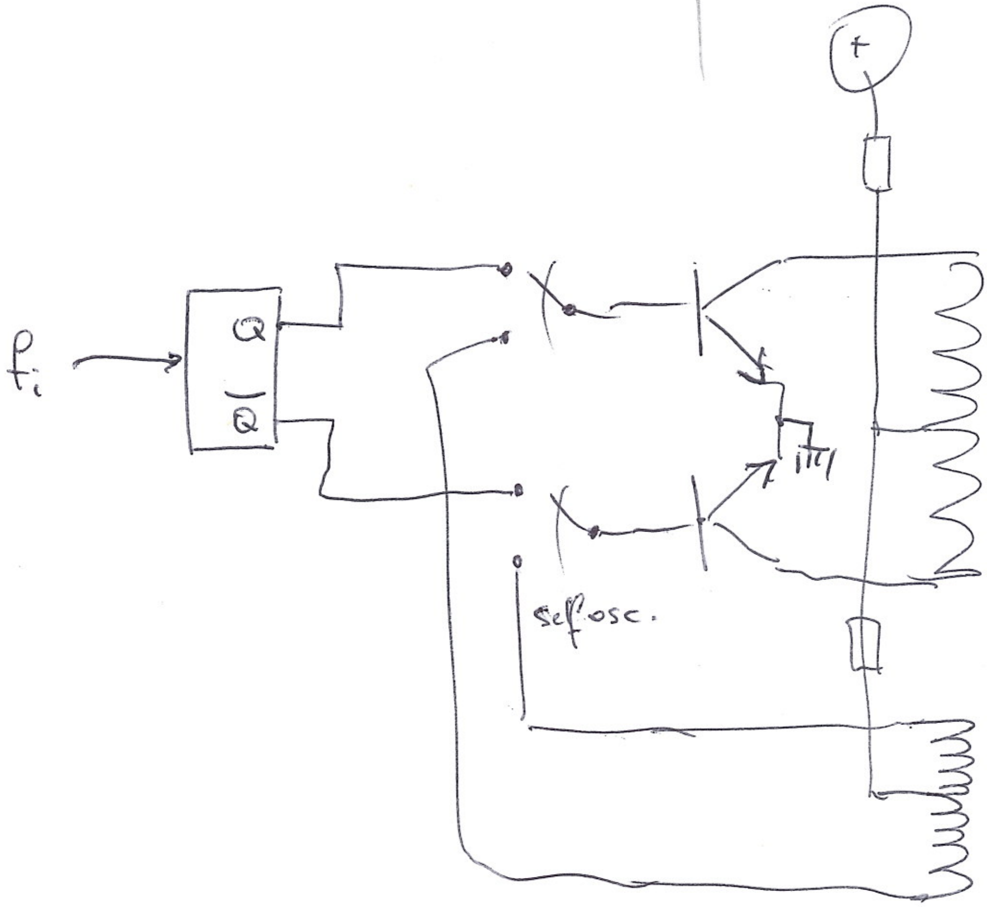


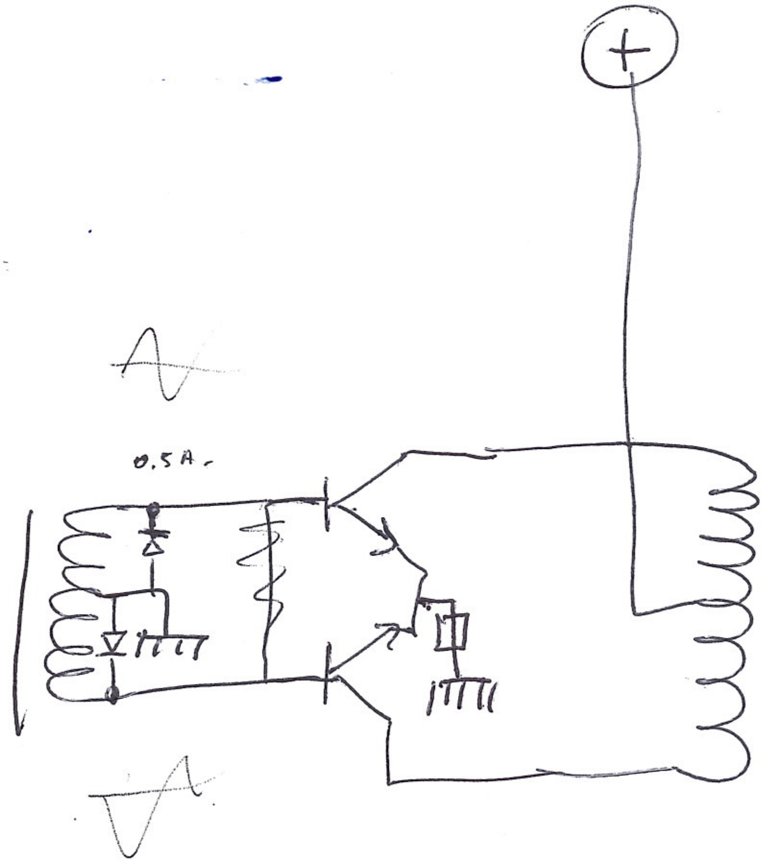


BYX 71

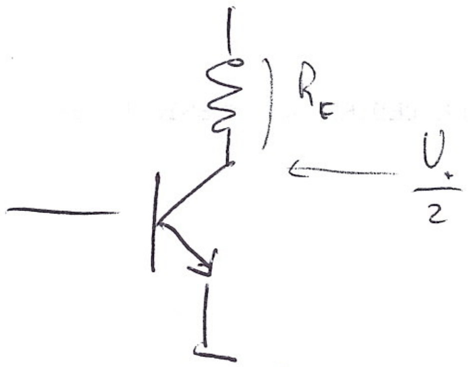
Moq.

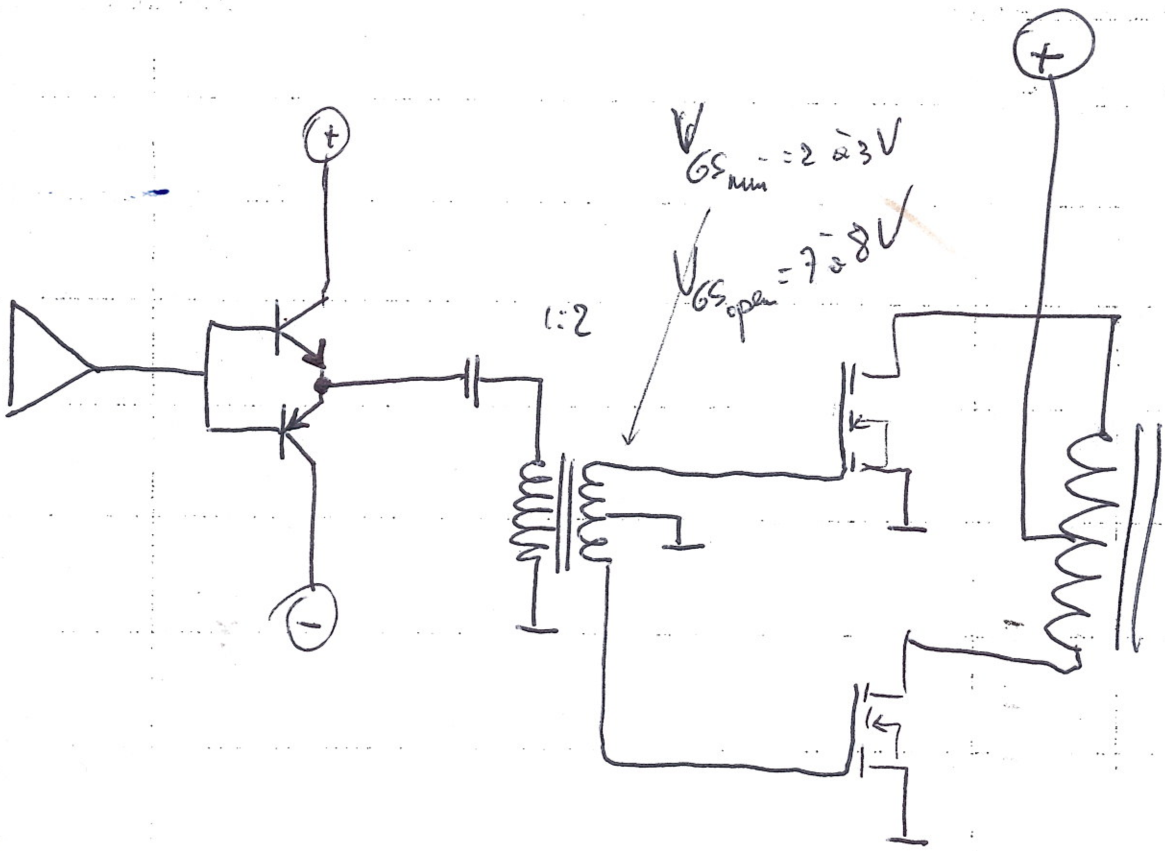






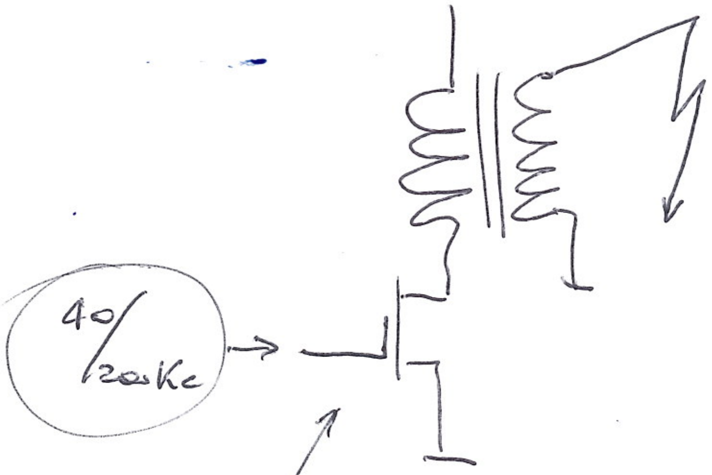
$R = \frac{0,8}{0,5} = 1\ \Omega$





Mosfet switcher generator:

Opbouw van schakeling:



IRF 430 (1,5A)

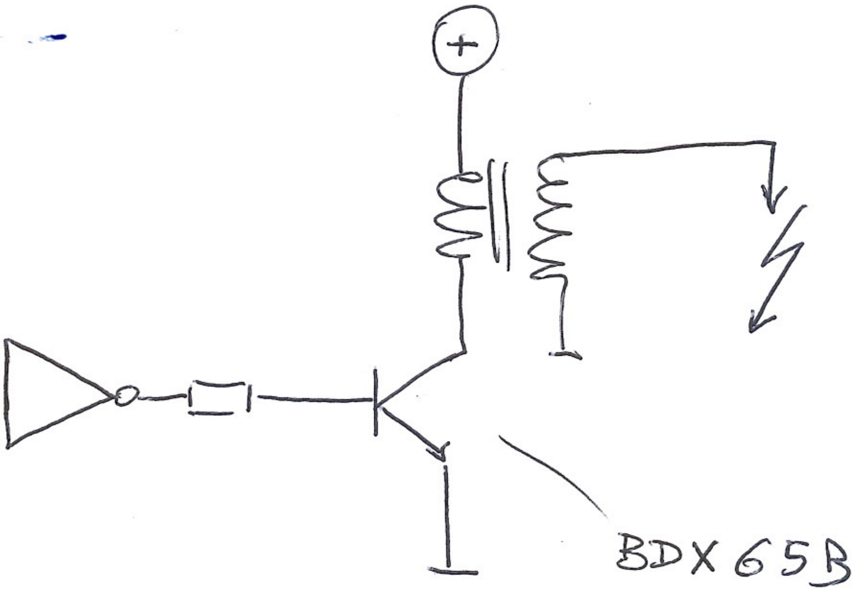
IRF130

⇒ U_{polar} : 4V

I_{drain} = 8A

39.901
3.314
43 215

7715
2628
32 018
42 361



$U_{CBO} < 120V$

$U_{CEO} < 100V$

Darlington.

$I_{c\,max} = 16A.$

P_{max} 117W

$T_J^\circ < 200^\circ C$

$h_{FE} > 1000$

(typ. 3300)

$U_{CE} = 3V$

f_{hfe} 50kHz

(by $I_c = 5A$)

complement PNP = BDX64B