

RESEARCH NOTEBOOK

ROBERT J. VAN DE GRAAFF

HIGH VOLTAGE ENGINEERING TECHNIQUES

Locating Lightning Flashes by Radio

Dr. Nikola Tesla - the Forgotten Super
man of Our Industrial Age - by
Ralph Bergstresser. ✓

6197 Temple Hill Rd. - Hollywood
464-2322.

No 1-0-0

315

Dear Bill. -

Here's a letter and information from

Tuesday, July 21, 1970

2:00 p.m.

Hi, Bill.....

Here is your lightning book. Unfortunately, I spilled what was left of my coffee just as I was reaching to bring it up to the office to mail. The only damage was the section from SCIENCE on Tesla, where the coffee seeped in under the plastic folders. I carefully took the pages out and blotted them with clean water and cleaned out the folders, just as quick as I could. They don't look TOO bad, but you can imagine how bad I feel about it. I'm very sorry!!!

I slipped the Griffith Park things into a new folder, as the old one you had stapled at the bottom had coffee in it. Luckily it didn't get into that material!

We received your letter and your will here at the office yesterday morning. I will put the original in the safe deposit box at World Savings, and keep one copy for your file and one for ours. I think you were wise to get that tended to, as it always results in such a mess if something happens and there is no will.

I just called and talked with Tom Suttner. It seems that your accounting has been approved already, and the hearing on Thursday the 23rd is for the judge's signature only. So, I don't need to go in to court at all. Mr. Suttner estimates that the court order releasing the funds should be back to his office in a week from the 23rd, but he can't guarantee that. So, either make your plans for your leave for the 1st week in August, or play it safe and make it for the 2nd week in August. One thing you might consider....if you make it for the 2nd week in August, you will be here for Grandpa Lou's 83rd birthday on August 12th. That would be nice.

Ray Hall was in here 30 minutes ago, and he says if you can get your leave to begin on a Sunday night, or Monday or Tuesday, he would gladly drive down to pick you up at Ft. Huachuca. He gets off work at 2:30 on Sunday, and could leave right from work. He would go to San Diego and straight across to Tuscon. He figures he can make it in about 5 hours!!!??? I thought it was very nice of him to offer to do this, but I don't know if you will want him to or not. He figures about \$15.00 for gas, and that would be a slight savings in money, if not time for you. I told him I'd let him know.

How's the weather down there? Any more electrical storms? Boy, that lightning strike was TOO close at 20 feet.....WOW! It might take you for the fastest way to ground, since there aren't any trees out there.

Grandma Lorna called last night and said she is now exercising on a big 3-wheeler bicycle, and Grandpa follows along behind with the cane to "hook" her if she gets going too fast! Isn't that wild??? He may get a bike too, and they can ride together. She is also going to start swimming in the pool, at the doctor's instruction. Sounds like they are going to have some fun, huh?

Well, I've got to get an insertion order out and mail this, so I'll close for now. Tried Lynn, and the line was busy, so I haven't ~~talked~~ talked with her yet.

Love, Mom



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GRIFFITH OBSERVATORY
LOS ANGELES, CALIFORNIA

Tesla coil (1,300,000 volts) produces sparks
several feet long resembling natural lightning
and also causes gas-filled tubes to glow.

COLOR PHOTO BY ROBERT W. CHASE

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GRIFFITH OBSERVATORY and PLANETARIUM GUIDE BOOK



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FOREWORD

THE GRIFFITH OBSERVATORY was a present to the City of Los Angeles, given by the will of Colonel Griffith J. Griffith. At the same time he provided for the Greek Theater. Previously he had presented Griffith Park to the City, in 1896.

▲ The Observatory was opened officially on the night of the 14th of May, 1935. It is divided into three main divisions. First is the Observatory proper. In this division the principal instrument is the twin refracting telescope. Other instruments are the three solar telescopes which are fed by a triple mirror system. One of these produces a large image of the sun on a screen in the Hall of Science. A second places the image of the sun on a 5-inch grating spectroscope. The third does the same for the one-half Angstrom filter showing the distribution of hydrogen on the sun.

▲ The Hall of Science, which is the second division, shows more than 100 exhibits from the most notable achievements of modern physical science. New exhibits are built and added from time to time.

▲ The third division is the theater of the heavens, with its Zeiss planetarium. The ceiling of this theater is a hemisphere 75 feet in diameter. On it the planetarium instrument in the center of the room projects the sky almost exactly as one would see it under the very clearest of conditions, from any place that he might choose in the whole world at any hour for thousands of years past or future. The capacity of the theater is 538 and at night demonstrations, especially during the summer months, it often is filled completely by those who for an hour find themselves in an artificial universe.



PHOTOGRAPH OF THE GALAXY IN ANDROMEDA

Small visitors regarding greatly enlarged transparent photograph of the galaxy in Andromeda. This is a disk-shaped collection of stars similar to our own galaxy or Milky Way system. The distance of the Andromeda galaxy is about 2,200,000 light years. On a clear dark night it is visible as a faint patch of light. (Mount Wilson and Palomar Observatories.)

THE GREAT GALAXY IN ANDROMEDA

▲ Our galaxy of stars or Milky Way system described in the previous article is only one of a vast number of similar stellar systems extending away from us in space as far as our telescopes can reach. Only four are visible without a telescope, and two of these are so far south they cannot be seen from the United States. The one most easily visible to us is the galaxy in the constellation of Andromeda. It is nearly overhead and hence well-placed for observation about nine o'clock in the evening in November. On a clear, dark night it appears as a faint hazy patch of light about the size of the full moon, roughly 15 degrees to the north and east of the center of the Square of Pegasus.

▲ For a long time astronomers thought this object in Andromeda and others like it visible in their telescopes were glowing clouds of gas or "nebulae" comparatively nearby in our own galaxy. But on photographs of the object in Andromeda taken as early as 1889 the outer edge appeared to be resolved into stars. And by 1928 it was proven beyond doubt that the object in Andromeda was not a nebula, but another stellar system far outside our own galaxy. The first measures of its distance put it at 900,000 light years, but it is now believed to be much farther away than this, probably about 2,200,000 light years.

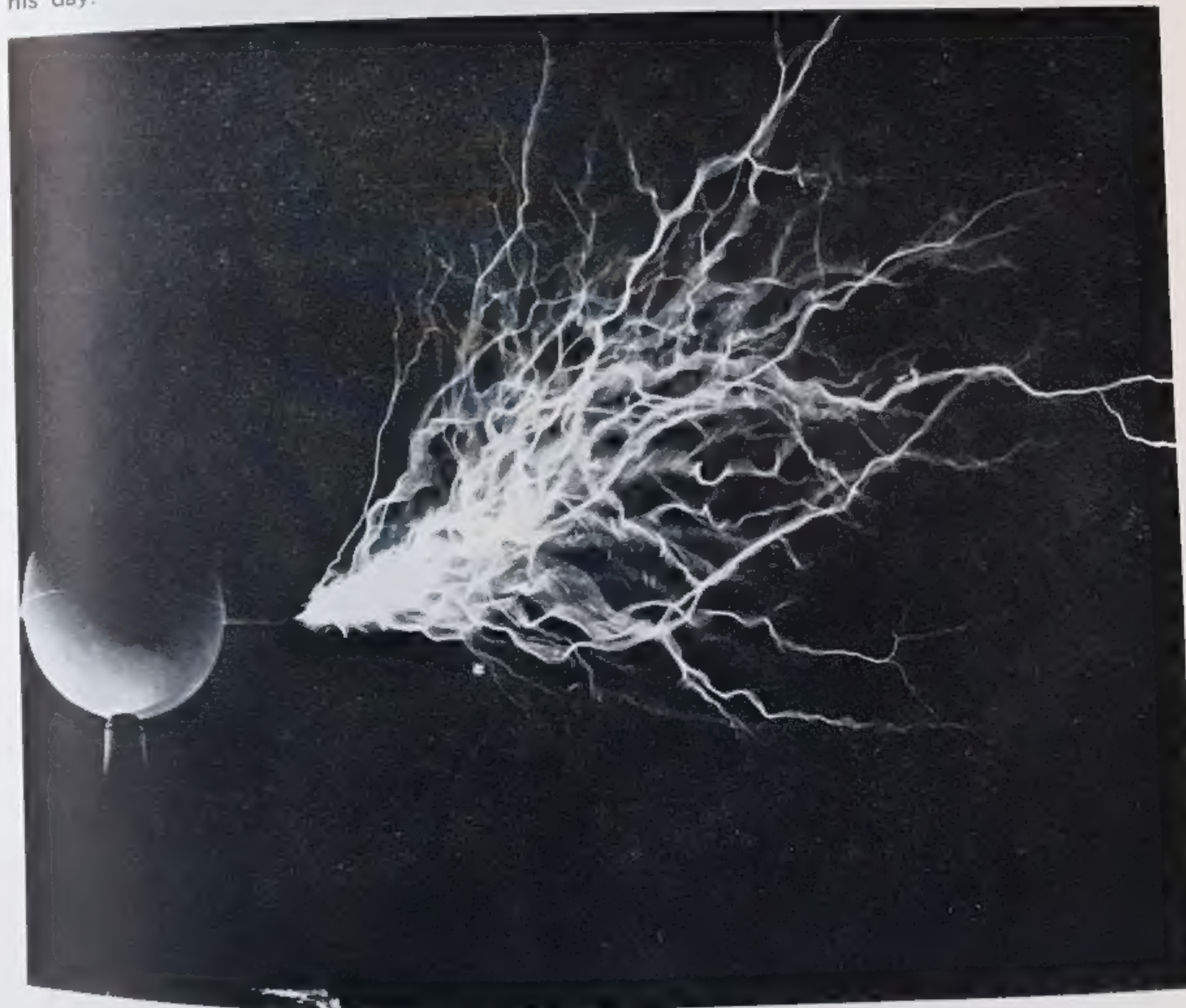
▲ A distance of two million light years seems enormous compared with distances in our solar system of a few light minutes, or even hundreds or thousands of light years within the Milky Way. Yet to the astronomers who specialize in the study of galaxies, such a distance seems quite small. So small, in fact, that they refer to some 17 galaxies within

about two million light years of the sun as being members of the "local" system. Galaxies have now been observed singly, in clusters, and even clouds containing thousands of members. We have been able to trace them out to distances of around two billion light years.

▲ Our photograph shows a boy and a girl gazing in awe at a huge enlargement of a photograph of the Andromeda galaxy taken with the 48-inch Schmidt telescope on Palomar Mountain. Long ago there must have been some cave man, more observant than his mates, who noticed this hazy patch of light in Andromeda and wondered vaguely why it looked different from the other objects in the night sky. Today the children can see at a glance that it is a vast collection of stars. But how long it has taken us to find the answer. Almost as long as it took the light to reach us that formed the picture itself!

HIGH VOLTAGE COIL (Tesla Coil)

▲ From the earliest records we read of man's wonder at and fear of lightning. Zeus, of the Greeks, who became Jupiter to the Romans, carried lightning in his hands. His northern equivalent, Thor, carried a hammer, the thunderbolt, which would return to him like a boomerang after he had cast it at his foes. Benjamin Franklin, of a more scientific turn of mind than the earlier story tellers, demonstrated that lightning is identical with the toy, electricity, which intrigued men of his day.



THE HIGH VOLTAGE COIL

▲ Very early in the development of electrical apparatus, men were able to get a short spark with a sharp crackle which suggested the experiment carried out by Franklin. Two generations ago this spark had become a foot or more in length and the crack almost deafening if heard in a closed room.

▲ Man, however, could not create the tremendous electrical pressure (voltage) necessary to obtain the bolts many feet long that have been supplied so prodigiously by nature. Only during the last few decades with millions of volts available has he been able to produce very minor lightning strokes.

▲ This coil, with an electrical pressure of more than a million volts, produces sparks several feet long which bear a great resemblance to natural lightning.

▲ In changing electricity at ordinary voltage to that which produces these long sparks, there is no creation of energy. Merely the pressure is increased. It is somewhat similar to the use of a lever. A small pressure at the end of the long arm enables one to exert a pressure on the other end great enough easily to lift an automobile. The coil increases electrical pressure enough so that the electricity presses its way through several feet of air.

▲ The electrical discharge of the exhibit differs from lightning, however, in that it reverses its direction of flow with tremendous rapidity. From this characteristic it loses most of its danger to man. Indeed, one who knows what he is about can receive the spark on a metal rod held in his hand and yet experience no discomfort. The innocent appearing primary coil at the base, on the other hand, is death dealing.

▲ At frequent intervals guides operate the coil and give explanatory talks.

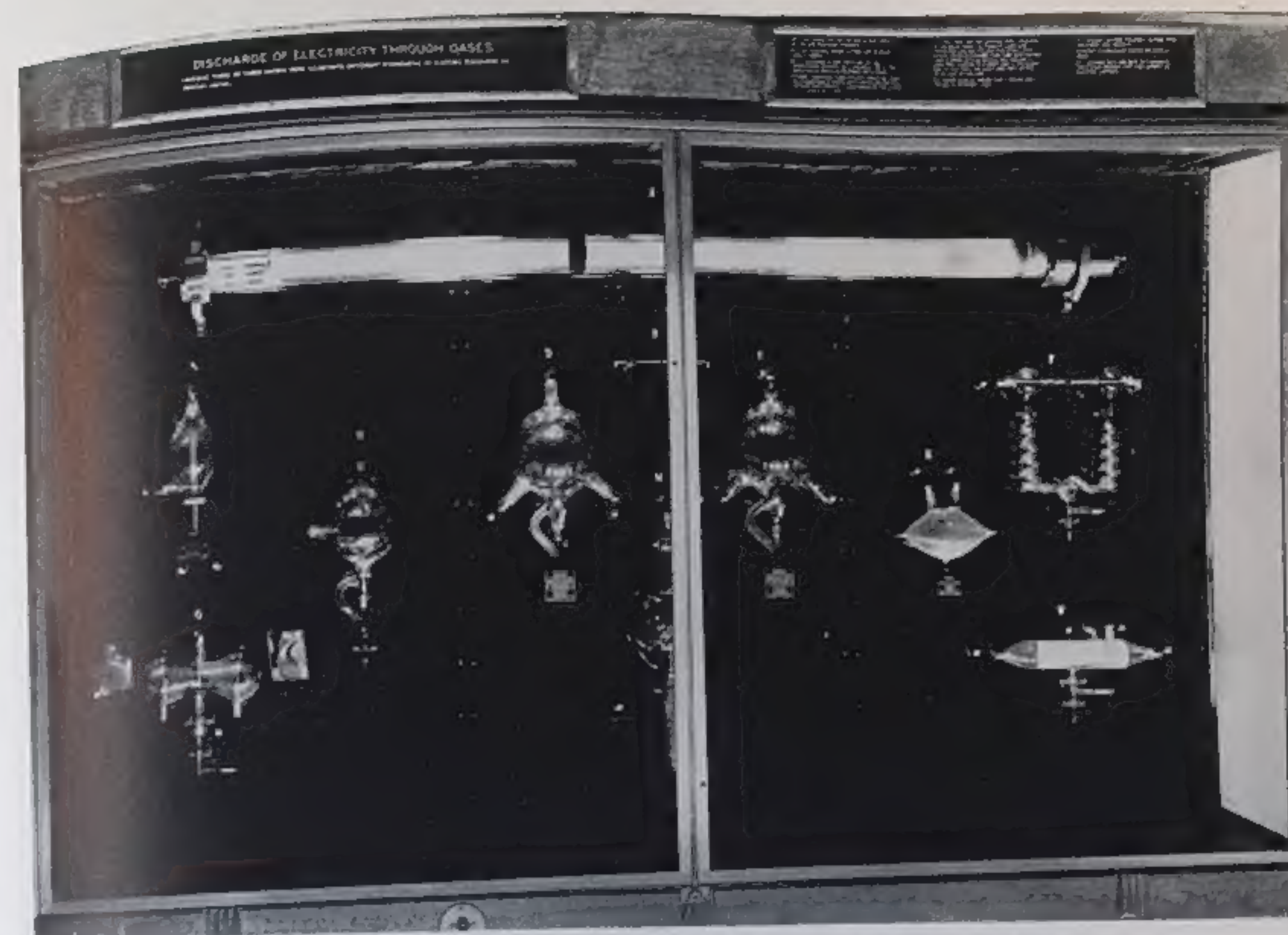


EXHIBIT OF DISCHARGE OF ELECTRICITY THROUGH GASES

ELECTRICAL DISCHARGE THROUGH GASES

▲ Many kinds of electrical discharge tubes have come into every day life. They perform a myriad of services for man, most commonly in X-ray, in radio performance, advertising, and illumination, though there are other valuable applications.

▲ Some of the most interesting tubes are grouped in this exhibit and so arranged as to explain a little of the nature of the electrical discharge.

▲ The five-foot tube at the top of the exhibit shows how the electrical discharge changes with the pressure of the air in the tube. A vacuum pump removes air from the tube for about three minutes, then air is let into the tube and it is pumped down again.

▲ Two of the tubes show that a force is exerted on an electrical current in a magnetic field. Several of the tubes show the difference between current flowing in a tube at low and medium pressures. Another tube shows how current flowing through a tube at very low pressure travels in straight lines and forms shadows. One tube shows that if the pressure of the gas is correct the discharge may pass over a fairly long path rather than jump a short spark gap which has a higher resistance.

▲ The effect of electrical particles in causing minerals to give light of their own is shown dramatically by a tube which has a little pile of different kinds of minerals and by another tube in which flowers, made from sheet copper and painted with clear chemicals, glow under the electric bombardment, giving forth the brilliant colors.

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August 1965

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THE TESLA COIL

Anyone who has watched the Tesla coil in operation at the Griffith Observatory will have noted its spectacular spark resembling, on a small scale, the natural lightning during a thunderstorm. The air acts like an insulator until a certain voltage per foot or potential gradient is exceeded. This corona type of discharge into the air can be seen on a dark night on high voltage transmission lines. As the voltage is increased the coronal streamers become longer, and if this increase continues, the streamers reach the other side of the circuit, or ground, if the circuit is grounded. When this occurs, an arc is established and the current rapidly increases until the source or supply is exhausted or reduced in voltage to a point such that it cannot support the arc.

Millions of visitors have watched the operation of the Tesla coil and some may have wished to know more of its exact functioning. We receive many requests for information about the Tesla coil. We hope this description will answer these questions and anticipate a few that may have been unasked. A description of the Tesla coil was published in the Griffith Observer 17 years ago, but this issue is now out of print. This article will describe the operation as it is today, as some changes have been made in over 28 years of operation.

The name "Tesla coil" is usually applied to all tuned transformers of this type used to produce a very high voltage. Actually the correct name is "Oudin coil" when one end of the coil is connected to the ground. A Tesla coil has the grounded point in the middle and the spark jumps from one end to the other. We have the other half of the coil but did not have room in the museum to install it. The spark is about twice as long with the complete coil, as tested in our shops.

The following description of the apparatus is necessary to guide anyone wishing to build

a Tesla coil. One word of caution is appropriate at this point. When using a Tesla coil similar to ours, the voltage and current available from the primary and secondary of the coil is enough to have lethal results, if you come in contact with any of the wires. Extreme caution must be used by you and anyone else who may be around the equipment. Many interesting exhibits have been made of the Tesla coil with less power in the driving transformer. These are not as dangerous.

The 120-volt current is fed to the transformer as shown in Fig. 1 through a line filter, which prevents any feedback of the radio frequencies produced by the apparatus into the electrical lines in the building. Each of the four capacitors has 2 microfarads of capacity and 1000-volt insulation. The two coils are wound on a form $3\frac{1}{2}$ inches in diameter and 12 inches long with 57 turns of No. 12 copper wire. The transformer is a power transformer in a case filled with oil. It is similar to the ones you see on power poles to step the voltage down for your home use. This transformer steps the voltage up and has a special type of winding, which limits the current when the spark gap shorts the high-voltage secondary coil. Neon sign transformers, which are often used for Tesla coils, also have a current-limiting winding, so that it is safe to short the secondary winding. This part of the apparatus is below the floor of the museum and is not visible to our visitors.

The rotary gap has two stationary electrodes and the wheel has 14 copper bars in an insulating disk which turns 1800 revolutions per minute. As each copper bar comes between the stationary electrodes, a spark jumps and this shock excites the primary circuit. The spark is between tungsten disks fastened to the ends of the copper bars. The spacing is about one-sixteenth of an inch, but this is not too im-

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AUGUST, 1965

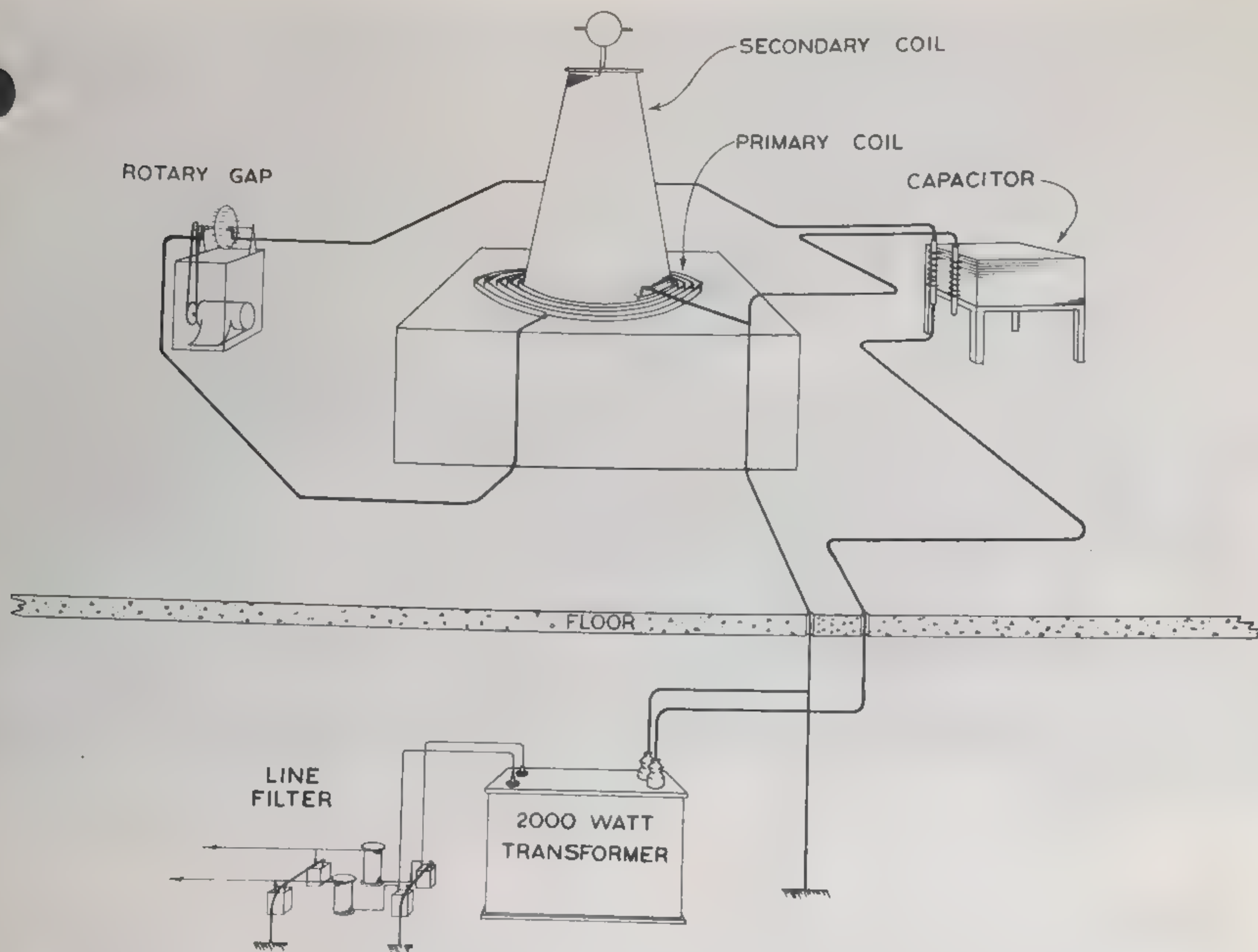


Fig. 1. Diagram of the Tesla coil. The parts shown below the floor are not visible in the museum.

important except that it must be small enough for the voltage from the power transformer to jump.

The capacitor is made of 30 glass plates 24 inches by 30 inches by $\frac{3}{8}$ of an inch thick. The 29 copper plates between the glass are 15 inches by 14 inches by 0.02 inch thick. The glass plates were made $\frac{3}{8}$ of an inch thick because the original capacitor had $\frac{3}{16}$ -inch glass and it was often punctured by the voltage. The primary coil has $5\frac{3}{4}$ turns of $\frac{3}{4}$ -inch by $\frac{3}{16}$ -inch rectangular copper bar. It is necessary to make the primary circuit consisting of the rotary gap, the capacitor and primary coil of heavy conductors, as many amperes flow in this resonant circuit and the efficiency would be decreased if the resistance

was not very low. We use No. 1 wire to connect these units.

The secondary form is 47 inches high and has a bottom diameter of 36 inches and a top diameter of 18 inches. It is wound with 400 turns of No. 14 copper wire. It is not necessary to make a tapered coil, but it is easier to prevent corona from the top turns of the coil if the diameter is smaller. The 12-inch ball on top is a hollow copper sphere. It prevents excessive corona from the top end of the coil and wires. This would constitute a loss of power. The points on each side concentrate the discharge for our visitors to observe more easily.

The operation of the circuit is quite complex and the use of 60-cycle alternating current for

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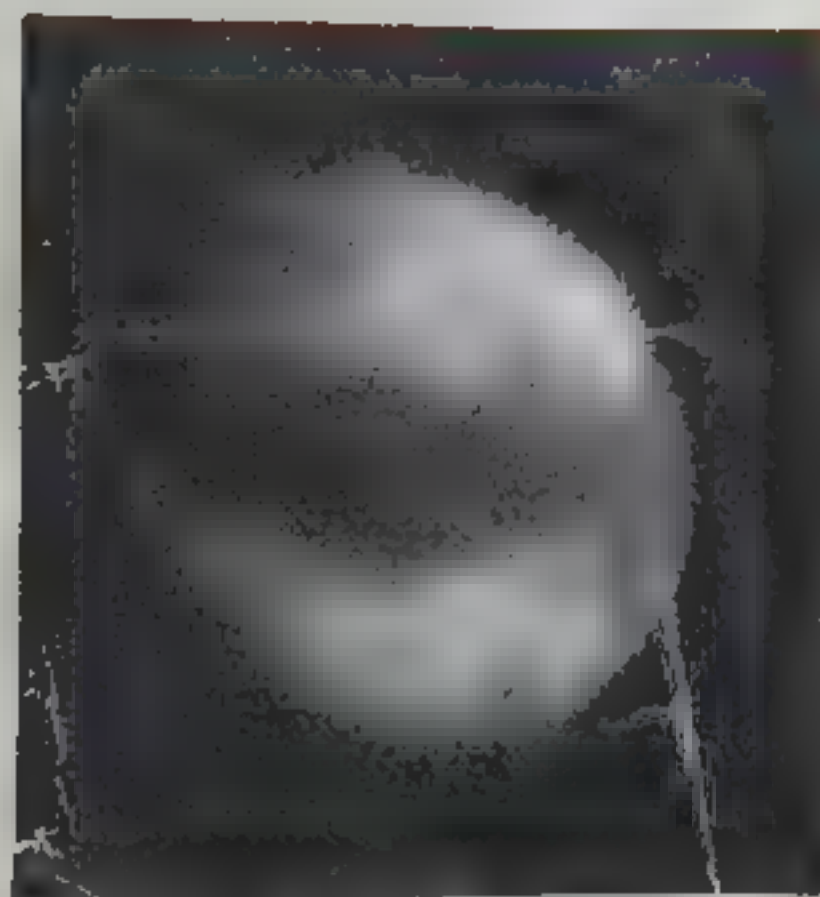
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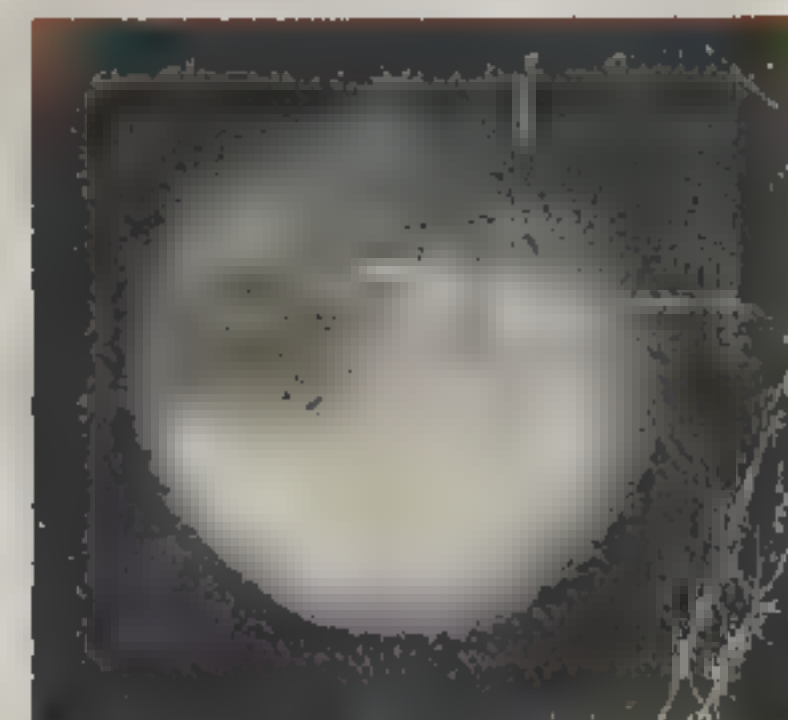
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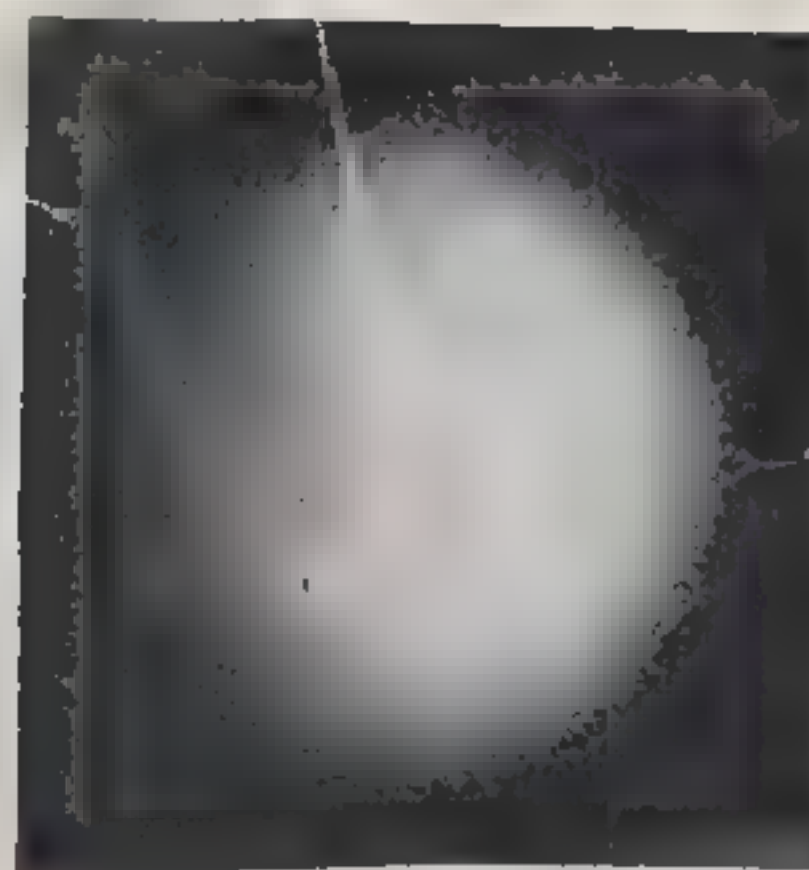
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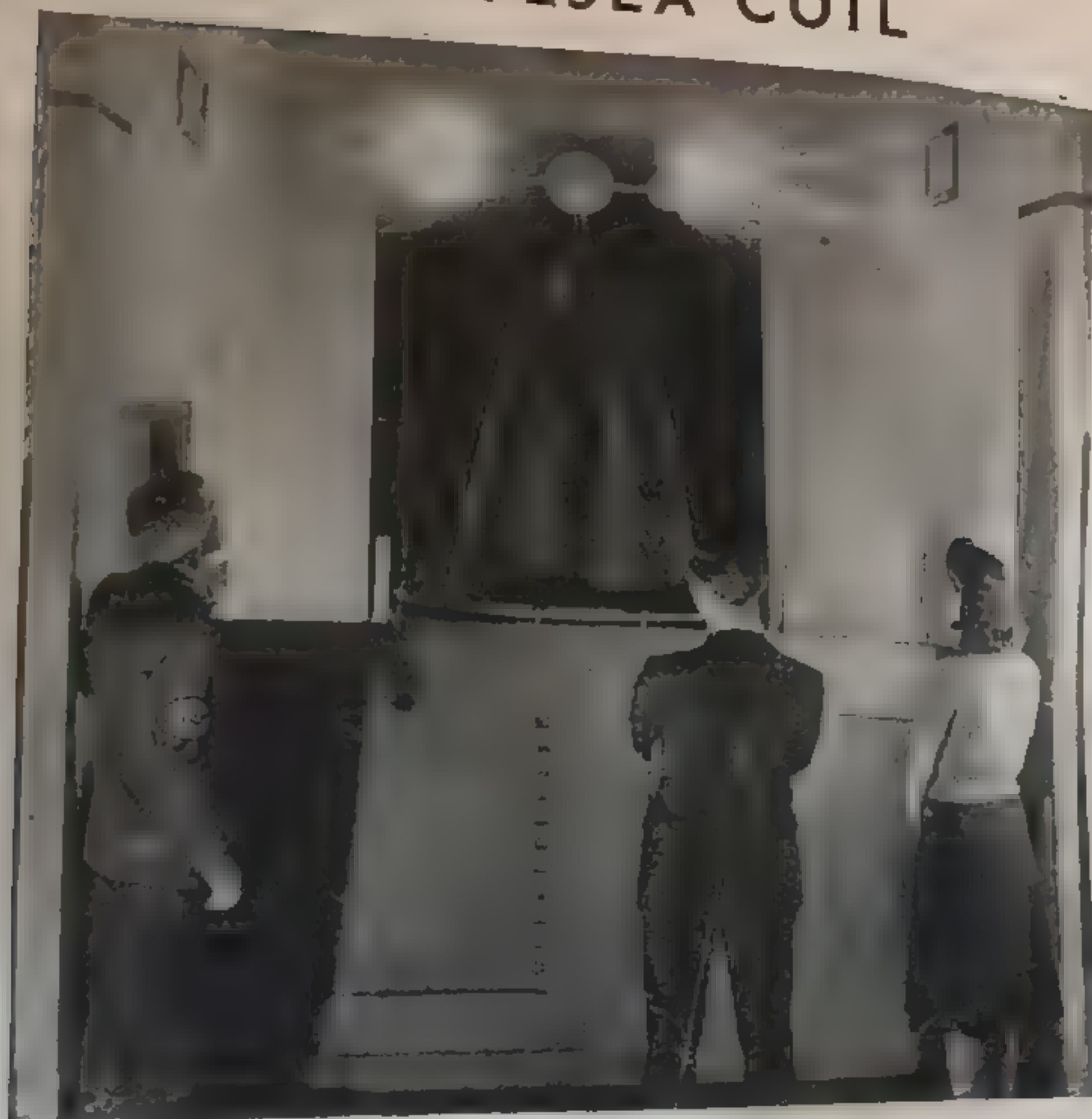


E.

MARS AT 1941 OPPOSITION

(See page 44)

THE GRIFFITH OBSERVER THE TESLA COIL



One of the most spectacular exhibits in the Hall of Science at the Griffith Observatory is the Tesla coil. Hundreds of thousands of visitors have thrilled to the flash of the giant spark produced by this device. They have marveled at the lighting of a fluorescent tube held in the hand of the demonstrator as he held it near the coil. They have been puzzled a bit perhaps when they have been told that the current lighting the tube travels over the surface of the skin of the demonstrator and therefore he feels nothing and is unharmed by the current. There is

never time for the guide to give a thorough explanation of the exhibit, and if he did, very likely most of his audience would become bored and stroll off to seek "amazement" elsewhere.

This article is written in answer to many requests for information regarding the Tesla coil. In it an effort will be made to answer all the various questions that have been asked in the past years, and to anticipate some that may be asked in the future.

The first and perhaps the most surprising bit of information about the Tesla coil at the

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APRIL, 1948

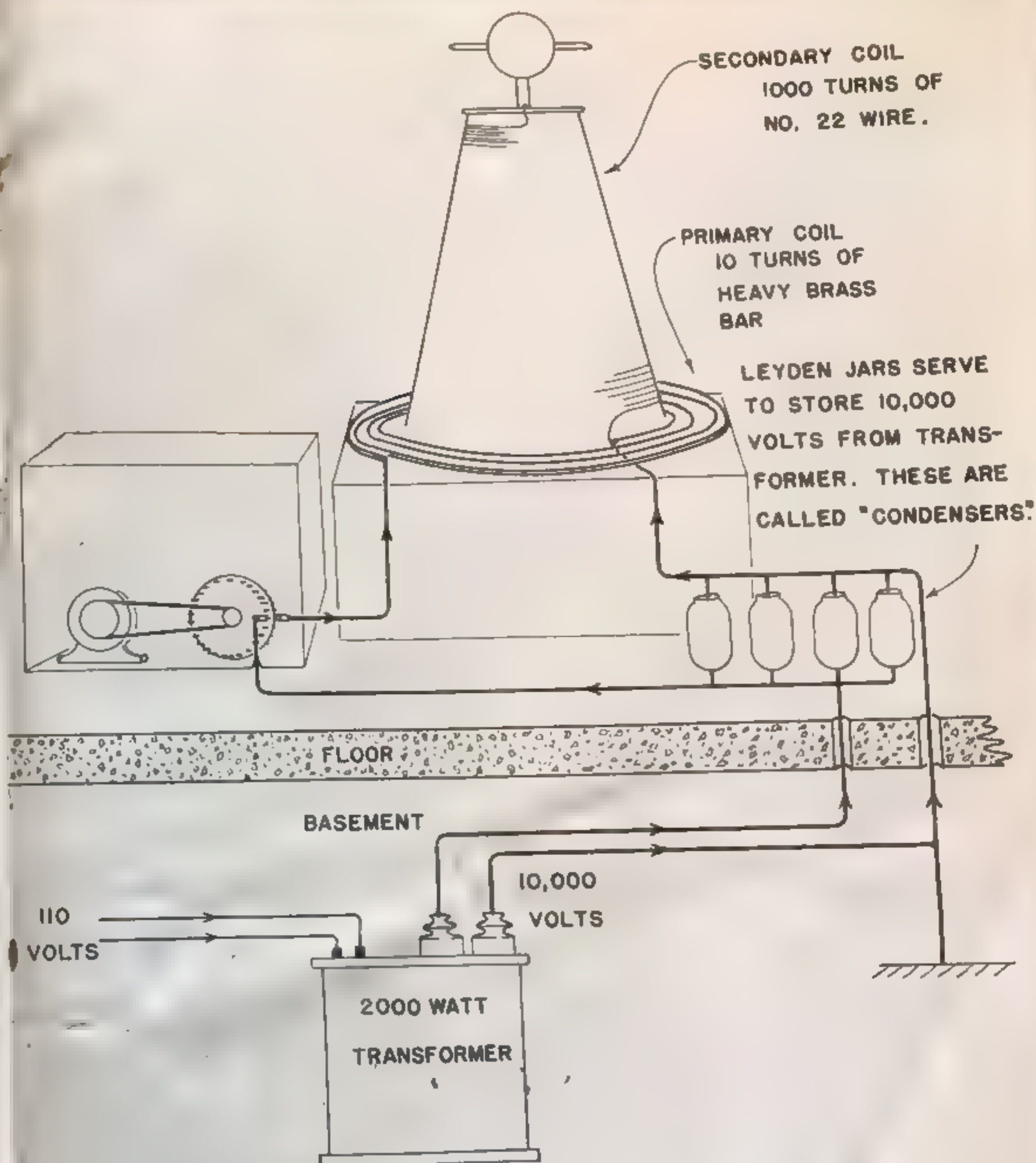


Figure 1.

Griffith Observatory is that it is not strictly a "Tesla" coil. While the term **Tesla coil** is applied generally to all high frequency air-core transformers used to produce a high voltage spark, the coil at the Griffith Observatory should be called an "Oudin" coil. The difference between the two types is not great. The Tesla coil is double ended and the spark jumps from

one end of the coil to the other, and the center of the coil is connected to ground. The Oudin coil is single ended, just half of a Tesla coil, one end being connected to ground and the spark jumps from the free end to ground. The coil at the Griffith Observatory is one-half of an actual Tesla coil. There was not enough space available to install both parts. As one watches the

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February, 1977

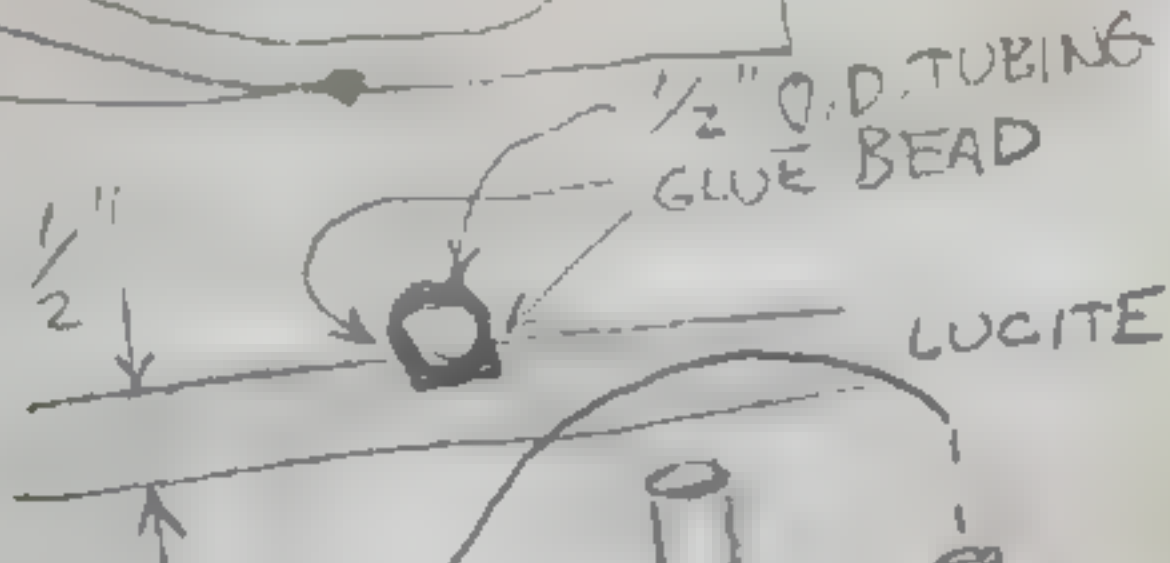
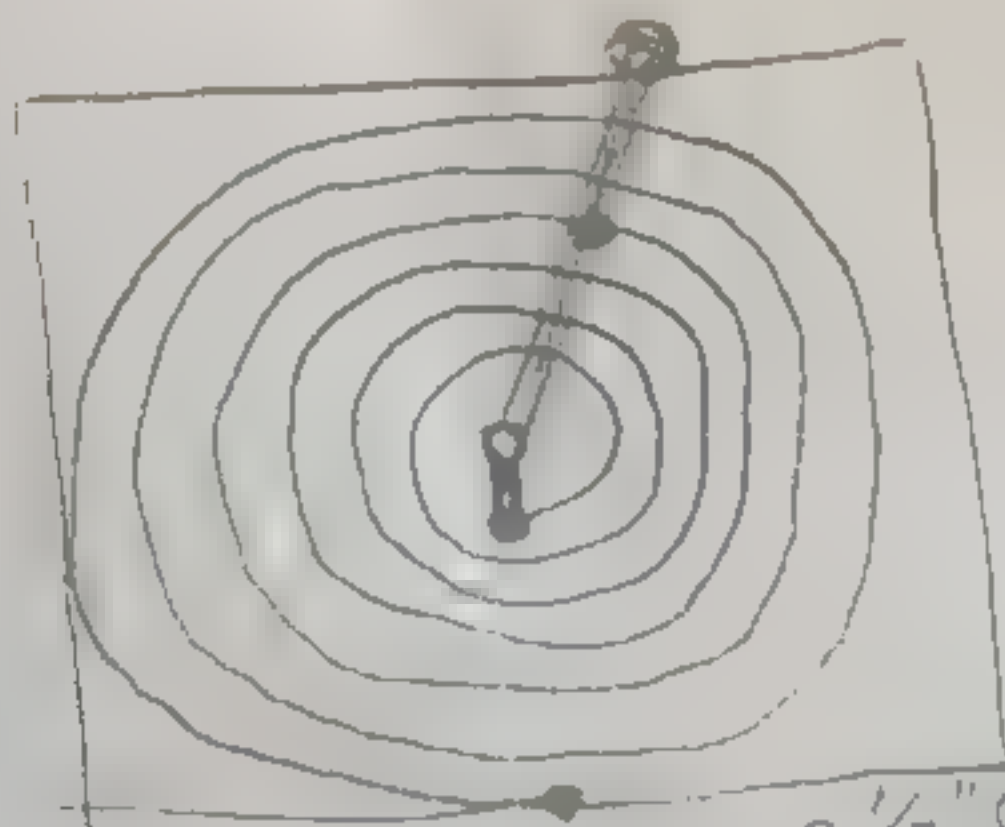
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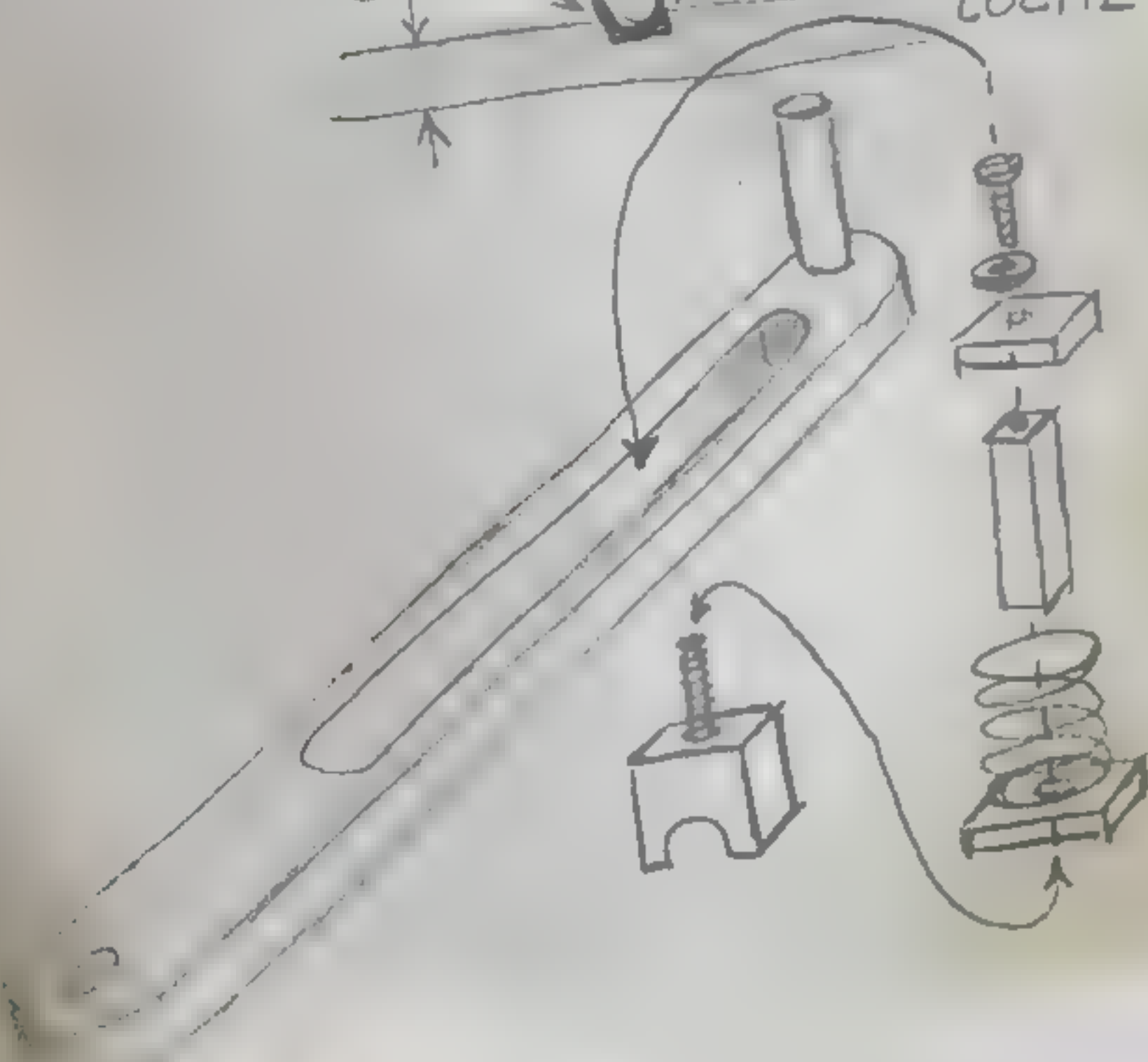
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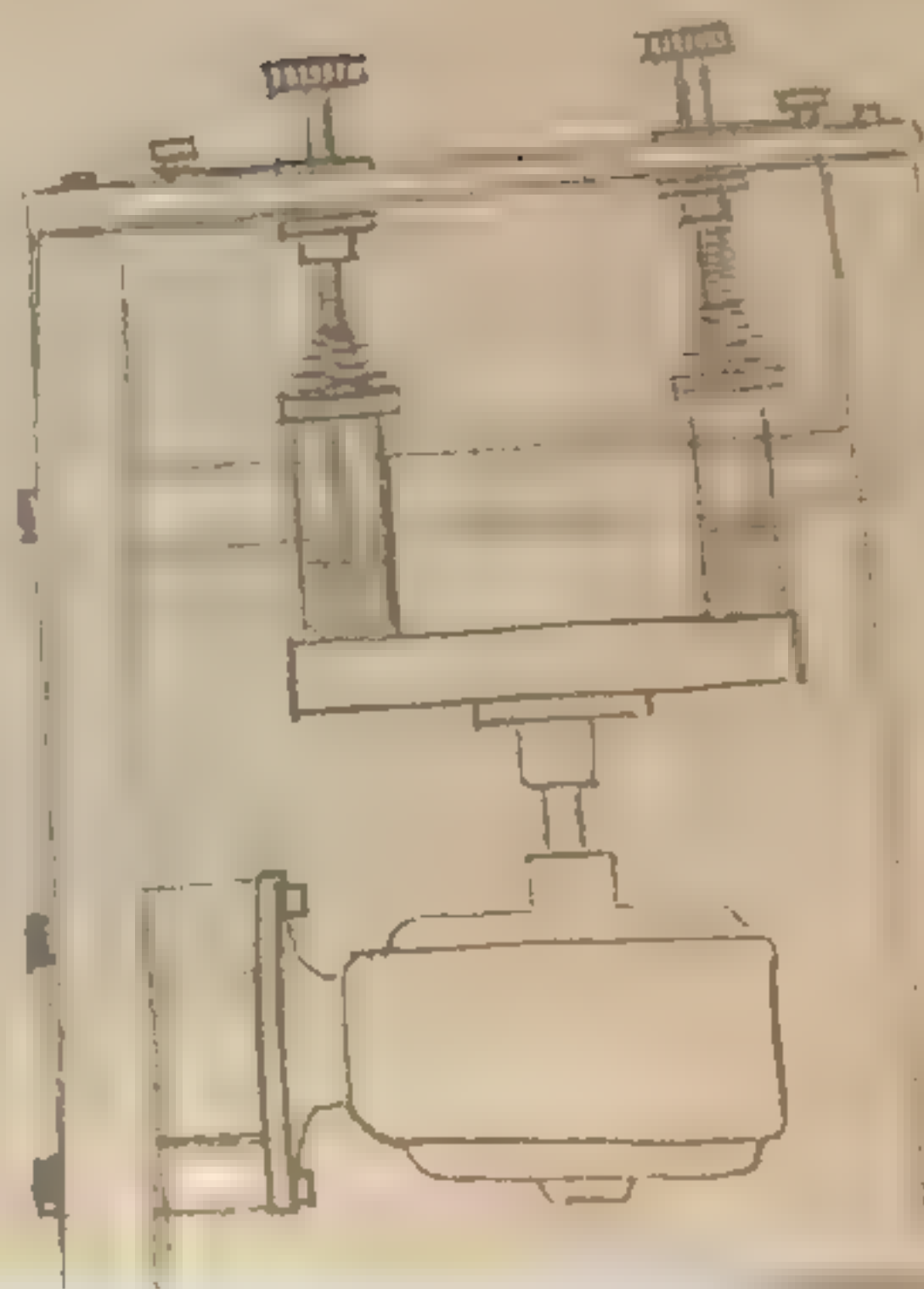


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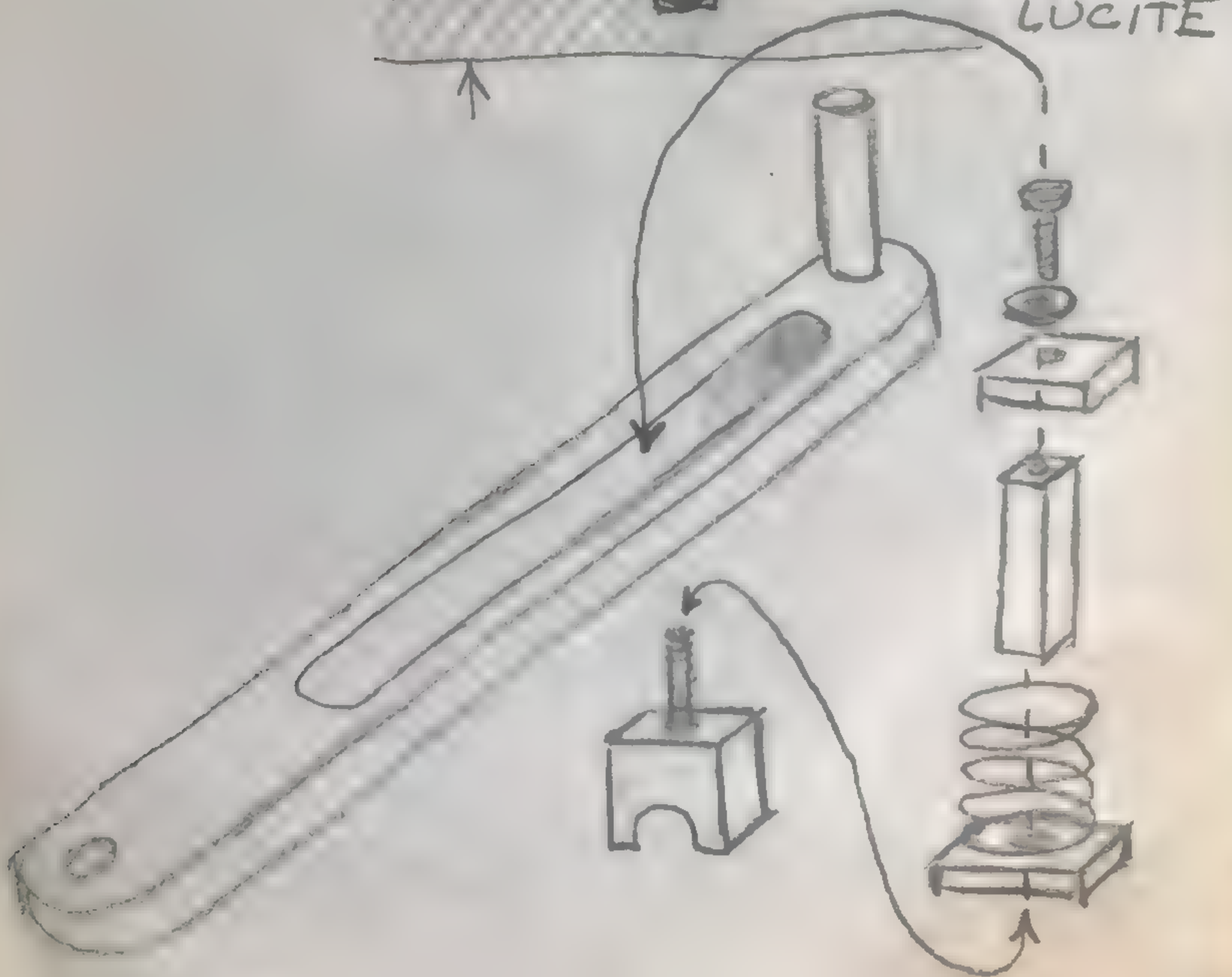
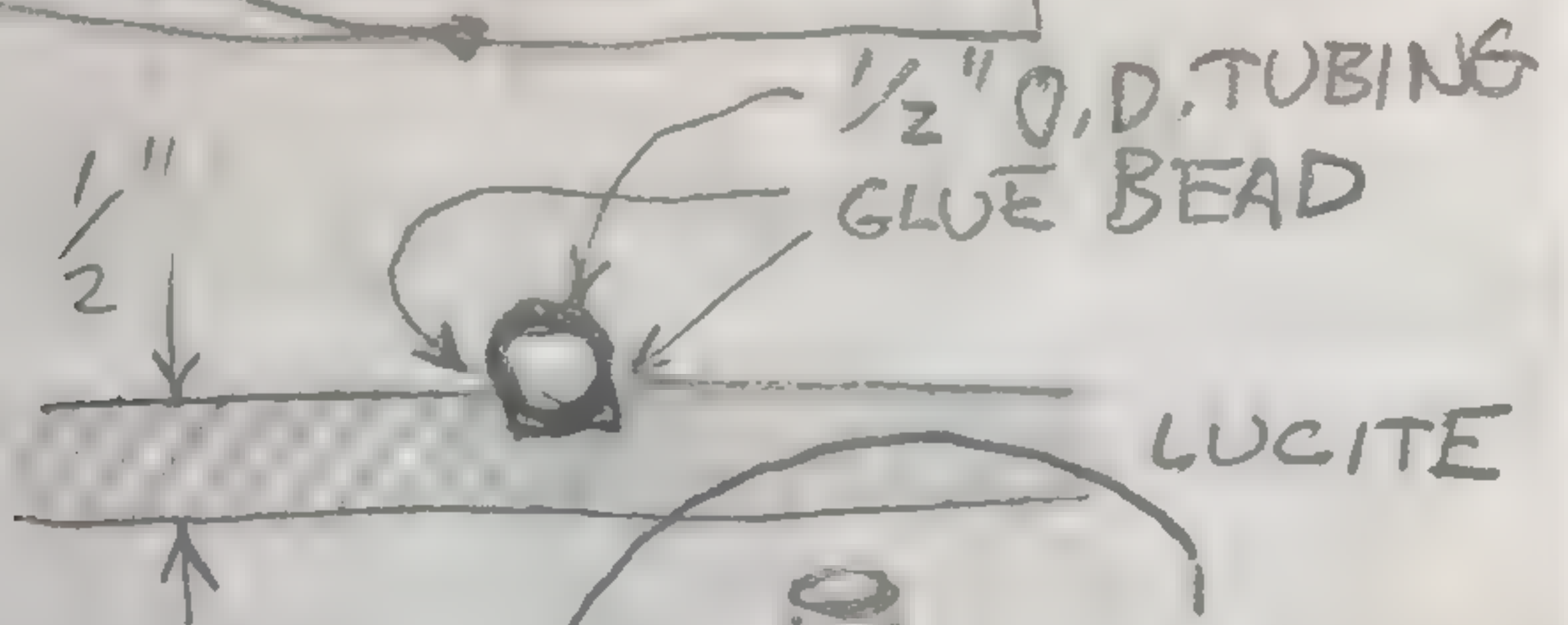
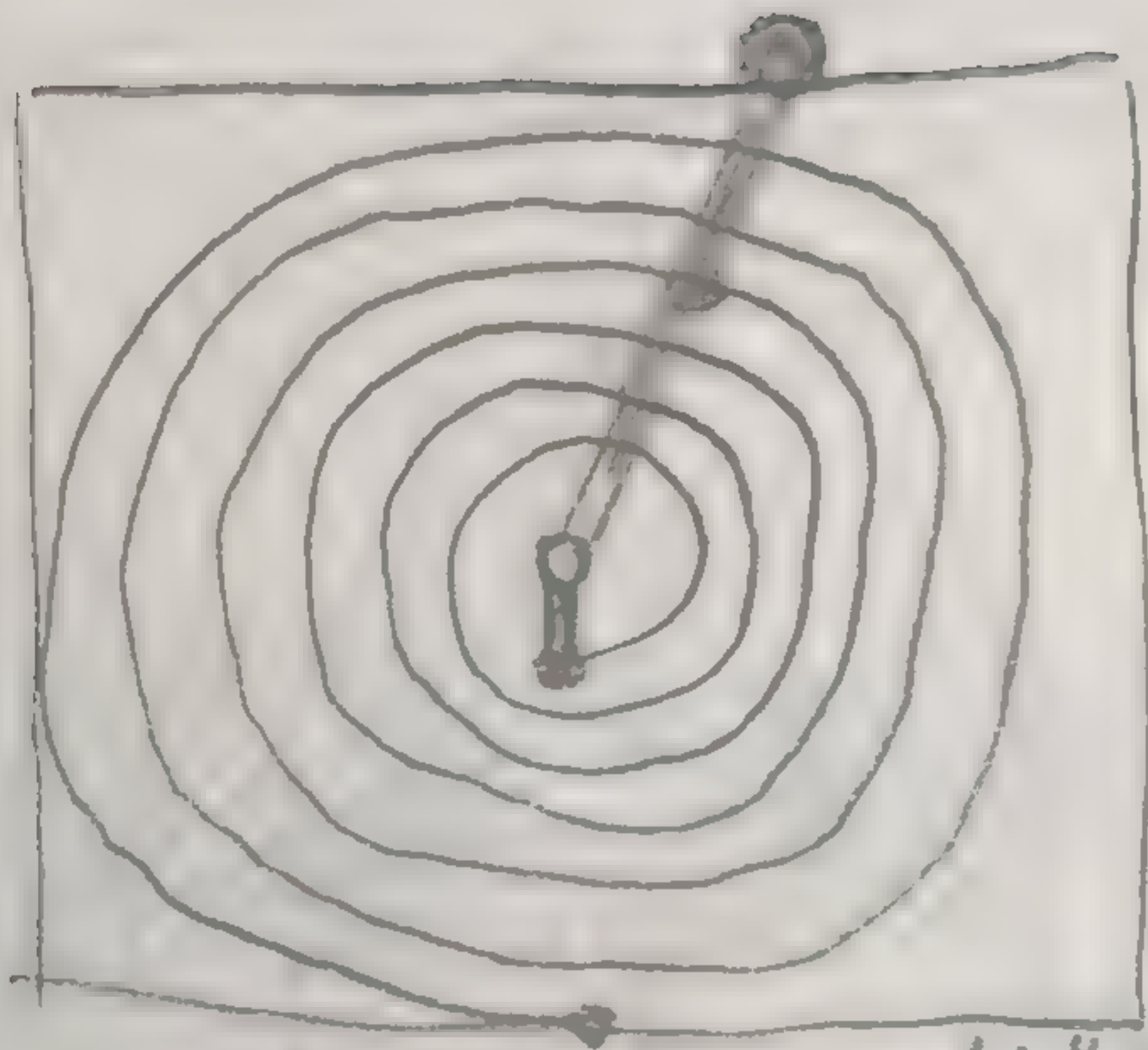
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Sincerely,

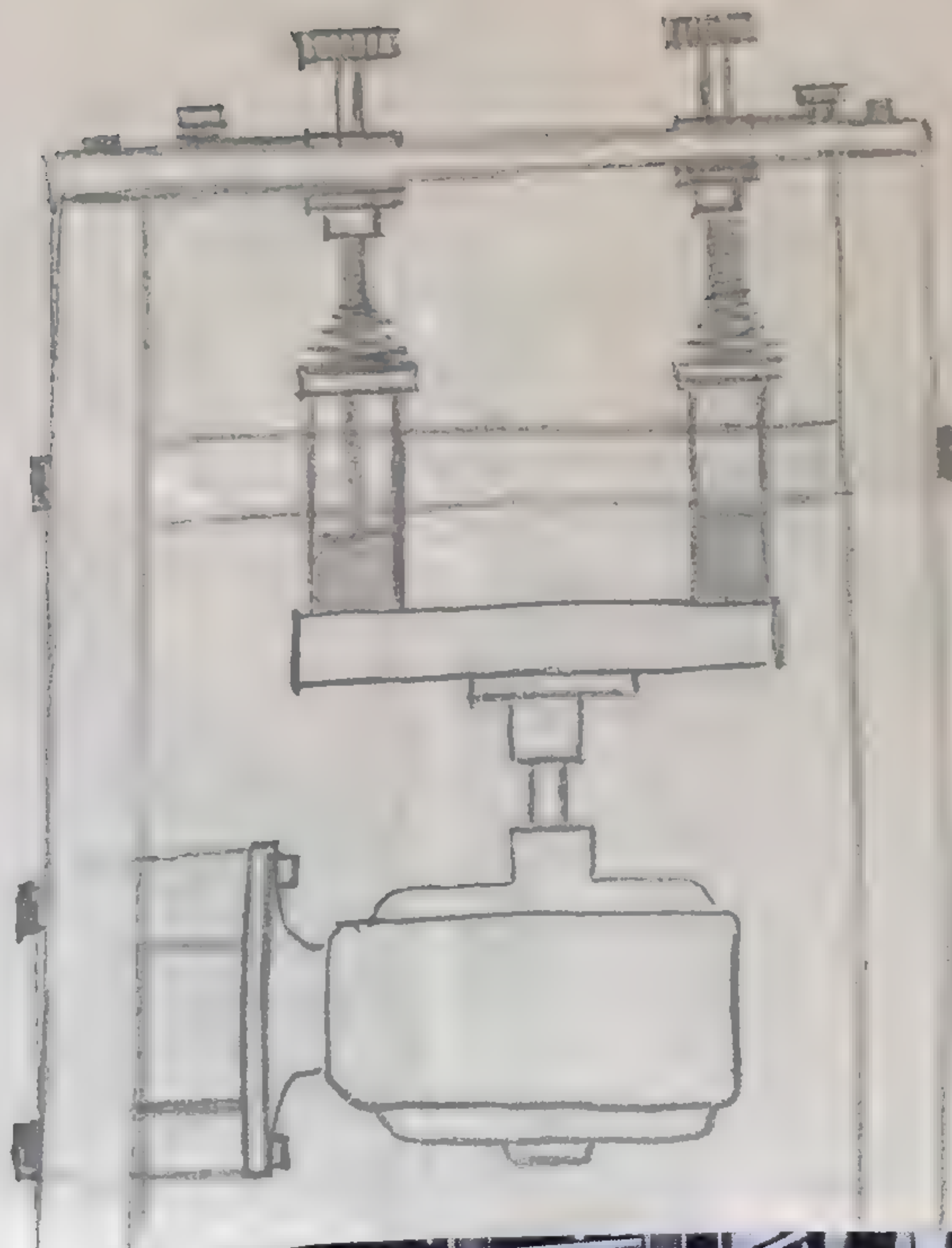
Leon Hall



1935

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C. H. CLEMINSHAW, PH.D.
DIRECTOR

LEON HALL
ASSOCIATE DIRECTOR

August 17, 1965

Mr. Bill Wysock
508 W. Lemon Avenue
Arcadia, California

Dear Mr. Wysock:

We used the pancake coil because it was easy to make and allowed the use of adjustable clips to tune the primary circuit. Copper is a soft metal and we used the rolls which are usually used for sheet metal. It was about 1936 when we tested the coils and my memory does not include the exact circuit used. I would suggest if you have uneven operation of the two coils that you try a series hookup instead of parallel hookup as you have now. We did not take any photographs of the two coils operating.

Sincerely,

Leon Hall
Leon Hall
Associate Director

LH:pow

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C. H. CLEMINSHAW, PH.D.
DIRECTOR

LEON HALL
ASSOCIATE DIRECTOR

August 5, 1965

Mr. Bill Wysock
509 W. Lemon Avenue
Arcadia, California

Dear Mr. Wysock:

Dr. Cleminshaw has asked me to answer your recent letter.

We are pleased that your photographs have turned out to be satisfactory. The books on Tesla sound interesting. We can translate German and possibly some French but not the other languages.

The calculated capacity of the condenser is 200 micromicrofarads as near as we can tell not knowing exactly the dielectric constant of the glass. This could be measured with greater accuracy with instruments we have at Griffith Observatory but this has not been done. Its exact value is not important to us as we vary the turns in the primary coil for resonance.

We had the two complete secondaries given to us without any primary coils. We constructed two identical primary coils for the two secondary coils. We had them setup side by side in the basement. We then operated them with the transformer we are now using. The transformer has a 110 or 220 volt input and we are now putting 120 volts across the 220 volt winding. When we tested the two coils at the same time we put 230 volts across the 220 volt primary getting about twice the voltage to charge the capacitors which at that time were Leyden jars. I can assure you that this is true as I personally setup the coils both in the basement and upstairs in the museum.

At the present time one of the secondary coil forms is in the basement. After about fifteen years of operation it was necessary to replace the secondary in use because of breakdown in the winding. We stripped the winding but have not had time as yet to rewind it.

I am enclosing a "Griffith Observer" which describes the "Electrical Discharge in Gases" exhibit. I do not believe an article has been written on the Jacob's Ladder exhibit.

If we can furnish any additional information please feel free to write us again.

Sincerely,

Leon Hall







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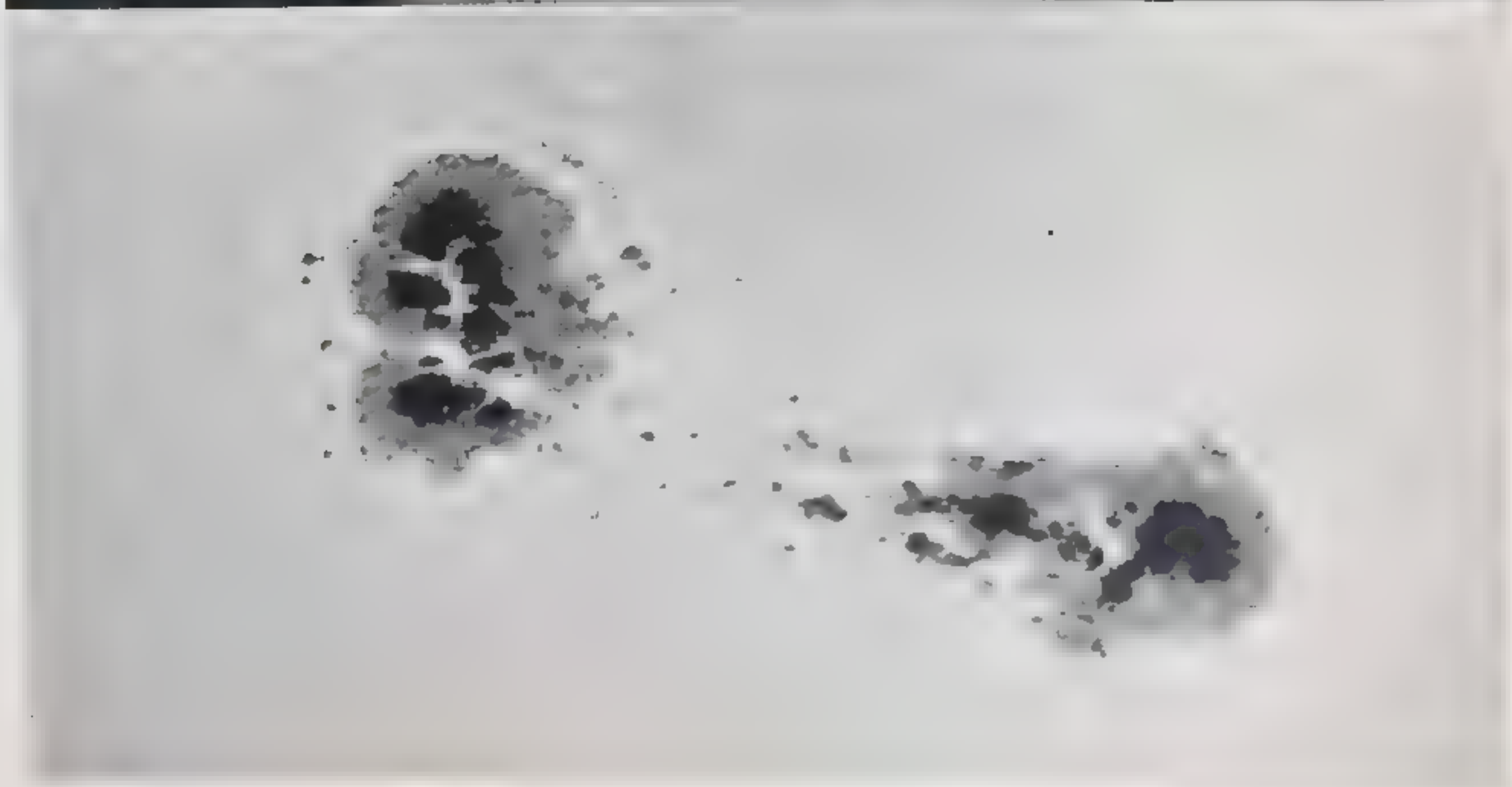
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NOVEMBER, 1938

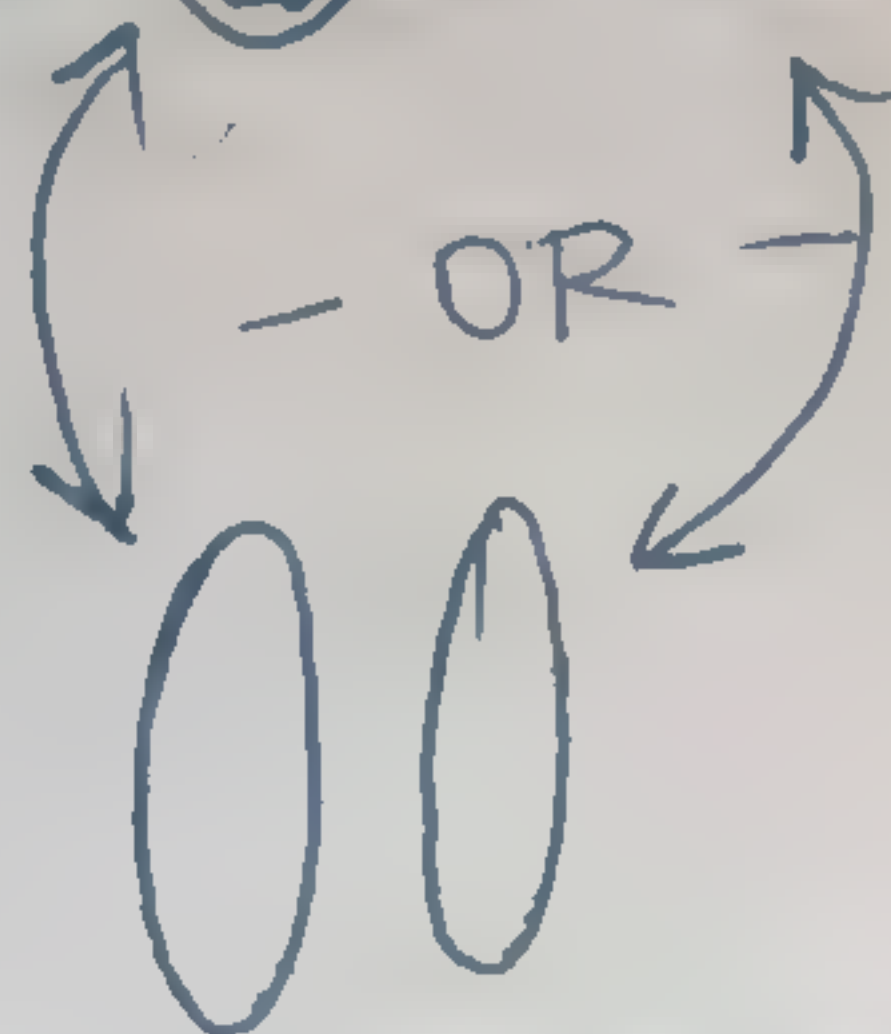
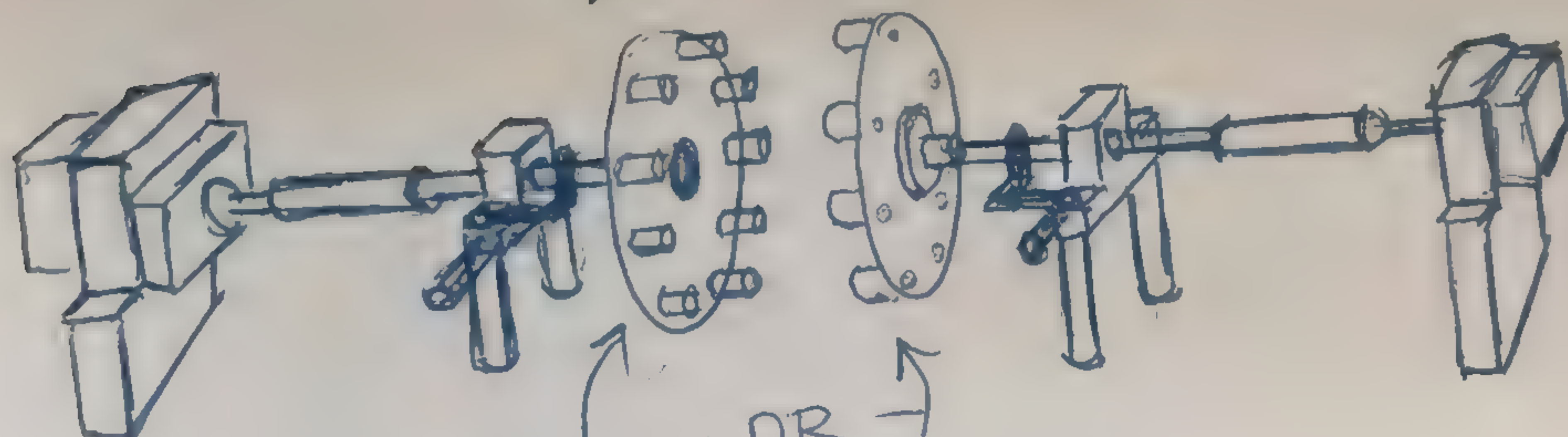
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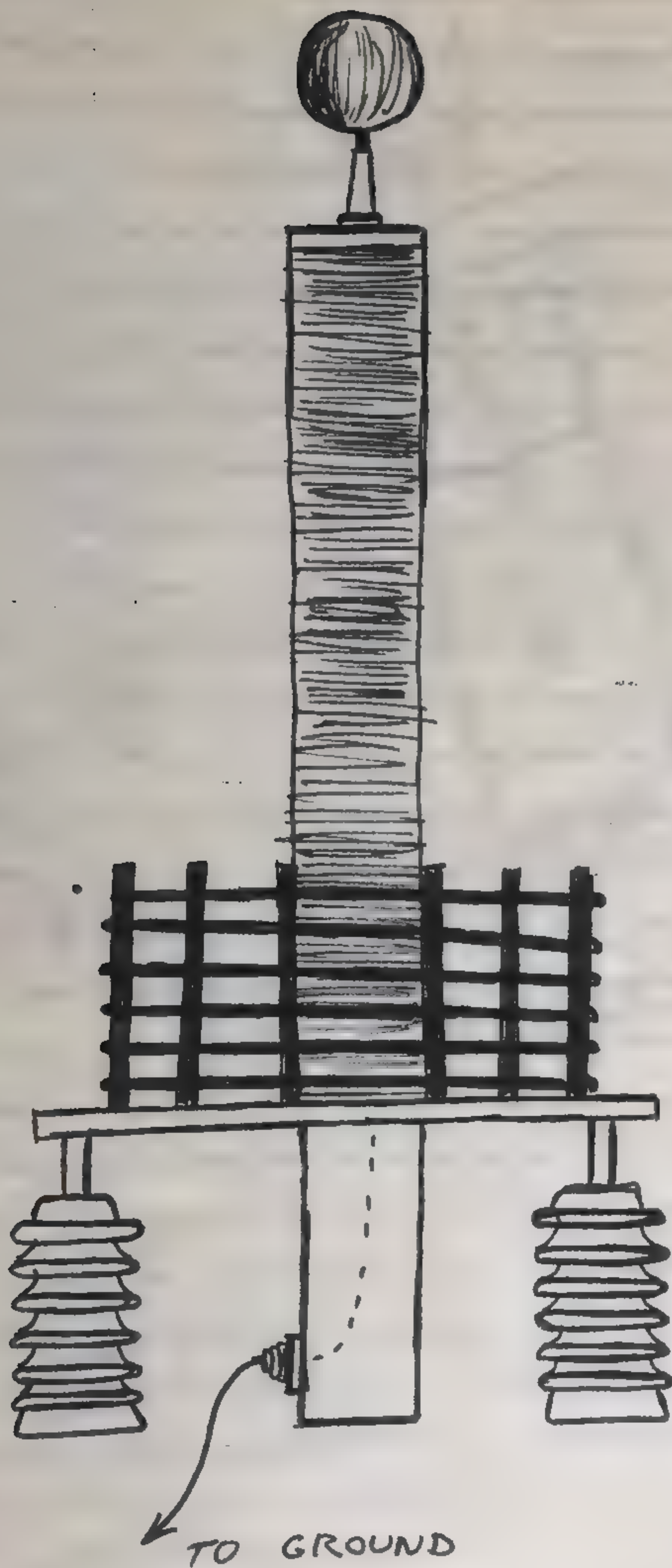
SUNSPOT GROUP

Photographed 1937 July 28 with Sixty-foot Tower Telescope at Mount Wilson

SELF-COOLING DUAL
ROTARY GAP



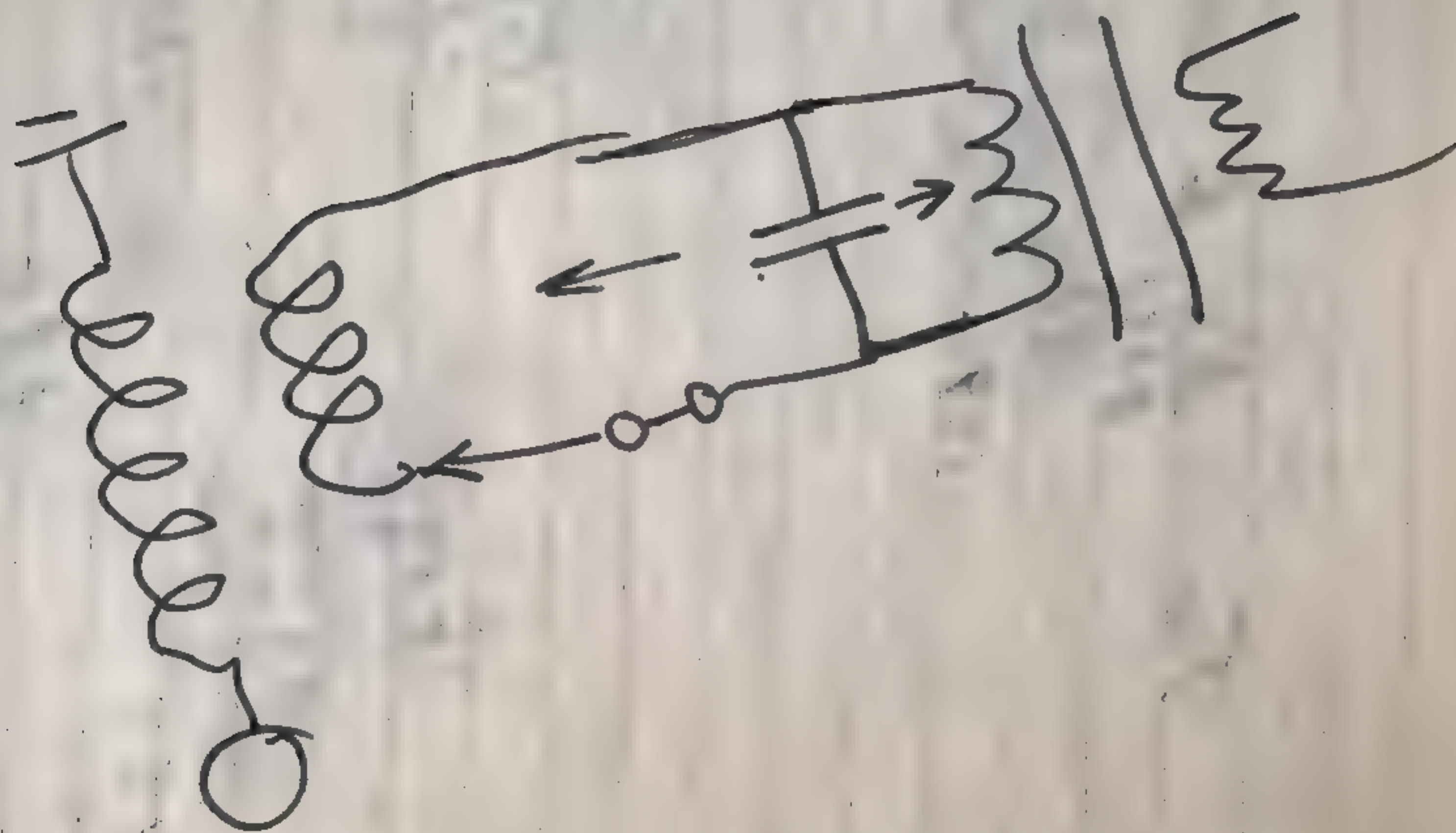
SELF COOLING
QVENCHEd GAP



600 TURNS
18 SOLID
(FORMVAR INSULATION)
EACH TURN SPACED
 $\frac{1}{8}$ "

6 TURNS $\frac{1}{2}$ " $\times$ $\frac{1}{4}$ "
COPPER BAR

T_2
100:1 RATIO



T₂

500:6 RATIO

83:1

18.8KV @ 500 MA IN

1540KV @ ~.18 MA OUT

100%
EFFECIENCY

$$\begin{array}{r} 76 \\ 18800 \\ \underline{83} \\ 36400 \\ 156400 \\ \underline{154000} \\ 2400 \end{array}$$

$$\begin{array}{r} 150:6 \\ 25 \\ \underline{1150} \\ 12 \\ \underline{36} \\ 30 \end{array}$$

$$\begin{array}{r} 83 \\ 6 \overline{) 500} \\ \underline{48} \\ 20 \\ \underline{18} \\ 2 \end{array}$$

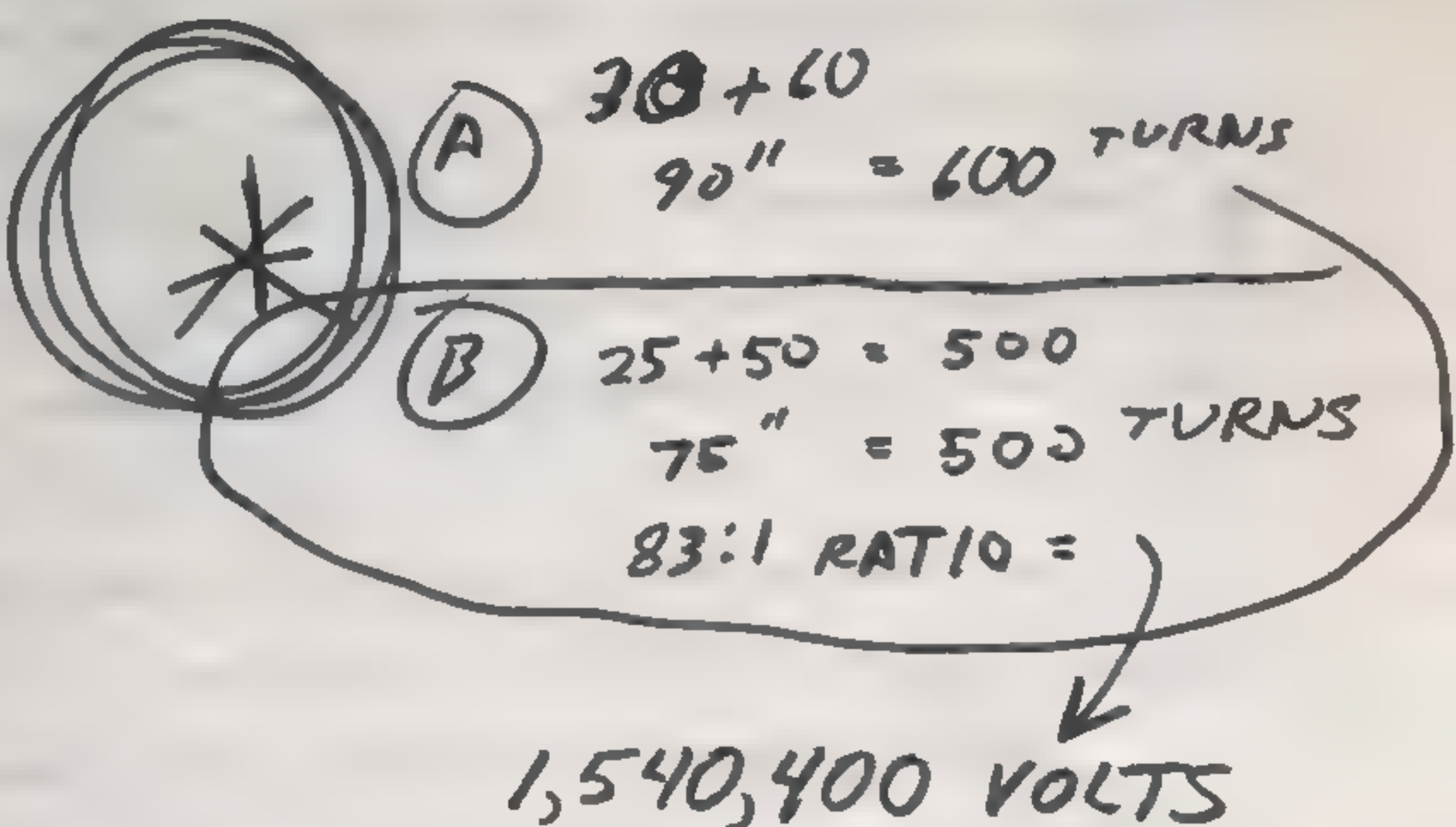
25:1 RATIO

150:6 TURNS RATIO

$$\begin{array}{r} 18.8 \\ \underline{25} \\ 940 \\ 376 \\ 4706 \end{array}$$

$$\begin{array}{l} 11 = 10 \text{ T} \\ (60) \quad (60) \text{ (A)} \\ (50) \quad (50) \text{ (B)} \end{array}$$

$$\begin{array}{r} 18800 \\ \underline{25} \\ 94000 \\ 37600 \\ \underline{470000} \end{array}$$



3.14

6.08

$$\begin{array}{r} 2.12 \\ \hline 125643.11 \\ 128 \\ \hline 7.3 \end{array}$$

$$\begin{array}{r} 125643.11 \\ 128 \\ \hline 125643.36 \\ 6 \\ \hline 37.68 \end{array}$$

5 4 X top of singh = 5
37.62 in. = 1
1.07 in. = 1

$$26.3726 \quad (22.64)$$

75.1' 20' 11" 74' 41' 72"
11' 12' 13' 14' 15' 16' 17' 18' 19' 20' 21' 22' 23' 24' 25' 26' 27' 28' 29' 30' 31' 32' 33' 34' 35' 36' 37' 38' 39' 40' 41' 42' 43' 44' 45' 46' 47' 48' 49' 50' 51' 52' 53' 54' 55' 56' 57' 58' 59' 60'

$$\begin{array}{r} 3520 \\ 1240210 \\ \hline 3520' \end{array}$$
$$\begin{array}{r} 15700 \\ 15700 \\ \hline 26.0 \end{array}$$

$$\begin{array}{r} 7.04 \\ 5 \overline{) 3520} \\ 35 \\ \hline \end{array}$$

86.07"

$$\begin{array}{r} 3520 \\ 1240210 \\ \hline 3520' \end{array}$$

3520'

80.0

42.210"

CAPACITANCE

$$C_{ap} = \frac{1.1 \epsilon A}{4\pi d}$$

In Micro Micro Farads

ϵ = dielectric constant
 A = Area in square centimeters
 d = centimeters plates are apart

INDUCTANCE

$$L = \frac{\mu N^2 A}{l} \times 10^{-9}$$

in henrys

$$L = \frac{\mu N^2 A}{l}$$

μ = permeability (Air = 1)

N = # of turns

A = cross-sectional area of form (sq inches) eg 1

l = length of coil (in) (cm)

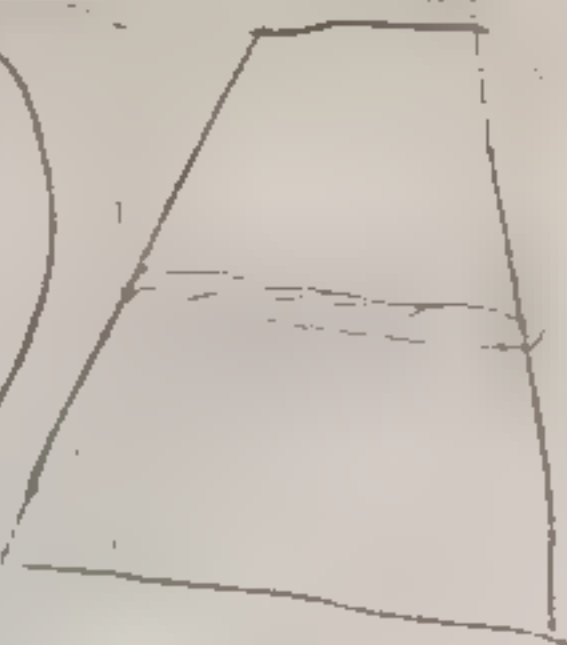
RESONANCE

$$f = \frac{1}{2\pi\sqrt{LC}}$$

Diameter (mean) cm

2996' #14

66' $\frac{1}{4}$
COPPER
TUBE



10.00
11.00
48.00

6.60

75.60

118
38

4
2 | 54
27

56
29

5.94

12
423

85

CIRCUIT D

21 13

2
3.14
27

1

42 4

3384

2198

3 36 3

35955

628

48

84.78

3.14

42

6694

12 | 791.28
72

71

10

112
400

2996 1628

12 | 35955 1256
24

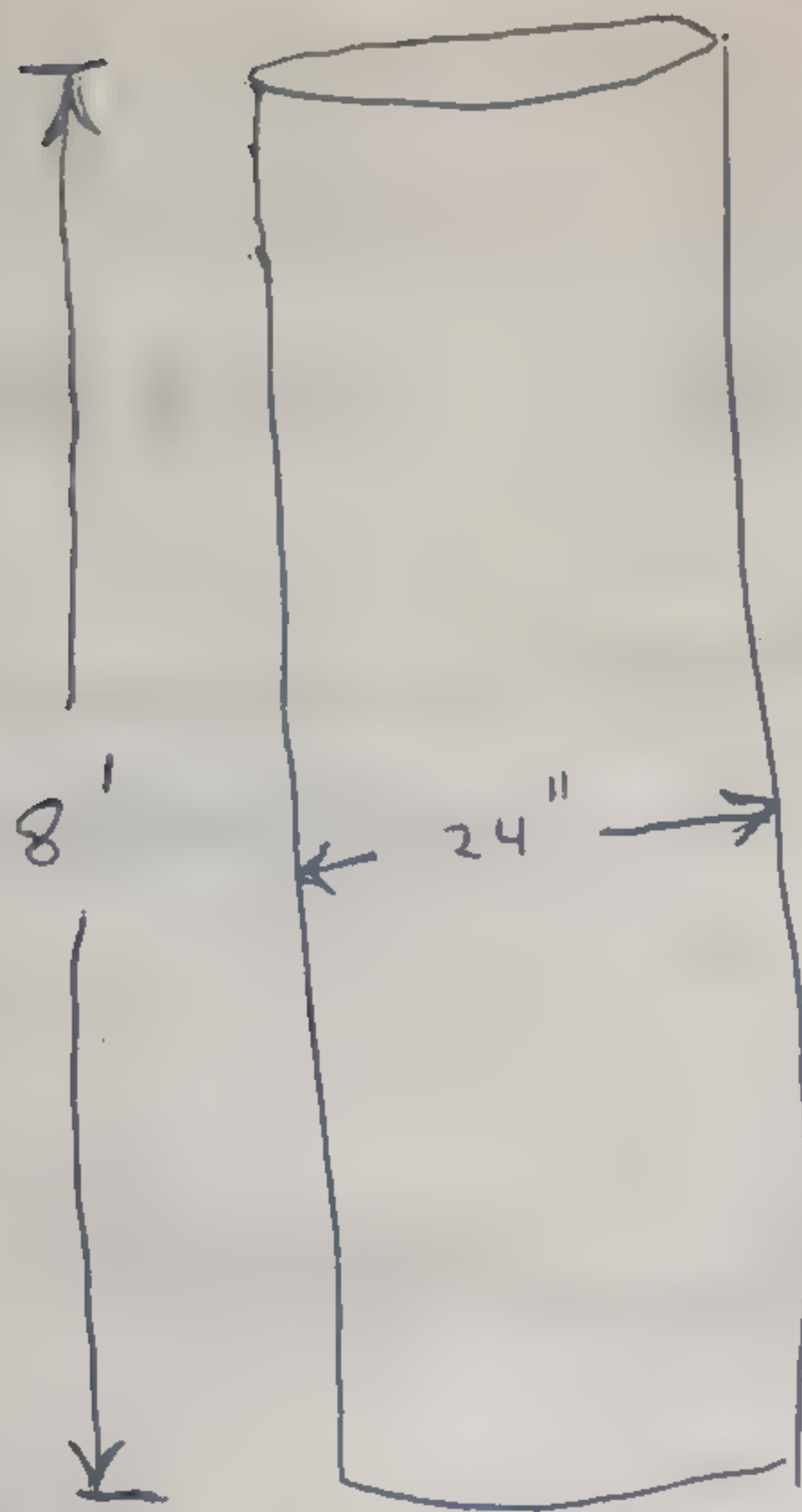
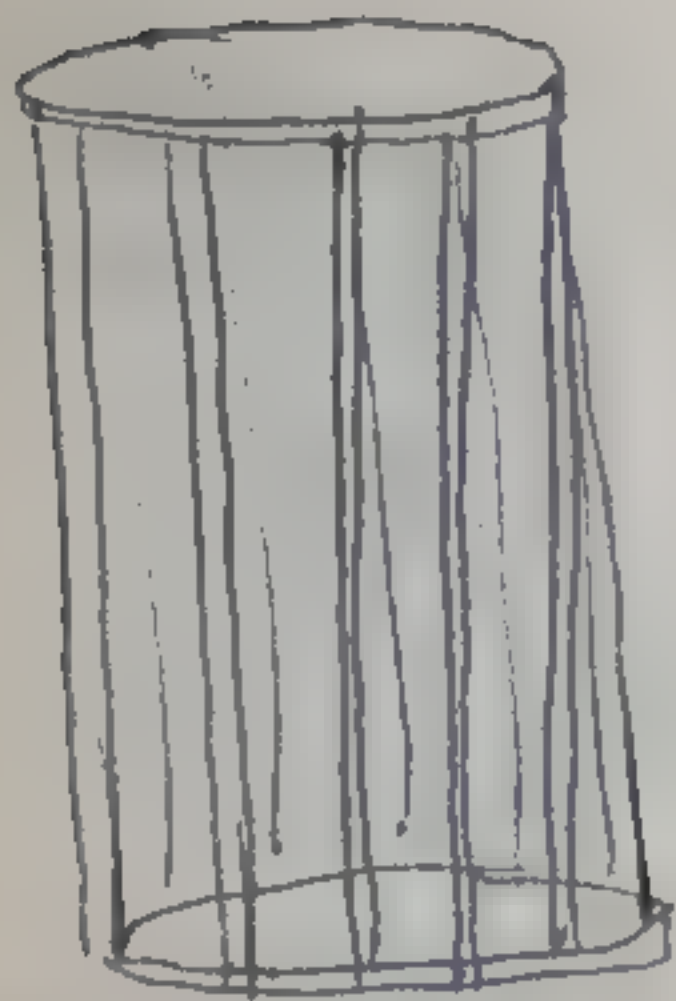
131.88

119

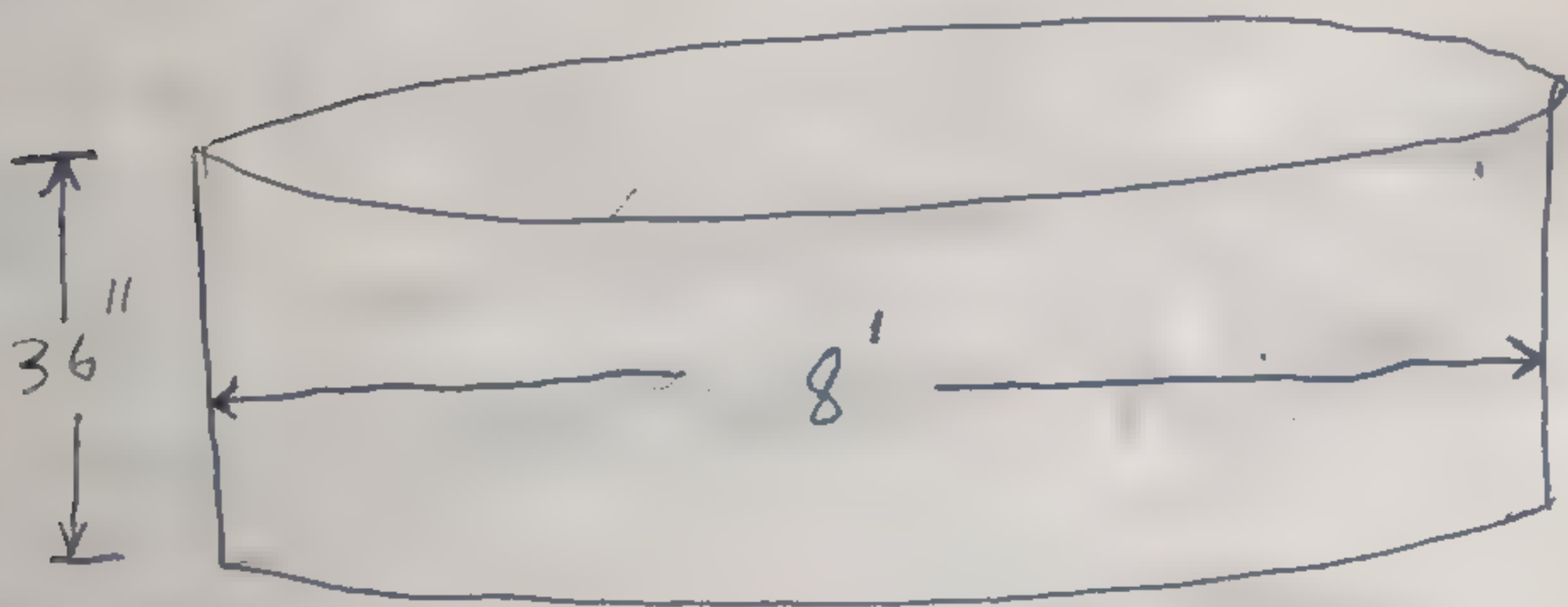
108

115

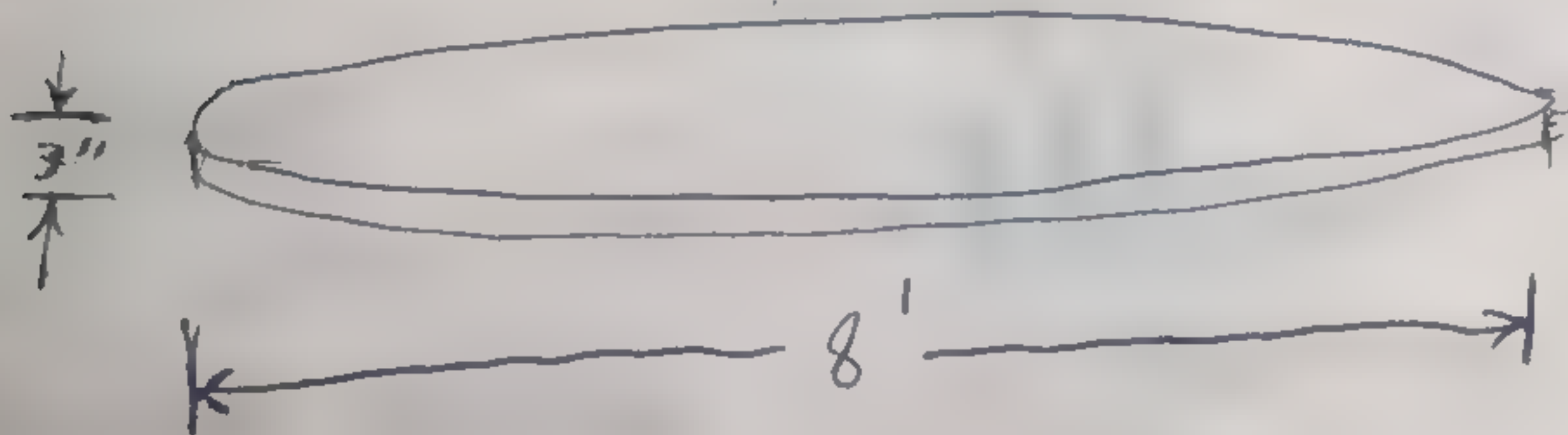
791.28



L3



L2



L1

L1

TESLA

PRIMARY: 100 K @

30 MA INPUT

L2

||

SECONDARY: RATIO OF

5:1

100,000 $\frac{11}{10,000.000}$ (50 TO 10 TURNS RATIO)

FIRST BOOST

$$5 \cdot X = 500,000$$

@ 6 MA

L3

TESLA

INDUCTANCE COIL

$$\begin{array}{r} 50 \overline{) 6 \text{ MA}} \\ \underline{50} \\ 100000 \end{array}$$

$$\begin{array}{r} 50 \\ \underline{000000} \\ 25 \\ 2500000 \end{array}$$

RATIO OF

50:1

(500 TURNS TO 50 TURNS)

SECOND VOLTAGE

$$\text{BOOST} = 50 \cdot X_2$$

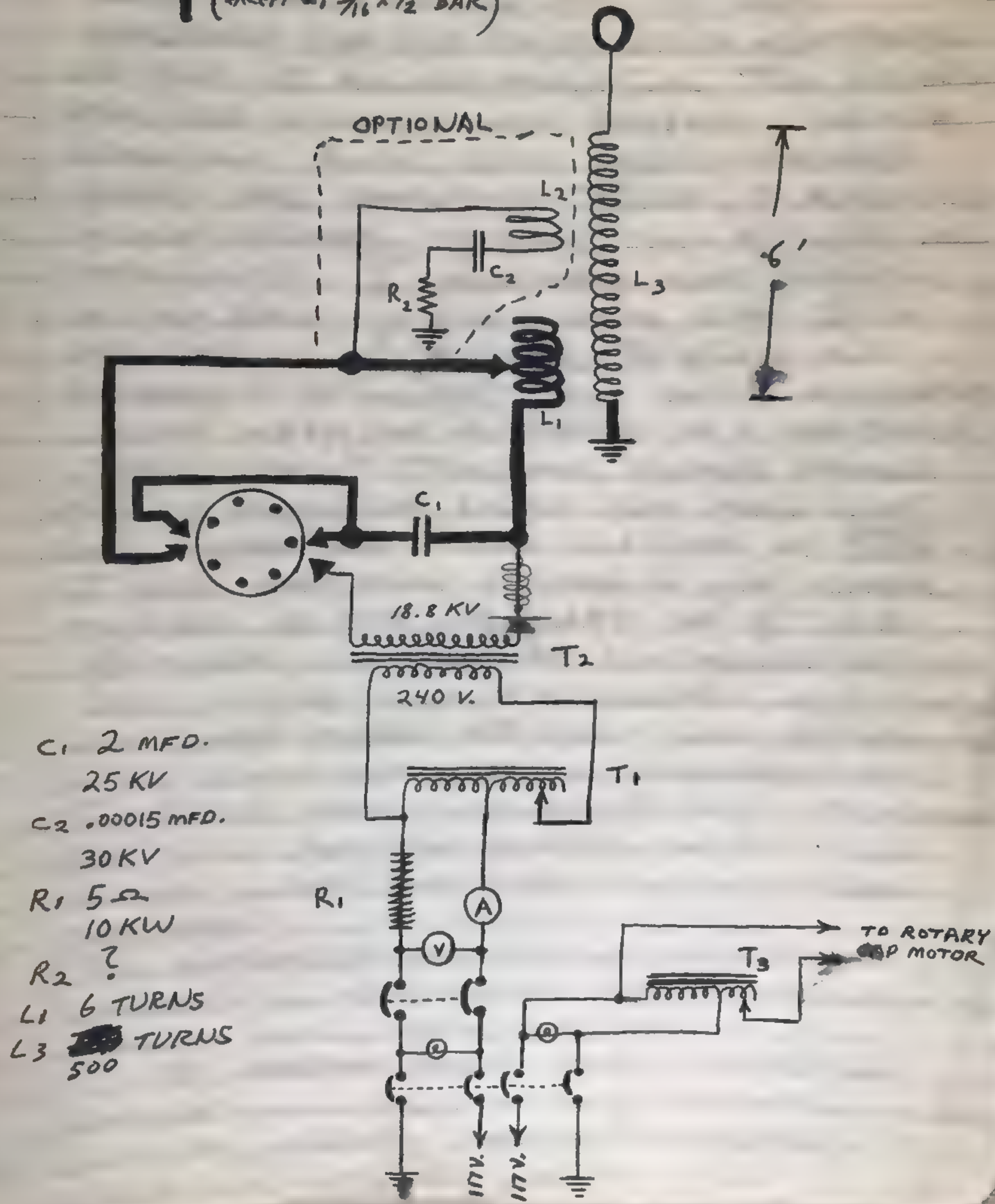
2.5 MILLION VOLTS

AT .12 MA OF CURRENT

12.10"

#12 INSULATED SOLID COPPER AFTER T₁
#10 " STRANDED " BEFORE T₁

1/4" O.D. COPPER TUBING
(EXCEPT L₁ 3/16" x 1/2" BAR)



- C₁ 2 MFD.
25 KV
- C₂ .00015 MFD.
30 KV
- R₁ 5 Ω
10 KW
- R₂ ?
- L₁ 6 TURNS
- L₃ ~~500~~ 500 TURNS

TODAY, FEBRUARY 26, 1969, I HAVE PROGRESSED INTO THE THIRD DAY OF PREPERATION ON THE 1.5 MEGAVOLT TESLA COIL. THE ROTARY SPARK GAP COMPLETE WITH REVISIONS, AND THE CAPACITOR BANK, HAVE BEEN FINALIZED, READY FOR OPERATION. TODAY, I PURCHASED MORE COPPER TUBING, CONNECTORS, AND TERMINALS. I DISCOVERED THAT COPPER, IN ANY FORM, IS NOW WORTH SOME \$2.00 PER POUND. AT THIS RATE, TO BUILD THE PRIMARY & SECONDARY COILS OF THE OSCILLATOR WOULD MEAN THE POSSESSION OF A VARITIBLE "FORT-KNOX!" HOWEVER, COPPER TUBING RUNS AT SOMEWHAT LOWER COST THAN DOES SOLID COPPER BAR PRICED IN A RATIO OF $\frac{\text{FEET}}{\text{WEIGHT}}$.

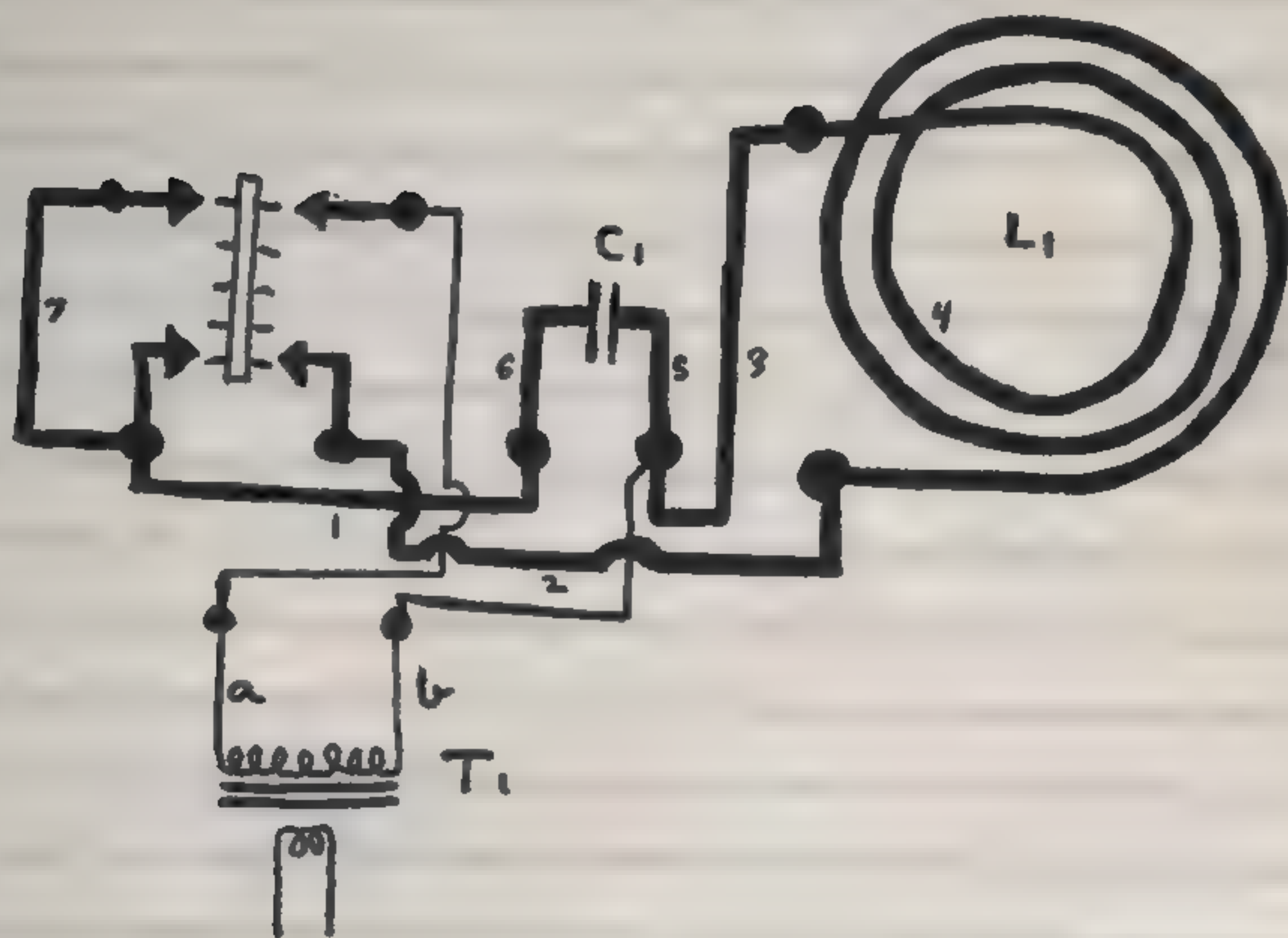
I HAVE THEREFORE ELECTED TO USE COPPER TUBING IN THE PRIMARY OF $\frac{1}{4}$ " O.D. .

AS THERE WILL ONLY BE SIX TURNS IN THIS COIL, WOUND ON A HORIZONTAL AXIS, (PANCAKE) NOT MORE THAN 60 FEET WILL BE EMPLOYED WHICH WOULD REPRESENT A REASONABLE COST. THE TURNS RATIO WILL BE 83 TO 1. THIS MEANS 500 TURNS FOR THE SECONDARY OF #12 SOLID COPPER WIRE WITH SLIGHT SPACING BETWEEN THE TURNS.

THE ROTARY GAP PERFORMS WITH EXCEEDING EFFIENCY ON PRELIMINARY TESTS CONDUCTED ON IT USING A SMALL TANK CIRCUIT.

MY ~~ANXIETY~~ ANXIETY IS SUCH THAT I CAN PERCEIVE IN MY MIND, THE WHOLE APPERATUS WORKING WITH THE HIGHEST DEGREE OF EFFIENCY. I EGERLY AWAIT MY EXPECTATIONS.

TANK OSCILLATOR ARRANGEMENT



As can be noted, heavy lines 1 thru 7 indicate $\frac{1}{4}$ " O.D. tubing made of copper. This is the keynote to the ultra-high efficiency obtained in this tank circuit because of the relatively high inductive capacitance and almost negligible inductive reactance. The lines from T_1 output a, b, are of some length utilizing #12 solid copper wire that has Formvar insulation. Being of such construction, the lines a, b offer a considerable greater amount of inductive reactance helping to prevent R-F feedback from reaching T_1 's secondary. This, along with the new design of the rotary spark gap, serves to isolate as much as possible, the oscillations of the tank circuit to C_1 and L_1 . Thus, the efficiency of the whole circuit is further increased.

0013

001

00025

01

01275

$$\begin{array}{r} 500 \overline{) 100.0} \\ \underline{100 } \end{array} \quad \begin{array}{r} .2 \\ \hline \end{array}$$

$$\begin{array}{r} 15 \ 000 \\ \underline{100} \\ 000000 \\ 000000 \\ 150000 \\ \hline 1,500,000 \end{array}$$

CX

Lightning

by

Bill Wysock

~~3 lines~~

Bottom margin

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Controlling Purpose

This term paper ~~is~~ written on lightning. ~~It~~ contents contain ~~how~~ lightning became early mans fear ~~and~~ and god, and how ~~it~~ it became a wonder and hazard to modern day people.

This term paper explains how scientists beginning back ~~in the~~ ^{in the} sixteenth century learned scientific knowledge about lightning. It tells of artificial lightning men have created to learn by ~~in~~ in simulated natural conditions to make lightning less and less of a hazard.

Sentence Outline

- I Lightning is caused by electric charges in the earth and clouds.
- II Lightning is a high potential or voltage with a high current or amperage usually in the order of two hundred-thousand amperes.
- III Lightning is made up of a pile of electrons attempting to equalize each other.
- IV An electric charge is the accumulation of electrons at concentrated points or massavly distributed.
- V There are four main kinds of lightning;
 1. Bead lightning, lightning that has glowing streamers as in bolt lightning, and has little ball-like beads in these streamers
 2. Ball or streak lightning, is the most commonly seen of all types and has a concentrated point on earth and cloud.

Sentence Outline con't.

3. Sheet lightning, most commonly seen when bolt lightning is not present. It has a mass-
evenly distributed charge
and discharge hence, there
is no concentrated point
hence, no damage or destruction
is inflicted on the earth below.
4. Ball lightning, most
phenomenal and yet
unexplained. This type
has been claimed to have
been seen by hundreds of
people mostly in their
homes where a bluish-colored
ball comes at slow speed aiming
for a window or door with
a streaming tail behind.
People claim it comes into
their homes and rolls
and bounces around the floors
until suddenly, it disappears.
People also claim that afterwards
there is a smell of sulphur.

September Outline ~~cont.~~

VI Lightning takes place where there is a strong potential difference between two heavenly bodies in a storm.

Lightning

42

From the beginning of time man has been curious about the environment that surrounds him. One of the most phenomenal wonders of this environment is lightning. One may ask what is lightning?

A simple answer would be; lightning is electricity manufactured by nature. Lightning, was an enemy of early man. To a Greek, lightning was a god named Zeus, who was supreme ruler of the sky and whose weapon was a bolt of lightning which he sent speeding down to earth. Today lightning is a phenomena of science. The following explains lightning.

Lightning is a discharge of electricity of short duration. With less than ten millionths of a second a single bolt of lightning

may yield enough electric power to supply the entire electric bill of the United States for one week. This is a tremendous amount of power. Unfortunately this power can not be harnessed. ~~A by~~

A lightning bolt is measured in electrical terms called voltage and amperage. Where normal house-type current is rated at one hundred, ten volts and thirty amperes, a single stroke of lightning may have a potential voltage ranging from ten million to one hundred billion volts and from one thousand to two hundred thousand amperes.

If calculated to a power measurement called wattage, normal house electricity would yield close to a maximum of three-thousand watts.

On the other hand, a single lightning stroke of one hundred million volts at two hundred-thousand amperes would yield 20,000,000,000,000,000 watts. This is the average power output of one lightning bolt.

At this very second, about one thousand - eight hundred bolts of lightning are striking over the earth. At this rate there is a constant electrical charge being fed into the earth. This charge is wholly a positive charge. That is, the earth normally has a mass - absence of electrons.

The earth, the shape of a sphere, has generally a positive charge while the ionosphere, the lightest and largest layer of air, has a mass negative charge or excess of electrons.

Between the ionosphere and the earth there is an electrical potential of four hundred-thousand volts at one thousand-eight hundred amperes of current under normal or dry atmospheric conditions.

The earth and the ionosphere exchange their positive and negative charges in an attempt to equalize each other. This "flow" of electricity is called an "ionic current." If a man is six feet tall, he has an electrical current of two hundred-sixty volts going through him.

This same condition takes place in an electrical storm. Often a bluish glow takes place at sharp points in the neighborhood of a strong potential difference.

This is especially true of masts on ships. In the older days it was known as "St. Elmo's fire" and quite often it frightened sailors. On land, the leaves of tall trees and high blades of grass often revealed St. Elmo's fire around their tips during a storm.

Today science has proven that St. Elmo's fire is intense ionizing collisions of electricity with molecules of oxygen making them luminous. Another name for St. Elmo's fire is corona, or brush discharge.

The cause of lightning has always been a mystery to man. At first, lightning was supposed to be the doings of Zeus, now a myth.

In the sixteenth century, Lord Kelvin made an experiment similar to the ~~throy~~ today. This was an oil-drop apparatus that took a stream of oil droplets and dripped through two rings made of metal. The rings were insulated and they collected electrical charges from drops of oil as they dripped through.

Negative charges from the oil were collected on one ring, positive on the other. A valve controlled the volume of oil dripping through the rings. This machine developed almost two hundred volts and gave a small jolt to anyone touching it. Today scientists believe that clouds, cumulonimbus clouds in particular, work in much the same way as does the oil-

drop apparatus. A cloud has moisture and when a cold front moves in on the moist, warm air, condensation takes place and rain drops form. Then if an updraft takes these water drops high into the top of the cloud, these drops break up into more, even smaller drops and then into smaller drops.

This cycle is repeated over again and again. Because like oil, water droplets have electrical charges and this cycle takes place, tremendous potentials develop in the cloud. These potentials in relation to the earth range from ten to one hundred million volts.

Science has not only tried to find the cause of lightning, but also determine how to

protect buildings, people, power lines, trees, etc from the destructive, menacing pranks of lightning. Lightning may strike a power line and send surges of electricity to power stations and wreck or burn out machinery or surge into a home thus destroying or setting to fire the home and property.

It may kill, cook, or even vaporize people who may be in a direct or indirect path in circuit of lightning. It may strike dry brush areas in forests, such as tall, dry trees and set the entire forest on fire.

So to help prevent damage and destruction, science made an effort to overcome lightning's hazards. In order to do this scientists had to build equipment sensitive enough that lightning could

be studied indirectly. This is considered the only safe way of studying lightning. One of the first great contributions to the knowledge of lightning was Benjamin Franklin's kite experiment in the summer of 1752 and the lightning rod in 1747. ~~7~~

The construction of the kite experiment was a kite, a line of thread ~~a~~ key, and a silk ribbon. On a summer day in 1752, an electrical storm was brewing over Pennsylvania and Ben had his kite high in the air.

The rain made the line of string wet and the kite too. In other words the kite became conductive to "electrical fluid," as it was called in those days.

They began to conduct a small portion of the electricity in the air. This current ran down the string where the brass key was. The key and the string were insulated by the silk ribbon held in one hand of Ben, and he touched his knuckles to the key with the other.

This brought a display of sparks, blue and bright, that were followed by little snapping noises. This proved Franklin's theory that lightning is electricity and does have positive and negative charges.

This is probably the most important knowledge because electricity is in man's hands and he may conduct experiments and simulate the results to the behavior patterns of lightning.

Among Franklin's other contributions to the knowledge of lightning, is the lightning rod. This device consists of a sharp-pointed rod which is mounted on the highest location of the object to be protected. Often there are several rods mounted to insure protection from lightning.

It works in the way of preventing an electrical charge from building up between the storm cloud and the earth in the near vicinity of a building, home, or structure.

The sharp point causes ionizing collisions in the air. This "corona" or brush charge causes a leakage of electrons so they can not build up, thus preventing a lightning bolt and hence preventing

destruction. Lightning rods are not the only means of protection and they can not offer protection ~~and they can~~ under certain circumstances. As science progressed, new machines that generated electric power to help and benefit mankind came into being making the hazards of lightning and other weather conditions a menace and means of destruction.

For example, a power station that transmitted power to a community was in grave danger if the power lines weren't protected. An oil well could become as explosive as a case of dynamite if not properly shielded from lightning.

To help prevent lightning from becoming a menace, scientists, electric companies, corporations, and specialists joined in research to find a practical means of controlling the problems of lightning. ~~Among~~

Among them, the General Electric Company contributed greatly to our present day knowledge of lightning. General Electric assigned part of its staff to lightning research. Among these people was Charles Proteus Steinmetz, a German born immigrant who was a mathematician.

He applied for work with General Electric Company in 1889 and was paid twelve dollars a week.

Soon after he had begun work E. E. F. Creighton, a former Stanford University professor, joined with Stinmetz in research on lightning in the General Electric Research Laboratory at Schenectady, New York.

Together they devised lightning arresters of many different kinds and designs that would allow a surge of lightning current to bypass an electrical power line to ground. This effective method of protecting power lines prevented burn-outs in transformers, generators, and most of all appliances in the homes of the community.

Then lightning became a personal matter to the little German scientist.

One summer at Camp Mohawk, a little camp on the banks of the Mohawk river, Stinemetz was suddenly met face to face with nature's own force. On a humid Thursday in August 1920, a sudden storm took place. Stinemetz decided to wait until the following day to go to Camp Mohawk.

The next day he left for the camp. When he arrived he was surprised to find ~~the~~ cabin's insides in little pieces everywhere and the tree just outside the shattered window splintered like tooth picks.

Although the cabin was now worthless and Stinemetz wanted vengeance against nature's misbehavior, he was amazed at the sight of it.

A mirror, his work bench and table, and his window were all that were shattered. He pieced the broken mess into their original forms so that the path of the lightning and its power were easy to see.

From his knowledge of physics, he was able to calculate and learn clues about the bolt which had struck his cabin. Afterward it became apparent that in order to really learn anything about lightning, man would have to be able to direct lightning where he wanted it at his will.

He now turned to the problem of making lightning, "manmade lightning."

He finally convinced the General Electric Company to build a one hundred - twenty thousand volt artificial lightning generator. This generator used a principle called the "Leyden jar theory" named after the university of its inventor, Pieter van Musschenbroek who made this discovery in 1746.

The construction of this device is simple. It consists of a wide-mouth bottle which has a metal coating of lead extending up to about two inches of the top on the inside and outside. A rubber or wooden cork stops up the bottle and has a metal rod connected to the inner coating and projecting out through the top of the cork.

Then if a high voltage direct current is connected to the coatings each will become highly charged with electrons. The di-electric, or glass, prevents the coatings from discharging.

If a number of these "condensers" are connected in parallel, the discharge potential becomes greater. Sturtevant had ~~become~~ ^{manufactured} the General Electric Company two hundred lead coated glass sheets.

He used sheets instead of jars because they were easier to manufacture. Then he connected them in parallel so that there were two common wires.

The lead these into a switch. If the switch were thrown into one position, the condenser would become charged by a high voltage direct current made by a high voltage alternating current transformer and a pair of special rectifier tubes.

After the condenser had received a full charge, the switch was thrown into the other position allowing the lead coatings to discharge all their electricity together across a large spark gap.

The spark discharge given off by this condenser was at five million horsepower.

The discharge was of short duration~~s~~, and was blinding bright followed by a deafening clap of thunder. It was two feet long and was followed by that distinct odor of ozone which is caused by ion collisions with molecules of air as we learned earlier.

In 1922 Sturmetz had completed the generator and had invited Thomas Alva Edison and some associates for a demonstration. They stood behind a wire screen for protection against possible electric shock.

The transformer-rectifier was turned on and the switch was thrown into "charging" position.

After a bell rang meaning that a bolt of artificial lightning was about to strike and the coatings had received their full charge, the switch was thrown into "discharge" position. There was a bright spark followed by a clap of thunder.

After the spectators' vision had returned, they saw that all that was left of a block of wood that had been placed in the spark gap was splintered to pieces.

Dramatic as this seemed, Stinemetz was not satisfied because it was too small for practical experimentation and it was a mere one five-hundredth of the power output from one average bolt of lightning.

About this time another scientist came along by the name of Karl Marx. Together he and Stimmetz made out the plans for a surge type of generator. In 1937 the construction began.

The generator was built in two parts, each developing a potential of five million volts. Between the two generators there was a thirty foot spark gap and a potential difference of ten million volts. Unfortunately, the little German scientists never lived to see it work. He died in 1923.

The ten million volt generator was completed and exhibited at the 1939 New York's World Fair in "Stimmetz Hall."

Still later another generator was built. Each half developed seven million-five hundred thousand volts potential and between them fifteen million volts potential difference.

Instead of a thirty foot gap there was a fifty foot gap. With these generators scientists could direct artificial lightning for their experiments and learn by simulated natural conditions on laboratory scale. But high voltage generators do not provide everything scientists need to know about lightning.

Artificial lightning is used for testing insulators and lightning arrestors to prevent lightning from menacing the public power lines.

In order to learn more, scientists had to develop devices that would probe deeper into the characteristics of lightning. Among these were the Four oscillograph.

Since lightning is over in a "flash," a mechanical instrument, an electric instrument with mechanical movements, such as a galvanometer, would begin to register several hundredths of a second after a bolt had ended.

The oscillograph however, incorporates a stream of electrons in a cathode-ray tube and amplifier circuit. The oscillograph, with its stream of electrons reacts almost precisely to the instant a lightning bolt occurs because an electron

stream and a lightning bolt are both electrical, and electricity travels at the rate of one hundred-eighty six thousand miles a second. Therefore if a bolt occurs one hundred miles away, the oscillograph would record the bolt with accuracy down to the ten-thousandth of a second.

Pu Four's oscillograph utilized the modern cathode-ray tube and was used to detect the speed that a lightning bolt travels in seconds, feet, and miles. To make further use of the oscillograph Pu Four adopted an amplifier circuit and relay that the same speed and accuracy would measure the peak potential, current, air resistance of lightning.

For instance, the highest amperage recorded to date is two hundred twenty thousand amperes. The highest voltage or potential is in the order of ten billion volts. When you stop to consider that one-thousandth of one ampere is sufficient to paralyze the muscles of the body, including the heart muscle, 220,000 amperes would not only paralyze, but vaporize an unfortunate person who had the experience of becoming part of a circuit with lightning.

If you consider the ten billion volts at 220,000 amperes, you have enough pressure or potential, and enough current to carry the pressure possibly as far as twenty miles in the form of a lightning bolt.

Such instances are break, but it is not unnatural to see a lightning bolt strike nearby with the storm and clouds ten or more miles away.

Another and probably most interesting instrument developed by scientists for the study of lightning, is the high speed camera. The first form of this instrument was invented by Sir Charles Boys.

It consisted of a normal camera with a standard lens, except it had a special lens located so that it rotated around the center lens. This lens rotated at high speed and while the center lens took a normal picture of a lightning bolt, the rotating lens took several different parts of the bolt that revealed

how lightning decides when and where it will "strike" as we see it. Today scientists know from this form of camera and improved movie cameras, that a single bolt of lightning, as the human eye sees it, is really a series of "leaders" that start from a cloud, each growing longer until in a certain pattern, ~~they~~ another bolt starts from the ground growing in length and size until they connect.

The instant they do, the bolt becomes more intense as the tremendous electrical charges pour off from cloud to ground and ground to cloud until both heavenly bodies equalize, putting an end to the path the electrons have chosen to equalize

each other, hence, the bolt of lightning ends. All this takes place each time a bolt of lightning occurs and the time of the whole operation never exceeds one second at the extremes.

Before a "leader" takes place a "cylindrical" shape of ionized air molecules takes place. It is in this cylinder or "housing" that a leader takes form.

Also when we see a bolt of lightning actually what we see is two bolts of lightning that the eye "fuses" into one bolt. The first is usually from a cloud to ground and usually is the main "body" of the bolt the eye sees. The second bolt takes the same pattern but adds branches or "streamers" that branch off

the main bolt in unusual and interesting patterns in an attempt to reach the cloud. Most of the time these streamers never reach the cloud but sometimes they do and when they do, we see "chain" or "forked" lightning that has many little branches that disappear in the cloud and join into one bolt as it is seen closer to the ground.

There are many different types of lightning. Those known to scientists are classified in types:

The first type is streak or bolt lightning. This is the type most commonly seen. Bolt lightning has "leaders" and "streamers." The second type is sheet lightning. This is also very common and the nice thing about this

Type is that there is no destruction. Sheet lightning is a uniform discharge that is a layer of ionized air molecules causing them to glow. The charges in sheet lightning are massive and equal everywhere. When it is "spread out" like this there is concentrated points in the discharge hence no damage.

The third type of lightning seen only occasionally is bead lightning. Bead lightning resembles bolt lightning in that they both have streamers and leaders, only bead lightning appears as glowing streaks with little glowing ball-like beads in the streamers.

The fourth and most phenomenal of all is ball lightning. This type of lightning claimed to have been seen by seen by hundreds of people

as they describe it, is a large fire-like, glowing ball with a streaming tail that moves slowly down from the sky and often comes into homes through windows, doors, and sometimes even fire places.

It comes shooting in a home usually landing on a table or floor and either or both rolls around the house then disappears. Many people say that there is an odor of sulphur and a hissing sound that accompanies it. Even today scientists have no explanation for it.

Lightning is strange,
powerful and beautiful.
It may do good, or it may
do bad. In any event, man
has learned to accept this
act of nature as part of
his environment and has
learned to control and
inform himself about
lightning.

Bibliography

Sparks, Lightning, Cosmic Rays
Dayton Clarence Miller,
D. Sc., D. Eng., LL.D.
Professor of Physics Case
School of Applied Science.
1938, New York, The Macmillan
Co.

The Lightning Book

Peter E. Humeister
Doubleday & Co., Inc.,
Garden City, New York,
1961

The Book of Popular Science volume 3

The Grolier Society Inc.
New York, Toronto, 1954

Artificial Lightning, Dramatic
Experiments with High Voltage
pages 951-960

July '65

Bill Wysock
Griffith Observatory
Civics 9
Period 4
5/18/64
B 47

The Griffith Observatory and Planetarium

by

Bill Wysock



Mrs. Bowen
Civics 9
Period 4
5/18/64

July '65

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CONTROLLING PURPOSE

This term paper is written on one of the outstanding places in California, The Griffith Observatory and Planetarium. In the following pages, an attempt is made to describe some of the outstanding features and exhibits of this picturesque place located in the Los Feliz Hills.

Also in this paper are described some of my personal reactions and evaluations of my visit to the observatory on the night of May 13, 1964. This article also tells about some of the most notable achievements of modern physical science.

SENTENCE OUTLINE

- I. Foreword, describing the history, location, and divisions of the Griffith Observatory and Planetarium.
- II. The observatory proper, contains a (12) inch refracting telescope, made by Carl Zeiss, of Jena, Germany. It also contains (3) polar telescopes.
- III. A. The Hall of Science contains over 100 exhibits of modern physical science.
B. Among the most interesting of the exhibits are;
 1. The Foucault Pendulum
 2. The Iron Meteorite from Arizona
 3. The Tesla Coil
 4. The \$25,000 model of the Palomar telescope.
- IV. The Foucault Pendulum is the first sight a visitor sees when entering the building. It was invented by Jean Foucault. The brass ball of the pendulum weighs 240 pounds.
- V. The fragment of the meteorite of Arizona, believed to have fallen about 50,000 year ago, is made of iron and weighs 365 pounds.
- VI. The Tesla Coil of the Griffith Observatory, has a voltage output of over 1,300,000. Enherited by Dr. Fredrich Strong, it was given as a present to the observatory.
- VII. The Electrical Discharge Through Gases Exhibit, shows how X-rays are produced, how electron beams are bent by a magnetic field, and how electron bombardment on certain chemicals causes them to glow.
- VIII. In the Hall of Science, there is the exhibit of the (\$25,000) model of the telescop of Palomar Mountain. It was built by Samuel Orkin at a cost of nearly \$25,000 for a 1/24 scale model that is complete with motors and moving parts.
- IX. The main feature of the Griffith Observatory and Planetarium is the planetarium itself. It has a projector made by Carl Zeiss. The theater is of hemispherical design and holds an audience of 538 people. The celestial shows given there are most impressive.
- X. The Griffith Observatory and Planetarium are one of the many key places in California.

FOREWORD

The Griffith Observatory and Planetarium is located at the top of the Los Feliz hills at the end of Vermont Avenue. As one drives through the scenic winding road of Vermont Ave., he passes the famous Greek Theater. As he continues up and up Vermont, he comes to a large open space which is the top of the Los Feliz hills. The next item to come into view is the Griffith Observatory itself. After he has parked his car and proceeds to walk toward the building, he passes the two monuments, The Astronomers Mount, and the Equatorial Sundial. These two monuments add to the breathtaking beauty of the Griffith Observatory.

The Griffith Observatory was a gift to the City of Los Angeles, given by the will of Colonel Griffith J. Griffith. At the same time he presented the famous Greek Theater. At some time previous to this event, Colonel Griffith J. Griffith presented the Griffith Park to the City, in 1896.

The Griffith Observatory and Planetarium was first opened on the night of May 14th, 1935. It is divided into three large divisions. First, is the Observatory proper. In this division there is a 12 inch refracting telescope. This telescope is used for study of the various stars in our Western Hemisphere. In addition to this instrument, there are also three solar telescopes which are fed by a triple mirror mechanism. The first mirror is directed at a screen in the Hall of Science. The second makes an image of the sun of a five-inch grating spectroscope. The third aims a beam at a one-half Angstrom filter showing the various gases on the sun.

The second division, the Hall of Science, shows more than 100 exhibits of the most notable discoveries of modern physical science. These range from the 1,300,000 volt Tesla Coil to the \$25,000 model of the 200 inch Palomar telescope on the top of Palomar Mountain. From time to time, new exhibits are built and added to the other exhibits in the Hall of Science.

The third and most spectacular of all the items in the Griffith Observatory, is the Zeiss planetarium. This is a theater of hemispherical shape with a ceiling that is 75 feet in diameter. This ceiling simulates the Western Hemisphere upon which images of a man-made sky may be projected. The projector, is the Zeiss instrument, a combination of precision lenses and lamps. The theater has a capacity of 538 people, who for 1 to 2 hours, find themselves in an artificial universe.

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In the observatory proper, is the 12 inch refractor telescope of the Griffith Observatory. It was made personally by Carl Zeiss, of Jena, Germany, where the Zeiss Planetarium was built. In 1955, a smaller telescope was added onto the main telescope. It contained a nine and one-half Zeiss lens. The focal lengths are 16 feet 5 inches for the large telescope, and 11 feet 9 inches for the smaller one.

On a clear night, both telescopes are open to the public for observation. On the night of May 13, 1964, I visited the observatory and had the opportunity to see a star under observation. This star's name was Mizar. This is the star that marks the bend of the handle of the big dipper. To the naked eye, Mizar is a double star. The telescope not only shows the naked eye companion star (Alcor), but also reveals that Mizar is itself, along with its associate stars, double.

To keep the telescope in perfect alignment with the stars and planets, there is a mechanism that operates in conjunction with a master clock that drives the telescope at a constant speed, in order that it will follow the object under observation.

The building as one may notice, has 3 domes, a small one on the left and another on the right. The third, and largest dome, is located in the center of the building and is the dome of the planetarium. The left dome, holds the 12 inch refractor telescope. The dome on the right of the observatory houses the (3) solar telescopes as described in the "Foreword".

The (3) solar telescopes, one of which projected an image on a screen in the Hall of Science, is properly titled, the "camera obscura". It is an apparatus in which images of external objects are formed by a convex lens and thrown on a screen in a darkened chamber, for which the Latin words are "camera obscura". The camera obscura at the Griffith Observatory, is located in the west corridor of the Hall of Science. Its convex lens is directed outward toward the parking area and the entrance area of the observatory.

As one watches on the screen, he may see a car coming up the drive to the parking area or people walking towards the entrance door of the observatory.

Another solar lens focuses the sun's rays on a slit in a pit twenty feet deep. This slit is graduated in inch lines with 44,000 divisions between each inch mark. This measurement is engraved on a mirror surface and is called a "diffraction grating." The light reflected from the grating is spread out, just below

a microscope through which the visitor looks, into a continuous band of all the colors from violet to red, crossed by thousands of dark lines of various brightness, called the spectrum.

The third solar telescope, whose light beam is studied through a special filter made of quartz and calcite plates with polaroid polarizers, shows the way that the sun ejects "prominences" to great heights with terrific velocities. They rise above the sun's surface at various speeds up to 450 miles per second, and up to heights as 1,000,000 miles, which is more than the sun's diameter. These flaming red hydrogen prominences are of all sizes and shapes, and may be dynamically viewed by visitors at the Griffith Observatory.

In the Hall of Science, there are over 100 exhibits of the many fields of science. Among the most spectacular of the exhibits, are the Foucault Pendulum, the iron meteorite from Arizona, the Tesla Coil, the Electrical Discharge through Gases Exhibit, and the \$25,000 model of the Mt. Palomar telescope.

The Foucault Pendulum is the first sight a visitor sees when entering the building. It consists of an extremely long pendulum, a steel wire, 40 feet long, and a brass ball weighing 240 pounds which swings slowly back and forth near the bottom of a pit. Around the pit is a scale divided into 42 parts around the circumference of the pit. The reason the pit is divided into 42 parts is because at this point of the earth it takes 42 hours for the huge brass ball to complete one whole turn of swinging back and forth. The Foucault pendulum was an invention of Jean Foucault, a French physicist who made the discovery in 1851. He suspended a very heavy iron ball from a wire more than 200 feet long. This experiment was conducted in Paris. The pit in this pendulum was divided into 32 parts because of its location on the earth. A magnetic control which has no sidewise movement, is used to keep the ball at the observatory in motion. It is necessary to excite the ball because it has nothing to keep it in motion. The air friction, after a comparatively short time, would slow the pendulum to a stop otherwise.

In the East corridor of the Hall of Science, there is on exhibit, a meteorite, weighing 395 pounds. It is one of the fragments found ^{from} some thirty tons of iron meteorites that made the crater in Arizona at an estimated time of 50,000 years ago. The largest specimen weighs about 1500 pounds and is in the Colorado Museum of Natural History in Denver. The crater itself, measures 4250 feet in diameter, nearly 3 miles in circumference, and about 600 feet deep. The rim of the crater rises 135 feet above the plain, and is covered with fragments of rock ranging in size

from boulders as large as a family garage to tiny particles of sandstone. When the crater was first formed, before the down-coming crushed rock fell, it has been proven that the crater itself, was 1400 feet deep. The condition of the meteorite and the amount of it buried there still remains a mystery.

The Tesla Coil, located in the western corridor, is perhaps the most intriguing of all the exhibits in the Hall of Science. It was first built by Nicola Tesla in 1896. This particular model with an electrical potential of over 1 million volts, was built by Earl L. Ovington. It was inherited by Dr. Fredrich Strong, who gave it as a present to the observatory. It consists of a power supply transformer, an air-core, step-up transformer, or Tesla transformer, a glass-plate condensor, and a rotary spark gap. The power supply transformer steps common 110 volt house current up to 10,000 volts with an available power of 2,000 watts. This high-voltage is stored in the glass-plate condensor, until it has built up enough to jump the gap across the rotary spark gap. It then goes through the primary of the "Tesla transformer." This sets up an electrical field around the cone-shaped secondary coil, which builds up a tremendous high-voltage, high-frequency spark nearly 6 feet long through the air.

As one watches a guide operate the coil, he sees a beautiful lacey, lavender colored, discharge jump from the top of the hollow copper sphere atop the secondary coil into the air and occasionally into the steel-framed walls, which are good electrical grounds. This high-frequency current is completely harmless, and the guide often passes part of the current through his body to prove this fact. Sometimes he may hold up to the coil, a common florescent lamp, which when brought into the electrical field of the coil, will light up brilliantly. Yet the guide or person holding the lamp feels no discomfort at all. The innocent appearing primary coil at the base, on the other hand, is death dealing.

On the opposite side of the Tesla Coil in the Hall of Science, is the Electrical Discharge Through Gases Exhibit. This exhibit consists of a variety of rarified gas tubes and vacuum tubes, all of which show how an electric current passes more easily through a partial vacuum rather than through the air. A five-foot tube at the top of the exhibit shows how the electrical discharge passes through the tube more easily than when air is admitted into the tube. Two other of the tubes show that a force is exerted on an electrical current flowing in a tube at low and medium pressures. Another tube shows how an electron beam is bent by a magnetic field. Still another shows how X-rays are produced. One of the most beautiful tubes is the one that has a glass flower in a vacuum tube. When an electric current is applied to the tube, the flower glows with striking and beautiful colors, due to chemical reactions.

Also in this side of the Hall of Science, is the model of the 200 inch telescope on Palomar Mountain. This model was built by Samuel Orkin at a cost of nearly \$25,000. The original drawings were supplied by the California Institute of Technology. It was built to a 1/24 scale except for a few minor differences. Although the model is not operated, it is complete with working parts and motors.

The final and best of all the items at the Griffith Observatory is the Zeiss Optical Planetarium. No description can reproduce the impression made by a demonstration of the Zeiss Planetarium projector. The projector itself, looks like a diagonal-circular, frame with two spheres at each end, one at the top and bottom. It consists of two 1,000 watt lamps, one in each sphere, and many gears and lens alignments, one for each planet and a variety of stars, and moons. The Zeiss Projector is located in the center of a 75 foot diameter hemisphere ceiling. The ceiling is painted white, and if one stands in a certain part of the theater, listening to another person speaking across the room, he may become bewildered as to the direction that the voice is coming from, which is due to the phenomenal sound acoustics of the theater. Hence, the sound of the show being given, comes from a speaker in the top of the ceiling so that the sound will disipate evenly among the audience. The console controlling the Zeiss Projector, and the sound, is located in the area beside the entrance door. It looks to the visitor like the inside of an aeroplane control cockpit. Here, the operator operates the projector and as a matter of fact, he controls the show in it's entirety. The cost of admission is \$1.00 per adult and \$.75 for juniors. Children under five, are not admitted to the theater. Indeed, one who has had the opportunity to see a planetarium show, will never forget it, including the observatory itself.

Millions of people visit the Griffith Observatory and Planetarium every year. It is one of the highly regarded places of interest in California.

Good

BIBLIOGRAPHY

- I. _____, The Story of Griffith Observatory and Planetarium,
Board of Recreation and Park Commissioners, City of
Los Angeles
- II. _____, The Griffith Observer, the Griffith Observatory,
Board of Recreation and Park Commissioners, Los Angeles

(PG. 1)

1,000,000 VOLT TESLA COIL

On the night of August 12, 1965, Greg Johnson and myself, Bill Wysock, have completed all necessary work on the 1 megavolt Tesla Coil. A description of the completed coil follows herein.

For the power supply, we decided to use an X-Ray transformer for the reasons of obtaining extremely high voltages at milliamperages which would prove not harmful to accidental human shock. It is an Army surplus machine and is continuously variable from 11 KV to 120 KV. Its maximum milliamperage is 20 and is also completely variable by the usage of resistance windings. The machine was given to us by the courtesy of the Arcadia Clinic.

The Capacitor consists of a bank of 20 .05 MFD-8 KVD.C. oil immersed "glassmikes" which are connected in a series-multiple circuit with 10 capacitors in series in each group. Its total rating is .004 MFD at 80 KV D.C., although we run 110 KV A.C. through them. The reason we can do this is because of the specially designed spark gap used in the resonant circuit.

The Spark Gap is an ordinary stationary type with an air blast across it of just the right velocity, so as to prevent an arc from establishing, but also to interfere with the oscillatory spark discharge which completes the Tesla primary circuit. Its electrodes are of brass rod 1/8 inch in diameter with cooling flanges. The gap is variable from 1 inch to 2 1/4 inches striking distance.

In all of the various types of dischargers available, this type has proven most effective for this size of apparatus.

The Primary Of the Tesla Coil is a helix 16 inches in outside diameter. It consists of 25 turns of Belden high voltage cable which has a puncher rating of 75 KV. Since there is only a potential of 4.4 KV A.C. per turn, the dielectric incorporated in the wire proves more than satisfactory.

The Secondary Coil of the Tesla Coil is wound on a vinyl-chloride plastic coil form 6 inches in diameter and 42 inches in height. Upon it is wound 2,700 turns of gauge 26 formvar insulated copper wire. Three pounds of such wire is required to complete the entire coil. Lacquer was applied with many light coats and heavy coats at the top. On this, at the top-most windings ~~was~~ wound plastic tape to prevent corona discharge from escaping there. The top terminal is terminated with a 1 1/2 inch copper sphere which may be exchanged for larger spheres.

RESULTS OF OPERATION WITH THE MILLION-VOLT TESLA COIL

One of the first things Greg and I discovered, is that in order to obtain maximum theoretical output of this coil, we must use materials of the highest quality, the greatest separation of the individual components between each other, and heavy conductors in the resonant circuit as many amperes of radio-frequency current flow in this circuit. Without heavy conductors in this circuit, resistance will cut down greatly on the efficiency of the entire apparatus.

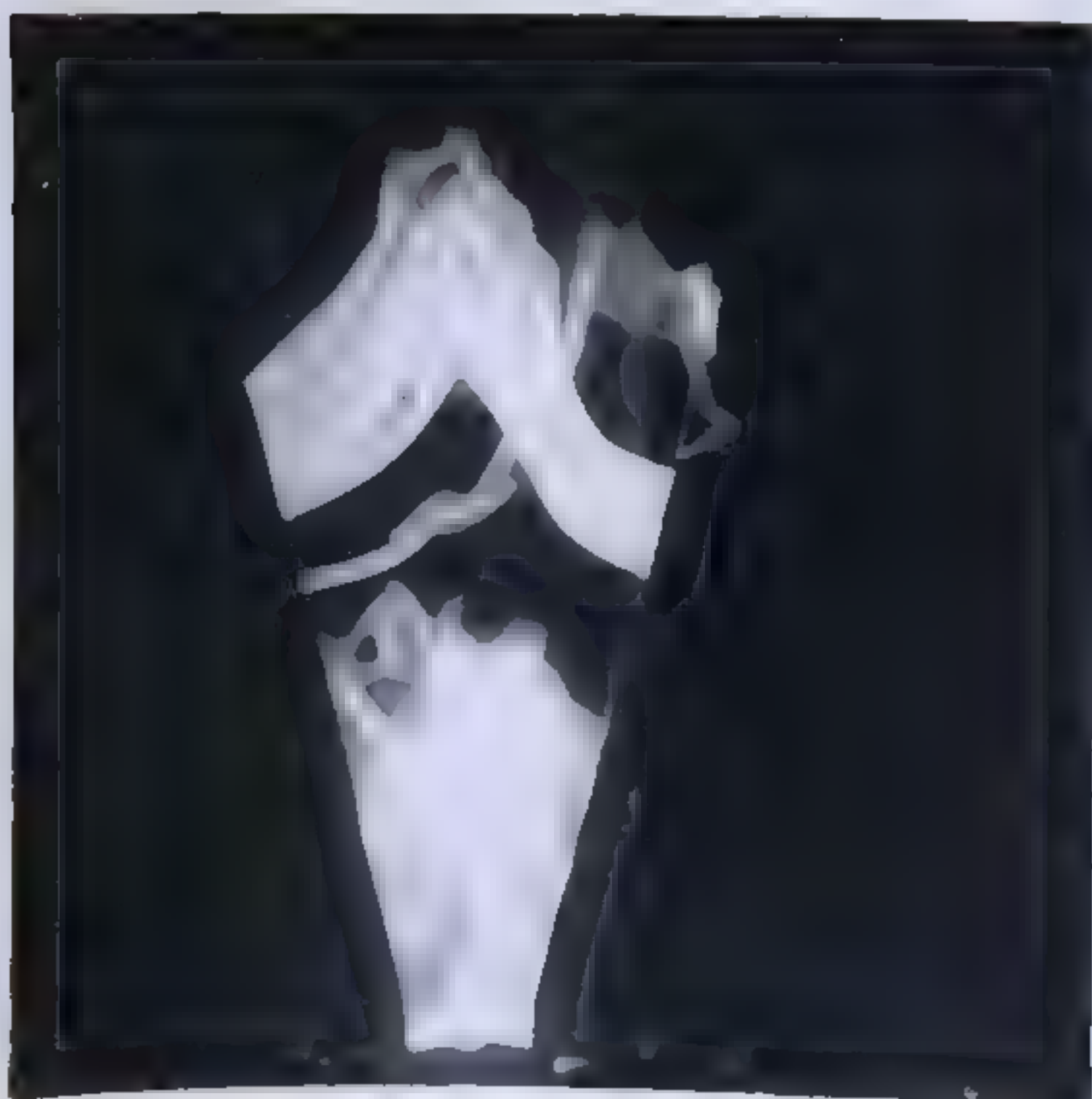
When the foregoing has been secured and all safety requirements are secured, the operation of the apparatus can be commenced. A complete description of the operation and results of experiments carried out with this coil follows herein.

Bill Wysock

"JACOB'S LADDER"

DISCHARGES OF X-RAY TRANSFORMER

100 KV 60 MA.



2 ONE-SECOND EXPOSURES

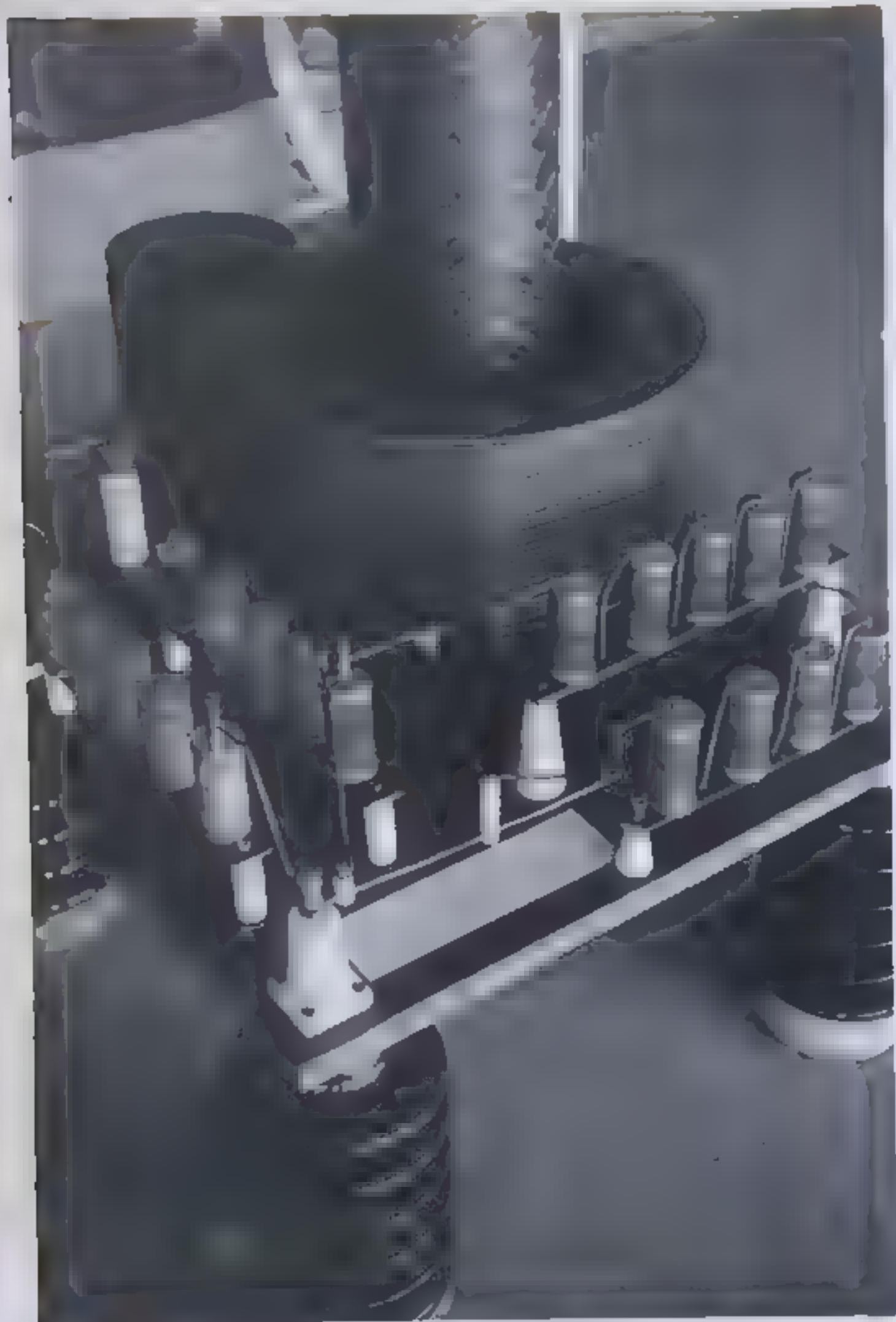
100 KV 60 MA.



1 TWO-SECOND EXPOSURE

(PG. 3)

PRIMARY COIL (25 T), INSULATION
TUBE, CAPACITOR BANK (.01 MFD 80KV),
BASE + 100KV INSULATORS



59 . 436

DOUBLE EXPOSURE. FIRST
GREG (1/50 SEC. @ F 6.8, THEN
1/2 SEC. EXPOSURE OF ARS @ F 6.8.



59 . 436

DOUBLE EXPOSURE OF GREG, MYSELF, + COIL

SEP . 65



"WE'RE TRANSPARENT BECAUSE OF
UNDER EXPOSURE.)

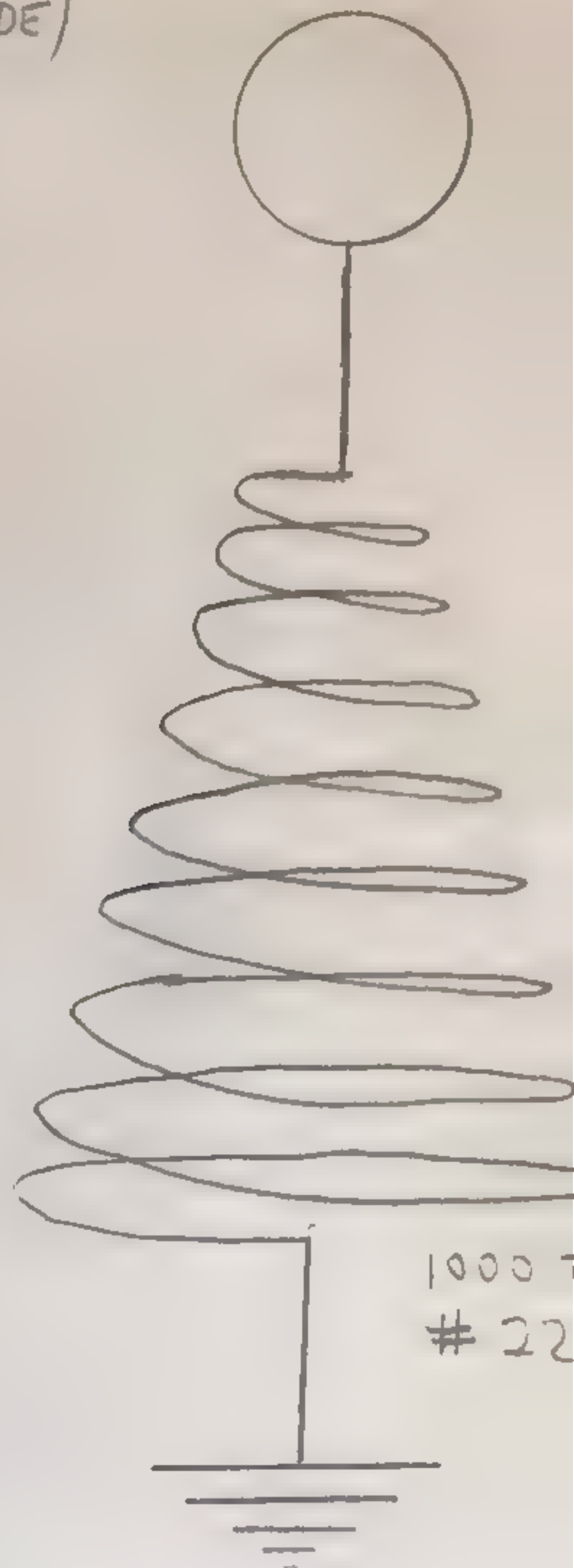
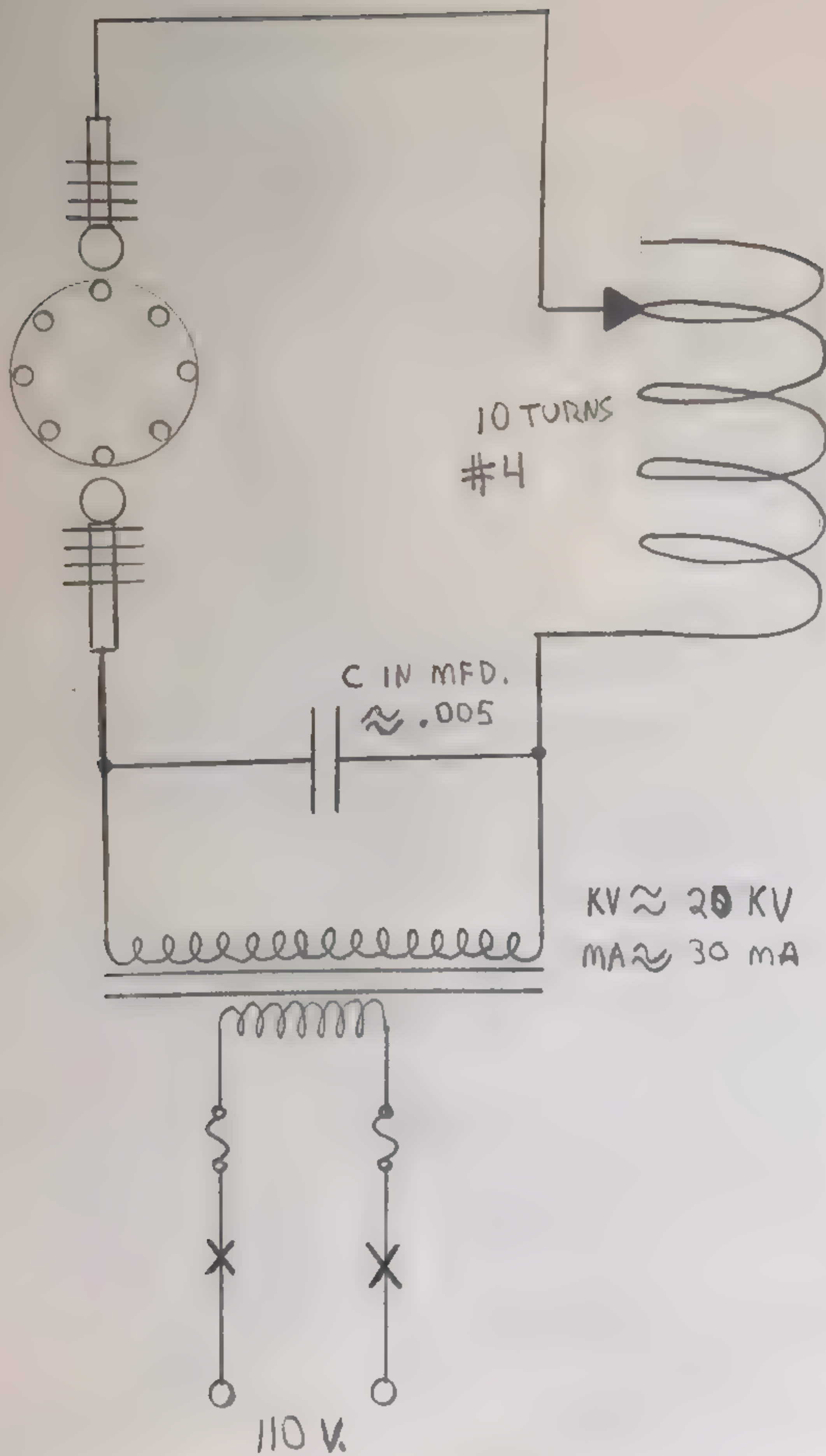
← OUR HIGH-VOLTAGE
LABRATORY...
GREG'S GARAGE.
NOTE ALUMINUM
POLE AGAINST
WALL (OUR "PORTABLE"
LIGHTNING ROD)

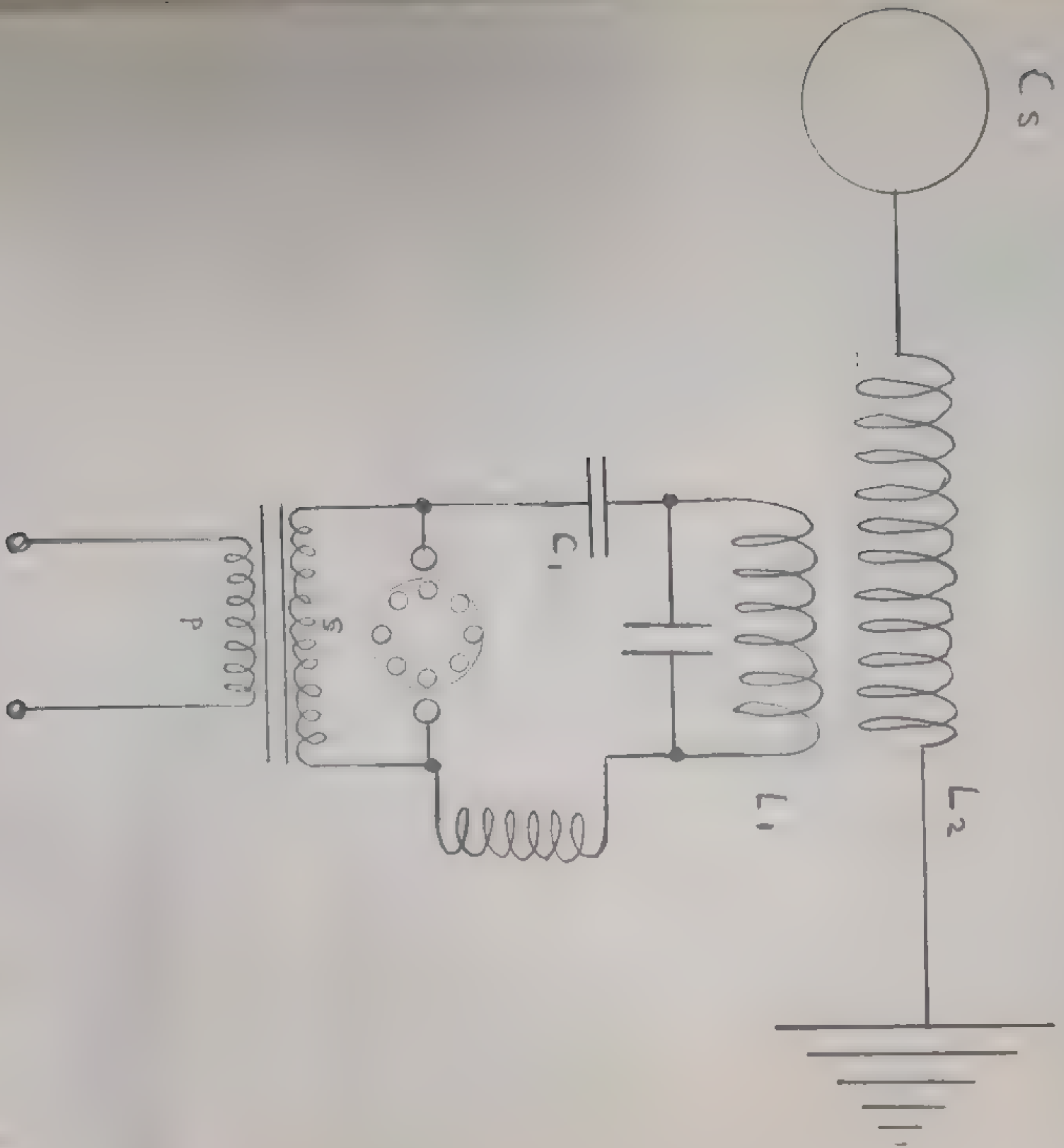
CIRCUIT

3 MEG, VOLT COIL

ALT. CIRCUIT (OTHER SIDE)

OF ROTARY
RODS
RPM $\approx$





THESE TWO DIFFERENT COILS CAN BE MADE TO OSCILLATE
IN A PUSH-PULL FASION BY MEANS OF ADJUSTING THE
REASONANCE OF $L_5 + L_6$. THIS, IN TURN, CHANGES THE FREQUENCY
OF $L_1 + L_2$... BY MATCHING THEM, LIKE A COUPLE OF IF CANS!

1,820,000 V.

820 KV

1000 KV

$$QL_1 \approx QL_2$$

L_1

L_2

L_3

L_4

GROUND

L_5 INDUCTANCE

L_6

AIR BLAST

C_1

C_2

C_1 .01 MFD
80 KV

120 KV
50 MA

17.2 KV
100 MA

C_2 .00715 MFD
20 KV

20 A.

20 A.

110-300 V.
AUTO TRANS.

110-220 V.
AUTO TRANS.

$C_3 - C_6$.01

1000V
MICAS

INPUT
120 V

40 A.

15 AMP

1 IN. SPARK = 20 KV

$$\begin{array}{r} 91 \\ 20 \overline{) 1820 \text{ KV}} \\ \underline{180} \\ 20 \end{array}$$

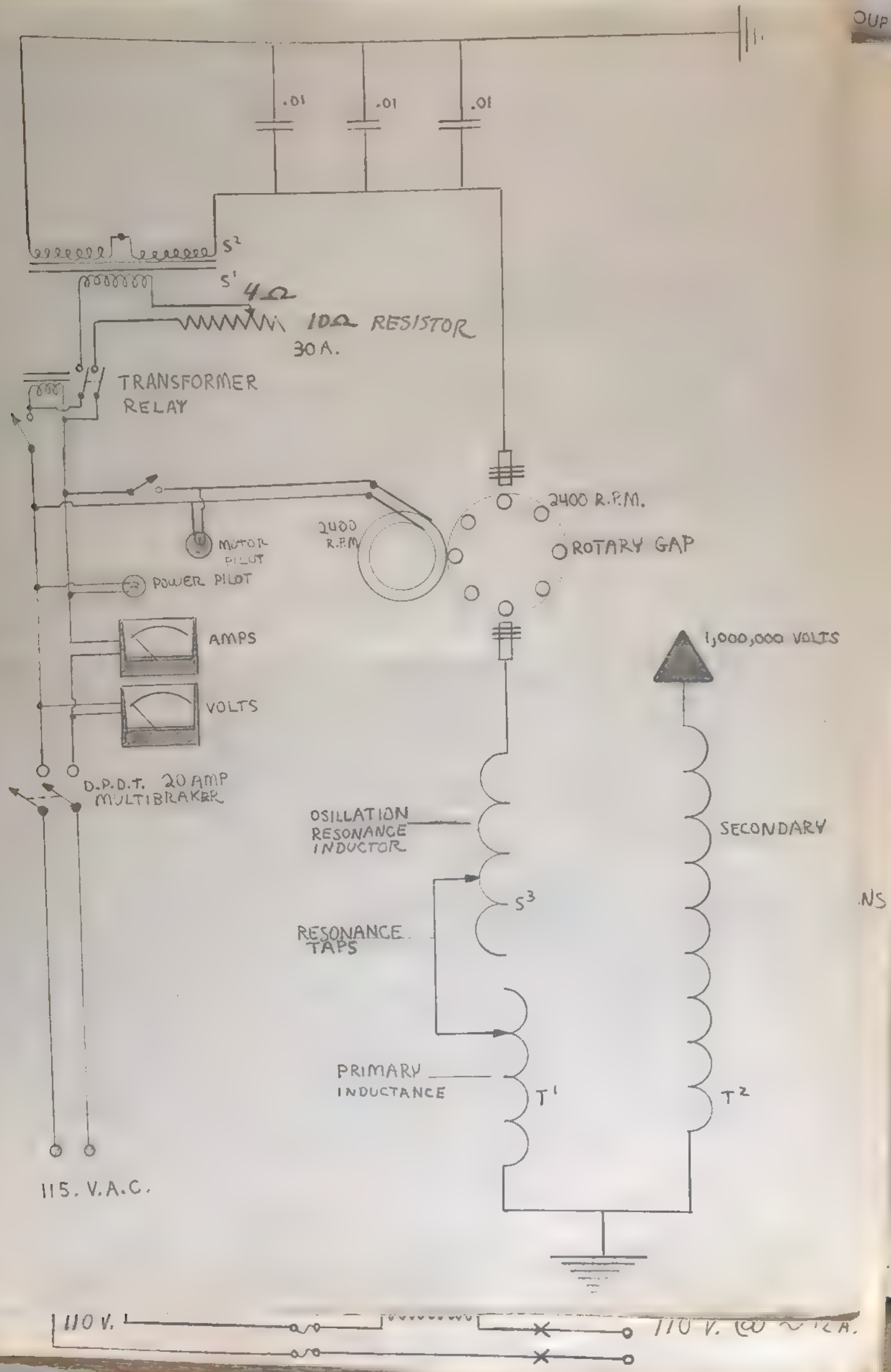
7.58 FOOT SPARK

1820 KV = 91" SPARK

$$\begin{array}{r} 7.58 \\ 12 \overline{) 91} \\ \underline{84} \\ 70 \\ \underline{60} \\ 100 \\ \underline{96} \\ 40 \end{array}$$

WI INIP-2

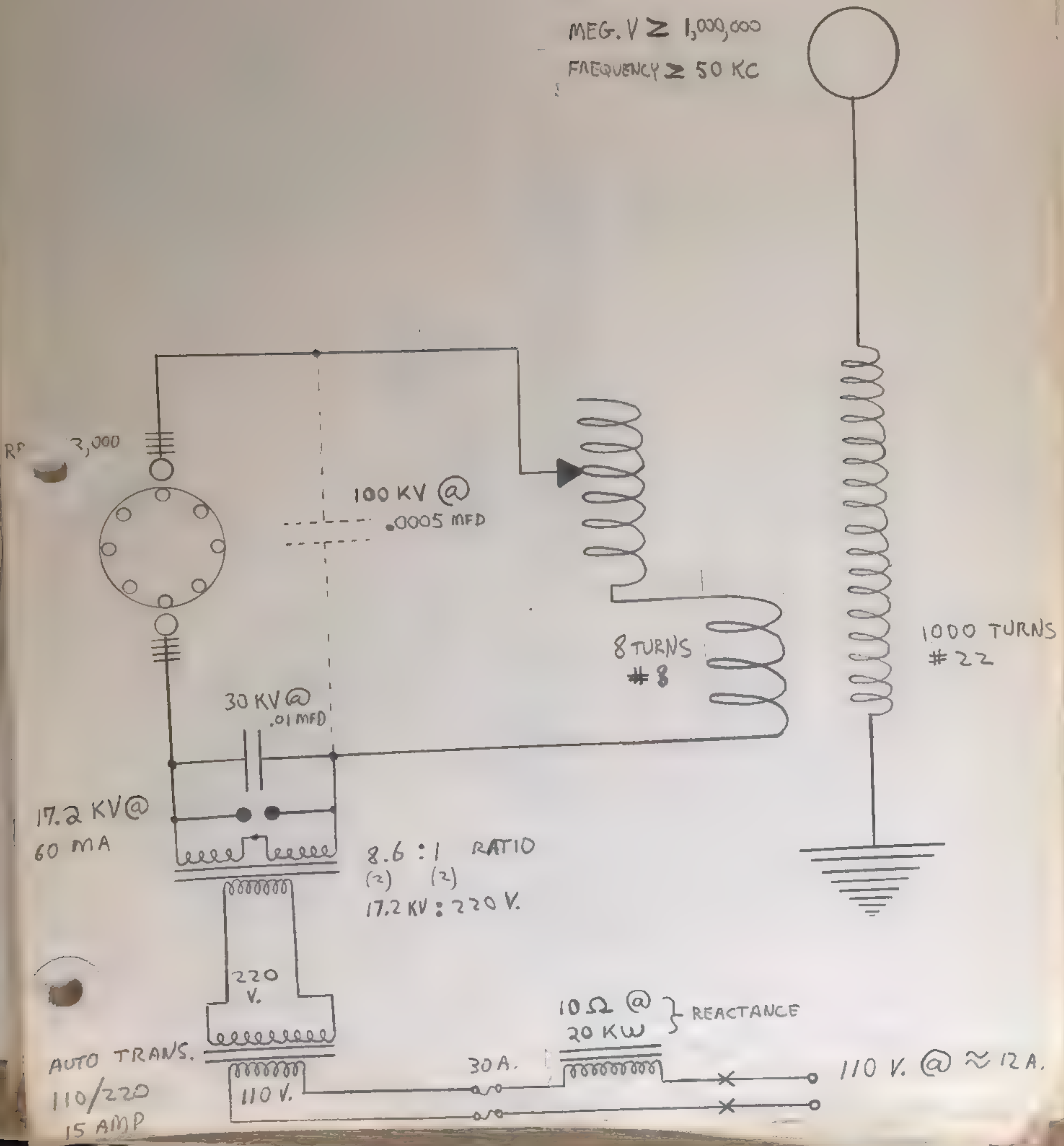
OUT IN



15 AMP

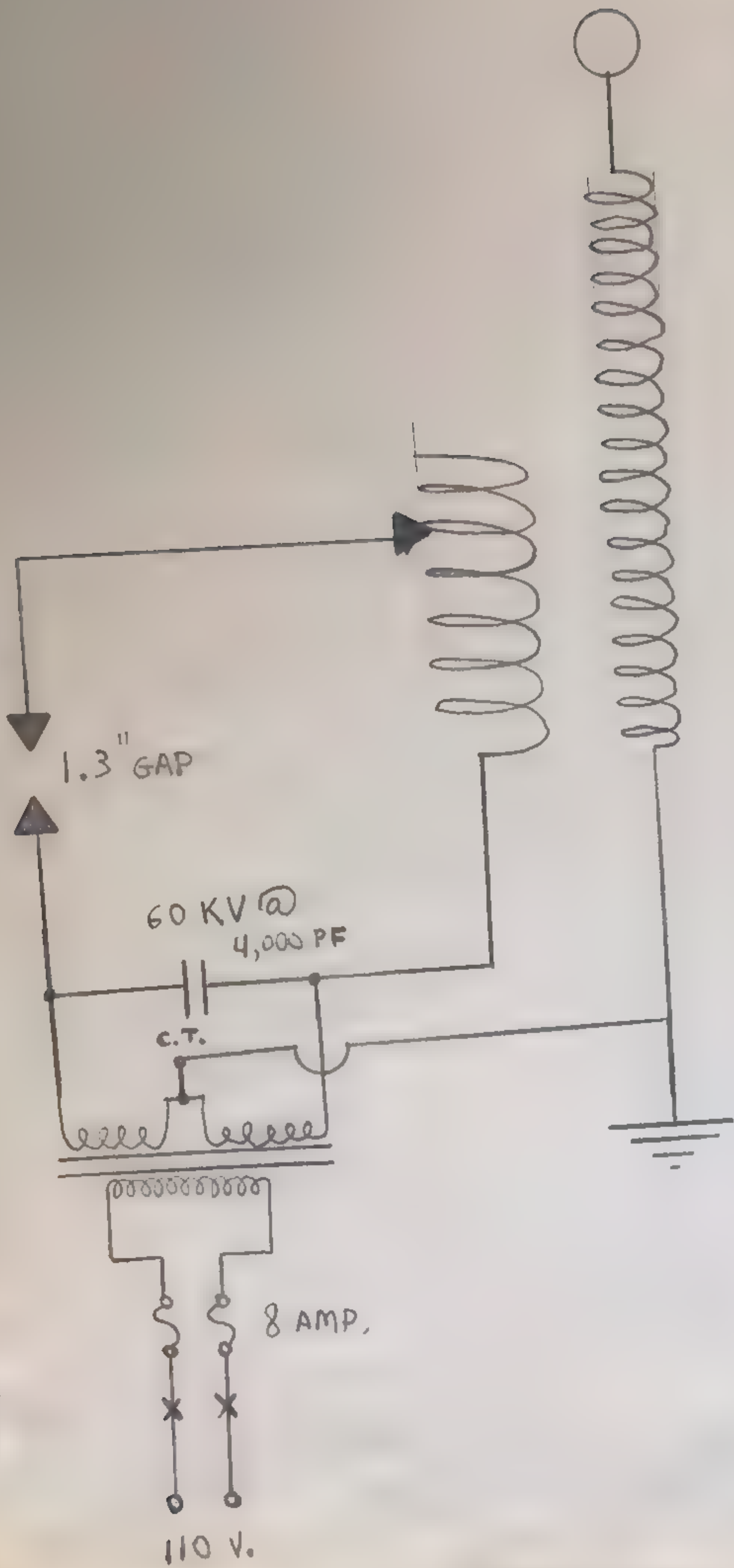
1,000,000 VOLT COIL

MEG. V $\geq$ 1,000,000
FREQUENCY $\geq$ 50 KC



500 KV COIL

KV $\approx$ 500 KV
FRE. $\geq$ 100 Kc



154 KV MODEL TESLA COIL

SPECIFICATIONS

INPUT VOLTAGE	117 V.A.C. 60 CY.
INPUT AMPERAGE	2.05 AMPERS
WATTS OF POWER (INPUT)	246
WATTS OF POWER (OUTPUT)	180
POWER LOSS IN TRANSFORMER	66 WATTS
MILLIAMPRAGE OUTPUT	20 MILLIAMPERS (.02 AMPS)
VOLTAGE OUTPUT	9,000 (9 KV)
CAPACITOR VOLTAGE	16,000 (16 KV)
CAPACITOR MFD. CAPACITY	.005 MFD.
PRIMARY TURNS	30
PRIMARY VOLTAGE	9 KV
PRIMARY AMPERAGE	20 MA.
PRIMARY FREQUENCY	300 KILOCYCLES (300 KC)
SECONDARY TURNS	500
SECONDARY VOLTAGE (TOTAL GAIN)	154,000 (154 KV)
SECONDARY VOLTAGE (INPUT)	0 VOLTS
SECONDARY VOLTAGE (PER TURN GAIN)	308 VOLTS
SECONDARY AMPERAGE OUTPUT	.00321 AMPS (3.21 MA.)
TURNS RATIO (PRIMARY TO SECONDARY)	30:500 (1:17), approx.
KILOVOLTS PER INCH DISCHARGE	20,000 (20 KV)
TOTAL DISCHARGE LENGTH	7.7 INCHES

APPENDIX 'A'

COIL DATA FOR TIMMINS COILS

PRIMARY

Five turns of No. 2 wire on 2 inch spacing, which amounts to 471 feet of wire. The capacitance will be in the order of .00146 uf. The inductance will be in the order of: pancake wound coil: .52 mH; cylindrical wound coil: .47 mH.

SECONDARY

Ten turns of No. 2 wire on 2 inch spacing, which amounts to 942 feet of wire. The capacitance will be in the order of .0029 uf. The inductance will be in the order of 1.8 mH.

The resistance of the coil will be .1472 ohms and the impedance will be 67.9 ohms, giving a Q of 460 at 6000 cycles per second.

A capacitance of .31 uf will be required to resonate this coil at 6000 cycles per second.

NOTE: Both the secondary and primary are wound on a 15 foot radius.

TERTIARY

One hundred and ninety (190) turns of No. 8 wire on 1" spacing, which amounts to approximately 3000 feet of wire. The capacitance will be in the order of .0093 uf. The inductance will be in the order of 14 mH.

The resistance will be less than 1.884 ohms and the impedance will be 528 ohms giving a Q of 280 at 6000 cycles per second.

The capacitance required to achieve resonance is .05 uf.

It should be pointed out that these values are based on mathematical formulas designed as approximations for low voltage coils and have been found very inaccurate for use in the calculation of values for these coils. The experimentally derived values of capacitance and inductance are invariably higher than the theoretical values. The only truly satisfactory method of obtaining values for this coil is by direct experimentation.

APPENDIX 'B'

VOLTAGE CALCULATIONS

The following is a set of calculations of the voltages which are theoretically available if the coils are all at their resonant and synchronous frequencies.

Let us assume that the primary is energized at 7.5 KV:

Then the voltage on the primary winding will be as follows:

$$v_p = 7.5 \text{ Kv} \times Q = 7.5 \text{ Kv} \times 266 = 1.995 \text{ Mv.}$$

The voltage on the secondary due to transformer action would be:

$$1.92 \text{ Mv} \times 2 = 3.84 \text{ Mv}$$

The voltage on the secondary due to resonance would be:

$$176.6 \text{ Mv} \times 280 = 49.4 \text{ Bv.}$$

From these calculations we can see that the coils can theoretically produce a voltage of 49.4 billion volts which be capable of jumping some 172 kilometers (in dry air from a 25 cm electrode). As is plain to see this voltage is far too high for practical management in this coil design, therefore one will have to be careful so as not to resonate all three coils simultaneously.

WINNIPEG ENERGY RESEARCH GROUP INC.
P. O. BOX 86, ST. VITAL POST OFFICE,
MANITOBA, CANADA. R2M 4A5

Wpg, 80 02 09

A.W. Shennan-Executive Assistant
du Pont Energy Control Corporation
2040 Avenue of the Stars, Ste 400
Los Angeles, California 90067.

*Past history
no connection now -*

Dear Tony;

Thanks for the data you mailed me recently with regard to some work Tim Richardson presumably did for you? I will respond to that further on, but first your request to have some missing pages replaced. Since you did not mention what month these pages were from I sent you the July pages 38,39,40,41,42. These are the first ones in the translation and therefore the most obvious, however, if I guessed wrongly please give the correct month next time and we will take care of it pronto.

Now your request to remain as a member of WERG and your kind contribution. It would be difficult for us to meet the terms of reference as set out in the incorporation act, which refers to "resident in Manitoba", but we can certainly have you as a corresponding member so there is no hitch to that. Since nobody has chipped into the pot this year, I cannot see why you should and I return your cheque herewith, with my appreciation for what you intended to do. We have no expenses other than the P.O. Box rent and postage for which we pass the hat now and then. So if this meets with your intent we gladly mark you down as our corresponding member and will keep you updated as time goes by. If it makes you feel better we will also inform you when we pass the hat for expenses and you can contribute whatever you feel like at that time? Incidentally I sent you the copy of our translations as a complimentary copy so no cost to you. Andrew Michrowski also got a copy from me for which he put a nice write-up in PACE Newsletter of Jan '80.

Back to the Calculations of Electrode Charge (Appendix "C"):

Presumably the writer of this appendix attempted to show the charge that can be collected by a sphere of 5 ft diam (151.2 cm) and assumes that if this sphere could be completely discharged in a certain time a certain amount of power is transferred?

According to the basic theory the charge of a sphere is $Q = CV$
 $C(\text{sphere}) = R(\text{radius})$ in this case $C = 75\text{cm}$ or $75 \times 0.00000111 = 8325 \times 10^{-10} = 0.00008325 \text{ mfd}$. The charge at 1 million volts can therefore be calculated as:

$$Q = 0.8325 \times 10^{-10} \times 10^6 = 0.8325 \times 10^{-4} \text{ Coulombes}$$

Now the energy represented by this charge at 1 million volts is

$$E = CV^2 \text{ or } \frac{1}{2} \times 0.8325 \times 10^{-10} \times (10^6)^2 = 0.4163 \times 10^{26} \text{ joules or wattsecs.}$$

To discharge this energy to say 1% of its original value over a resistance of say 1000 ohms (equivalent resistance of an ionized air column of 100ft) will take:

$Q = CV \cdot e^{-\frac{t}{CR}}$

or since $e^{-\frac{t}{CR}} = 1\% = 0.01$

$e^{\frac{t}{CR}} = 100$ and $\frac{t}{CR} = 4.61$

$C = 0.8325 \times 10^{-10}$ Farads

$R = 1000$ ohms therefore: $t = 4.61 \times 0.8325 \times 10^{-10} \times 10^3 =$

3.84×10^{-7} secs. On a 60 cyc base one discharge takes 4.17×10^{-3} sec

which is much in excess of the calculated time which means that the frequency can be raised at least 10^3 times, so that this system should be good for 60,000 cycles plus!

The energy discharged in the calculated time would be:

$0.4163 \times 10^{28} \times 3.84 \times 10^{-7} = 1.6 \times 10^{19}$ wsecs = 1.6×10^{16} kwsecs.

Where the KWHrs and wattsecs are mixed up in the stated calculations, we have a classical problem of mixing apples and oranges or in more technical language units.

Since these numbers are completely different from the quoted ones, this discrepancy has to be corrected.

Now in your letter to Will Mische you quoted: a smaller sphere would not be able to cope with the discharge- but you must remember that a smaller sphere cannot carry the same charge either!

Also in your calculations of wavelengths and frequencies you lost sight of the fact that when you are dealing with $\frac{1}{4}$ wavelengths you are assuming maximum potential at the open ended terminal. In order to preserve this concept, you have to work with odd multiples not even as you had assumed. In other words once you have a base frequency and calculated the $\frac{1}{4}$ wavelength (which may well become too long for comfort) then in order to shorten same you have to multiply or divide as the case may require by odd numbers.

Well, have fun Tony and keep your spirits up even if co-workers seem to cause some problems.

Our regards,



July 65

Showing results obtained
with 500 KV coil. Arcut
of this coil on reverse side.

Discharge in photo #1 showing
20 inch arc, 1 second time exposure.

Corona brush in photo #2 38 inches
in length, 1 sec. time exposure.

Secondary built by Greg Johnson

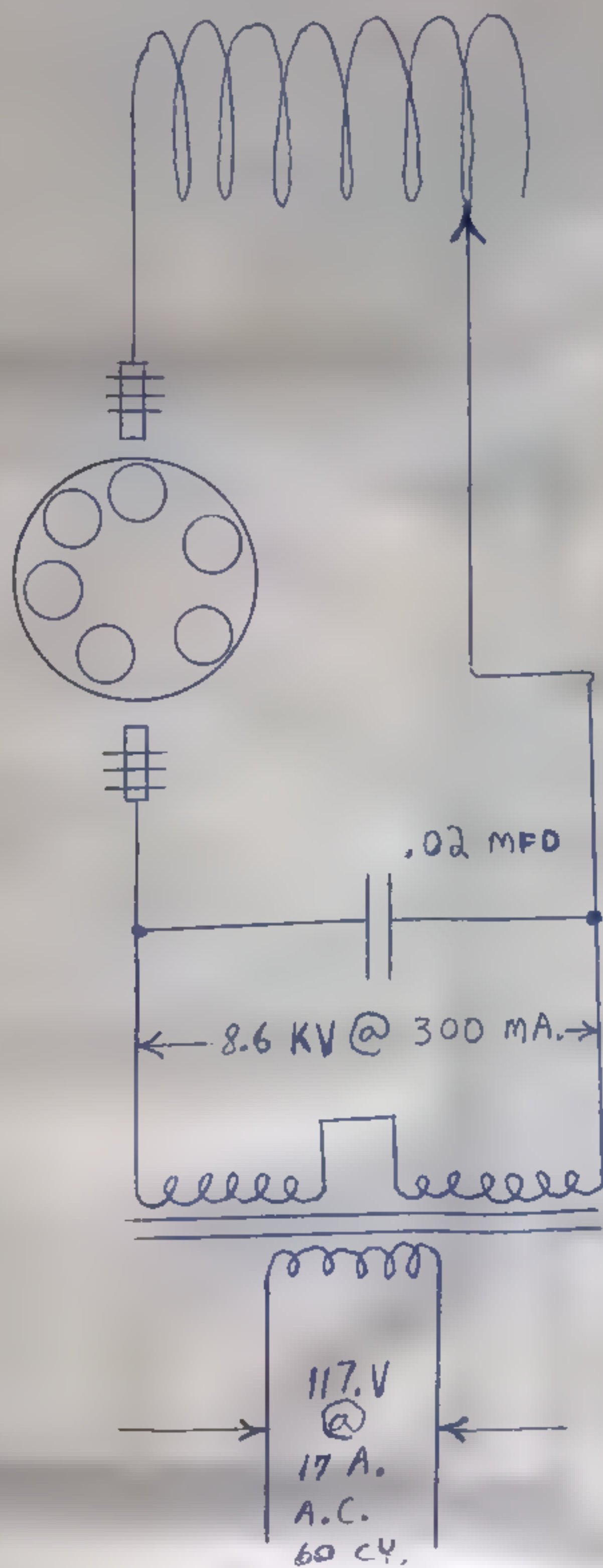
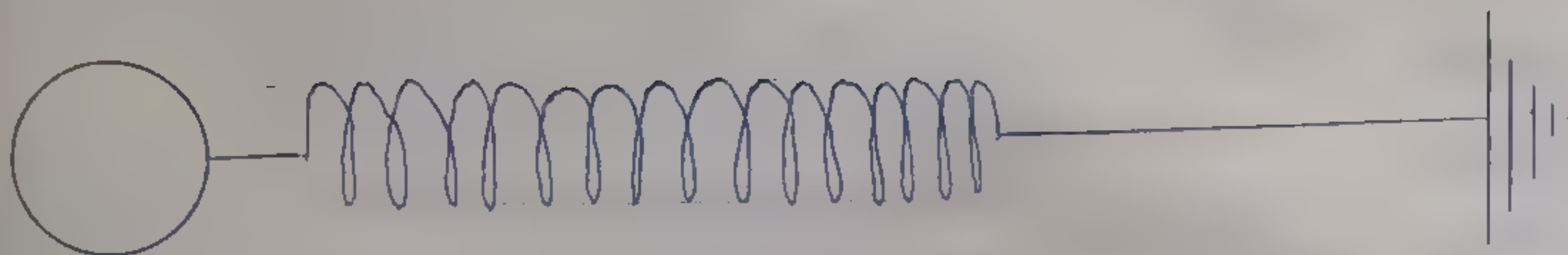


1



2

60 cm discharge tube
glowing under
influence of coil



A $\frac{1}{2}$ SECOND EXPOSURE @ f6.8.

LONGEST DISCHARGE IN PHOTO
REACHED RAFTER LIGHT SOCKET.

THIS IS A 46" SPARK REPRESENTATIVE OF ≈ 820 KV. BY $\equiv$ T.E. 20KV PER INCH OF DISCHARGE.

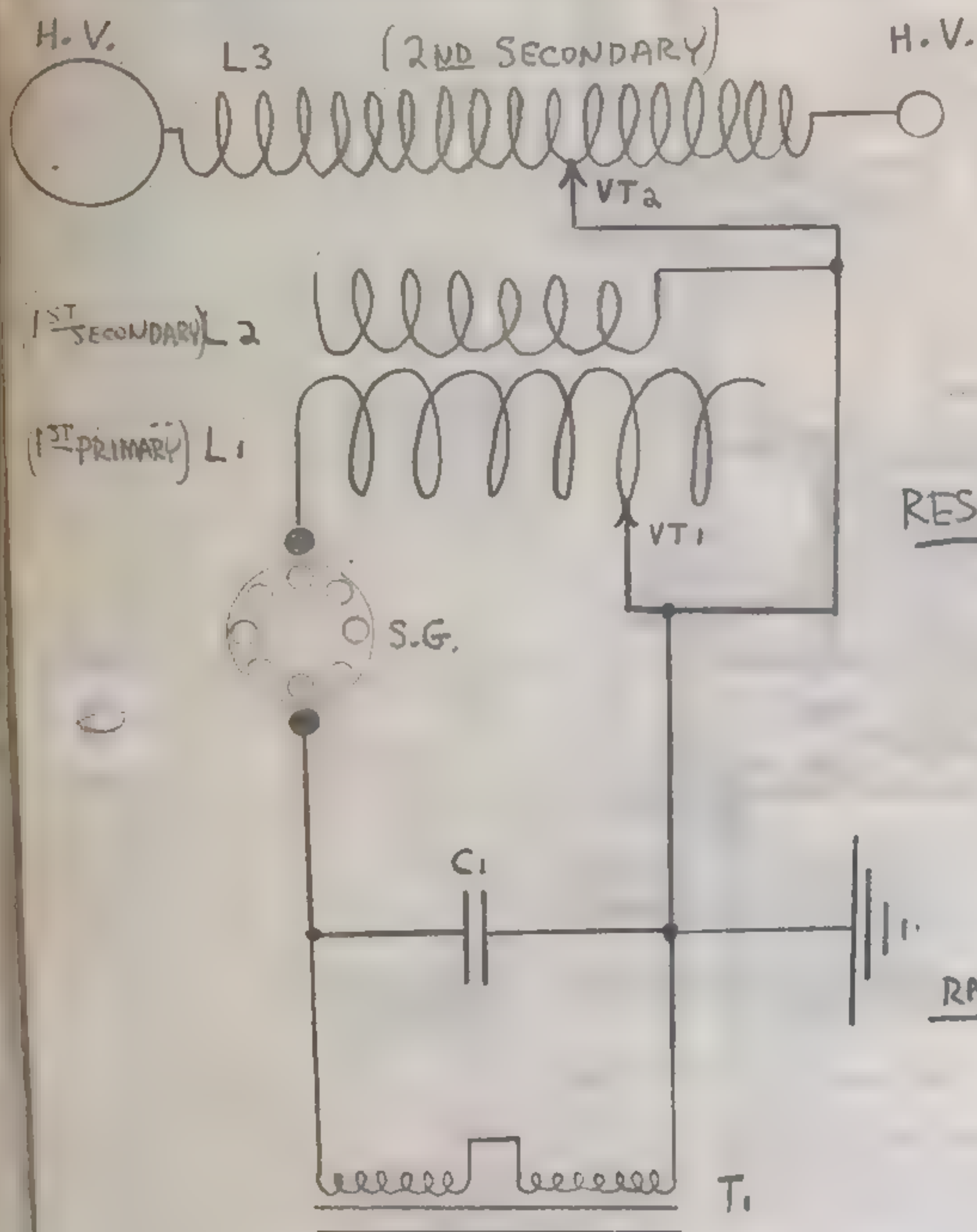
NOTE SMALL CORONA BURSTS FROM THE BALL.

ONE-SECOND EXPOSURE
OF THE SAME, IN FULL
ACTIVITY.



* IF AN INDUCTIVE ANTENNA IS COUPLED DIRECTLY TO T' , A LARGE OSCILLATOR CIRCUIT (ELECTROMAGNETIC FIELD) * WILL EXIST BETWEEN T' AND GROUND. ESTIMATED OUTPUT POTENTIAL;
 T' 12 MEG. VOLTS T

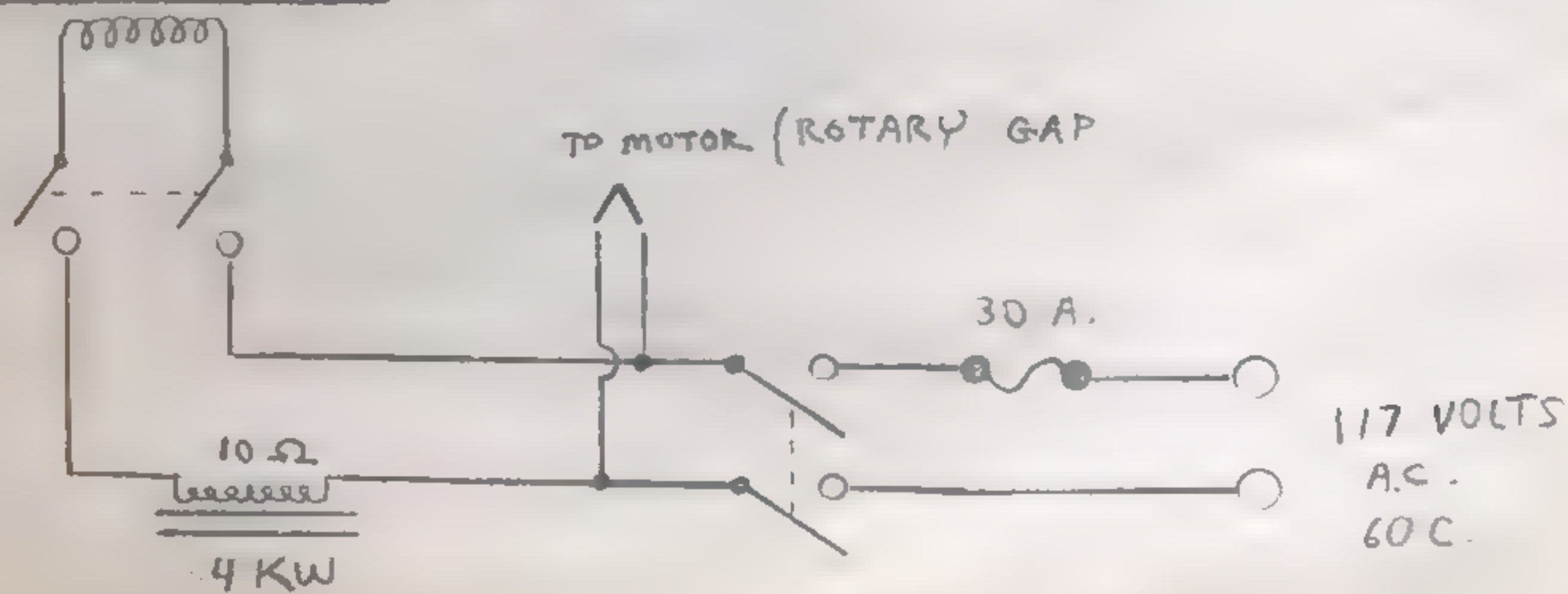
T', T - HIGH V.
 @ H. FREQUENCY
 + (4,000,000 VOLTS)
 + (100,000 C.P.S.)



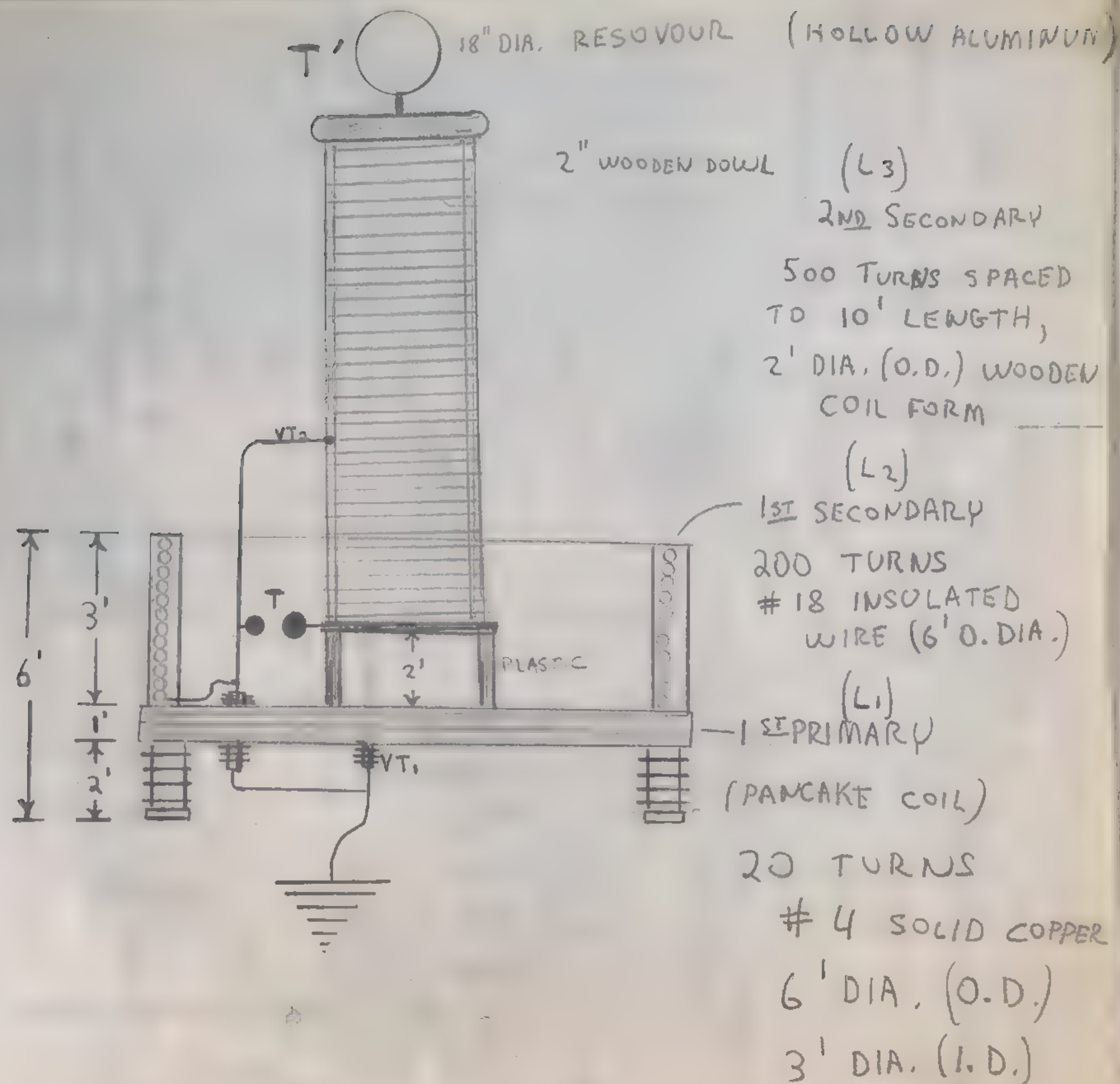
TUNING *
H.I. - VOLT : VT_2 OF L_3 IS
HELIX TUNED TO RESONANCE
 OF $L_1 + L_2$. VT_2 &
 VT_1 ARE GROUND TAPS.

* VT_1 OF L_1 IS TUNED
RESONANCE: TO NATURAL FREQUENCY
 OF L_2 AND C_1 IS TUNED
 TO INDUCTORS ($L_1 + L_2$)

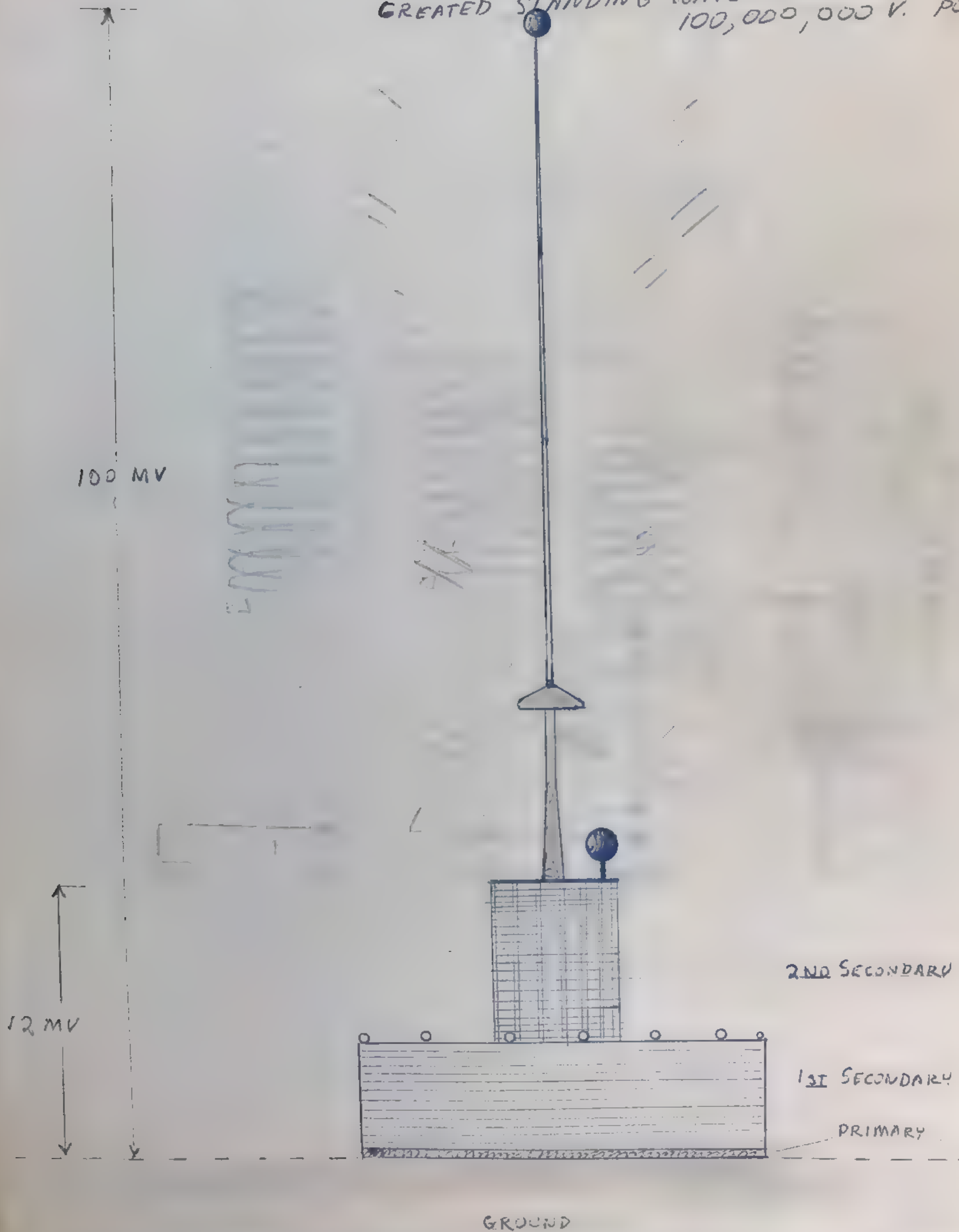
* THE LARGER THE
RATIO: CAPACITY OF C_1 , THE LESS
 # OF TURNS NEEDED IN
 L_1 TO ACHIEVE RESONANCE
 AND VISA-VERSA

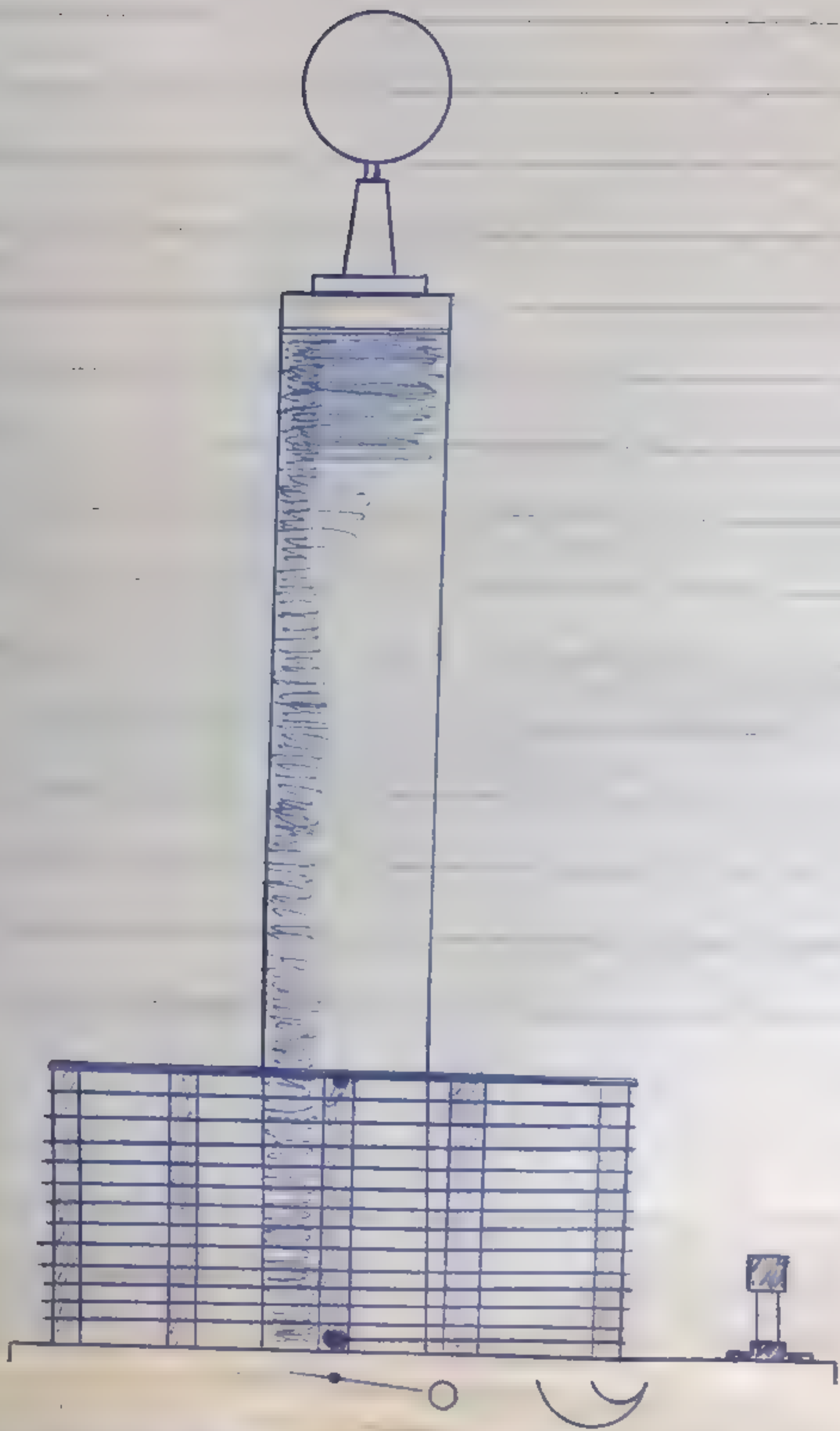


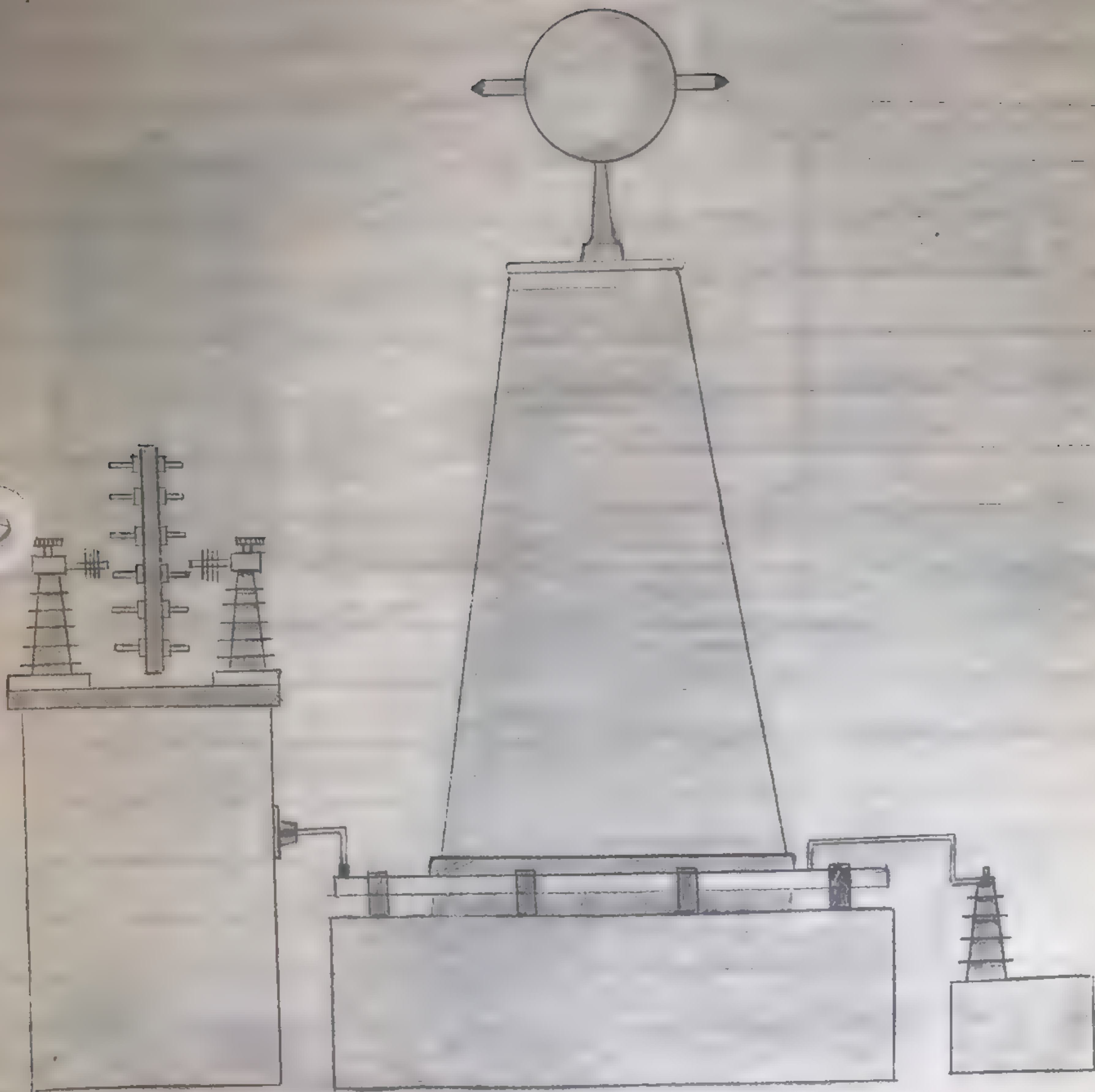
(DIAGRAM) OVER

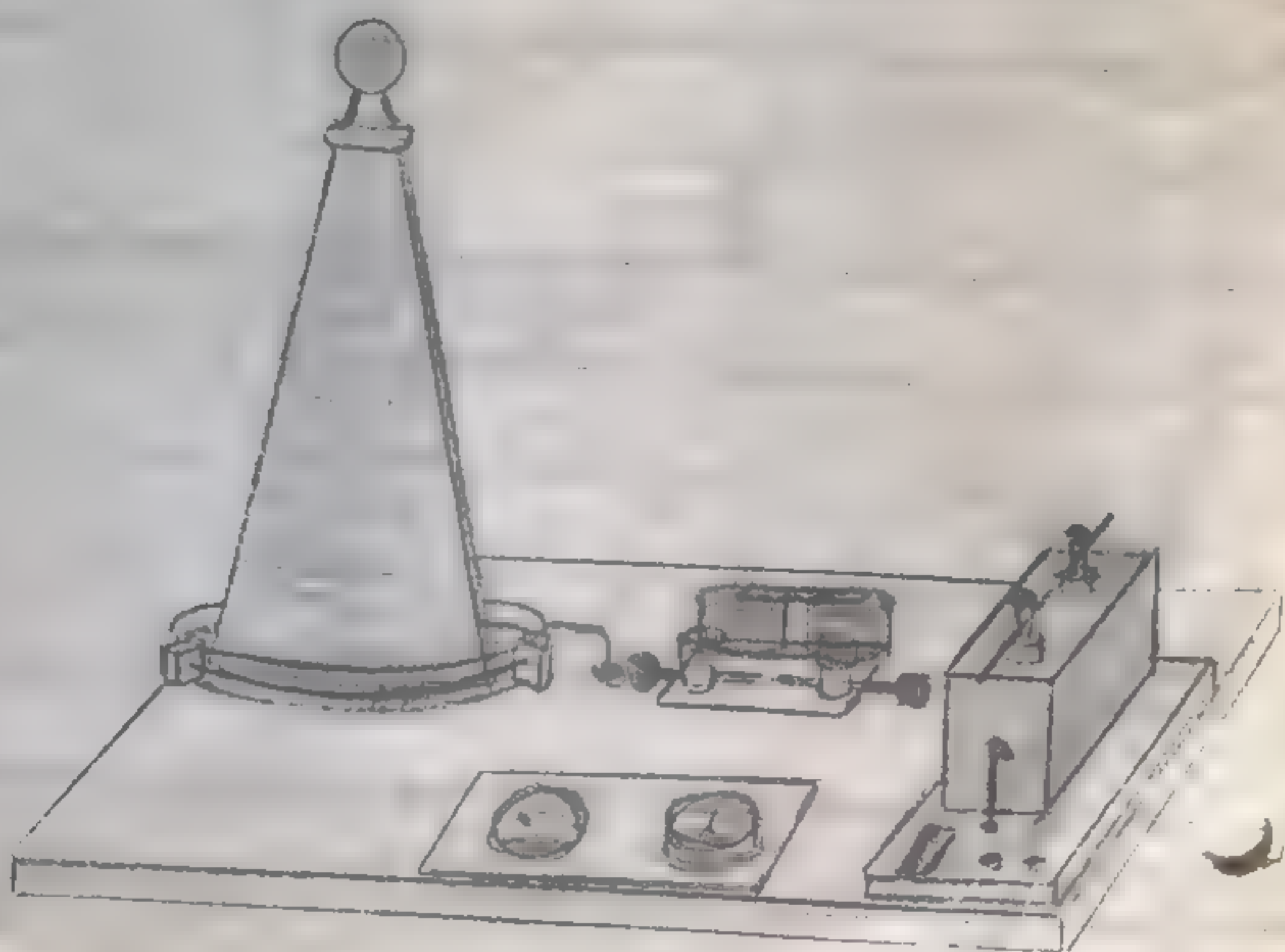
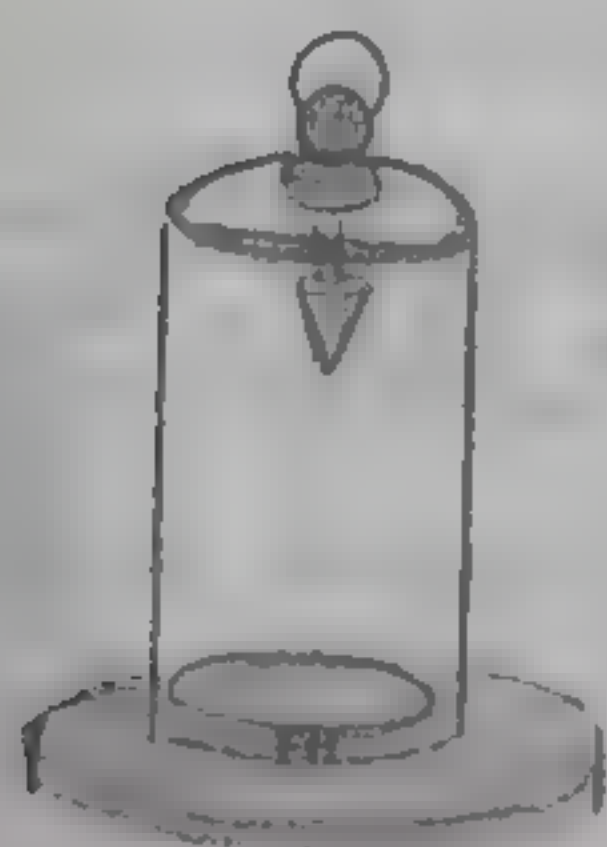
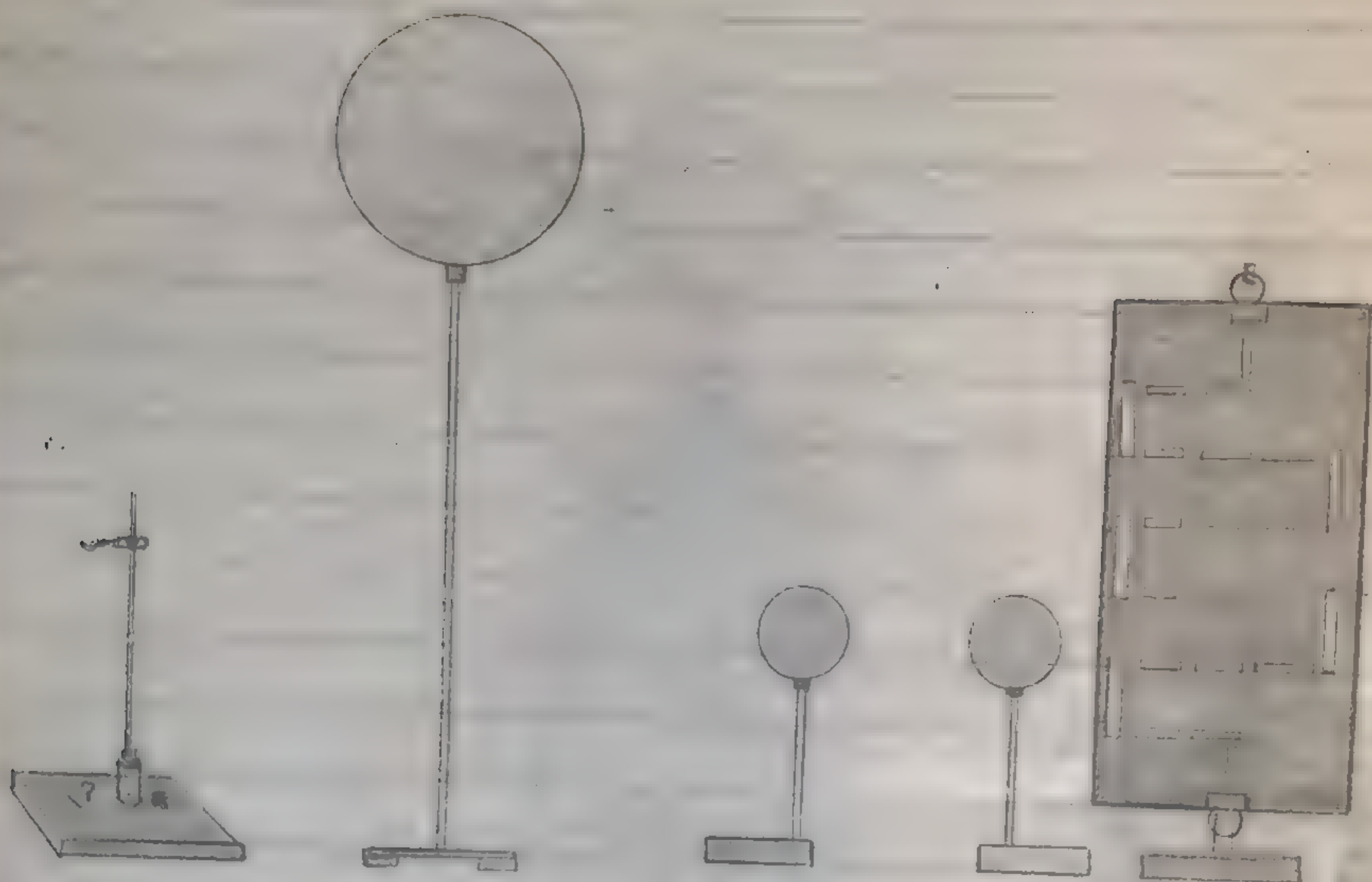


CAPACITANCE BETWEEN
RELATIVE GROUND AND
THE ANTENNA GAVE HIM
A BASIS BY WHICH THE OSCILLATOR
CREATED STANDING WAVES PRODUCING
100,000,000 V. POTENTIAL









REACTIANCE IS RESISTANCE WITHOUT A POWER LOSS

INDUCTIVE REACTANCE



VOLTAGE DIRECTION = MAGNETIC DIRECTION

INDUCTIANCE }
FREQUENCY } REGULATE INDUCTIVE REACTIANCE

UNKNOWN π

FREQUENCY
INDUCTOR IN HENRYS

$2\pi FL$

$$X_L = 6.28 \times 60 \times 10^{-3} \approx 3.768 \Omega$$

INDUCTIVE REACTIANCE IS MEASURED IN OHMS

CAPACITIVE REACTIANCE

AN AC. CURRENT WILL CHARGE &
DISCHARGE A CAPACITOR

MORE VOLTS = MORE REACTANCE IN A CAPACITOR

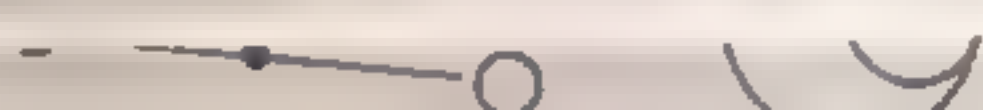
REACTANCE }
IS REGULATED } CURRENT
BY } FREQUENCY

MORE ϕ - LESS
CR

$$X_C (\text{IN OHMS}) = \frac{1}{2\pi FC}$$

- .00001 = 10 MFD
- .000001 = 1 MFD
- .0000001 = .1 MFD
- .00000001 = .01 MFD

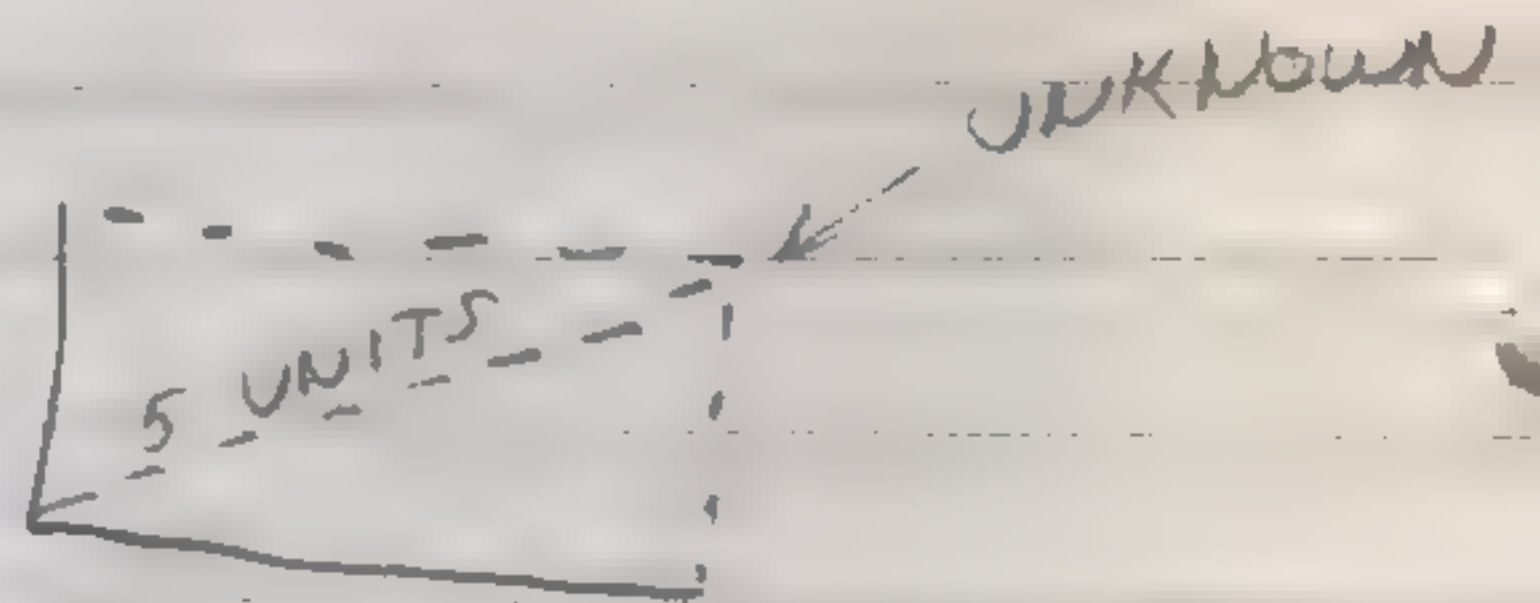
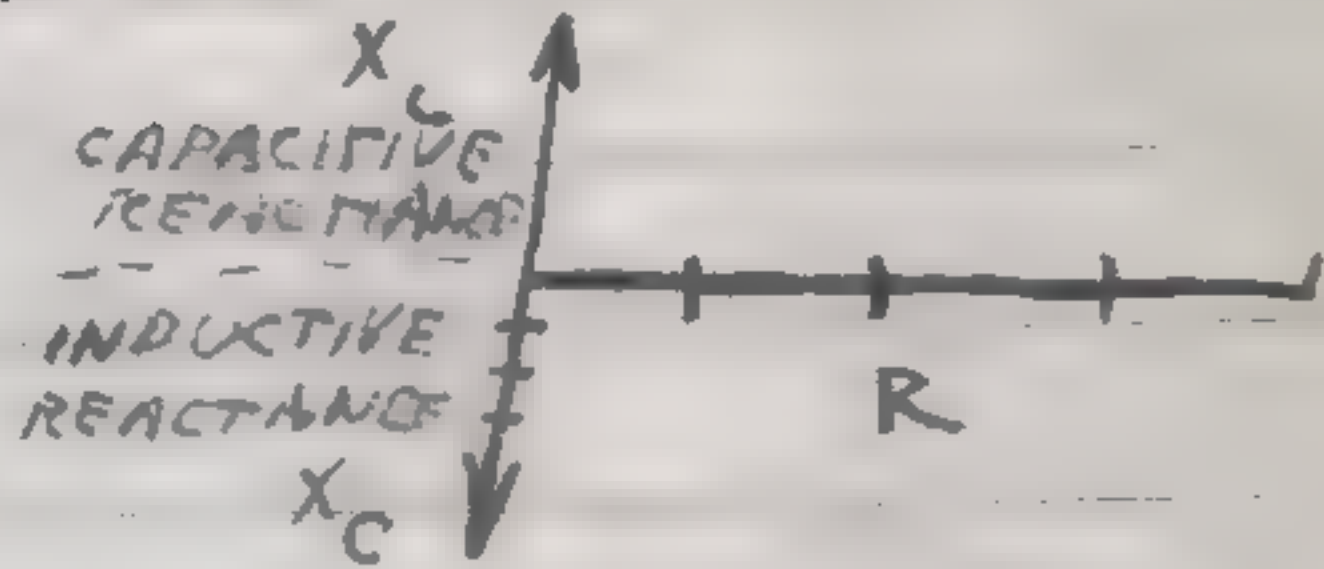
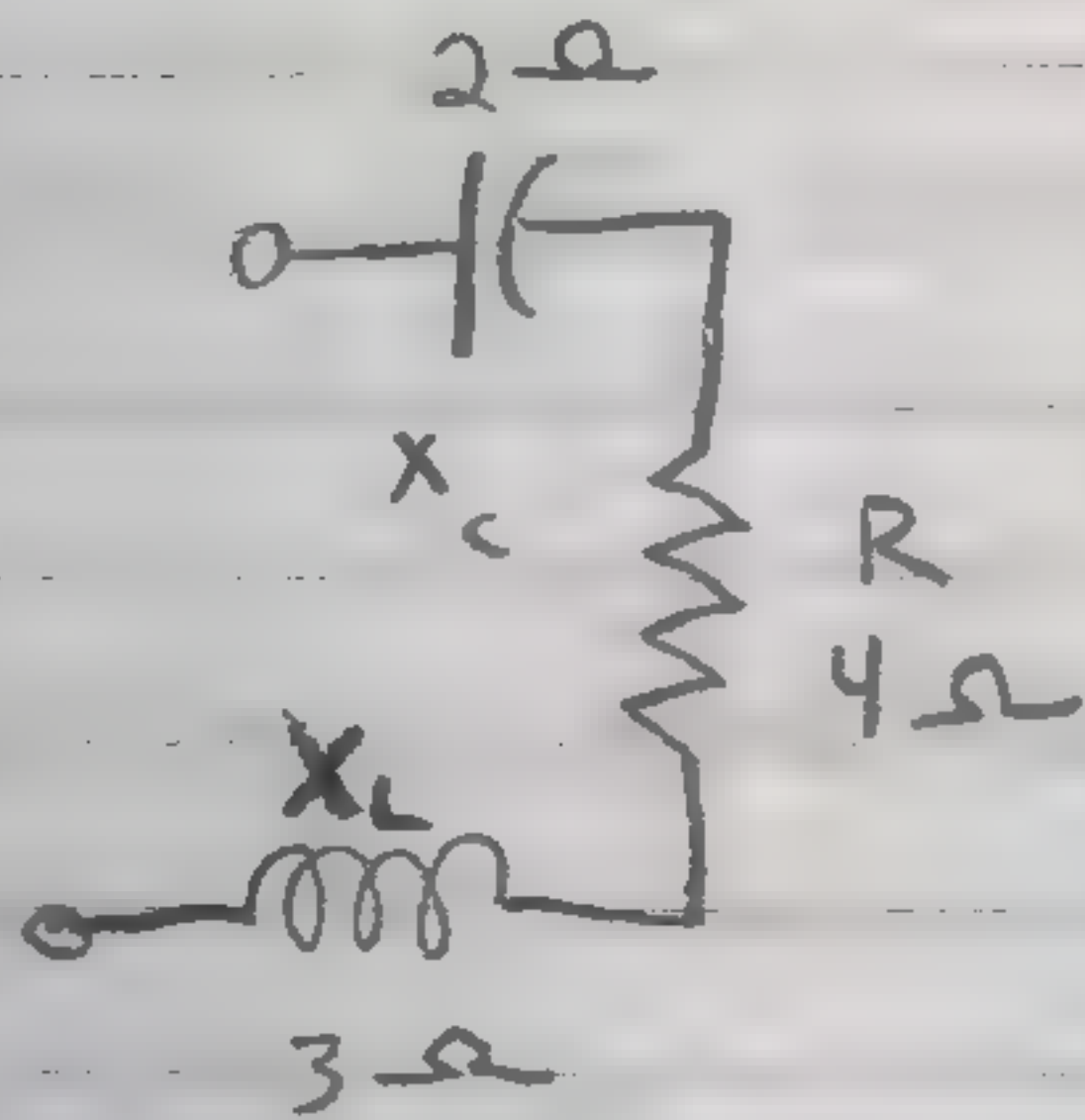
$$X_C = \frac{1}{6.28 \times 60 \times .00001} \approx \frac{1}{.003768} \approx 265 \text{ OHMS}$$



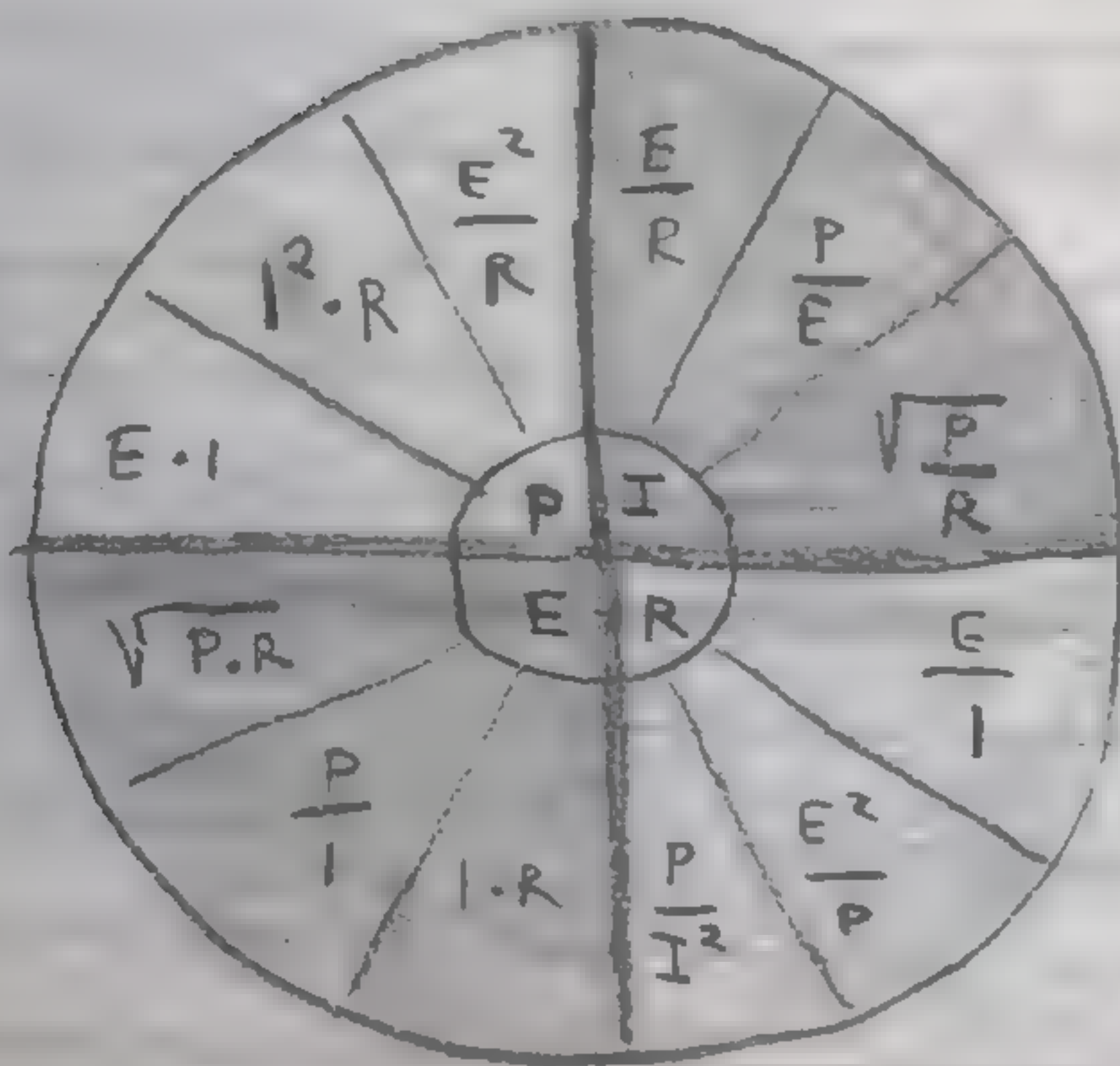
VECTORS

$$\text{IMPEDANCE} = \text{REACTANCE} + \text{RESISTANCE}$$

VECTOR REPRESENTATION



5 OHMS IMPEDANCE



The total energy stored in an L, C network during the process of charging is the sum of the energies stored in the capacitor and coil

Hence $W = \frac{CE^2}{2}$ for Capacitor

AND

$W = \frac{LI^2}{2}$ for coil

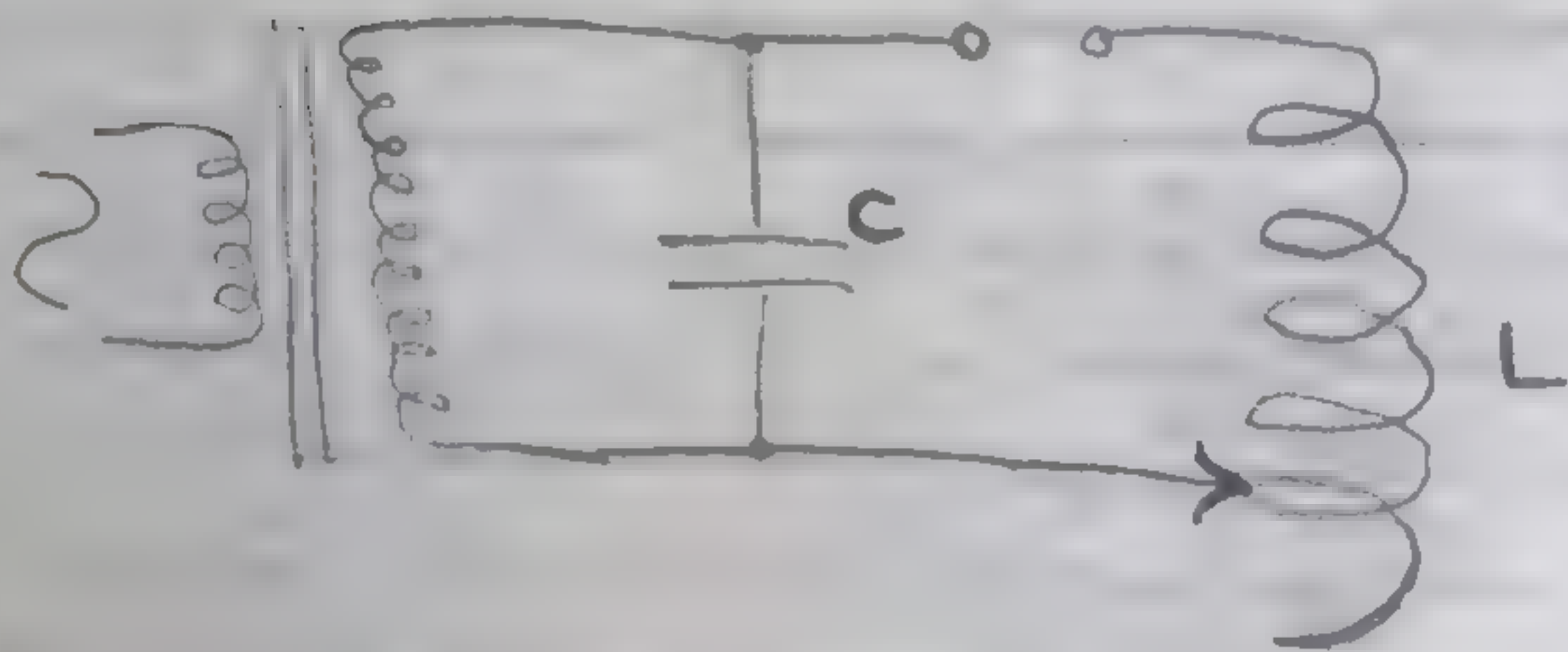
LET

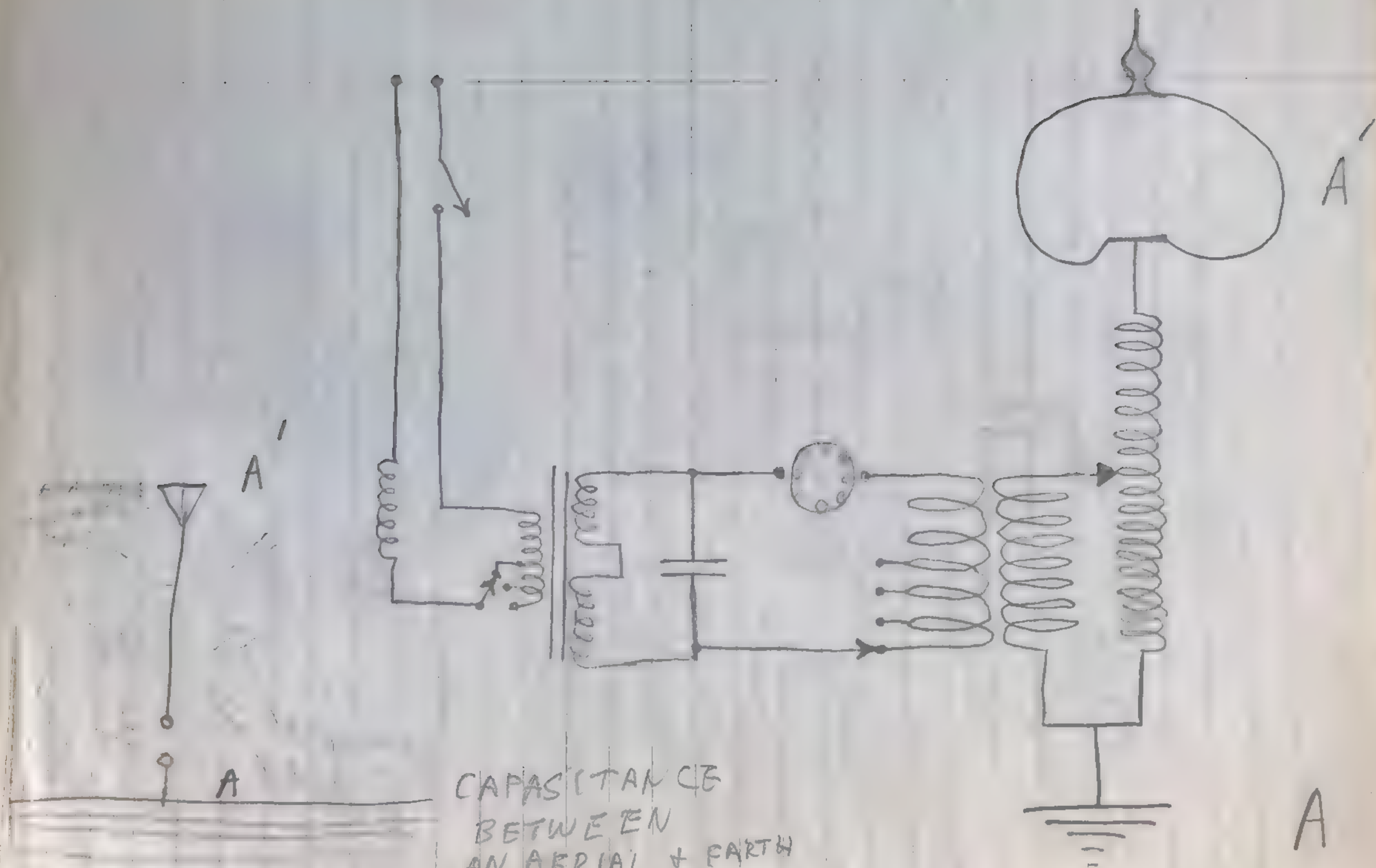
L = INDUCTANCE INCORPORATED IN COIL IN HENRY'S

C = CAPACITANCE OF CAPACITOR IN FARADS

I = CURRENT FLOWING THROUGH L

E = ELECTROMOTIVE FORCE IN VOLTS





WATTS AS TOTAL ENERGY STORED IN L & C.

$$W = \frac{CE^2}{2} \quad (\text{FOR CAPACITOR})$$

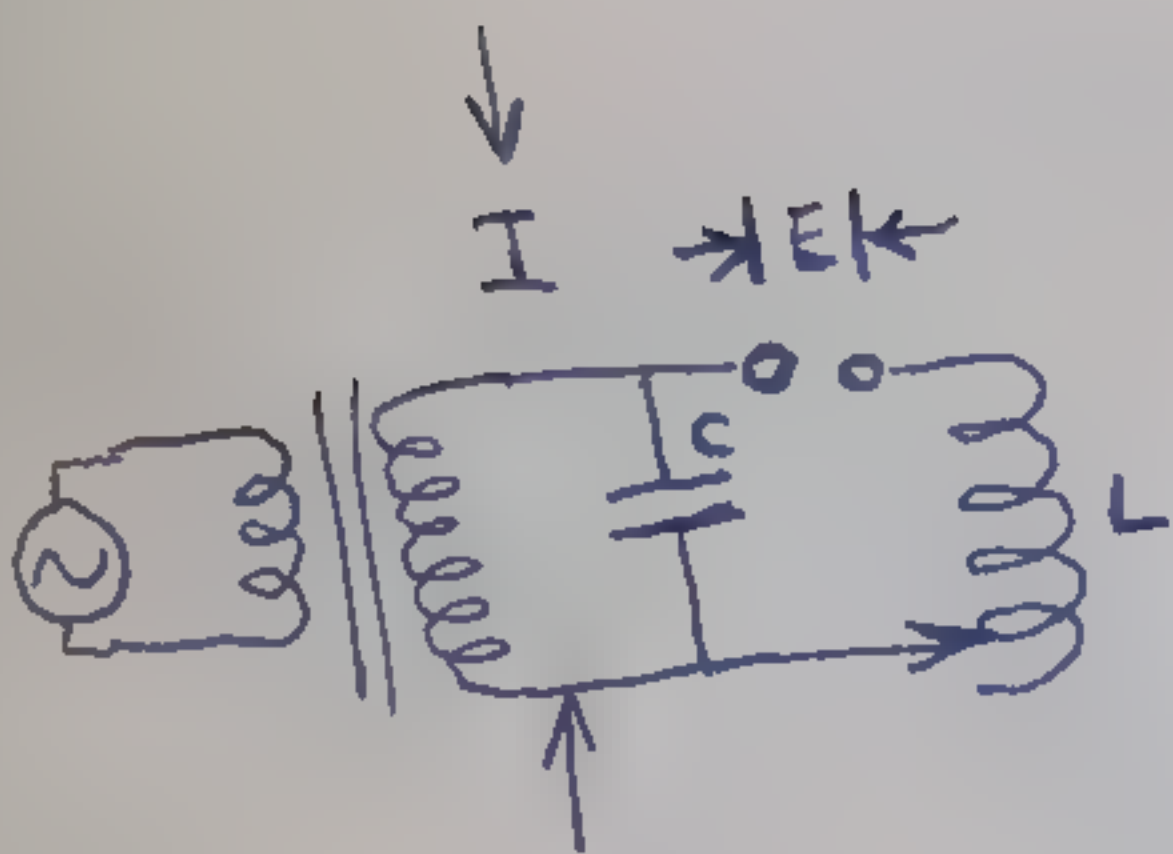
$$* W = \frac{LI^2}{2} \quad (\text{FOR COIL})$$

L = INDUCTANCE INCORPORATED IN
COIL IN HENRY'S

C = CAPASITANCE OF CAPACITOR
IN FARADS

I = CURRENT FLOWING
THROUGH L

E = ELECTROMOTIVE FORCE
IN VOLTS



$$W = \frac{LI^2}{2}$$

$$W = \frac{10 (1 \cdot 10^{-3})^2}{2} =$$

$$\frac{10 (10^{-6})}{2} = W$$

$$\frac{10^{-5}}{2} = W$$

$$\frac{.000001}{2} = .0000005$$

IF

L = PRIMARY INDUCTANCE
AS 10 HENRYS

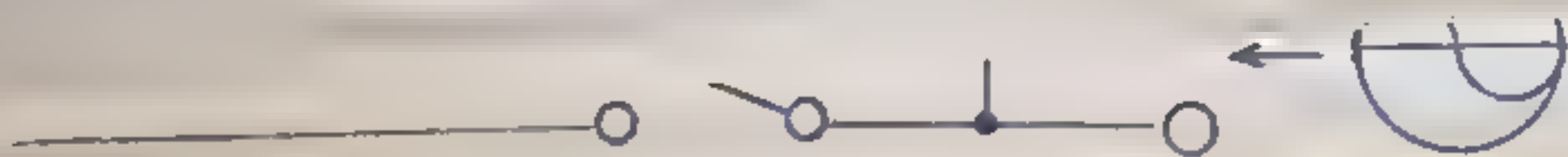
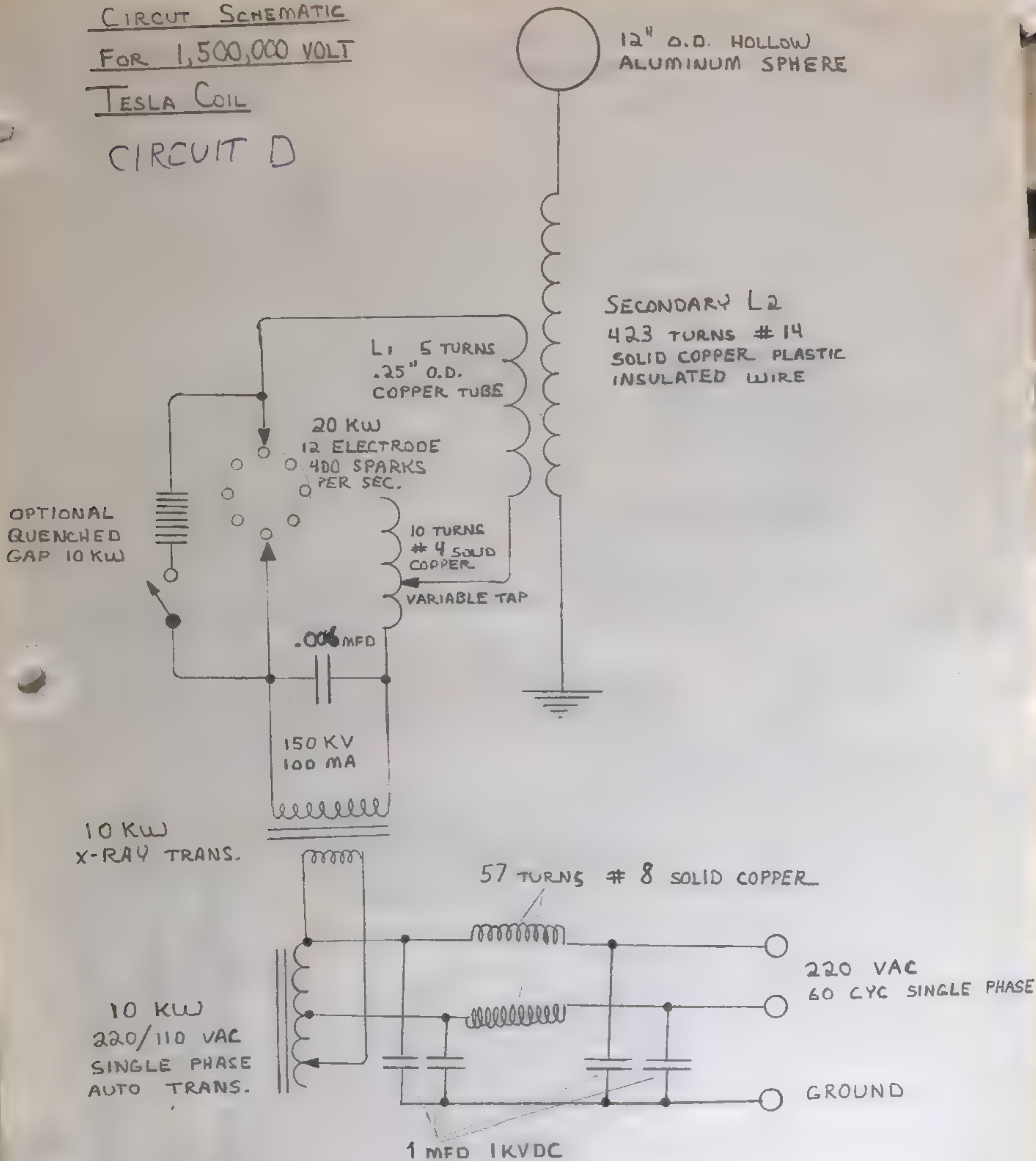
$$C = .02 \text{ MFD} = 2 \times 10^{-8}$$

$$I = 100 \text{ MA} = 1 \times 10^{-2}$$

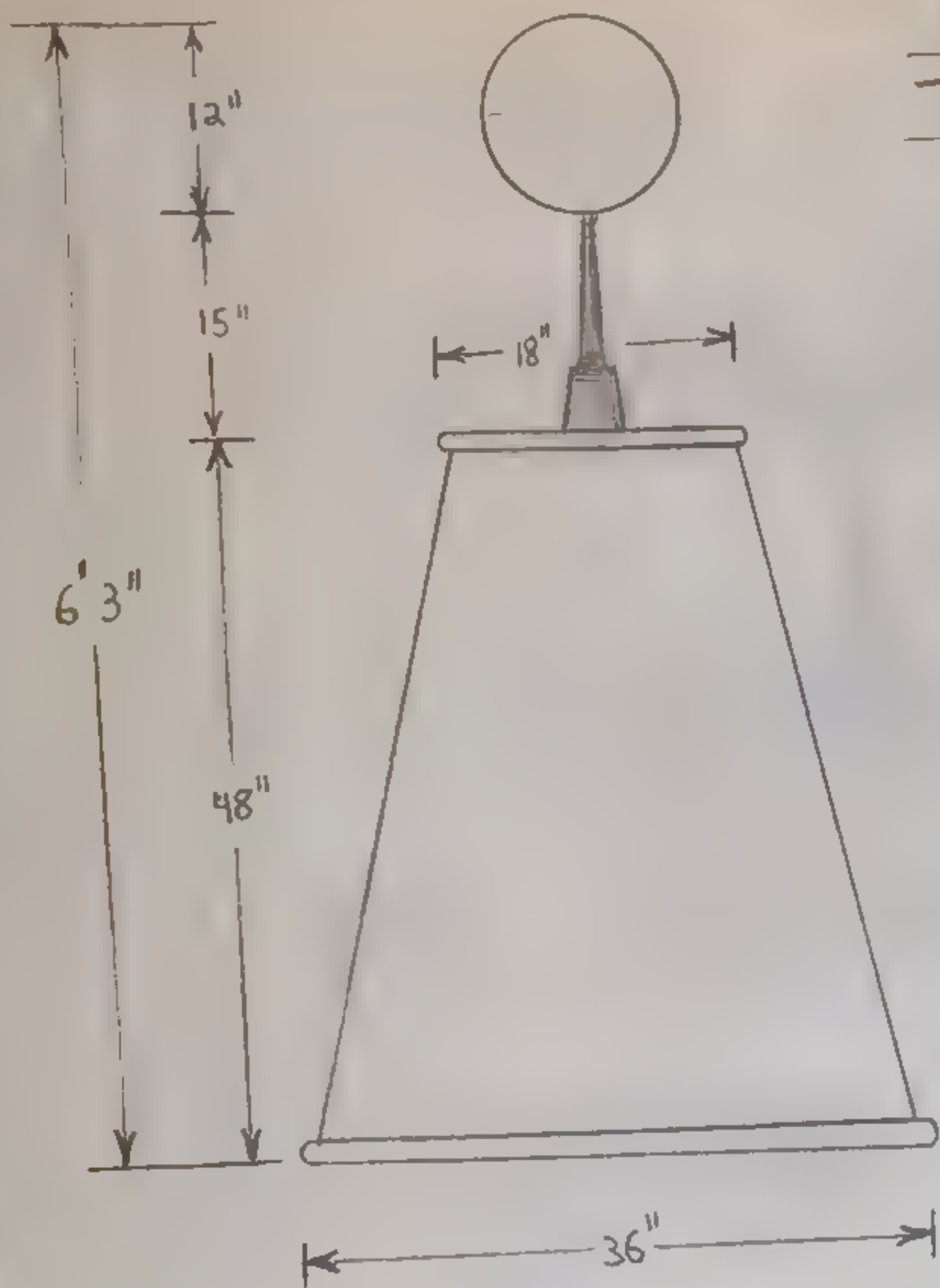
$$E = 150 \text{ KV} = 15 \times 10^4$$

$$5(10^{-6})$$

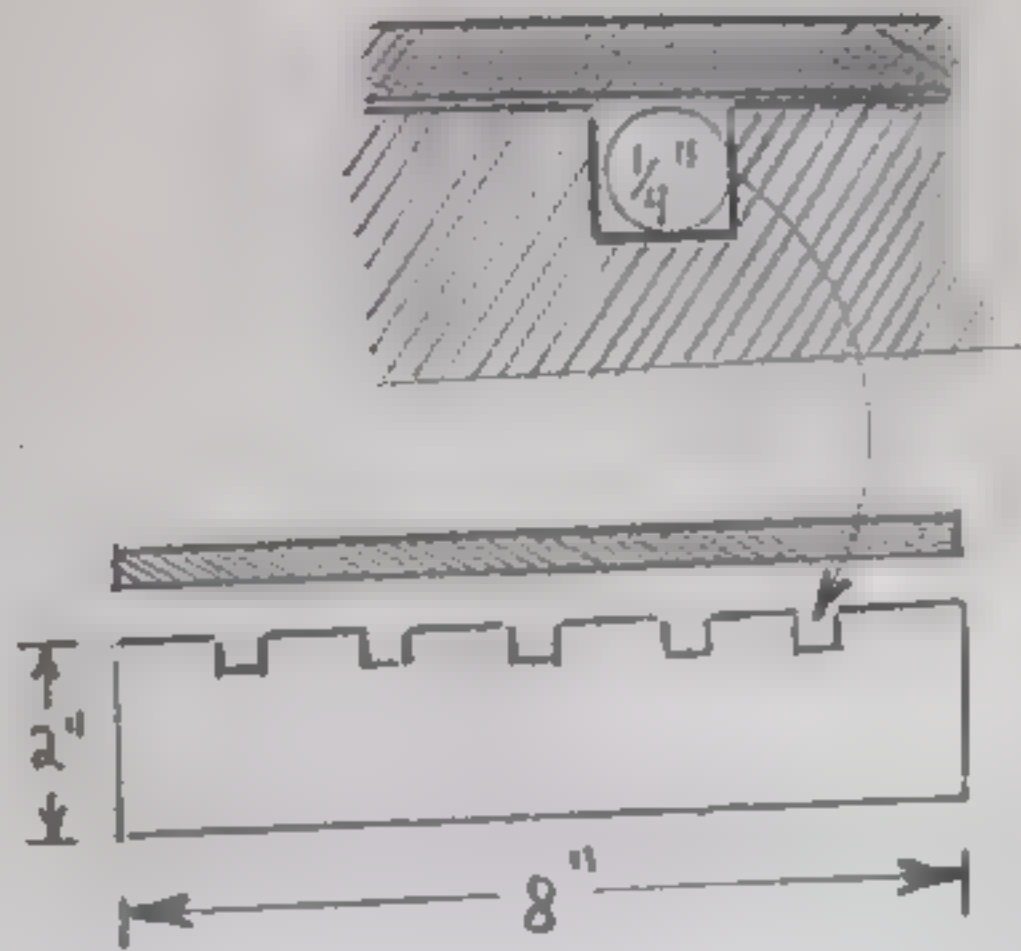
CIRCUIT SCHEMATIC
FOR 1,500,000 VOLT
TESLA COIL
CIRCUIT D



TESLA OSCILLATION TRANSFORMER CIRCUIT D



SECONDARY La

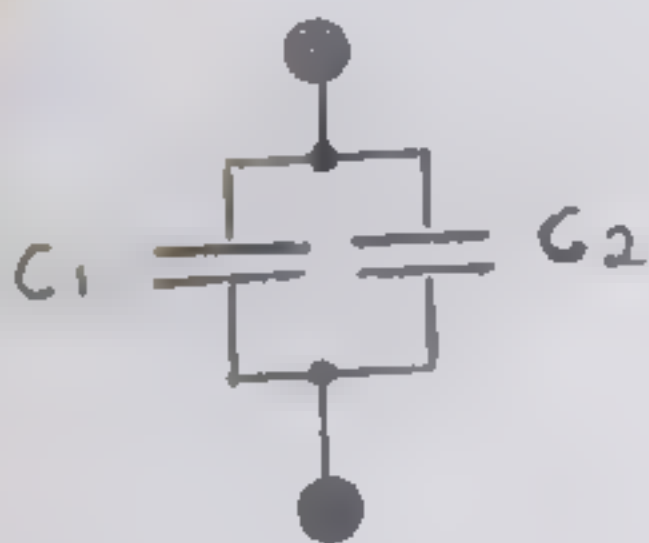


PRIMARY LI WOOD BLOCKS
VARNISHED FPR
8 BLOCKS

SCHEME

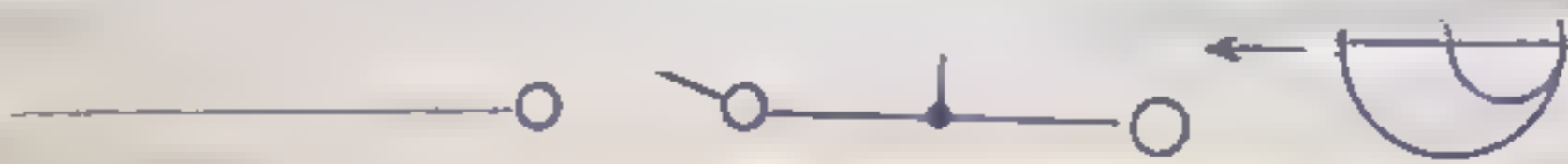
1" O.D. DOWL-FUR

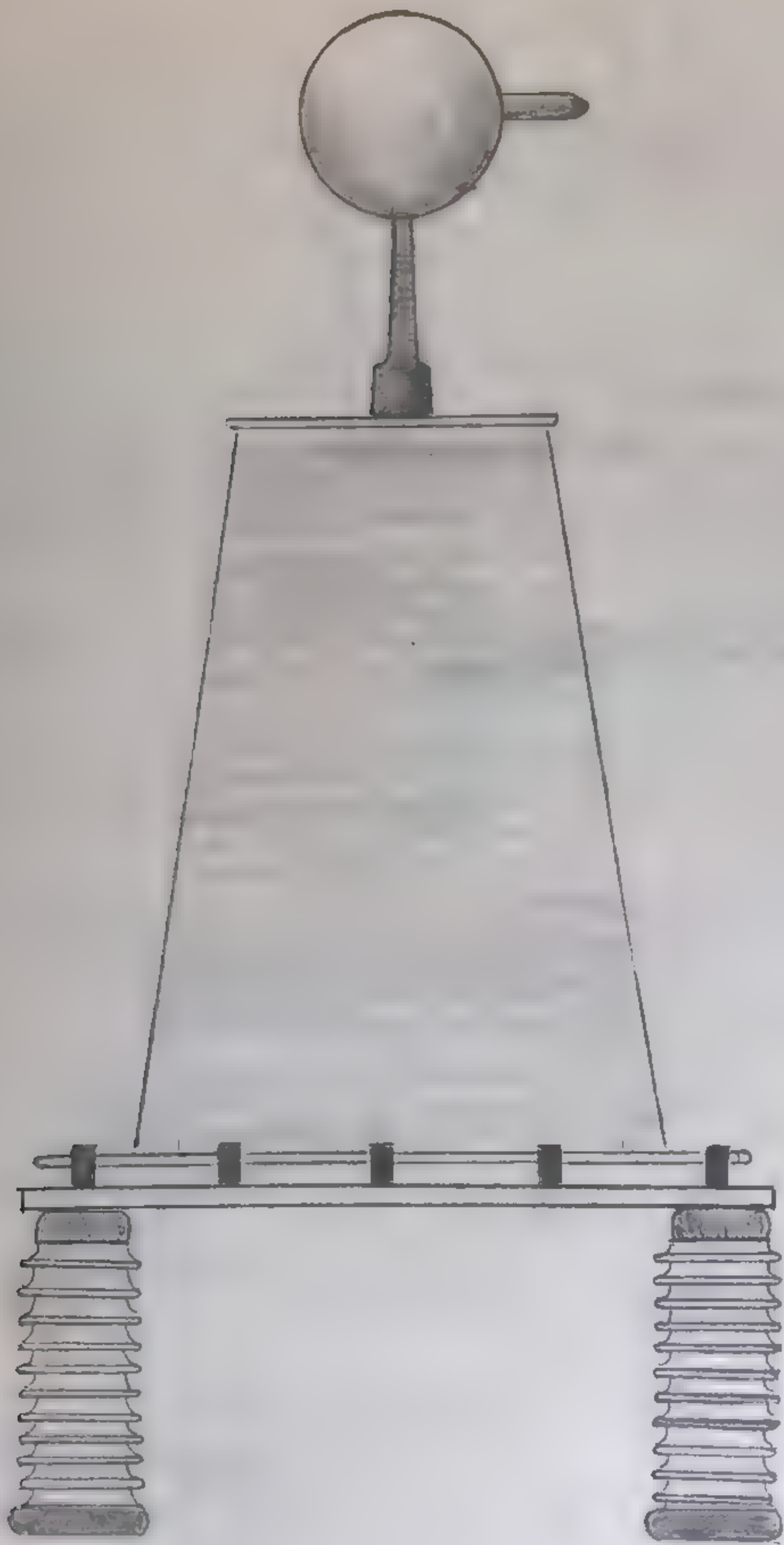
CAPACITOR

CIRCUIT

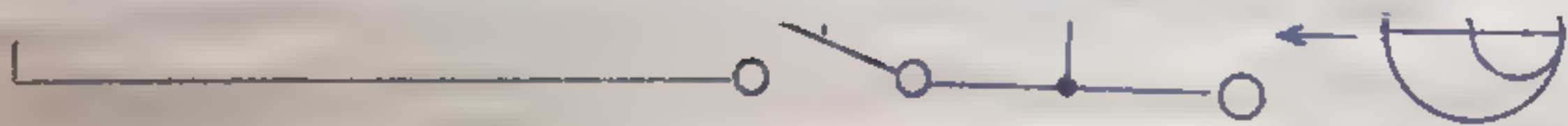
110 KVAC
.0066 MFD

$C_1 = 15 \text{ .05 MFD } 8 \text{ KVAC "GLASS MIKES" IN SERIES}$
 $C_2 = \text{ " " " " " " }$





CIRCUIT D



$$\begin{array}{r}
 1.5 \\
 40 \overline{) 60} \\
 \underline{40} \\
 200
 \end{array}$$

2
5
4
0

000000h2
0000h2
0000
0h
000009

1 ALUMINUM
BOX 6" x 3" x 2"

PK544
LA-FYETTE
AMP

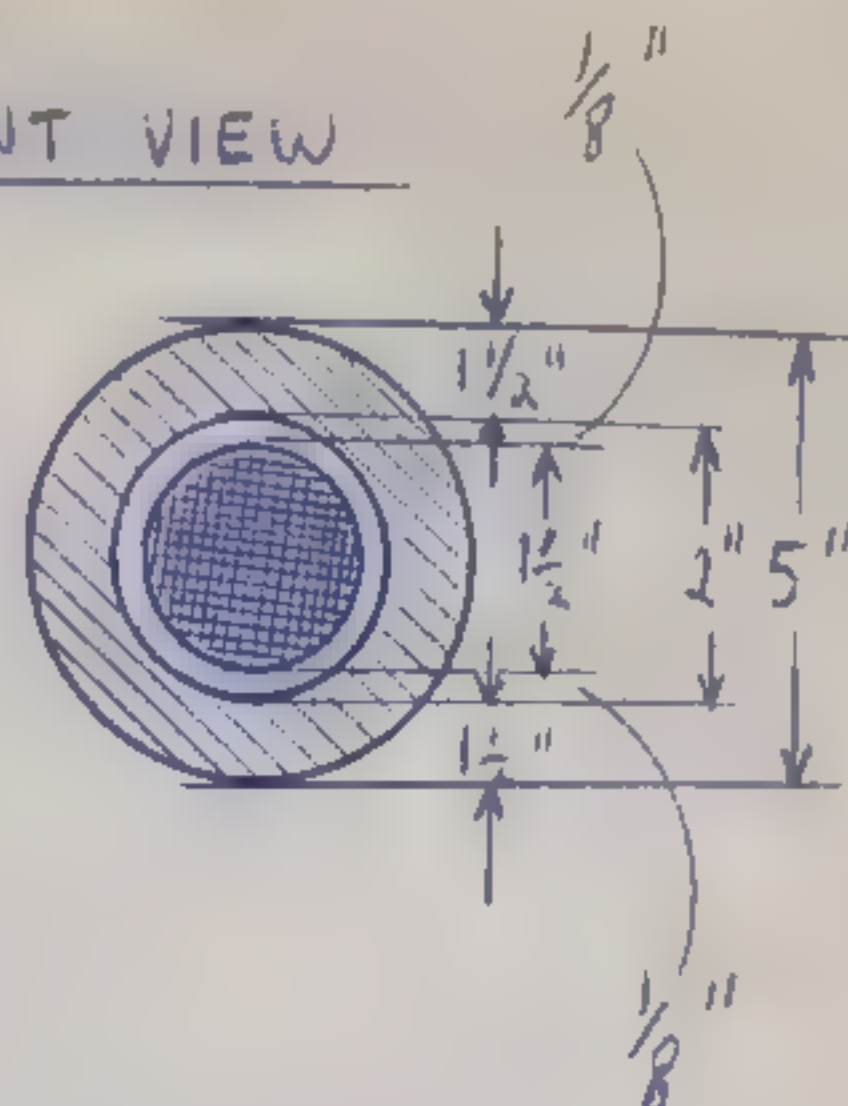
QUENCHED SPARK PLATE TEMPLATE

1/4" ALUMINUM STOCK

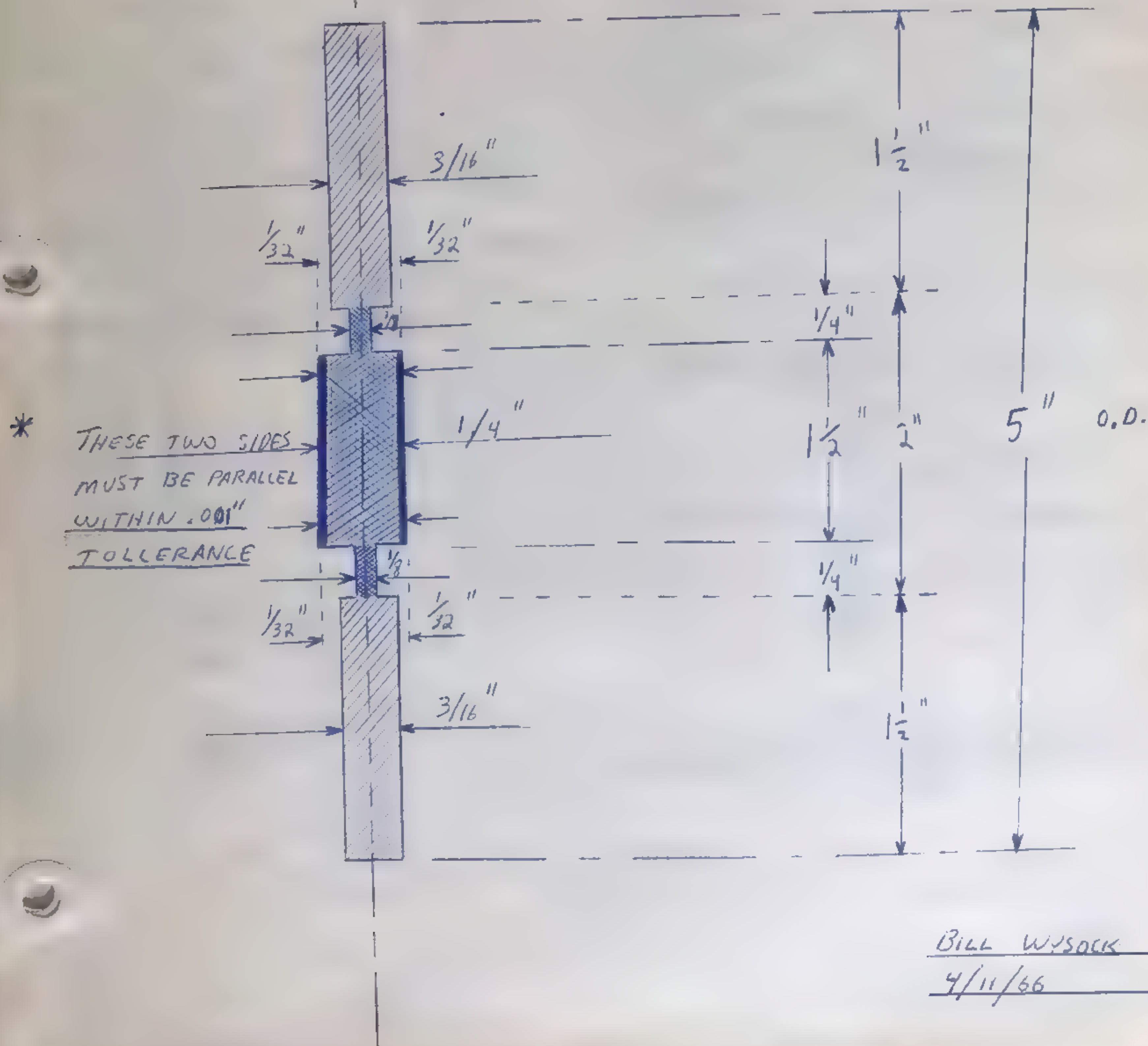
5 PLATES - EACH SINGLE-PIECE

CONSTRUCTION

FRONT VIEW



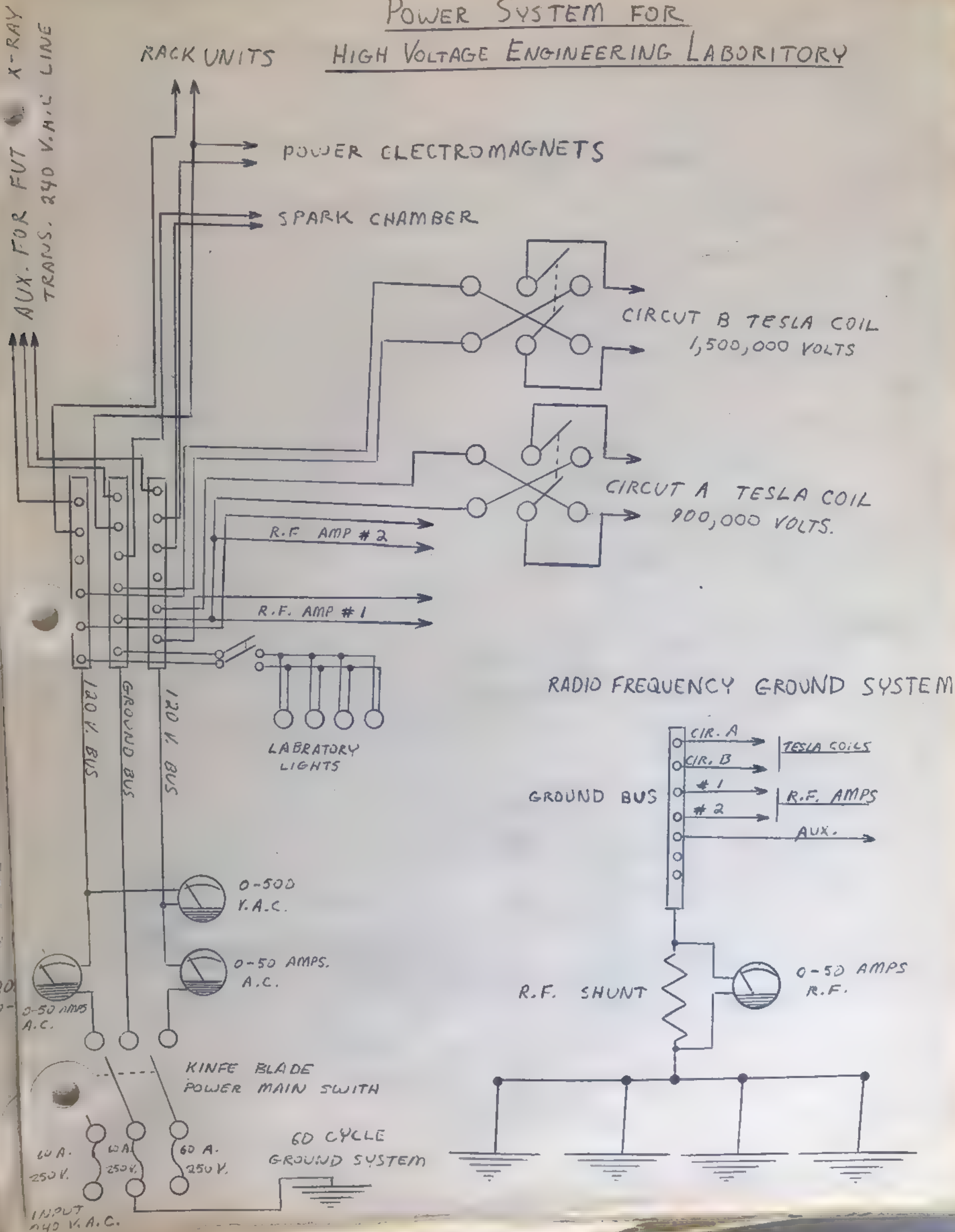
SIDE VIEW



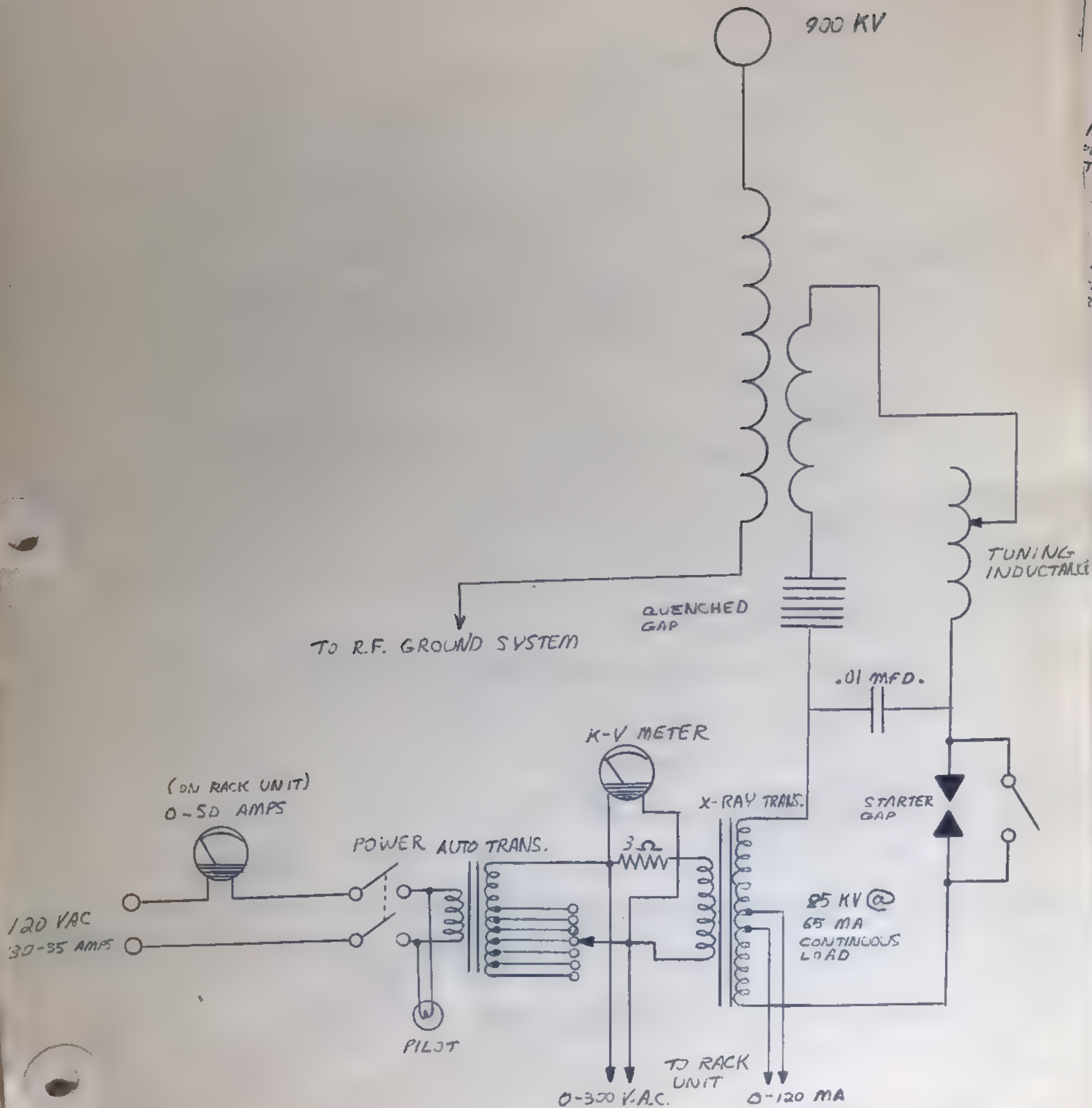
BILL WYSOCK

4/11/66

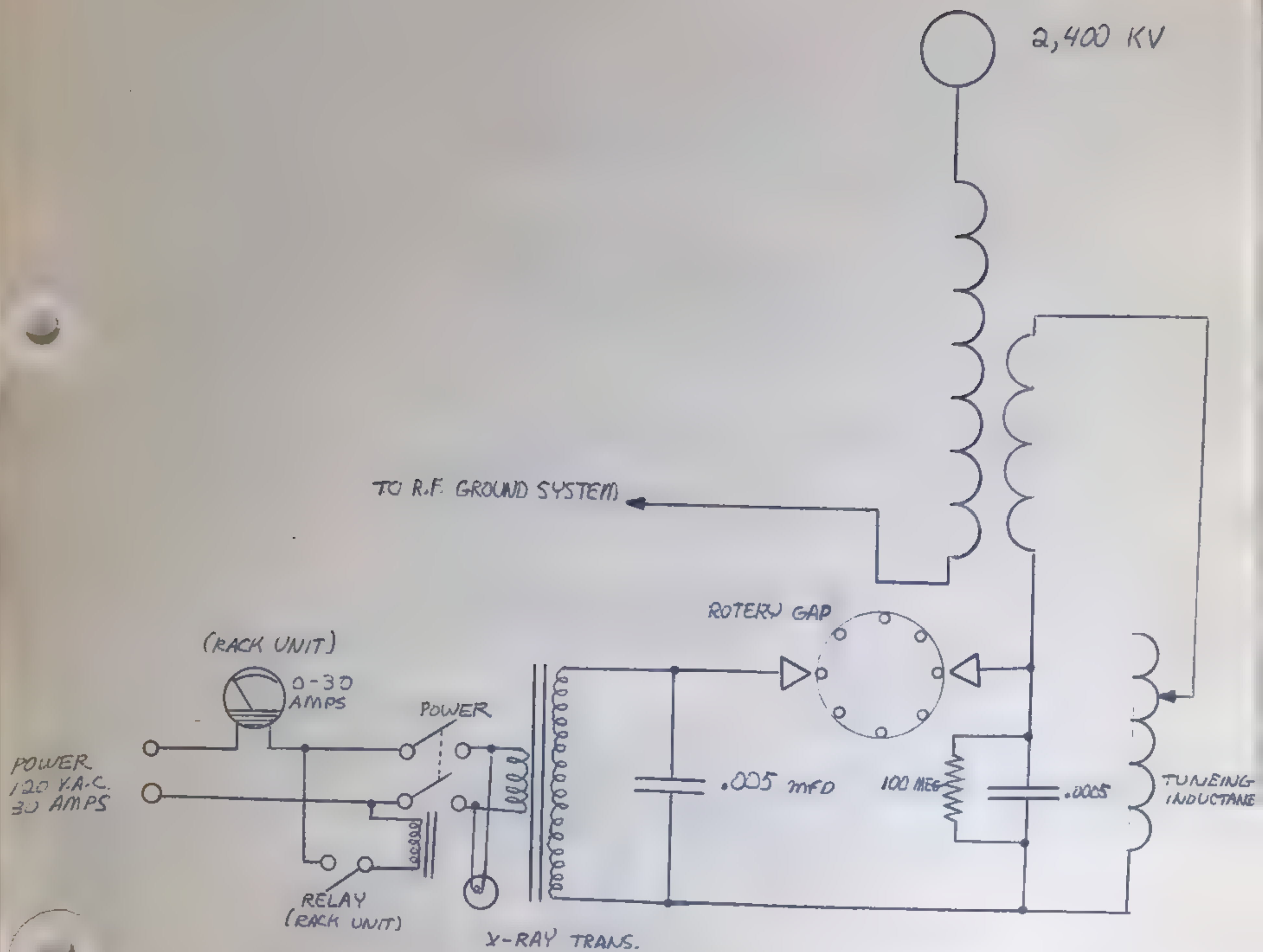
POWER SYSTEM FOR HIGH VOLTAGE ENGINEERING LABORATORY



CIRCUIT A



CIRCUIT B

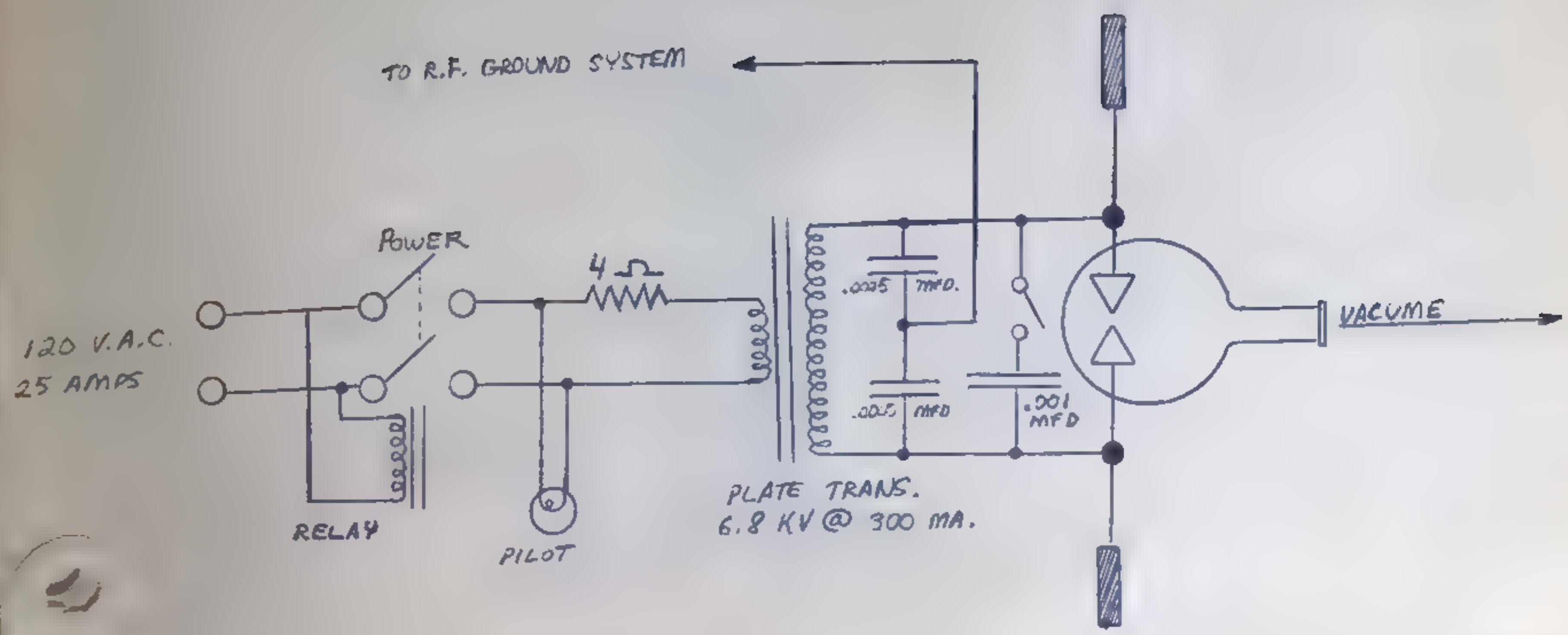


SPARK CHAMBER

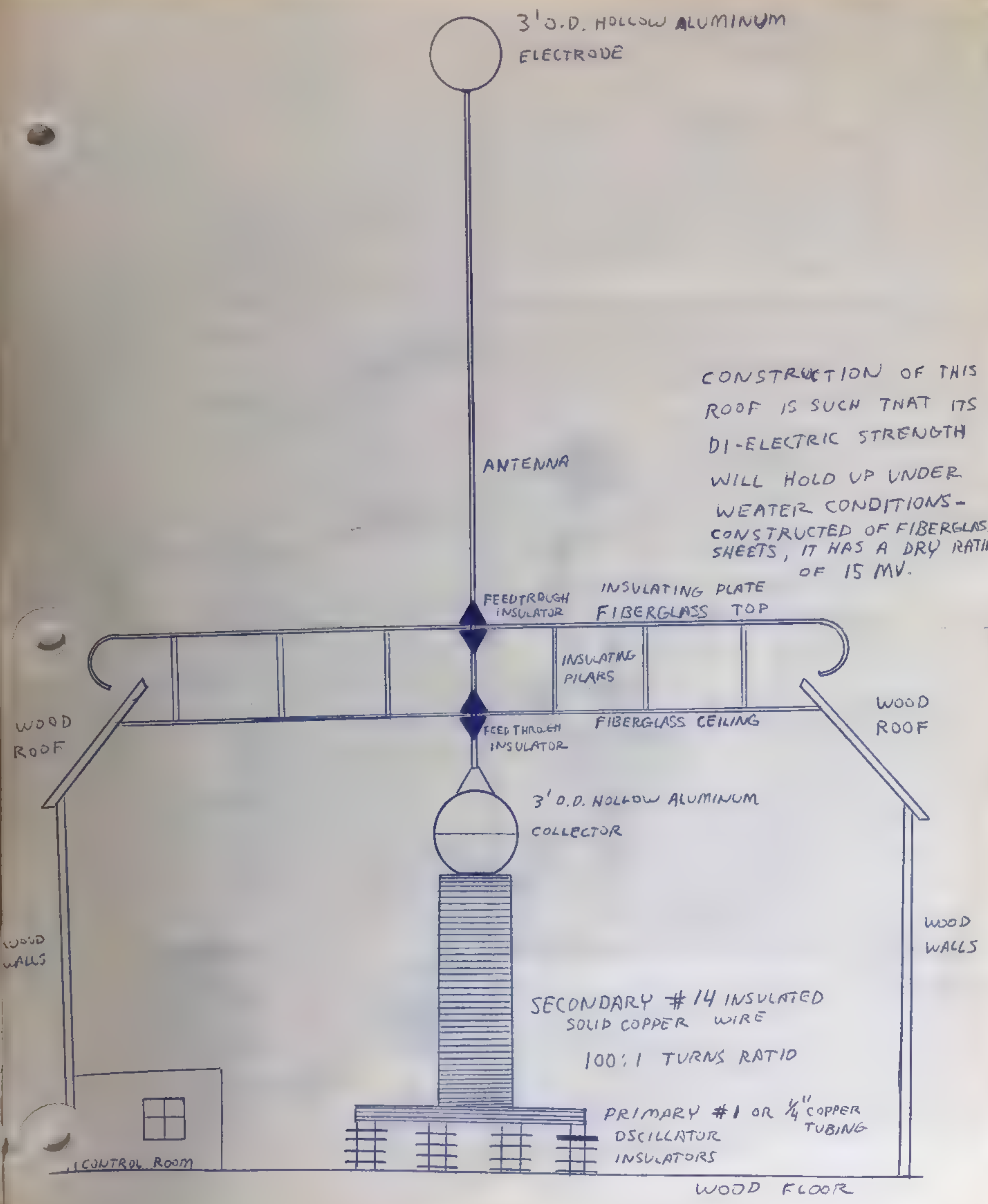
RATIO
KV RATIO
10KV
PER
TURN

100KV
PER
TURN

MV
R 10
NS



THE VAN DE GRAFF



CONSTRUCTION OF THIS
ROOF IS SUCH THAT ITS
DI-ELECTRIC STRENGTH
WILL HOLD UP UNDER
WEATER CONDITIONS -
CONSTRUCTED OF FIBERGLASS
SHEETS, IT HAS A DRY RATINE
OF 15 MV.

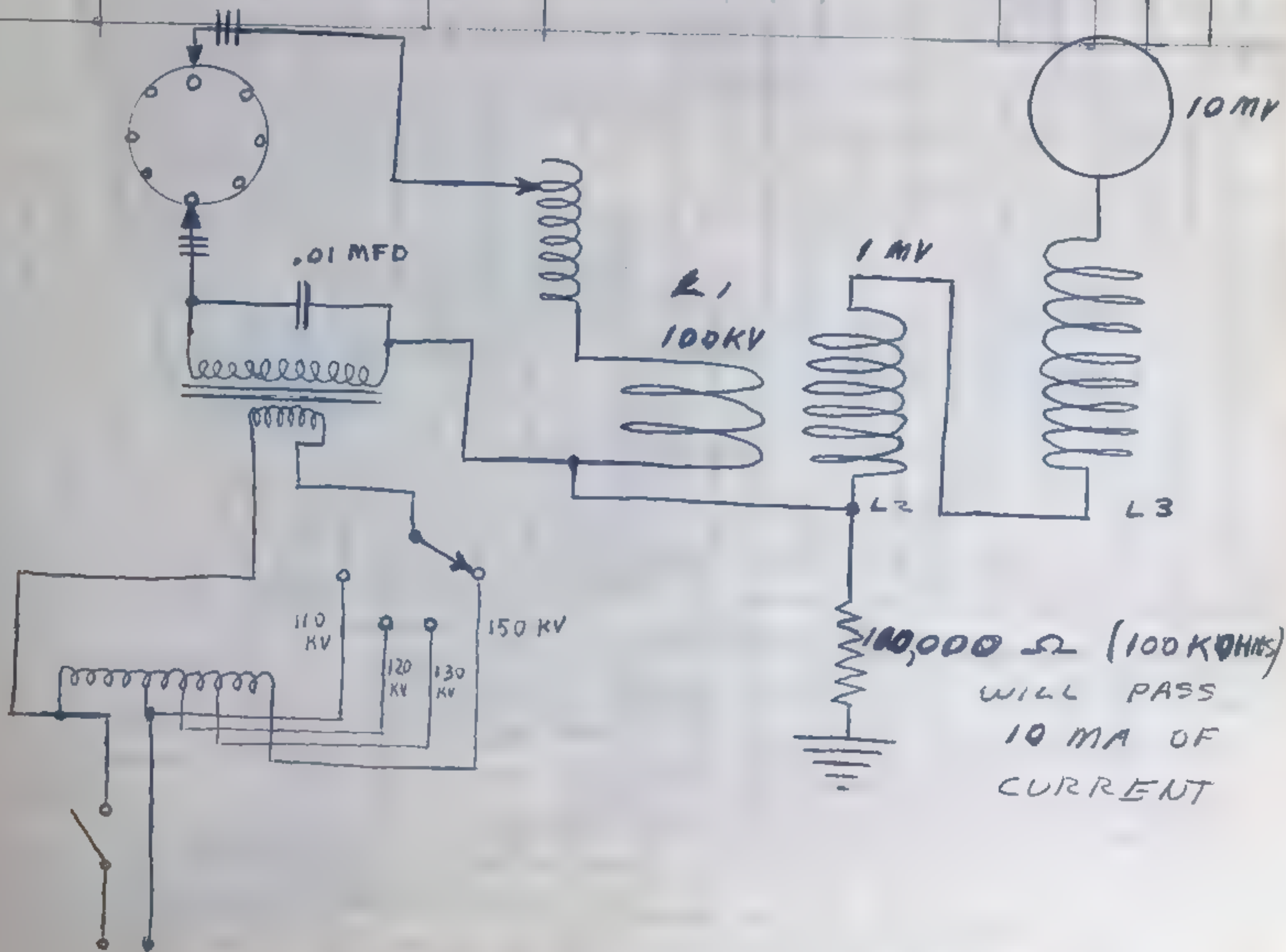
RATIO
10K
PER
TUR

100K
ER
TURN

MV
R 10
INS

THE VAN DE GRAFF

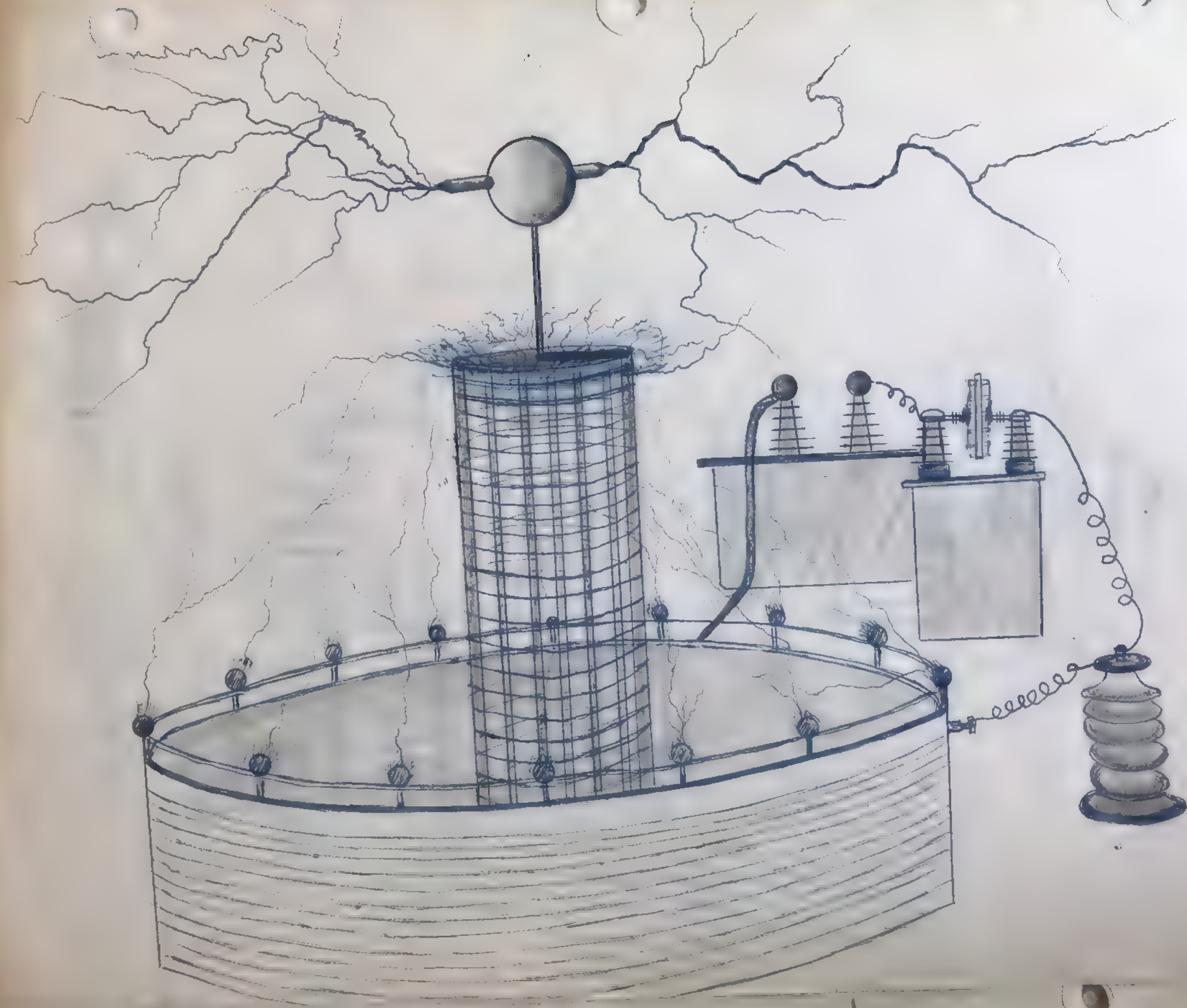
	COIL	NUMBER	INPUT V. VOLTAGE	INPUT AMPERAGE	TURNS	GAUGE #	TURNS	RATIO	KV RATIO
TESLA	PRIMARY	L1	100KV	60MA	10	1	1	10KV PER TURN	
(FIRST BOOST) TESLA	1ST SECONDARY	L2	1 MV	6MA	100	14	1:10	100KV PER TURN	
(SECOND BOOST) TESLA	2ND SECONDARY	L3	10mV	.6 MA (60 MICROAMPS)	1000	14	1:10	1 MV PER 10 TURNS	



THE VAN DE GRAFF

GENERATOR

UNLIKE CHARGES

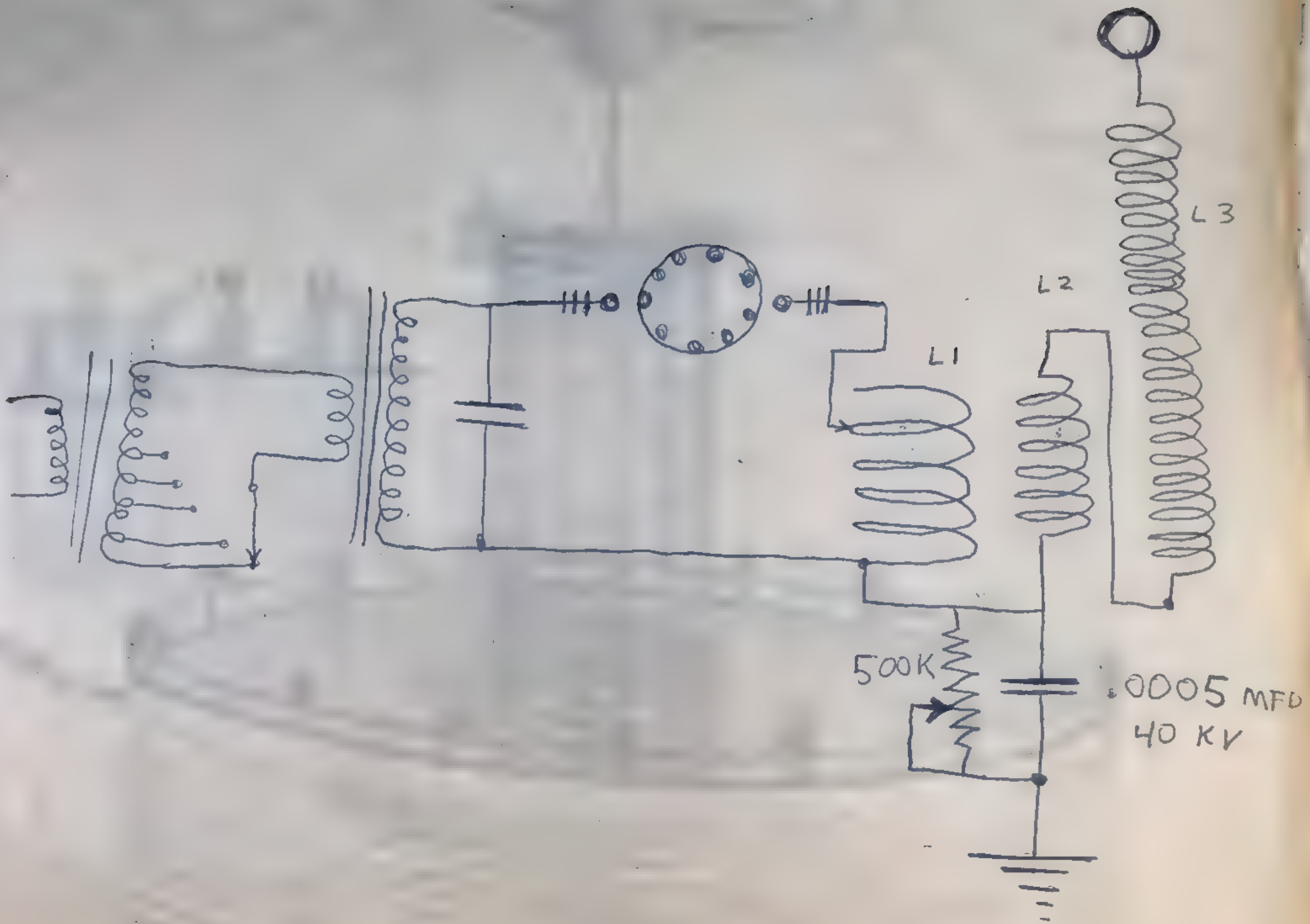


A 51 50 A

+ 1

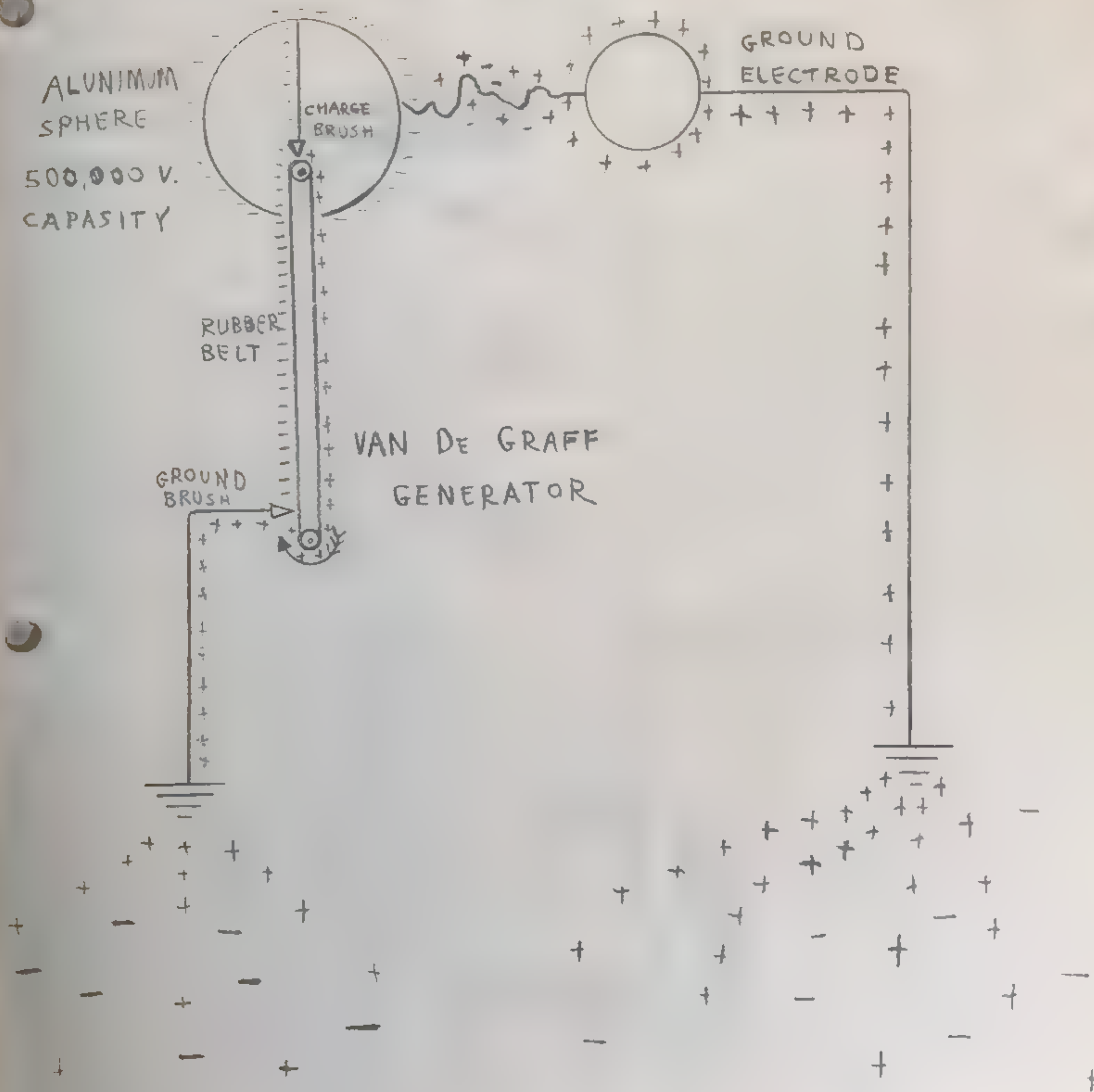
9 9

120 V.
30 A.
60 CY. A.C.

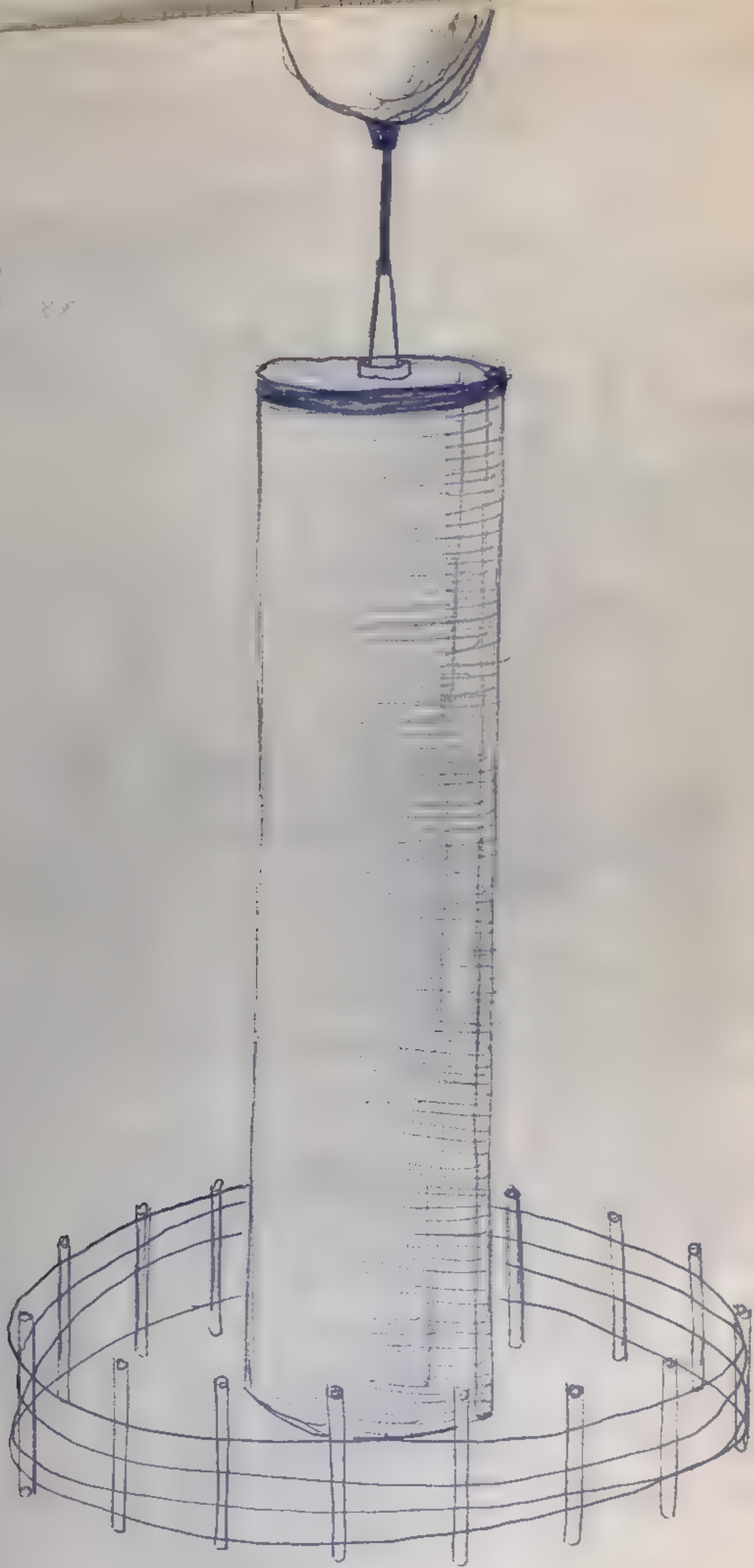


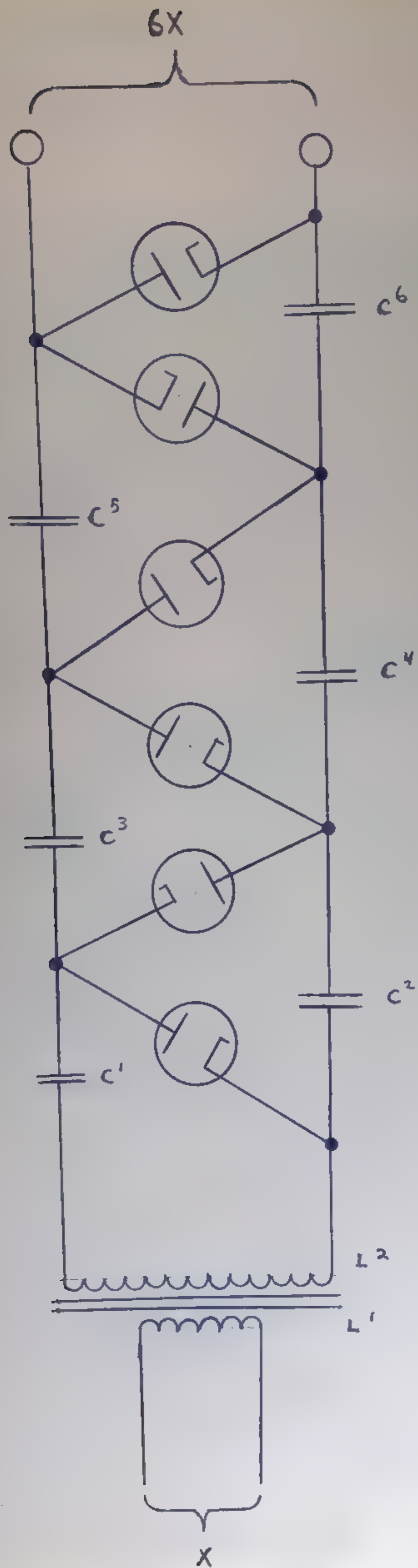
THE VAN DE GRAFF GENERATOR

UNLIKE CHARGES
ATTRACT



OPPOSITE CHARGES
ARE EQUILIZED IN
GROUND





44

LIST FOR VON MODEL C1 TEST SET

- T1 - 5 AMP POWERSTAT MODIFIED FOR CENTER TAP
- T2 - AIR INSULATED STEP-UP TRANSFORMER 615 VA 110v/20kv
- T3 - CURRENT TRANSFORMER

- C1 - HIGH VOLTAGE CAPACITOR .05 MFD 25 KV
- C2, 3, 4 - HIGH VOLTAGE CAPACITORS .02 MFD 50 KV
- CR - ELECTROLYTIC CAPACITOR 40 MFD 140 V
- CX - ELECTROLYTIC CAPACITOR 50 MFD 6 V
- CY - ELECTROLYTIC CAPACITOR 500 MFD 6 V

- SR - SELENIUM RECTIFIER 100 MA 125 VAC
- SI, 2, 3, 4, 5, 6, 7, 8 - SELENIUM RECTIFIERS 25 KV PIV 5 MA

- OL - CIRCUIT BREAKER 8 AMP INSTANTANEOUS TRIP
- OS - RANGE SELECTOR SWITCH

- N - NEON LAMPS NE 32
- NI - NEON LAMP NE 51

KV - KILOVOLTMETER, HIGH TORQUE, 50 MICROAMP, SCALE 30 & 100

H - RELAY TO HOLD OFF POWER IF GROUND IS NOT CONNECTED

G - PROTECTIVE AIR GAP

RV - DUAL VARISTOR 100 TO 160v DC

- R1 - HIGH VOLTAGE RESISTOR 500 MEGOHMS 100 KV
- R2 - RESISTOR 27,000 OHMS 2 W
- R3 - RESISTOR 2,700 OHMS 2 W
- R4 - RESISTOR NOMINAL 500K CALIBRATED
- R5 - RESISTOR NOMINAL 100K CALIBRATED
- R6 - RESISTOR NOMINAL 600K CALIBRATED
- R7 - RESISTOR NOMINAL 200K CALIBRATED
- R8 - RESISTOR 136 OHMS 4 W

THE FOLLOWING RESISTORS FOR USE WITH TOPPING UNITS:

- R6T - RESISTOR NOMINAL 600K CALIBRATED
- R7T - RESISTOR NOMINAL 200K CALIBRATED

- A1 - AMMETER 5 AMP RECTIFIER TYPE
- A2 - MICROAMMETER D-C 0 - 100 CORE MAGNET TYPE
- A3 - MILLIAMMETER D-C 0 - 1 CORE MAGNET TYPE

The Von

VON

*Birmingham 11
Alabama*

P.O. Box 3564

The Von Corp.

Attn: Mr. C. H. von Hermann Jr.

* SPELLMAN HI-VOLTAGE CO.
BRONX 67 N.Y.
WRITE FOR PRODUCTS
CAT.

CONDENSER PRODUCTS CO
* HI. VOLT PWR SUPPLY
NEED INFORMATION ON #PS50-2MGVT
* H-V TERMINAL BALLS

PRECISE MEASUREMENTS CO.

FLEMINGTON NEW JERSEY -
H-V TRANS. 'MODLE 50KV 50KV 5MA

E.F. JOHNSON CO. WASECA MINNESOTA
STAND-OFF INSUL.

CAT. #

* 135-67 .98 \$ ea.

* 135-54 .79 \$ ea.

135-47 1.85 ea

WRITE FOR
INFORMATION
ON H-V PWR.

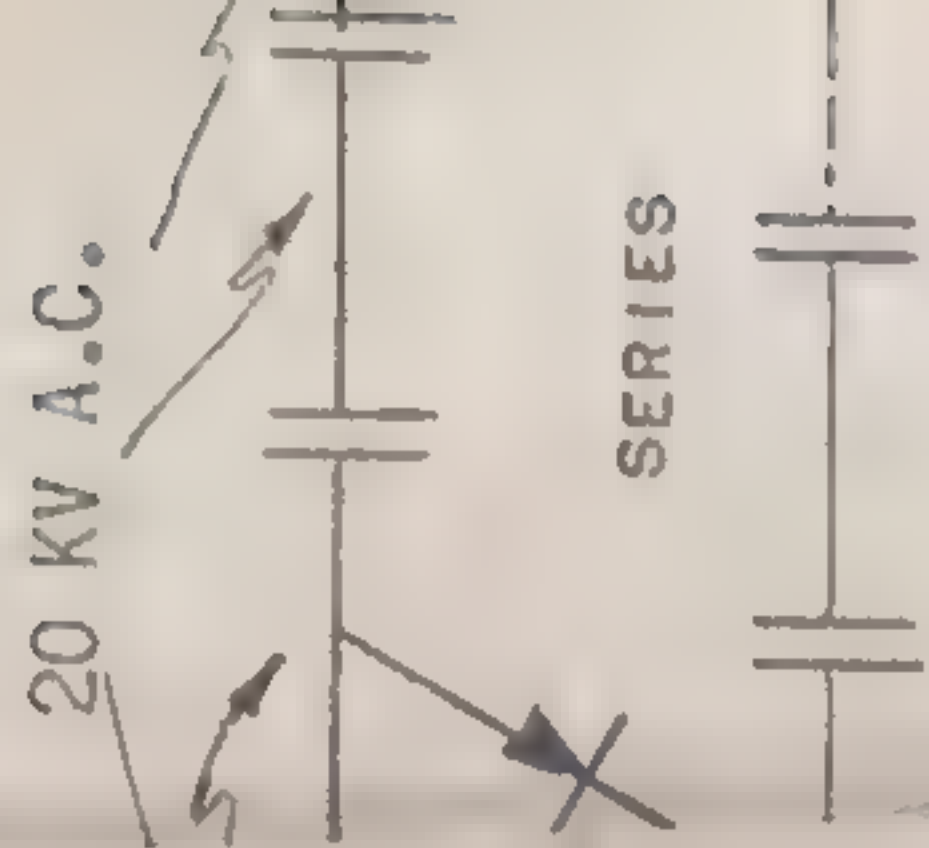
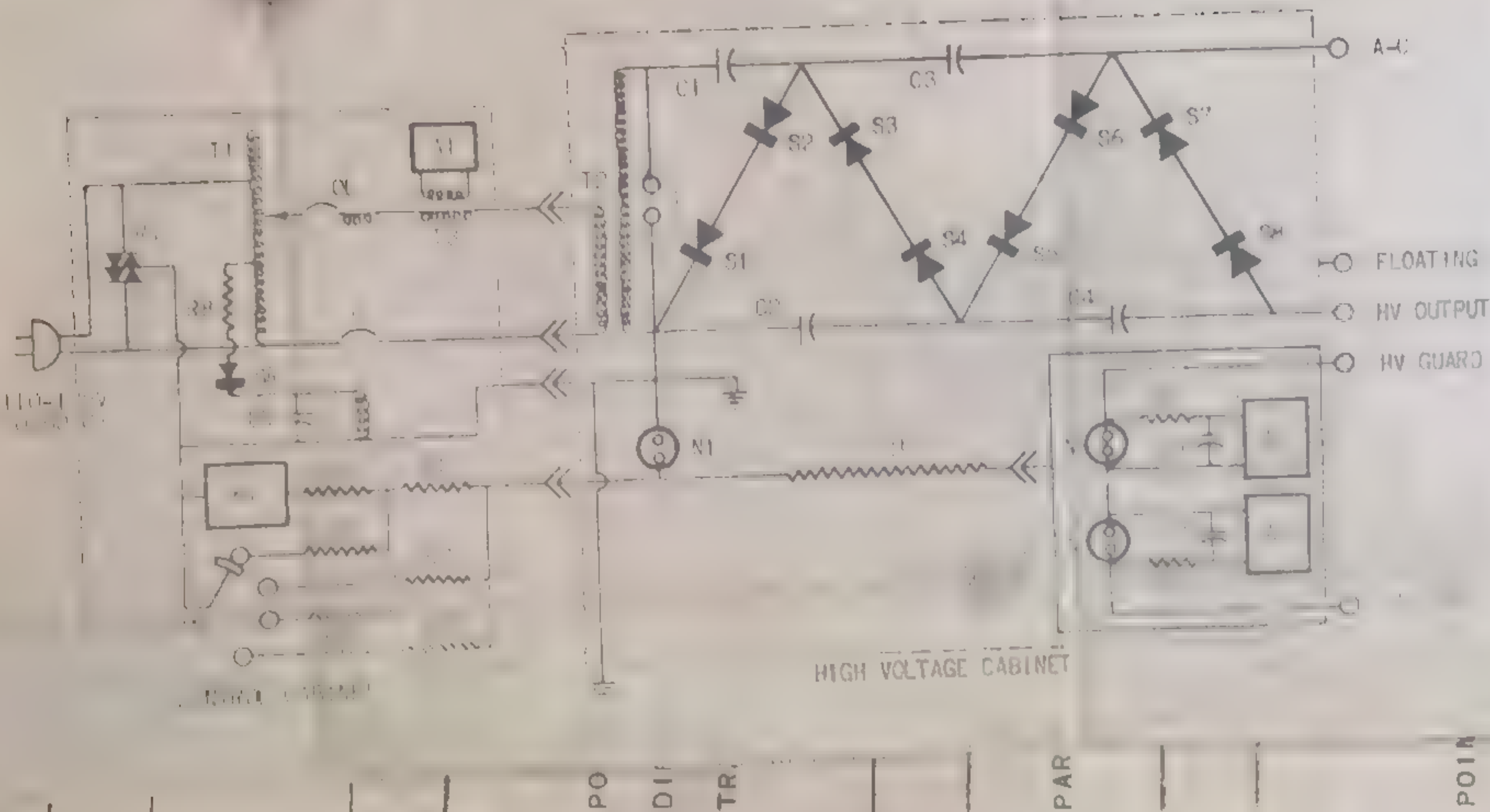
PLASTIC CAPASITORS INC.

CHICAGO 14, ILL.

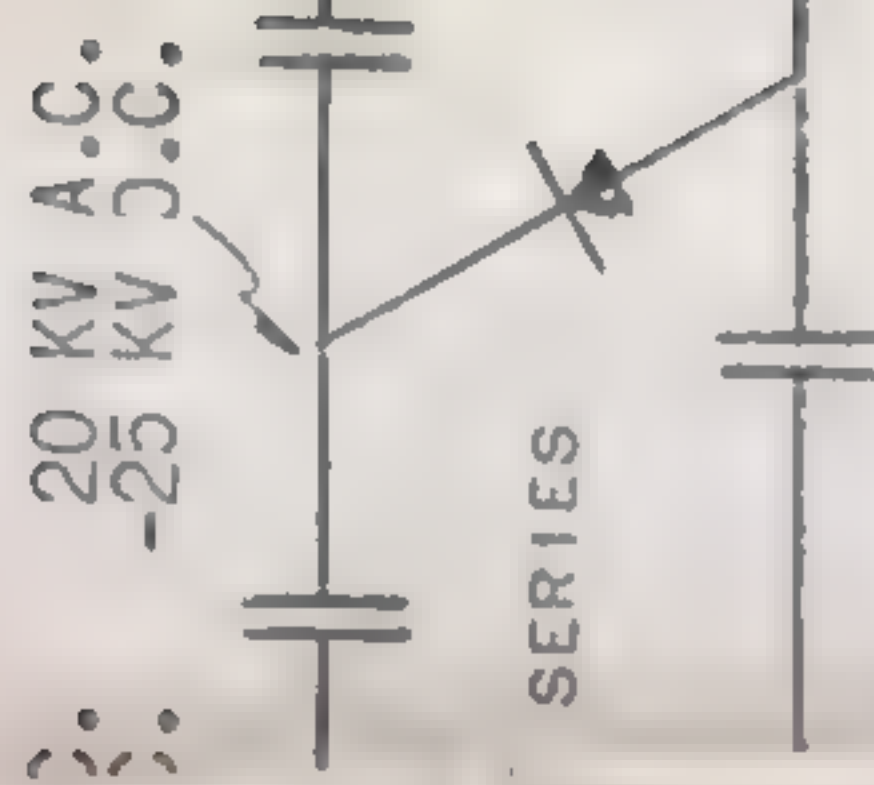
SUPPLIES

#	KV	MFD.	PRICE
* OF 200-203	20	.02	27.00
* OF 600-102	60	.001	36.50
OF 600-502	60	.005	41.50

HALF WAVE

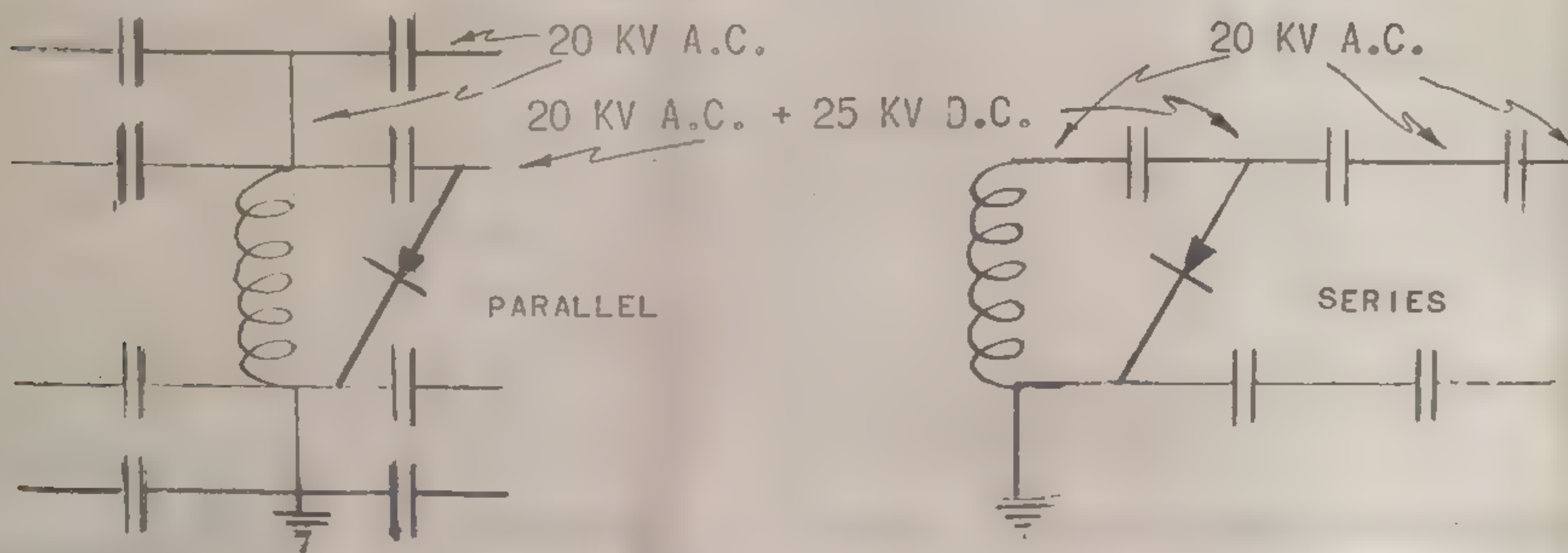


IN TWO OTHER
WILL ASSUME A
RE. THE

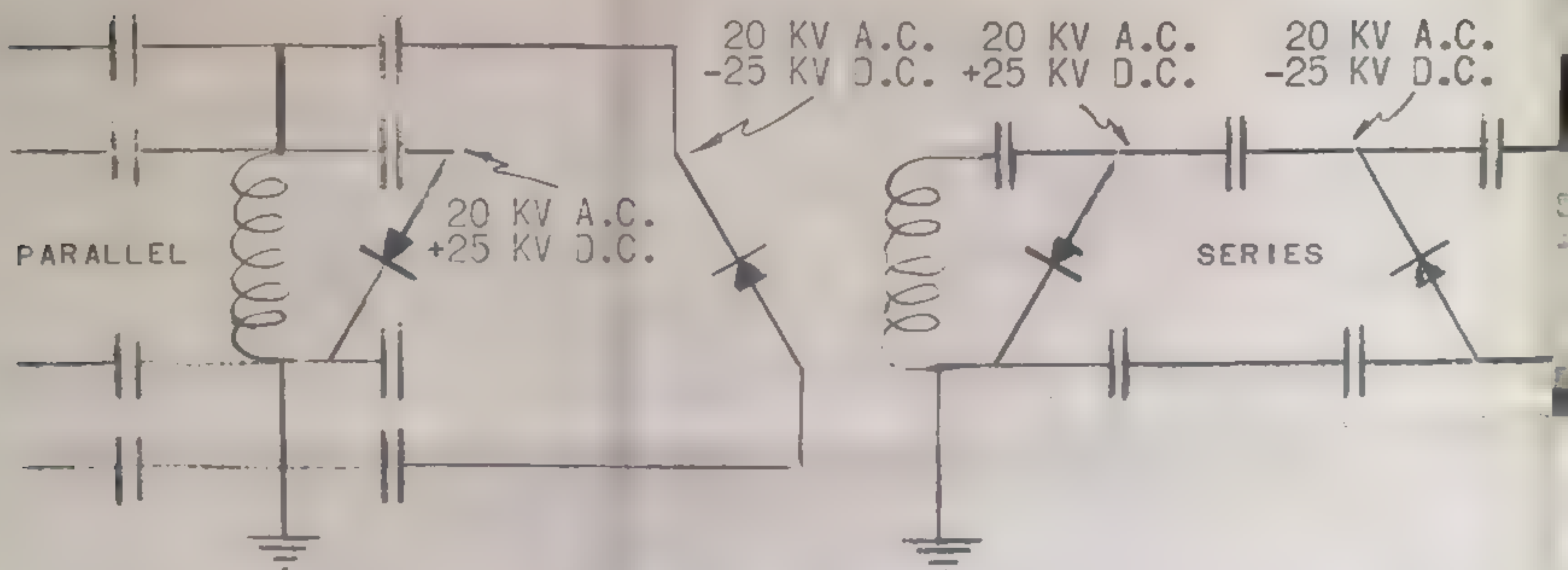


TWEEN VARIOUS
OW RIPPLE)
3LE. THE ODD
VLTAGE PRESENT

TO THE PEAK OF THE A.C. WAVE. THE TRANSFORMER SEES HALF WAVE RECTIFICATION.

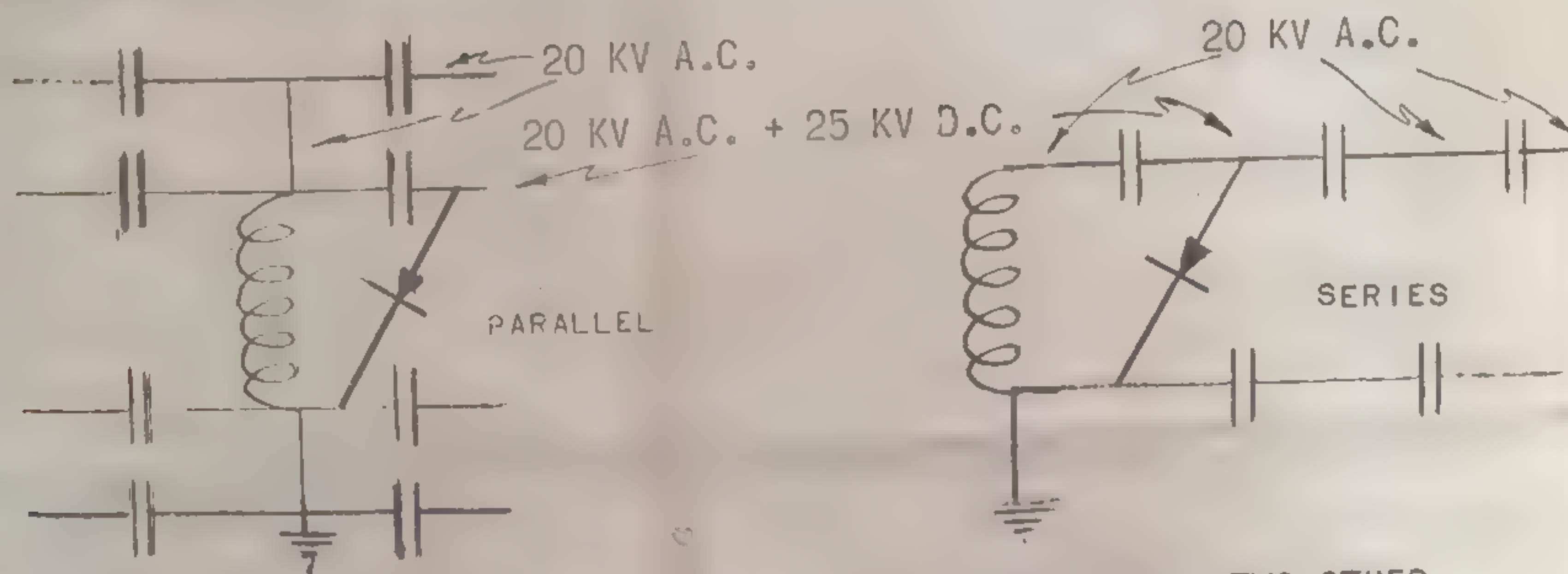


IF WE CONNECT ANOTHER HALF WAVE RECTIFIER BETWEEN TWO OTHER POINTS BUT IN THE REVERSE DIRECTION, THE CONDENSERS WILL ASSUME A DIFFERENCE IN D.C. POTENTIAL THE REVERSE OF THOSE BEFORE. THE TRANSFORMER NOW SEES FULL WAVE RECTIFICATION.

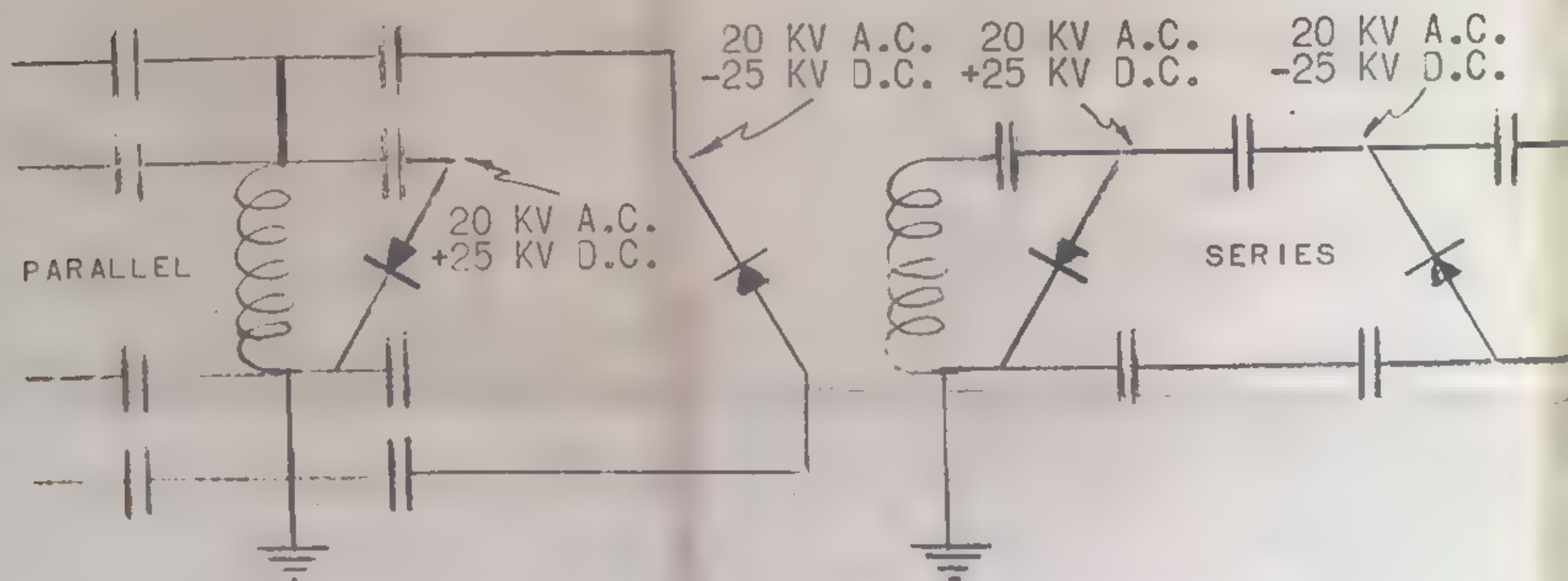


WE CAN THEN ADD ADDITIONAL HALF WAVE RECTIFIERS BETWEEN VARIOUS POINTS AND BY ARRANGING THEM IN SERIES OBTAIN USABLE (LOW RIPPLE) D.C. VOLTAGES IN EVEN MULTIPLES OF THE PEAK A.C. AVAILABLE. THE ODD MULTIPLES ARE NOT USABLE BECAUSE OF THE ORIGINAL A.C. VOLTAGE PRESENT AS A RIPPLE AT EACH.

TO THE PEAK OF THE A.C. WAVE. THE TRANSFORMER SEES HALF WAVE RECTIFICATION.

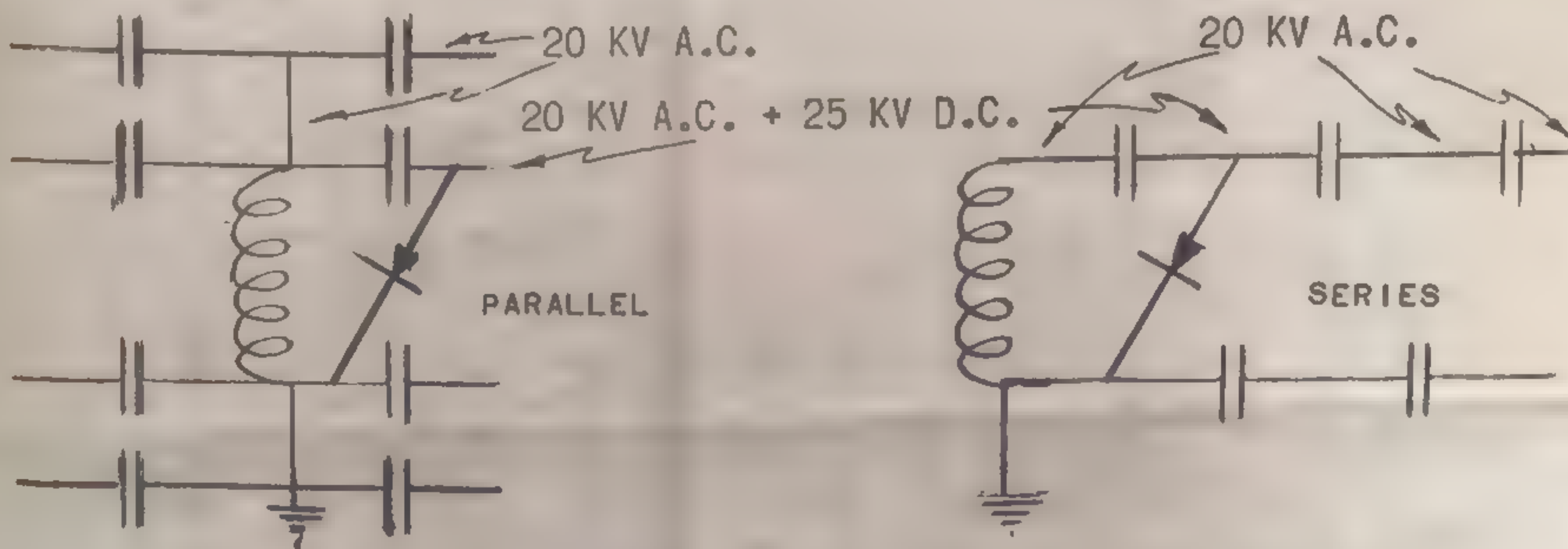


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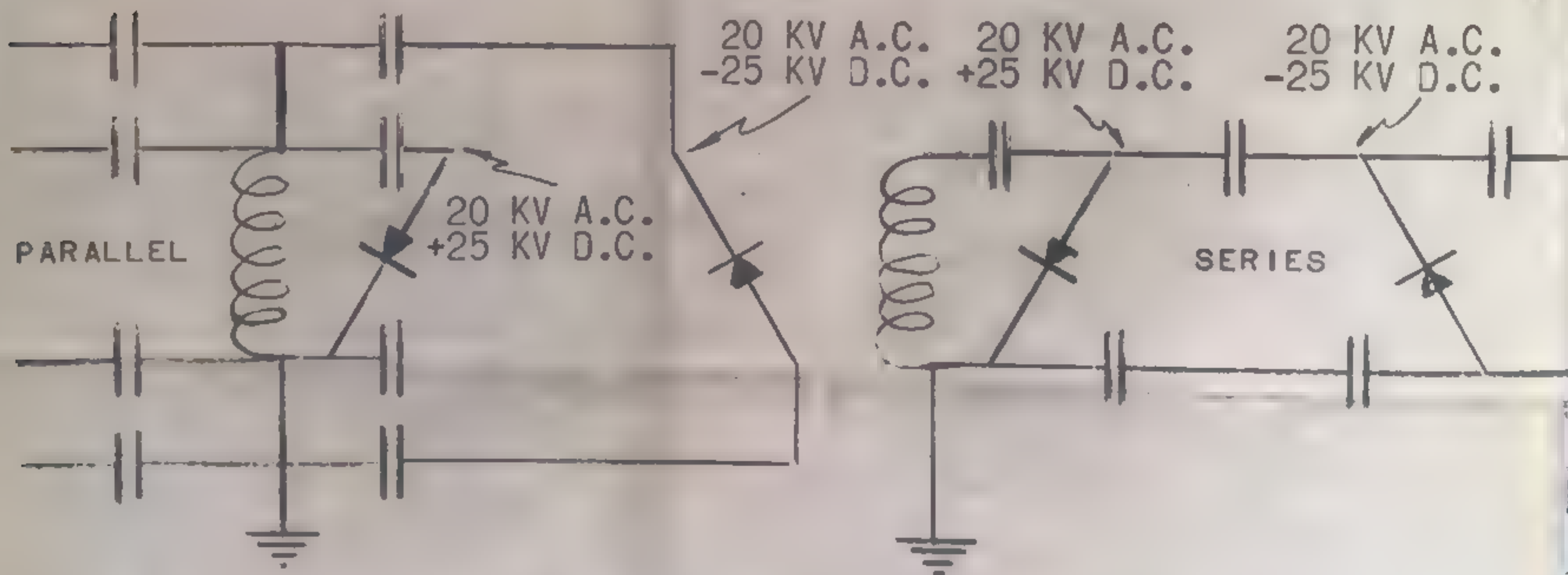


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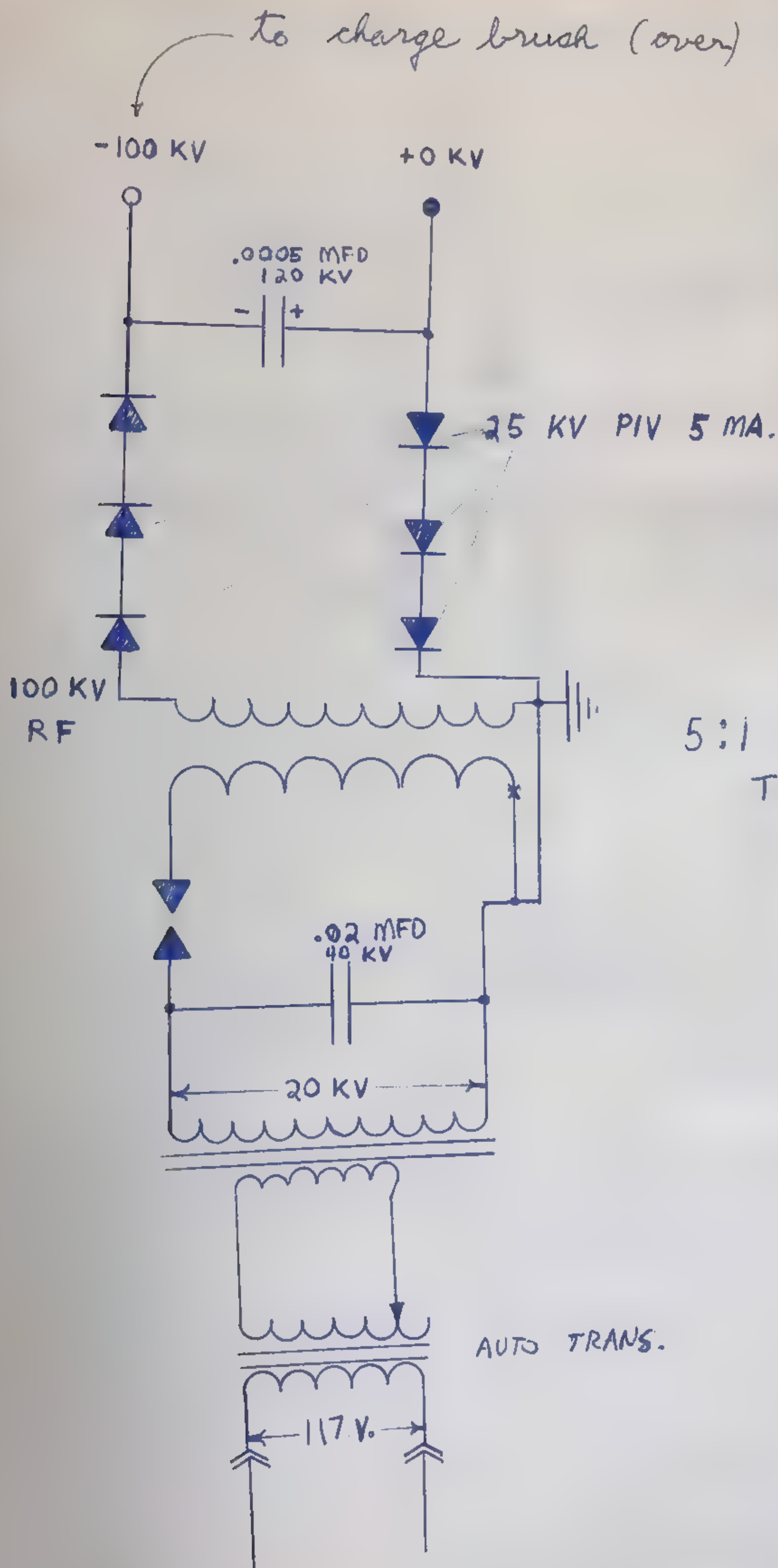
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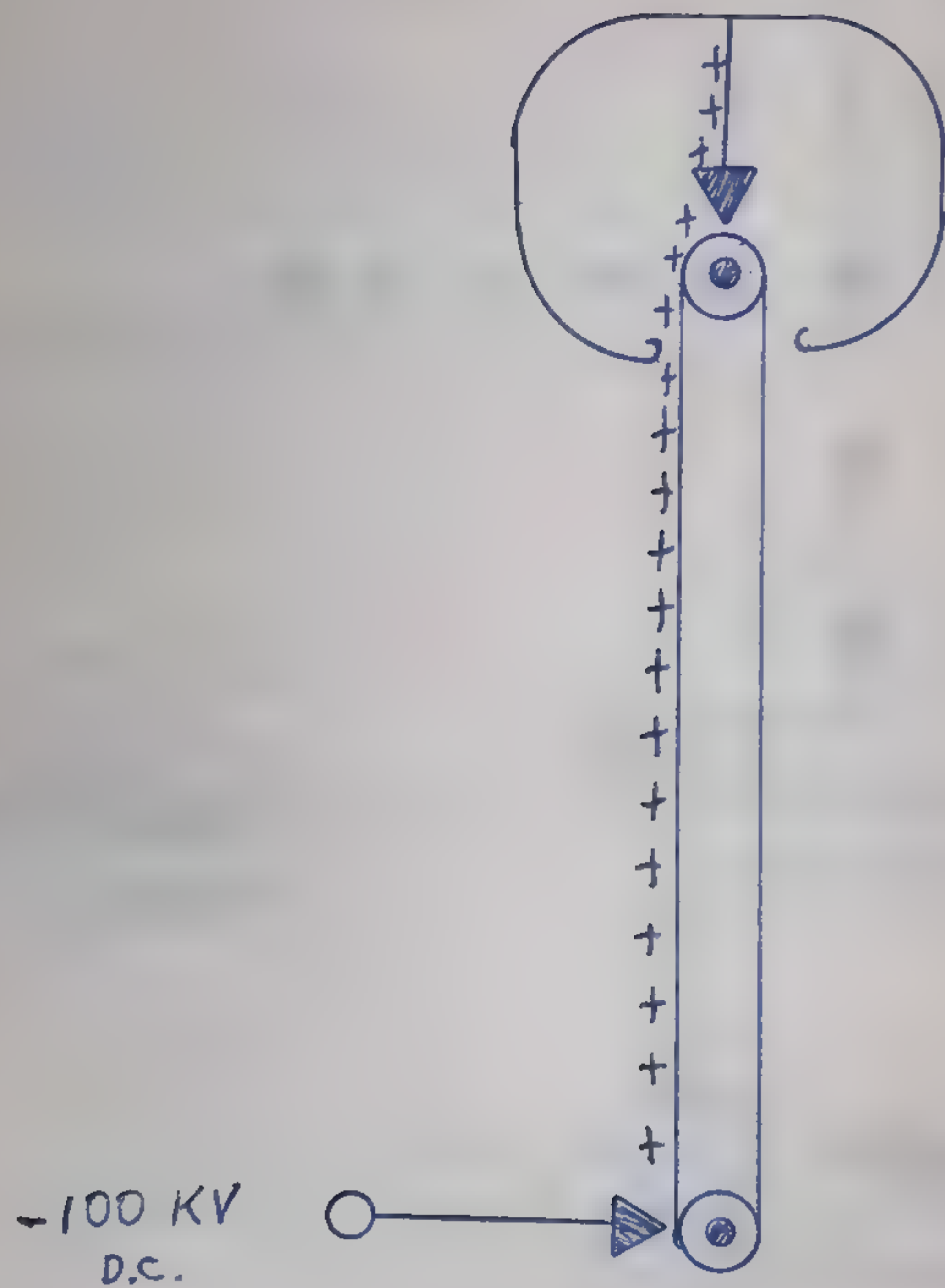


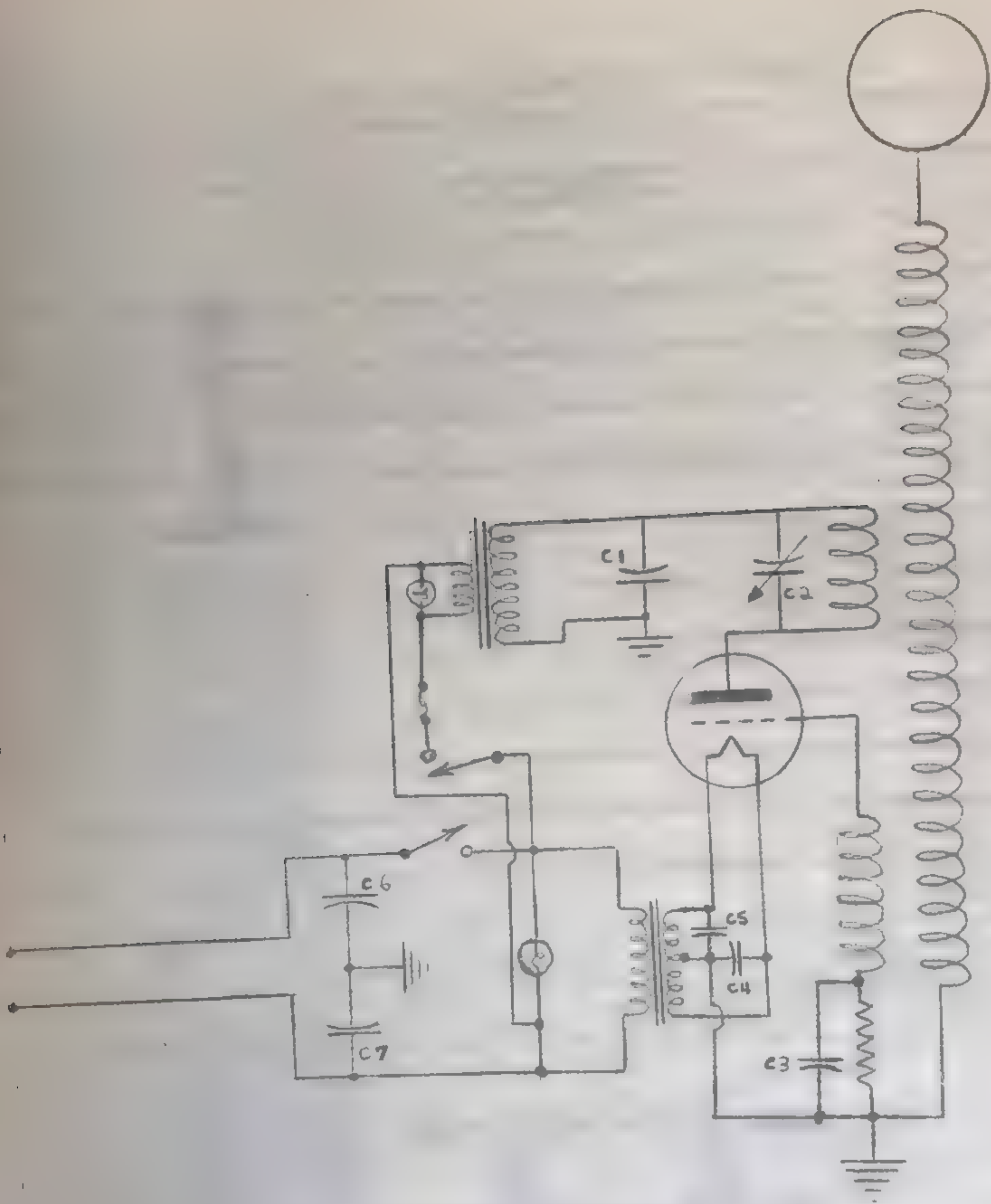
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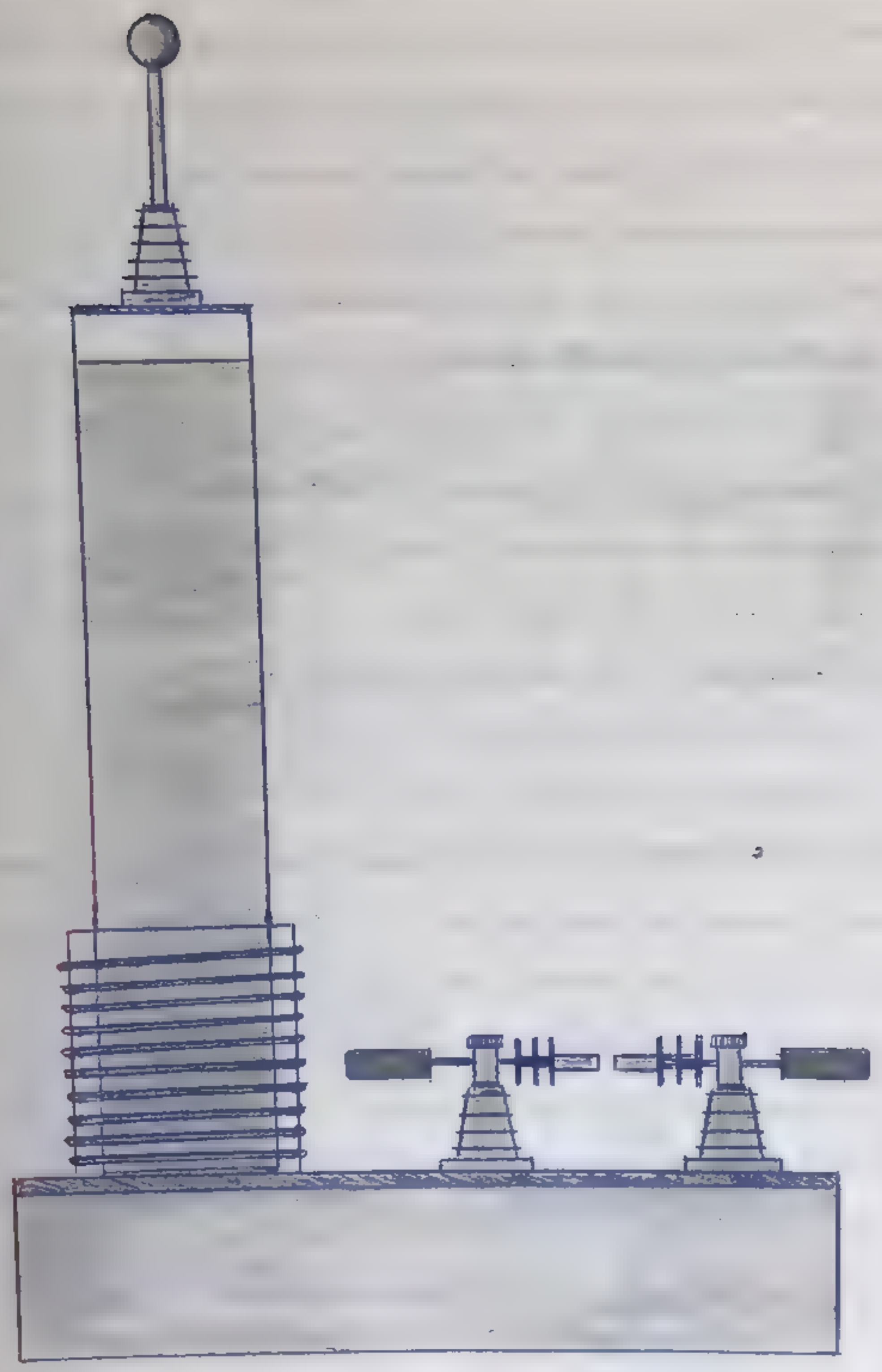




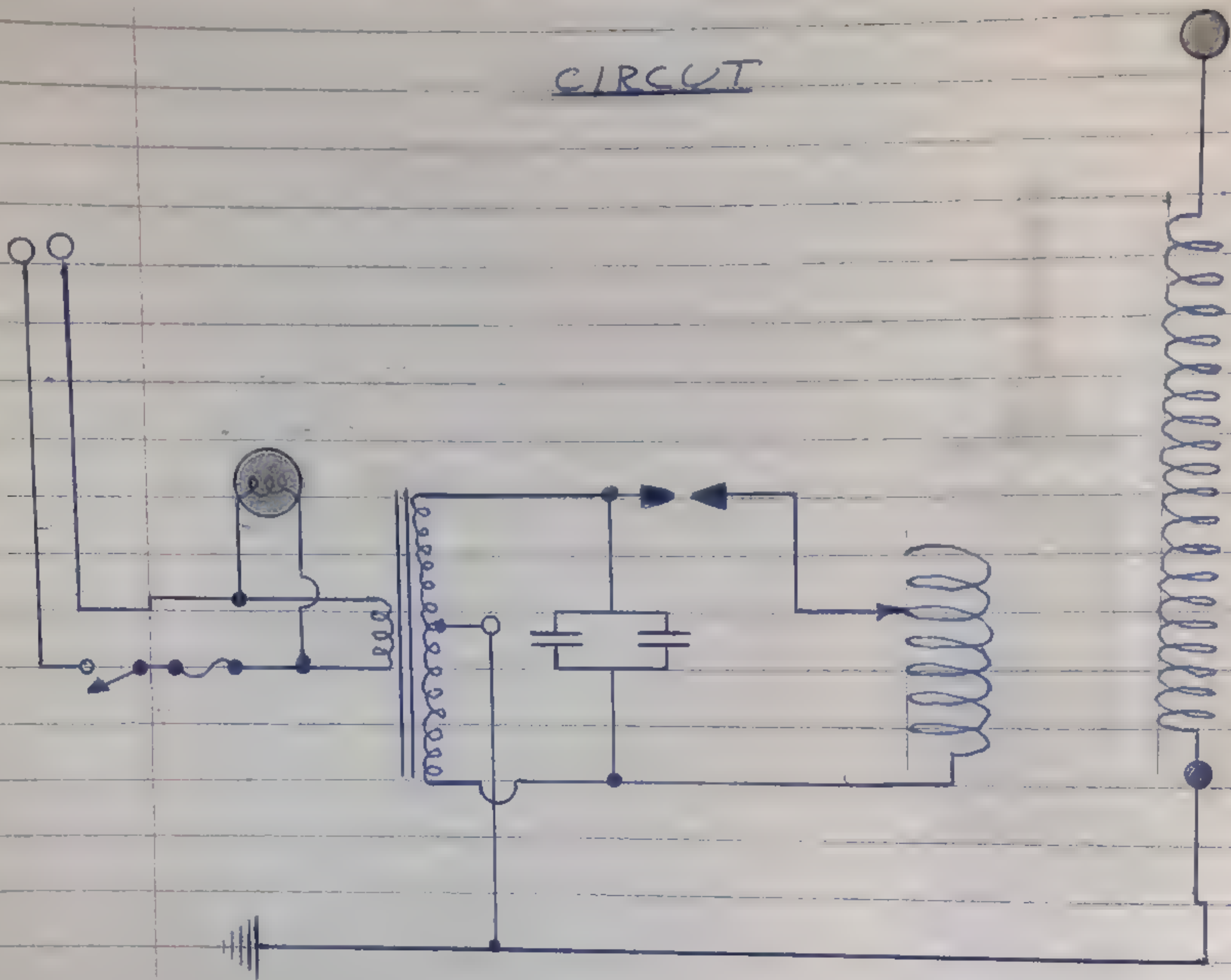
Bill W. Gock
Per. 1
Project # 5

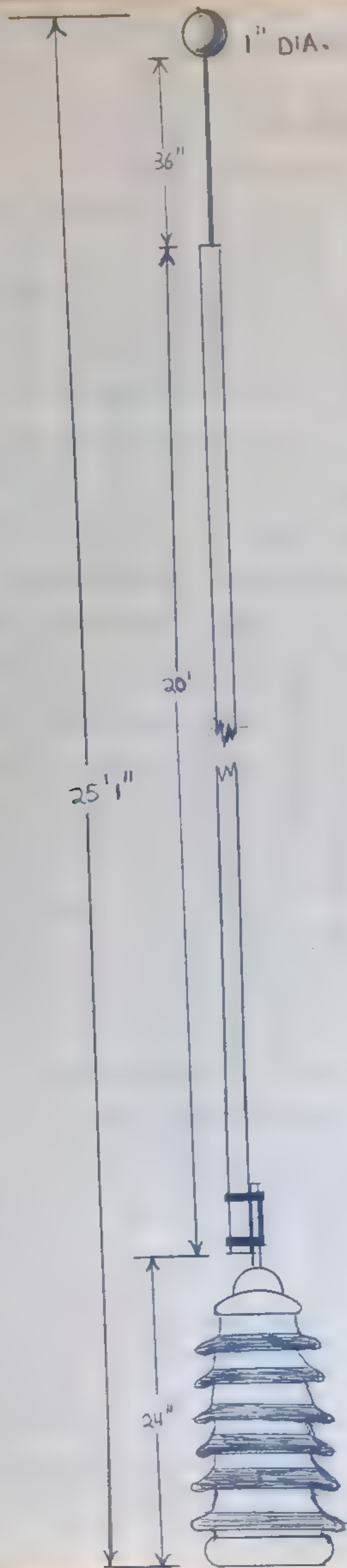
TESLA COIL / INDUCTION FURNACE

PICTORAL

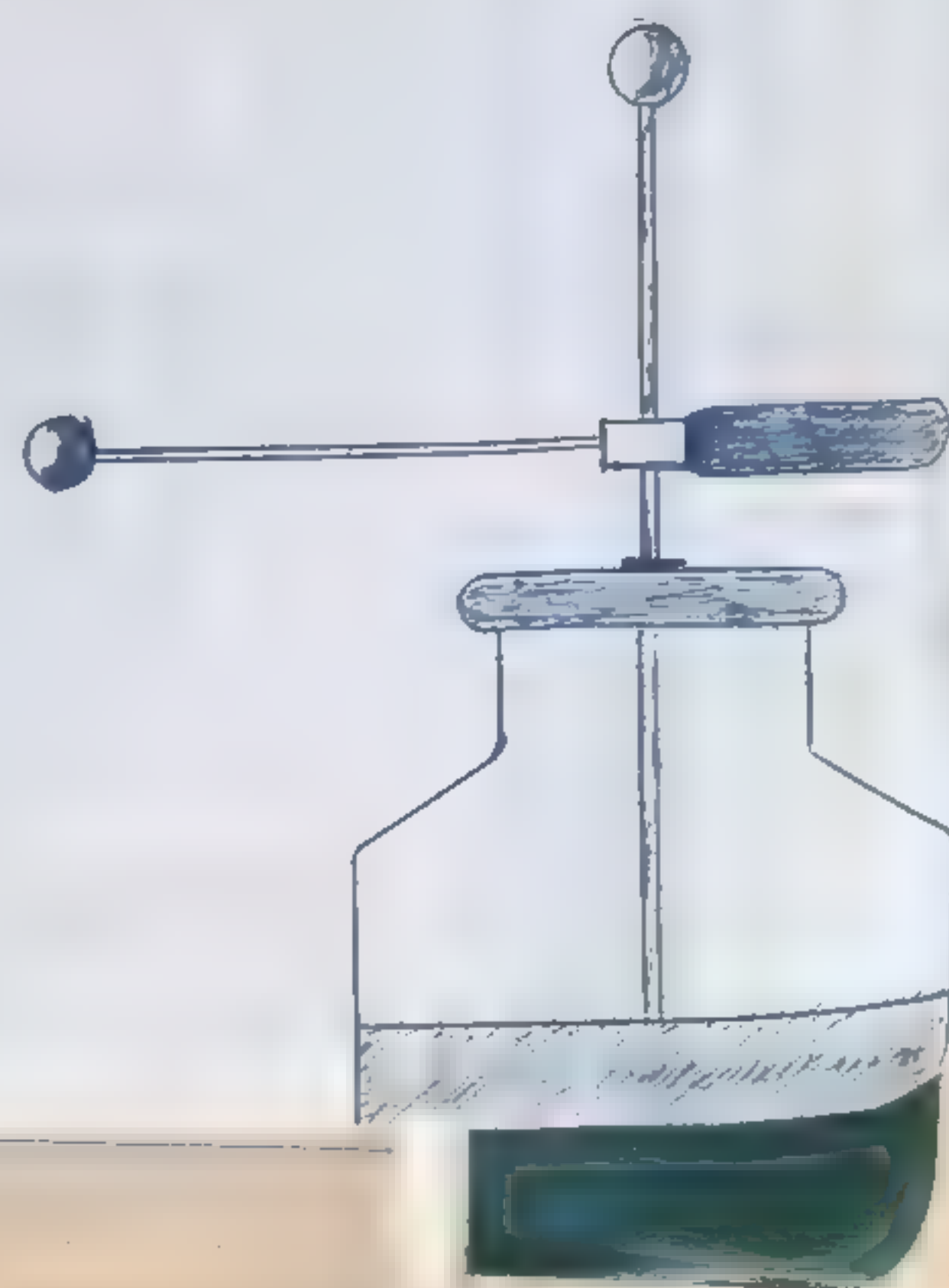


CIRCUIT





LIGHTNING ROD



6-6-65

Dear Bill

Sorry I was so long in answering your letter, and any thing I can do to help you in your experiment I will be glad to do.

This list of material is for the 100 KV unit so therefore the size of the Corona Control Balls would increase with the higher KV. There are no cat. no on these corona balls in my catalog I therefore suggest you contact the Von Corporation for this information.

If I can be of further help contact me, and I would be interested in your progress so good luck and above all be very carefull, because the hi voltage is dangerous -

Sincerely

J. B. Funt

P.S. here is an extra copy of Circuit I had - in case you lose the other
JBF.

8/5/66

Bill Wysock
509 W. Lemon Ave.
Arcadia, Calif. 91006

Prospect Place
Citou Springs, Colorado 80825
August 7, 1967

Dear Mr. Morris and Mr. Lee,

I am very interested in high-voltage engineering and have done much work in the fields of extreme high-potential electrostatic and high frequency phenomena.

I have already purchased your 500,000 volt modle Van de Graaff generator in kit form. I completed it a few years ago. Since then, I have made a few modifications on it, including a D.C. high-voltage source and improved corona brushes which I constructed out of metal hair combs.

I understand that you sell parts for a one megavolt generator. Could you possibly send me any catalogs or literature on this and any other items like it? Inclosed is ten cents which you require for postage. Thank you very much.

Sincerely yours

Bill Wysock

*We do have the 34" oblate
which sells for \$60.00 & can order
the belt. We were forced to
discontinue handling the rest
of the parts since there was
little call for same.
Morris & Lee*

you to look up many old magazine articles and scientific magazines with Tesla material. I would hesitate to take them some of my photostat material, which they might not want to keep for me.

Let me tell you what I could leave for you. My book from the Tesla Museum in Beograd called, Lectures, Articles and Patents, Nikola Tesla, 1856-1943 also a later one called Tributes to Tesla, Tesla-Museum (some of these are in foreign languages but not all). Also Thomas Commerford Martin's book on Tesla. The Tutt Library will have a couple of small books on alternating current by Tesla. etc.

The Tesla marker is located on East Pikes Peak Avenue on the south side, almost at Foot Street. It is a simple one, but nevertheless at least marked. Some day there will be a more elaborate one.

So possible with

be difficult dates for me

seek, I am getting ready for 16th. I rather imagine they

ng that period, but I will know e clear from Ft. Lauderdale an I be too sure of plans.

ok after some farm business alid. I intended to get this plumbing trouble which had to did not have time to get k.

ber since I have another class g out. Do you have any s--- Or would you rather come ne I could spare toward the last of August if possible. ne off who is as interested

y time-- would it help you llege) and have them m sure they would look after

ou could be my house guest

I will place my books at your insist on you studying them be most helpful in assisting

707 Prospect Place
Manitou Springs, Colorado 80825
August 7, 1967

Dear Bill,

I had not realized I had not answered your last letter. So possible with the hectic schedule I have.

Now as to the dates September 1st to 10th. These would be difficult dates for me to see you.

I have taught up until the last two weeks. Just this week, I am getting ready for my daughter and her family to visit me, arriving on the 16th. I rather imagine they will leave about the 28th but that is not certain.

I could certainly be able to see you for some time during that period, but I will know better when they get here how plans work out. They come clear from Ft. Lauderdale and so you can see, I can't ~~ask~~ them not to come, nor can I be too sure of plans.

Then as soon as they leave, I must go to Illinois to look after some farm business there and also to check on an elderly aunt who is an invalid. I intended to get this done two weeks ago when I finished my school but we had plumbing trouble which had to looked into-- a water main broke-- and by that time, I did not have time to get there and back in time for a lecture in Denver this week.

Now I know I am sure to be home by the middle of September since I have another class coming up at that time. But let's try to work something out. Do you have any fall vacation time such as teacher's convention holidays-- Or would you rather come out and take the chance of seeing me perhaps for what time I could spare toward the last of August. I would like to reach Illinois by the last of August if possible. You can see the predicament. I don't like to put any one off who is as interested as you are.

Now, Bill, if the 1st to tenth of September is your only time-- would it help you if I would place my books in Tutt Library (Colorado College) and have them turn them over to you for study if I were not home? I am sure they would look after you for me.

It would be much better if it could be at a time when you could be my house guest and we could discuss all this.

Now if you do decide to come anyway, with me not here, I will place my books at your disposal in Tutt Library, although I am sure they will insist on you studying them there. They also have a Tesla Bibliography, which would be most helpful in assisting you to look up many old magazine articles and scientific magazines with Tesla material. I would hesitate to take them some of my photostat material, which they might not want to keep for me.

Let me tell you what I could leave for you. My book from the Tesla Museum in Beograd called, Lectures, Articles and Patents, Nikola Tesla, 1856-1943 also a later one called Tributes to Tesla, Tesla-Museum (some of these are in foreign languages but not all) . Also Thomas Commerford Martin's book on Tesla. The Tutt Library will have a couple of small books on alternating current by Tesla. etc.

The Tesla marker is located on East Pikes Peak Avenue on the south side, almost at Foot Street. It is a simple one, but nevertheless at least marked. Some day there will be a more elaborate one.

Bill, I will ask the Tesla society to send you a Tesla Bibliography which will help you so much to locate articles written about him. I will also try to get you a copy of Thomas Commerford Martin's book on Tesla.

I am sure the library has O' Neil's book on Tesla, Prodigal Genius. I will leave mine if you haven't seen it. There is a juvenile out which I have, but you are past that. Also there is an occult book on him, but I would not encourage you to read it as it is too, too!

Also if you come, ^{after Sept. 1.} at that time, I can get you a room in a motel for \$4.00 a day with two double beds in it. That would mean \$ 2.00 apiece if you bring your friend. I am sure my beds will be full with my daughter and her family here, August and Sept. part

When I am gone I usually have some one to look after my place but I couldn't ask them to entertain for me.

If you can coincide your visit with my time when I could be home, I would be very happy to invite you to stay with me-- but you can see now it is at the moment.

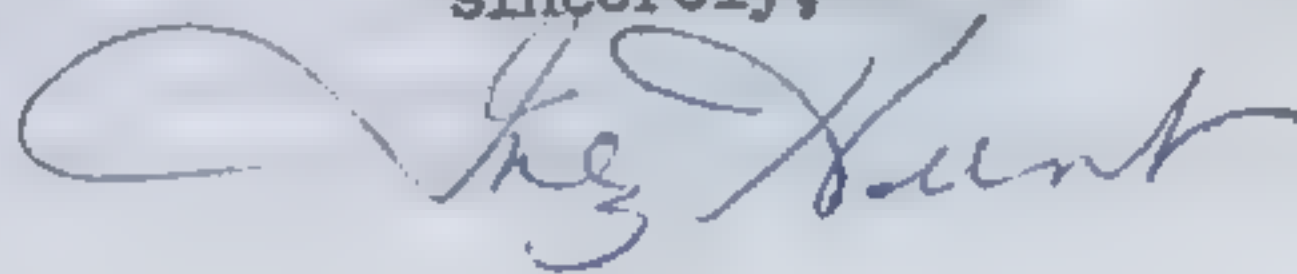
I am just sick to think I have made these plans which are so rigid because, I, too have to be back in time to teach school.

Well, there is all the information I can think of pertaining to your visit.

I am very anxious to meet you. I admire dedication in anyone.

Please let me know what you plan to do. I will help you any way I can, but my time is so limited that I need to know as long in advance as possible. My calendar fills so quickly.

sincerely,



The place where I would get you a room, is owned by a very charming friend of mine. She is wonderful to students. She is making a very special rate. It is not a stylish or an impressive place. In fact I haven't seen the rooms, but I do know student tours who go there each year, just because she is so wonderful to them.

If you do come-- please drive so very carefully. It is a long trip and you would be in labor day traffic. Please realize this. You are a serious minded student. The world can not afford to lose such young men. So don't be careless. I would not want to feel to blame. You may have something very important to give the world before you are through.

If you should need to phone
my number is
(303) 685-9016

707 Prospect Place
Manitou Springs, Colorado
April 25, 1967

Dear Bill Wysock,

Please forgive my neglect. I thought I answered your last letter-- but I may have neglected it. But I can tell you I have talked about you to many people. I am so proud of any young man who has such ability as you must have to be following such a promising path.

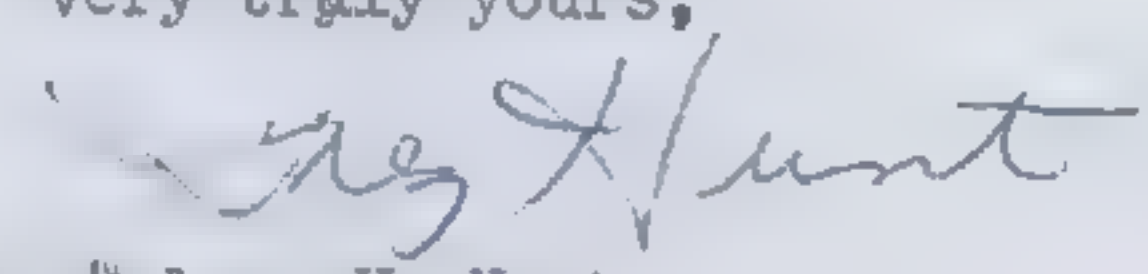
Bill I do have an extensive amount of information. You are welcome to everything I have. But please wait until the middle of May for me to have time to think what I might send you. Would you like pictures? would you like a list of my books and photostats? Would you like a Tesla Bibliography? Would you like to get in touch with the Tesla Society which would send you data on Tesla? Would you like for me to give you information about the interest which Russia had in Tesla? Or anything you can think of I will help as much as I can. Do you know about microfilm letters?

I had a serious operation last summer and am recovered but do tire easily. And I am sure you do not know how busy a life I lead. I am a lecturer-- did ten of them in the past two weeks -- I write a column for a paper-- I teach a class and conduct historical tours for the University of Colorado Extension in Colorado Springs. At the moment I am rushing to get ready to leave tomorrow for Hemet California. I don't think I will go to the coast-- so I doubt if I can see you but if I should go that way I will get in touch with you. This will have to be a very hurried trip since I must be back in Colorado Springs to speak for a convention on May 6. You can see how rushed I am but in clearing my desk for departure in less than 24 hours, I felt I must answer your letter. It was for men such as you that I wrote the book.

I have just finished doing some Tesla research on a carbon button lamp for an oil company in Texas. All of this takes time. Forgive me.

I was so pleased with your poem at the bottom of the page-- for I, too write poetry. I have two published books of it. Tesla wrote poetry, too, you know. Good luck. Had-- and some day I'll meet you.

very truly yours,


Mrs. Nelson V. Hunt

I will be in Hemet for their Ramona festival on April 29.
Possibly at the Coachlight Motel-- or I may be with the historian there
Clarence Swift. Not sure of which place.

707 Prospect Place
Manitou Springs, Colorado
August 10, 1966

Dear Bill Wysock,

I have just received your letter and am always glad to hear from any one interested in Nikola Tesla. Only those who have delved into his story and sensed the magnitude of the genius can understand the sort of kinship that comes about in this common interest.

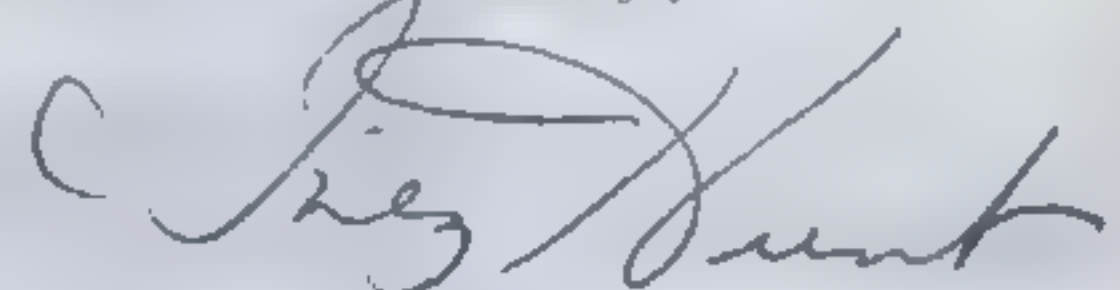
As a Tesla fan, I am convinced that his ideas have never been successfully or sufficiently explored and the world may yet benefit from some of his ideas.

About the book. It was finished a year ago last December. It has had very good reception, considering that so very few people are aware enough of this man to be even curious. The book had an excellent review in the Los Angeles paper a year ago in February. It has also had excellent reviews in electronics magazines and many other publications. In case you should want to see it the title is LIGHTNING IN HIS HAND, THE LIFE STORY OF NIKOLA TESLA. It probably is in the Los Angeles library. I know it is in the New York Public Library. If it is unavailable at a book store you could buy it by contacting the publisher, Alan Swallow, Sage Books-- 2679 South York, Denver, Colorado.

I imagine I have the same books which you have from Yugoslavia. I have one called Lectures Articles and Patents. The most recent one is Tribute to Tesla. I have a very extensive Tesla library and am doing further research.

I do appreciate your interest.

Cordially,



Mrs. Nelson V. Hunt.

Please note change of address. 707 Prospect Place
Manitou Springs, Colorado

The book is almost ready for a second edition.

707 Prospect Place
Manitou Springs, colorado 80829
August 30, 1971

Dear Bill Wysock,

Going through my desk I came to your letter-- unanswered.

I am sure you do not know how much I have to do. Please forgive me when I do not get the correspondence taken care of. I need a secretary.

To explain-- I have an assignment of 8 books to do all of which have to be researched. I operate a full time lecture business which does sometimes 50 lectures in a year. I have a new book coming out next month. I am on the board for the Library.

Teach 3 or four classes for the University each year. Did a series of classes for the summer school this summer. That is a brief view of my life.

I had hoped to see you this summer. What happened? Of course I am often out of town on lectures. Did you get married? So many questions.

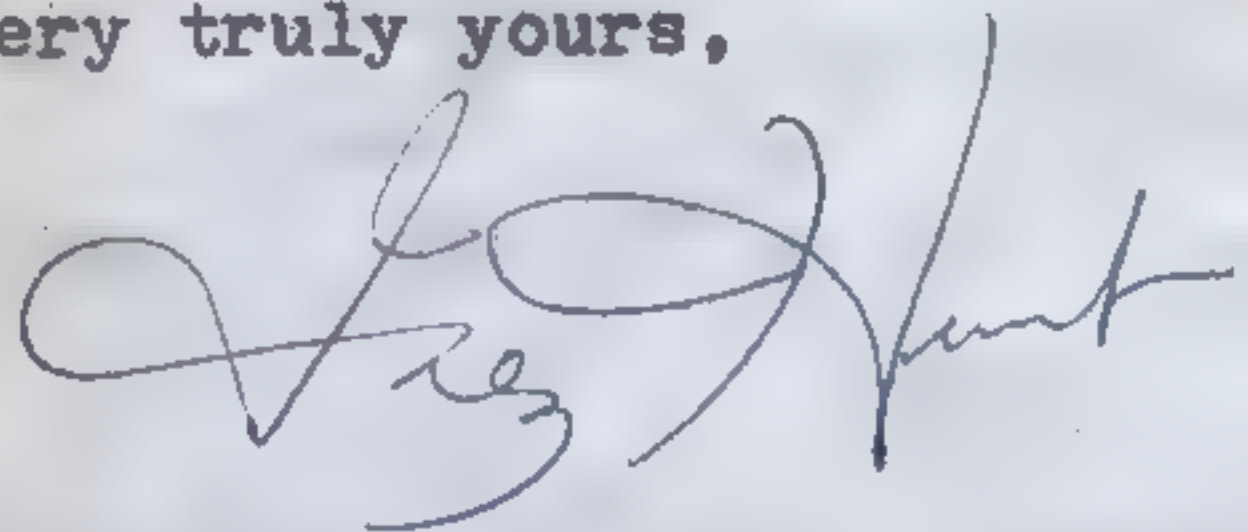
I have had a number of summer guests also. But I am sorry to have missed you.

Please do forgive me for my slow correspondence. I just can't get it done particularly when each book brings new correspondents.

I must rush and get dinner for my husband.

Just wanted you to know, I am so interested in what you are doing, although I seem so negligent.

Very truly yours,



So hurried - forgive typing -

UNIVERSAL SCIENTIFIC COMPANY, INC.

1312 S. Thirteenth Street

Vincennes, Indiana

Phone TU 2-2970

Q U O T A T I O N

TO

Mr. Bill Wysock
500 West Lemon Avenue
Arcadia, California

QUOTATION NO. 253

ATTN.

DATE January 14, 1963

Reference Your Inquiry No. Letter Dated 1/8/63 we are pleased to quote as follows:

ITEM NO.	QUAN- TITY	CATALOG NO.	DESCRIPTION	UNIT	PRICE	AMOUNT
1.	1	608	Manual - Tesla Coil Demonstrations Blevins - Plus Postage Charges -	Ea.	\$ 2.00	\$2.00

Our Representative In Your Area Is:

F. O. B. : Vincennes

TERMS : 1/2%, 10 days, net 30

SHIPMENT 10 days after receipt
of order.

UNIVERSAL SCIENTIFIC COMPANY, INC.

BY Howard O. Meuche

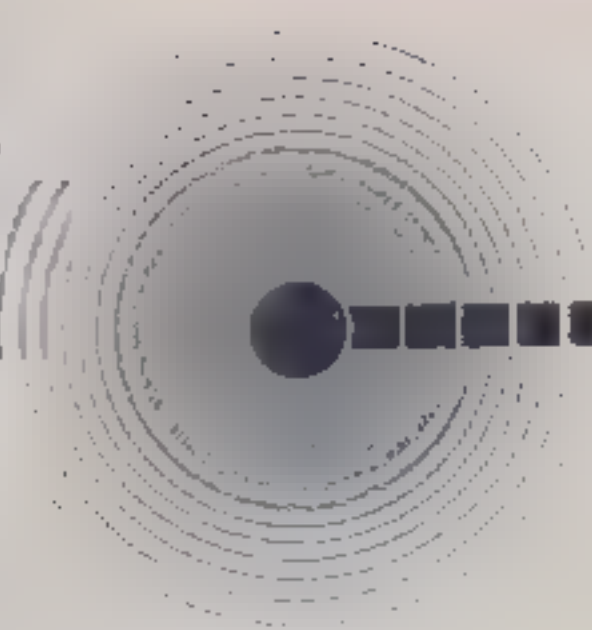
Howard O. Meuche, General Manager

This Quotation Is Subject To The Further Conditions Contained On Reverse Side Hereof.

CONDITIONS

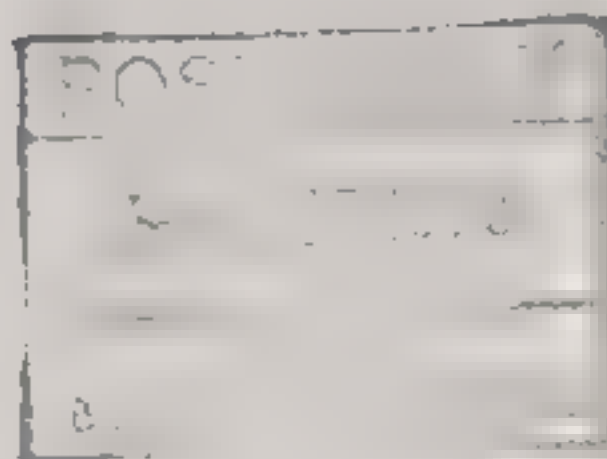
1. All agreements including shipping promises, are contingent upon strikes, fire, accidents, or other causes beyond our control.
2. If quotation is rendered to any buyer located in a state where the seller is required to pay a sales, use or occupation tax, or if the United States Government adopts a general sales tax, then any such tax will be added to the price quoted above, and rendered as a part of the invoiced price.
3. This quotation may be withdrawn and is subject to change without notice after 60 days from date of quotation.
4. Any shipping promise offered herein, or subsequently offered, is contingent on demands for materials requiring preferential services by reason of any United States Government National Program.
5. Any transportation charges included in this quotation are based on existing freight rates and therefore, are subject to revision in the event of any change in rates.
6. This quotation is made subject to the standard Government termination clause, or equivalent protection, if an order resulting from this quotation is terminated or curtailed for the convenience of the Government.
7. Orders once placed into production are not subject to change or cancellation.

Professional
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4914 BALDWIN AVE. • TEMPLE CITY • CA 91780 • (213) 442-2120

Oct.1, 1975
Butterworths Publications LTD.
88 Kingsway, W.C. 2, London, England



Dear Sirs:

I am interested in a book published by you in 1954. It is titled,
HIGH VOLTAGE LABORATORY TECHNIQUE, by J.D. Craggs and J.M. Meek. I do not know if
you have printed any more recent editions since 1954, but I am very interested in
obtaining a copy of this book. I would also be seriously interested in any other
publications you may have on the above mentioned subject material, and related subject
material.

If you would be so kind as to send me a quote I will immediatly send in my order
in the form of a cashier's check. Thankyou for your co-operation.

Sincerely yours,

Bill Wysock

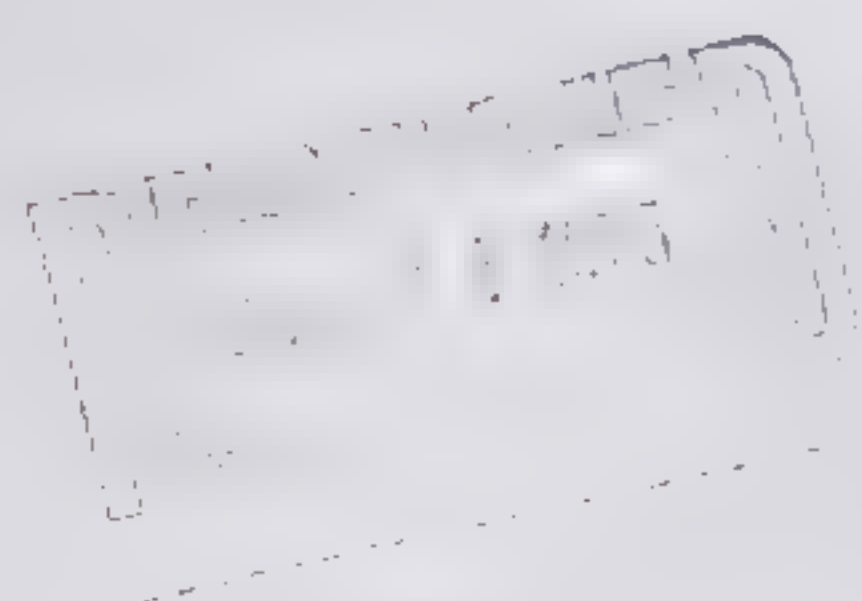
Bill Wysock

Please pardon the inconvenience
but to speed our reply we
have answered on your own
correspondence.

BUTTERWORTHS

161 AVE. 8
READING, ENGL. RG1 01667

*This book is out of print
We have no stock*



PSS.....t



HIGH VOLTAGE
TEST EQUIPMENT

Peschel Instruments Inc.

CAPE CORAL INDUSTRIAL PARK, CLUB DRIVE, BOX 847
CAPE CORAL, FLORIDA 33904 TEL: 813-LI 2-3164

December 5, 1968

Mr. Bill Wysock
509 W. Lemon Avenue
Arcadia, California 91006

Dear Mr. Wysock:

Thank you for your inquiry on High Voltage Test Equipment. We are indeed pleased to enclose our catalog and recent supplemental literature on our expanding line. Prices indicated are current and fully competitive, but the units listed are not all inclusive. We can build modified or custom units to your exact requirements.

If you have any questions, require application advice or desire a quote please call direct or write us your full requirements.

Very truly yours,

PESCHEL INSTRUMENTS Inc.

Frederick Peschel
Frederick Peschel, President

FP/lh

P. S. If you wish to be placed on our mailing list to obtain new literature, as released, please return this letter with any necessary corrections to your address.

TELEPHONE
AREA CODE 914
279-8091

P. O. DRAWER A
BREWSTER, N. Y. 10509

HIPOTRONICS

INC
BREWSTER NEW YORK

"High Potential Electronics"

December 11, 1968

509 W. Lemon Avenue
Arcadia, California 91006

Attention: Mr. Bill Wysock

Dear Mr. Wysock,

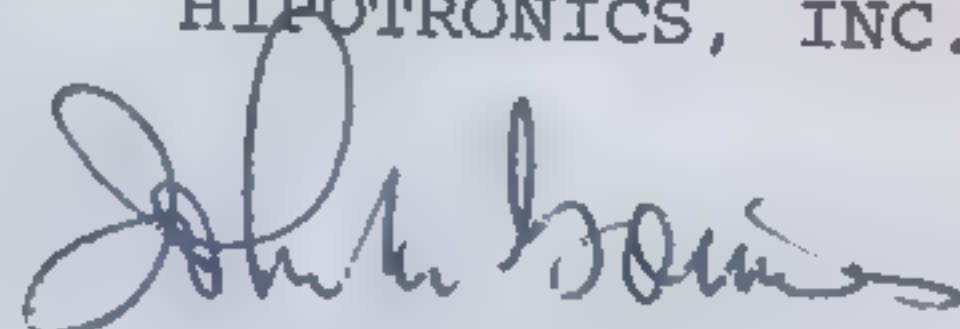
We do make several types of electrodes, high voltage switches and associated high voltage hardware, but this is only incidental to our main business, which is high voltage test equipment and power supplies. Most of this hardware is incorporated into testing facilities we design and construct for our high voltage test equipment customers.

Enclosed you will find a catalog listing most of the equipment we offer for sale.

We hope this information has been helpful.

Sincerely yours,

HIPOTRONICS, INC.



John M. Gaines
Marketing Manager

JMG/lp
Enclosure

18 MAY, 1976

DEAR NICK:

MY INTEREST IN DR. TESLA BEGAN IN HIGH SCHOOL WHEN I WROTE A TERM PAPER ON THE MAN. BEFORE THAT TIME, I HAD WASTED MANY HOURS BUILDING TESLA COILS ONLY TO HAVE ONE WORK AS DISAPPOINTINGLY POOR AS THE OTHERS. AFTER THE SERVICE, A TECHNICAL COLLEGE, A 4-YEAR COLLEGE, AND ~~AT~~ A TIME AT MY PRESENT JOB AS A QUALITY CONTROL ENGINEER, I MET A MAGICIAN WHO ASKED ME IF I WOULD DESIGN A LARGE TESLA COIL FOR HIS ACT. SOME QUICK EXPERIMENTATION SOON REAFFIRMED OLD DISAPPOINTMENTS, AND AFTER SOME DIDDLING, I SOON FOUND THE ONLY WAY TO ATTACK THE PROBLEM WAS SYSTEMATICALLY, AND ~~BY~~ ARMED WITH SOME OF TESLA'S WORK.

THIS INFORMATION, HOWEVER, WAS SCARCE AND OFTEN INACCURATE. FINALLY, I READ T.C. MARTIN'S BOOK IN THE VAULT OF A LARGE LIBRARY. SHORTLY THEREAFTER, I BEGAN A SET OF EXPERIMENTS TO SOLVE THIS PROBLEM BECAUSE THERE WAS NO DATA TO BE HAD. THE INFORMATION I PRESENT TO YOU, THEREFORE, REPRESENTS THE ANSWERS I SOUGHT FOR MANY YEARS BUT, TO MY HONEST BELIEF, HAVE NOT BEEN PUBLISHED BY ANYBODY. IF I HAD HAD THIS INFORMATION AS A YOUNG MAN, I COULD HAVE BUILT GOOD COILS IMMEDIATELY. (BREIT, TUVET & DAHL, 1930; COIL WAS TOO BIG FOR HOME EXP.)

AFTER ALL THE WORK, I DECIDED TO FINANCE ~~THE~~ A VERY LARGE COIL FOR THE STUDY OF FIREBALLS BY SELLING COPIES OF MY STUDY IN TESLA COIL DESIGN. IT WAS ADVERTISED IN POPULAR SCIENCE, MAY, 1976 pg 181. THE RESULTS WERE POOR. SHORTLY AFTER THIS, I WROTE TO YOU, PURCHASED YOUR BOOK, WHICH IS ONE OF MY MOST PRIZED POSSESSIONS, AND DISCOVERED MR. GOLKA HAD BETTER EQUIPMENT THAN I IMAGINED WOULD EVER ^{HAVE} BEEN BUILT SINCE 1899. IF ANYONE IS GOING TO CRACK THIS FIREBALL THING, IT WILL PROBABLY BE HIM.

THANK YOU FOR YOUR INFORMATION. I INTEND TO TALK TO AS MANY PEOPLE IN COLORADO THIS SUMMER AS I CAN FIND.

I HAVE SEEN FIREBALLS AND BEAD LIGHTNING (BECAUSE I LOOKED FOR IT) AND FIND THERE ARE MORE AND MORE EDUCATED PEOPLE WHO HAVE OPENED THEIR MINDS TO THE EXISTANCE OF THESE THINGS. WITH MY INFORMATION, I MAY BE ABLE TO CONTACT A FEW MORE EXPERIMENTERS WHO ARE CURIOUS ABOUT NON-TEXTBOOK PHENOMENA.

VANDUS HAS RAISED THE PRICE OF ITS BOOKS FROM \$25.00 TO \$60.00 SO I WILL TRY TO SEE A COPY OF IT BEFORE ORDERING TO ASCERTAIN ADDITIONAL ^{BEYOND T.C. MARTIN.} INFORMATION. AGAIN, THANK YOU FOR YOUR EXPERT HELP. IT IS MY SINCERE HOPE THAT THROUGH YOU, MY LITTLE CONTRIBUTION MAY HELP SOME EXPERIMENTER BUILD THE COIL HE WANTS. PLEASE CONTACT ME IF I CAN BE OF HELP.

Sincerely,

Thomas W. Lee

WHAT IS THE NAME OF THE REPORT BY DR. JIM TUCK OF LOS ALAMOS?

PARAMETERS OF COILS CONSTRUCTED

	DESIGN 1	DESIGN 2	DESIGN 3	DESIGN 4	DESIGN 5
DIAMETER OF PRIMARY, INCHES	2.5	5	9		
LENGTH OF PRIMARY, INCHES	1.5	2	5		
TURNS PRIMARY	6	6	5		
GUAGE WIRE PRIMARY, AWG	16	14	3/7" Cu		
PRIMARY INDUCTANCE, MICROHENRIES	2.	8	5.6		
PRIMARY RESONATING CAPACITOR, μF	0.007	0.022	0.037		
PRIMARY AND CAPACITOR RESONANT FREQUENCY, KHZ	1400	480	360		
1					
DIAMETER OF SECONDARY, INCHES	1	2	3		
LENGTH OF SECONDARY WINDING, INCHES	10	12	18		
TURNS SECONDARY	1430	1900	1300		
GUAGE WIRE SECONDARY, AWG	34	35	28		
SECONDARY WIRE LENGTH, FEET	375	1000	1000		
SECONDARY D.C. RESISTANCE, OHMS	100	340	146		
SECONDARY INDUCTANCE, MH	5.1	25.7	17.7		
SECONDARY NATURAL FREQUENCY, KHZ	1400	500	500		
SECONDARY MAXIMUM Q @ 500 KHZ	160	237	840		
SECONDARY AND SPHERE RESONANT FREQ., KHZ	1500	430	520		
SPHERE TERMINAL DIAMETER, INCHES	1.7	4	6		
SPHERE CAPACITANCE, μF	2.4	5.7	8.5		
TRANSFORMER SECONDARY VOLTAGE, VOLTS	4000	2500	1800		
TRANSFORMER SECONDARY CURRENT, MA	18	30	60		
TRANSFORMER SECONDARY D.C. RESISTANCE, OHMS	18K	15K	—		
TRANSFORMER NAMEPLATE RATING, KVA	0.09	0.225	0.360		
SECONDARY COIL FORM MATERIAL	PLEXIGLAS TUBING				
SECONDARY INSULATING MEDIUM	COLORLESS MINERAL OIL				
MAXIMUM DISCHARGE LENGTH, SPHERE TO POINT, IN.	4	8	18		
MAXIMUM RECTIFIED (1/2 WAVE) OUTPUT, KILOWATTS	55	—	—		
HEIGHT OF SECONDARY COLUMN, INCHES	12	12	24		
OUTSIDE DIAMETER SECONDARY COLUMN, INCHES	2	3	5		

1 Sept. 1976

Mr. Thomas W. Lee
9 East Maple Street
Marcellus, N.Y. 13108

Dear Mr. Lee:

I have your letter of 18 May, 1976 describing your research and accomplishments in building various Tesla high potential-high frequency resonators, written to Mr. Nick Basura of 3414 Alice Street, Los Angeles, California.

Nick passed your letter along to me as I am engaged in exhaustive research and construction of well built oscillators ranging in size from 25 kv to 5,000 kv output potential. My goal in mind, (as for the largest coils) is an attempt to create a favorable atmosphere for producing artificially ball lightning.

My efforts in this area are along side of those being conducted by Mr. Golka of Wendover Utah, whom I just finished spending nearly a week's time with, at his Wendover Air Force Base location. It is my belief that a common mode missing link for a more complete scientific understanding of BL may involve a certain type of F.R. cavity characterized by agil mobility of location and unique other conditions involved.

I have been a deciple of Nikola Tesla and his experiments for over fourteen years. Nick informs me that you have a book, EBERNARTS HIGH FREQUENCY MANUAL, circa 1911 for sale. I would like to purchase this book from you, as well as any other material relating to Tesla or other areas of high voltage, such as Van de Graeff generators etc. The former reminds me of a company known as Morris and Lee. By any chance are you of the same? If so, what is the company doing nowadays? Also, The Lee Engineering Company was responsible for successfully reprinting Thomas Crowford Martin's book on Tesla. Any conection here?

Your May 18 letter made mention that you had published a book on Tesla coil design. Is ther any chance of my obtaining a copy of this book from you? Are you taking any part on the documentary film being made on Tesla. I hope to be of some use in that direction also. I am anxious for your reply. Untill next time I am,

Sincerely yours

William C. Wysock

14 Sept 1976

DEAR BILL:

I AM PLEASED TO HEAR YOU HAVE WITNESSED MR. GOUKA'S EXPERIMENTS.

EBERHART'S MANUAL DOES NOT INCLUDE MATERIAL WHICH IS OF INTEREST TO YOU. IT IS A PHYSICIAN'S MANUAL FOR DIATHERMY USING TESLA COILS. THE REASON I WROTE THE INSTRUCTIONS FOR BUILDING A TESLA COIL IS THAT ANY DATA THAT EXISTS ON TESLA COIL DESIGN (BREIT, TUBE AND DAHL, JAN 1, 1930 PHYSICAL REVIEW, VOL 35, A LABORATORY METHOD OF PRODUCING HIGH POTENTIALS), IS INCOMPLETE. ALTHOUGH OBSCURE PAPERS WERE WRITTEN ON TESLA COIL DESIGN IN THE SAME PERIOD WHEN THE HIGH VOLTAGES PRODUCED ~~AND~~ PROMISED TO HELP SMASH THE ATOM, THESE REFERENCES ARE DIFFICULT TO INTERPRET AND APPLY. THE ONLY REFERENCE CONTAINING ANY DETAILS IS T. C. MARTIN'S WHICH I'M SURE YOU HAVE READ. MR. GOUKA HAS CERTAINLY LEARNED MORE THAN ANY OTHER PERSON IN THE U.S. BY READING THE NOTES IN THE TESLA MUSEUM.

SINCE I COULD NOT AFFORD AN OCEAN VOYAGE, I CHOSE TO REPEAT TESLA'S FIRST EXPERIMENTS. BASICALLY, DR. TESLA BECAME VERY DISGUSTED WITH ENTREPRENEURS STEALING HIS IDEAS AND DELIBERATELY TRIED TO MISLEAD PEOPLE IN LATER YEARS. HE WAS AN EXCEEDINGLY INTELLIGENT MAN. MY PLANS ARE PERFORMANCE CURVES, DESIGN CURVES, AND GENERAL GUIDELINES FOR BUILDING A TESLA COIL OF REASONABLE SIZE THAT REALLY WORKS, AS ADVERTISED IN POPSCI MAY 1976. \$3.00 BASICALLY, I FOUND ALL THE MAGAZINE PLANS WERE LITTLE MAGIC THINGS THAT SOMEONE TINKERED WITH UNTIL THEY WORKED. MY FINDINGS WERE THE STANDARD SPARK-GAP COIL WITH AN OIL-FILLED MICA CAP AND OIL-FILLED SECONDARY COLUMN. THIS MAKES A TREMENDOUS DIFFERENCE IN THE PERFORMANCE REGARDLESS OF WHAT ANYONE SAYS.

ADDIO PYRANOL[®] INERTEEN[®] OR DIAZLA[®] BECAUSE THEY ARE
PLB. USE MINERAL OIL OR MOTOR OIL; HOWEVER, IF A BIG SPARK CRACKS
THE OIL, YOU MAY HAVE AN EXPLOSION

IN POP SCI YOU HAVE NOTICED INFORMATION UNLIMITED
LISTS. A GIANT TESLA. NICK SENT ME THEIR CATALOG AND I
ORDERED THE PLANS. IT IS SUPPOSED TO BE GOOD FOR A
MEGAVOLT OR SO BUT IT USES A PAPER CAP. THIS MEANS
IT HAS A LOW Q, IS ESSENTIALLY A LOOSELY COUPLED
IMPULSE TRANSFORMER, AND WILL PROBABLY KILL YOU. THERE
ARE LOTS OF THESE COILS AROUND. EXCEPT GE.

I AM IN NO WAY CONNECTED WITH ANY COMPANIES. I
FOUND LEE ENG. IN THE THOMAS REGISTER, CALLED THEM,
AND THEY TOLD ME NICK'S ADDRESS SO I COULD GET THAT
COPIED COPY OF T.C. MARTIN. IN LIBRARIES, THEY STAND
THERE WHILE YOU READ IT! IF YOU CAN READ IT! I AM
VERY GRATEFUL TO NICK.

FIREBALLS ARE COMMONER THAN WE SUPPOSE AND I'VE
SEEN SOME, BUT IT REQUIRES LUCK AND PERSEVERENCE.
I BELIEVE LONG CONDUCTORS AND, LIKE YOU, HIDDEN GEOLOGICAL
RESONATORS ARE IMPORTANT; BUT HOW IN HELL DID TESLA
KNOW THAT? HE DIDN'T CARE THE LAND IN COLD SPRINGS.
HOWEVER, I DON'T THINK HE LIED. AT THE TIME HE WROTE
THE JUNE, 1980 CENTURY MAG. ARTICLE, HE STILL HELD
HUMANITY IN GOOD REGARD.

SOME GUY IS GOING TO CRACK THIS LIKE THE KLEIN-
FOGELMANN AIRCRAFT WING. I AM AFRAID OUR EDUCATIONS MAY
HAVE CHANNLED OUR THINKING IN SOCIALLY ACCEPTABLE
DIRECTIONS, LIMITING OUR ABILITY TO DEAL WITH ABSTRACT
PHENOMENA THAT ARE OUT OF COMMON EXPERIENCE AND,
CONSEQUENTLY, OUT OF PHYSICISTS EQUATIONS AND ENGINEER'S
DESIGNS (I AM ONE). REMEMBER WHAT HAPPENED TO THE
STELLATOR AFTER WE SAW A TOKAMAK.

I HAVE BREATHED MY SHARE OF OZONE AND MY
CHANCES OF DOING ANY MORE WORK ARE SLIM. I HOPE YOU
SUCCEED, AND WOULD BE INTERESTED IN ANY BREAKTHROUGHS
YOU OR MR. GOLKA MAKE.

315-673-3226

Sincerely,
Thomas W. Lee 315-456-3737

TESLA COIL DESIGN AND CONSTRUCTION

(READ these instructions completely before attempting construction)

1. Visit the largest surplus store in your area, and purchase a mica transmitting capacitor having a capacitance in the range from 0.005uf(5,000pf) to 0.03uf (30,000pf) or a combination of smaller capacitors that will equal a value in this range when connected in series, series-parallel, or parallel. (See Drawings 1 and 2).

The voltage rating of the capacitor or combination should be at least 5,000 volts, but 10,000 volts is a safer value with most high voltage transformers available. Large transmitting capacitors may be rated for as much as 25,000 volts, which permits a large safety factor during normal operation, but use of these capacitors at full rated voltage is dangerous, requires a physically large apparatus, and forces the operator to have to find a method of quieting a large and energetic spark gap. Exhibition coils are an exception to this rule.

Take a small pocket ohmmeter with you when you purchase the capacitor. Any deflection on the highest scale when the meter is reading resistance and is connected across the capacitor means the capacitor may have a short. Be sure to allow the meter a few seconds to charge the capacitor through the internal resistance.

Inspect the capacitor carefully. If it is a phenolic encased unit, remove the bottom cover by pulling out four drive pins. If it is a ceramic-cased type, remove the cast aluminum top cover carefully. The insulation may be an alumina-filled tar, wax, epoxy, or sulfur. Inspect the insulation carefully for any signs of moisture. If moisture is found, bake the unit at a low temperature in an oven for a few hours. Reassemble the unit, filling with paraffin.

Nikola Tesla used oil-filled mica capacitors in his Colorado laboratory in 1899 and it represents the highest possible quality today, despite scientific advances. When stressing the capacitor in a Tesla Coil, deterioration gradually erodes the mica dielectric and a short eventually develops at the margin of the plates. To prevent this from happening, remove the mica stack from the capacitor housing and mount it in an oil-filled enclosure. With proper insulators for feeding the wires through the top, a glass jar works fine. This technique has the added advantage of showing any high resistance shorts as a string of bubbles emerging from the trouble spot in the stack. If these bubbles are seen, you may either replace the stack or remove the bad mica sheet. Care must be exercised when handling these stacks as the conductors are lead or tin foil and due to its softness, it will tear very easily and ruin the capacitor. When removing the old insulation from the capacitor, use a soft brush and plenty of patience. Acetone, gasoline, or mineral spirits will dissolve tar.

3.
Although removing the capacitor from its case, dissolving the encapsulant, and placing in a mineral oil bath represents a considerable amount of work as opposed to filling with paraffin in the original case, the oil-filled capacitor will last long enough to become an antique.

Do not attempt to substitute capacitors using paper, mica-paper, reconstituted mica, barium titanate (ceramic disc and "Doorknob"), polycarbonate, polyvinyl, or glass plate as their dissipation factors are too high and performance of the coil will be nonexistent or disappointing. Glass-cased, oil-filled polyethylene capacitors, relatively new items found in some surplus equipment of post-WW II origin, seem to work satisfactorily, but their long-term performance is questionable. Typical manufacturers of mica transmitting capacitors are Sangamo, Cornell-Dubilier, and Aerovox. Drawings of typical units are provided.

2. Examine Chart 3 and determine the approximate dimension of the secondary you wish to build. Also examine the drawing on the reverse side, paying special attention to the fact that the outside diameter of the outer shell is about one inch greater than that of the inside shell. Acrylic tubing costs become large above about 6" outside diameter. From the line corresponding to your choice, and the left-hand margin, read the AWG wire size choices available and select a size that is convenient to wind on a homemade jig. In general, the smaller the wire, the greater the output voltage. AWG 34 seems to be a reasonable choice unless you wish to use low frequencies for specific reasons. Find the intersection of the line corresponding to the size secondary you chose and the wire number and read the footage required from the bottom margin of the chart. Convert this footage to weight and purchase this amount of heavy formvar. Other insulation will work with some degradation in performance. Formvar is a yellowish color, enamel is a violet-brown. Double cotton, used by Dr. Tesla in his early coils is satisfactory, but the secondary will be much longer for a given wire size than anticipated.

Wind the secondary carefully, being careful to avoid overlapping turns or leaving large gaps between them. There is no substitute for a homemade jig in this operation, as reversing direction after an inevitable overlap is much easier than with a power tool. Lubricate both your hands and the secondary form lightly with petroleum jelly. This adds dielectric strength to the wire, keeps salt from the sweat from your palms from attacking the wire and insulation, prevents cuts and burns on your hands from the wire, and will keep the whole winding in place should you break the wire or release tension to remove a kink. Breaks are of no consequence if spliced neatly, soldered securely, and placed on the secondary with a 0.010" to 0.050" gap in the winding on either side to prevent arcing. Tensioning is largely perfected by practice. Experiment with the wire to find the point where it will begin to stretch and keep your winding tension well below there.

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3. Obtain all components as shown in drawing four in correct proportion for the size Tesla secondary you wind. Fasten the base positioner securely to the base plate such that the secondary will be centered. In a similar fashion, fasten the top cover and positioner together and drill the combination for a screw long enough to make a convenient high voltage terminal. Due to the fact that a properly operating secondary of this type should produce a voltage that will strike the length of the winding, you may wish to make the outer shell a few inches longer than the actual secondary. To avoid problems, a ring of acrylic should be used to position the secondary.

Drill and tap the secondary and outer shell bottoms for #4-40 or #6-32 screws, such that they lie at the same vertical distance above the bottom plate. Coat the backside and last few threads of a long #4 screw with acrylic resin and screw into the outer shell. Use the remaining resin to seal the outer shell to the baseplate securely. Leak check the assembly carefully using water with food coloring added as an indicator.

Trim the #4 screw forming the bottom terminal of the secondary winding very gradually with a flat file until the secondary, when inserted inside the outer shell, causes the bottom secondary screw to contact the head of the ground screw tightly. This connection is very important, as it is the common ground for the Tesla coil. This arrangement assures the removal of the secondary if desired. If difficulty is encountered with the bottom secondary terminal, a small but stiff spring may be substituted with excellent results.

Fill the assembly with colorless mineral oil obtainable from any drug store. Let the oil-filled assembly outgas for several hours before temporarily sealing the top cover with silicone rubber for testing. For even greater dielectric strength, the assembly may be vacuum outgassed with a pump. Any air bubbles present near the winding vastly reduce its dielectric strength. Seal the top cover with acrylic resin after completing the following stage of assembly.

4. Mount all components of the Tesla Coil securely and as close together as possible to limit stray inductance. Using solid conductor spark plug wire, meter lead wire, T.V. high voltage wire, or heavy silicone insulated wire, wind about 15 turns in the same direction as the secondary around the base of the outer shell tightly. Connect all components as shown in the wiring diagram and arrange the secondary high voltage terminal such that the length of a discharge from the terminal to your hand or a ground wire may be crudely measured. Open the spark gap slightly and energize the apparatus. A spark should be seen at the terminal. Alternately energize the coil and remove turns from the primary until the maximum spark length is reached.

Clip a ground wire to the coil common ground, open the spark gap to its maximum width as indicated in the spark-gap voltage table, and observe the length of the discharge. Approach this potential with your hand only with the greatest caution. Use a large metallic object to distribute the current to prevent R.F. burns. Sometimes the close coupling will cause the spark to have a blue portion in the middle. This spark will produce a shock.

5. Construction is completed by tuning the secondary with a sphere. Dr. Tesla used balloons coated with a metallic paint for his capacitors. For experimental purposes, toy plastic balls may be used, as balloons are nearly impossible to paint without bursting. Small world globes found in many stationery stores, are excellent terminals. Spun aluminum globes may be had for premium prices, and it is suggested that the diameter be determined very accurately before purchasing. All attempts to calculate the diameter of the terminal necessary to tune the secondary have been quite futile due to the large number of parameters that must be known with precision. A physicist with a well-equipped laboratory may do this routinely, but the experimenter is limited to experimentation. It is important to have the sphere as smooth as possible, since any sharp projection leaks away energy from the coil as corona and reduces its voltage.

The sphere should be conveniently removable as in most coils it will increase the energy stored in the secondary sufficiently to give a shock to the operator. Experimentation involving the use of the hands to hold objects while the coil is running will be considerably more comfortable without the sphere.

When the breakdown voltage, or disruptive potential, of the sphere is reached, the discharge takes on the characteristics of an electrical flame and is quite formidable to observe, as each breakdown is accompanied by a set of smaller ones, displaced from the first in time and space at a low frequency.

CONSIDERATIONS

A. The output voltage of a Tesla coil is determined largely by the ratio of the capacitor in the primary circuit and the capacitor (sphere) required to tune the secondary. The length of the spark produced, however, is dependant on the fundamental frequency, the waveshape, the charge densities of the discharge points, the humidity, and the barometric pressure. To claim a spark length or even an output voltage (considering the complex waveshape) is foolish. In general, if quality components and workmanship are used, the performance of a Tesla coil of this type is not disappointing. Be careful not to allow the discharge to follow the outer shell for any period of time as the acrylic will melt and eventually char, producing a permanent carbon "track" which will short out the secondary. The output may be rectified using small solid-state T.V. type high voltage diodes connected in series. The potentials obtained, when stored in a capacitor, are extremely dangerous and caution is advised. This arrangement is quite suitable for small linear accelerator power supply, high-energy pulse phenomena, and x-ray generation.

B. Be considerate of your neighbors when operating this device. The secondary is a rather inefficient radiator of R.F. at the frequency at which it operates, but overtones often can be heard for quite a distance. Use a portable radio to do a crude field-strength survey and adjust the spark gap and time of operation such that you create minimum interference.

If the transient supressor is not used on the primary of the high voltage transformer, especially in cases where resonance boosts its output, the spikes generated will radiate interference and may blow incadescent lamps and damage line operated electronic equipment using semiconductor circuitry.

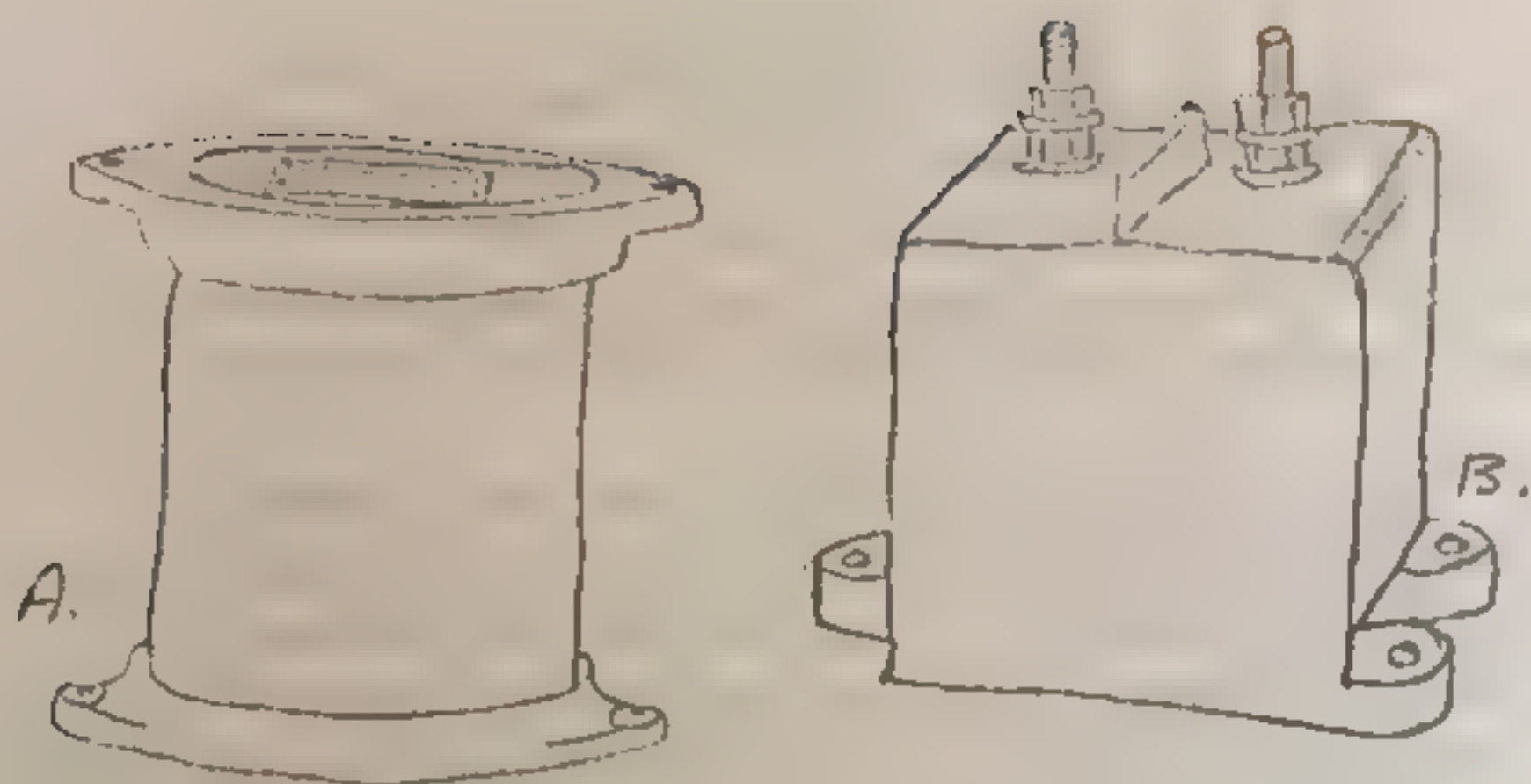
C. If a large coil is to be built for exhibition purposes, the oil-immersed method is impractical. The secondary should be wound with heavy wire of the correct length on a large form and the primary around that, ata respectable distance away to prevent arcing. In general, Tesla's Colorado Laboratory utilized this scheme, the large turn radii of the coils accomplishing what the oil does in smaller coils. The capacitors required to resonate this primary will become necessariaily large, and the charging current at 60Hz will become large enough to require rectification of a high voltage transformer at a moderate current, a very expensive proposition. Early experimenters used synchronous spark gaps to overcome this problem. In general, as the size of the Tesla coil increases, the expense increases dramatically, making really large coils of interest only for very specialized interests with large bankrolls.

A low frequency of operation may be forced by the use of electronic oscillators or pulse modulator-type arrangements. However, the former forces a sine waveform, lacking most of the physical effects at high potential inherent in the Tesla coil, and the latter is no more than a spark coil without a core, having a steep wavefront and very little oscillatory energy. Both of these methods are complex, expensive, and far removed from the classic historical phenomena being investigated.

D. The frequency of operation of the Tesla secondary as indicated on chart 3, will be lower than indicated. The reason for this is the effect of the dielectrics present which serve to prevent corona loss and enhance the operation of the coil. These materials slow the wave as it traverses the length of the secondary winding and consequently lowers the natural frequency. The frequency of operation is only approximate, as it is a complex wave, the characteristics of which are determined in large part by the spark gap breakover time. For this reason, the standing wave may appear at a position different from the top of the secondary although it appears to be operating at peak efficiency.

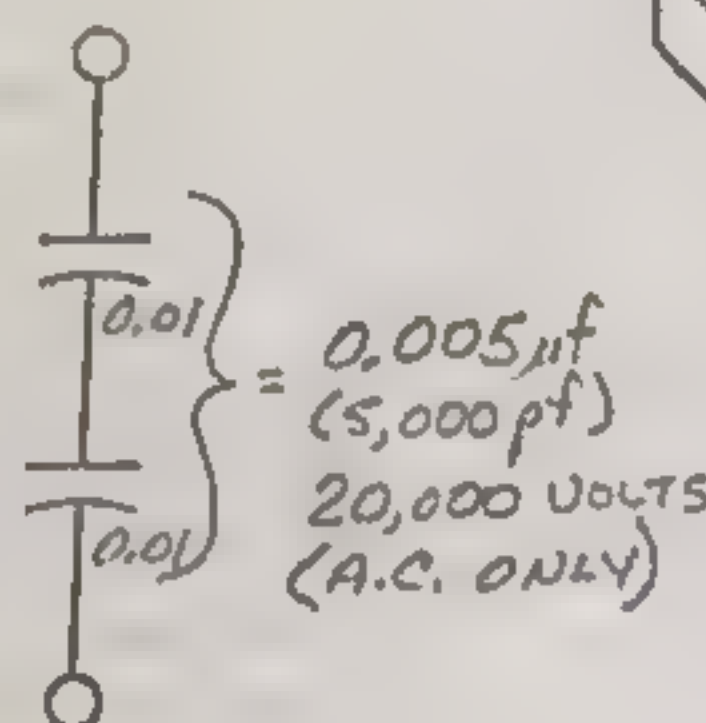
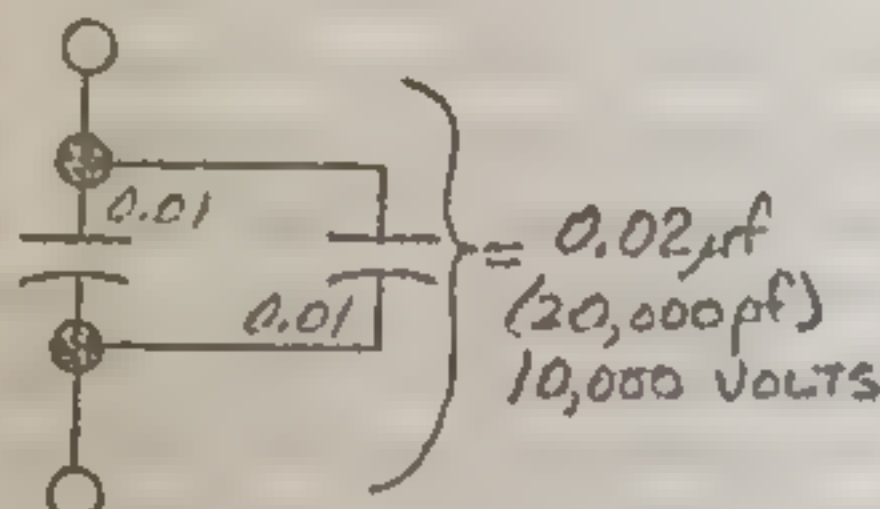
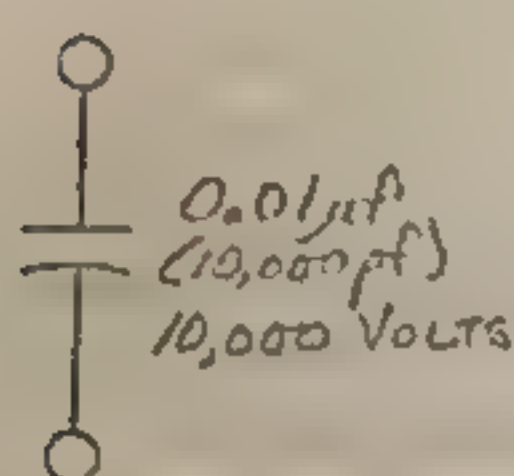
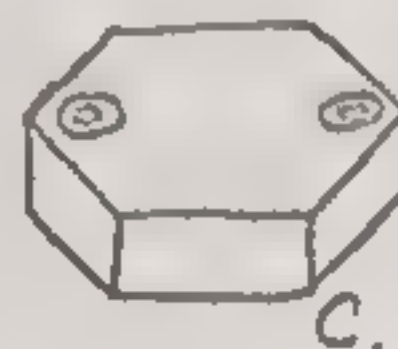
It is for this reason that this design procedure emphasizes constant experimentation and optimization. The validity of this method may be rationalized by inspecting the adjustments in any radio receiver.

Typical tuning curves for a Tesla coil are shown in the appendix. The non-symmetry of the primary capacity tuning curve is due to the current-limiting characteristics of the high voltage transformer at current levels greater than the nameplate rating.

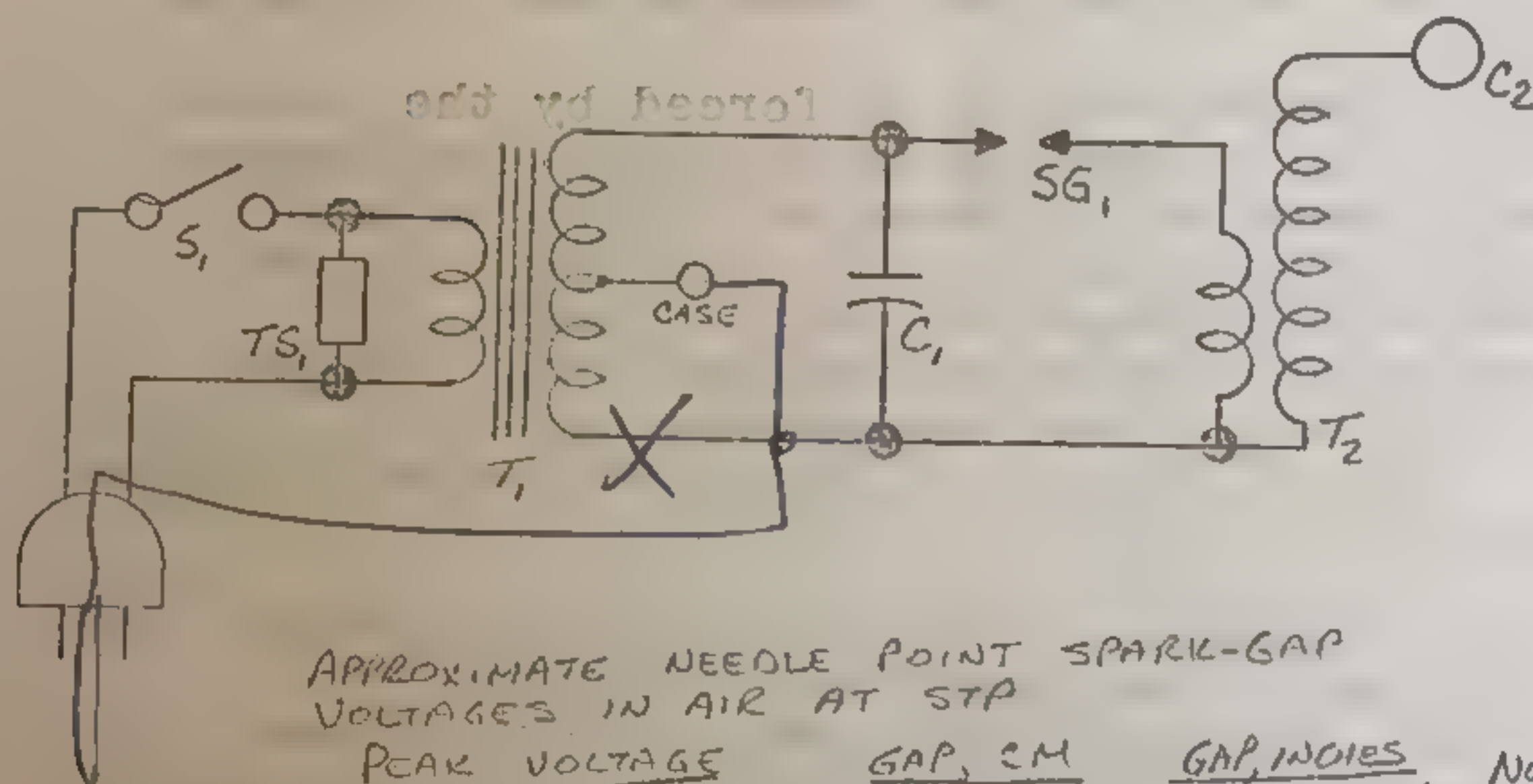


TYPICAL MICA TRANSMITTING CAPACITORS

- A. CERAMIC TYPE WITH CAST ALUMINUM END CAPS (UP TO 35,000 VOLTS)
- B. PHENOLIC-CASED TYPE. (OCCASIONALLY BLACK CERAMIC)
- C. MOLDED PHENOLIC TYPE.



$$C_{EQ} = \frac{C_1 C_2}{C_1 + C_2}$$



COMPLETE SCHEMATIC

T₁ = NEON SIGN OR FURNACE IGNITION TRANSFORMER 4,000 TO 15,000 VOLTS, 18 TO 120 MILLIAMPERES.

T₂ = TESLA COIL ASSEMBLY

SG₁ = HOMEMADE SPARK GAP MADE WITH SMALL MACHINE SCREWS

TS₁ = TRANSIENT SUPPRESSOR OF SELENIUM, SILICON CARBIDE OR METAL OXIDE

C₁ = MICA CAPACITOR

C₂ = SECONDARY TUNING SPHERE.

APPROXIMATE NEEDLE POINT SPARK-GAP VOLTAGES IN AIR AT STP

PEAK VOLTAGE	GAP, CM	GAP, INCHES	NOTE:
10,000	0.9	0.354 = 11/32	
20,000	1.8	0.70 = 23/32	
50,000	5.2	2.04	
100,000	16	6.30	
200,000	36	14.1	
300,000	55	21.6	
1,000	0.09	0.035 = 1/32	
2,000	0.18	0.070 = 5/64	
3,000	0.27	0.106 = 7/64	
4,000	0.36	0.141 = 9/64	
5,000	0.45	0.177 = 11/64	
6,000	0.54	0.212 = 13/64	
7,000	0.63	0.248 = 1/4	
8,000	0.72	0.283 = 9/32	
9,000	0.81	0.318 = 5/16	

1. SPARK GAP CHARACTERISTICS AND CONSTRUCTION SUBJECT TO WIDE VARIATION - DETERMINES MUCH OF COIL PERFORMANCE

2. KEEP ALL LEADS BETWEEN C₁ AND PRIMARY OF T₂ SHORT AND HEAVY

3. SPARK GAP NOISE AND LIGHT MAY BE ELIMINATED BY ENCLOSING GAP IN BROWN OR GREEN GLASS JAR.

4. PRIMARY MAY BE COPPER TISSING IF ENCLOSED IN OIL. Q MAY BE IMPROVED BY SILVER PLATING.

SUGGESTED C₁ RANGES (NO RECTIFIER AT HIGH VOLTAGE)

COIL AND CORE (OPEN FRAME) NEON

4KV 12mA

6KV 18mA

7.5KV 12mA

10KV 18mA

ENCLOSED (PHENOLIC TYPE) NEON + FURNACE IGNITION

12KV 30mA

15KV 30mA

ALSO - 60mA

120mA

UP TO 0.01 (10,000 pf)

TO 0.02 WITH MORE IMPULSIVE OUTPUT

(CENTER TAPPED)

UP TO 0.02 (20,000 pf)

TO 0.04 WITH IMPULSIVE OUTPUT

(WILL GIVE A SHOCK)

DON'T MISS

EDN MAGAZINE

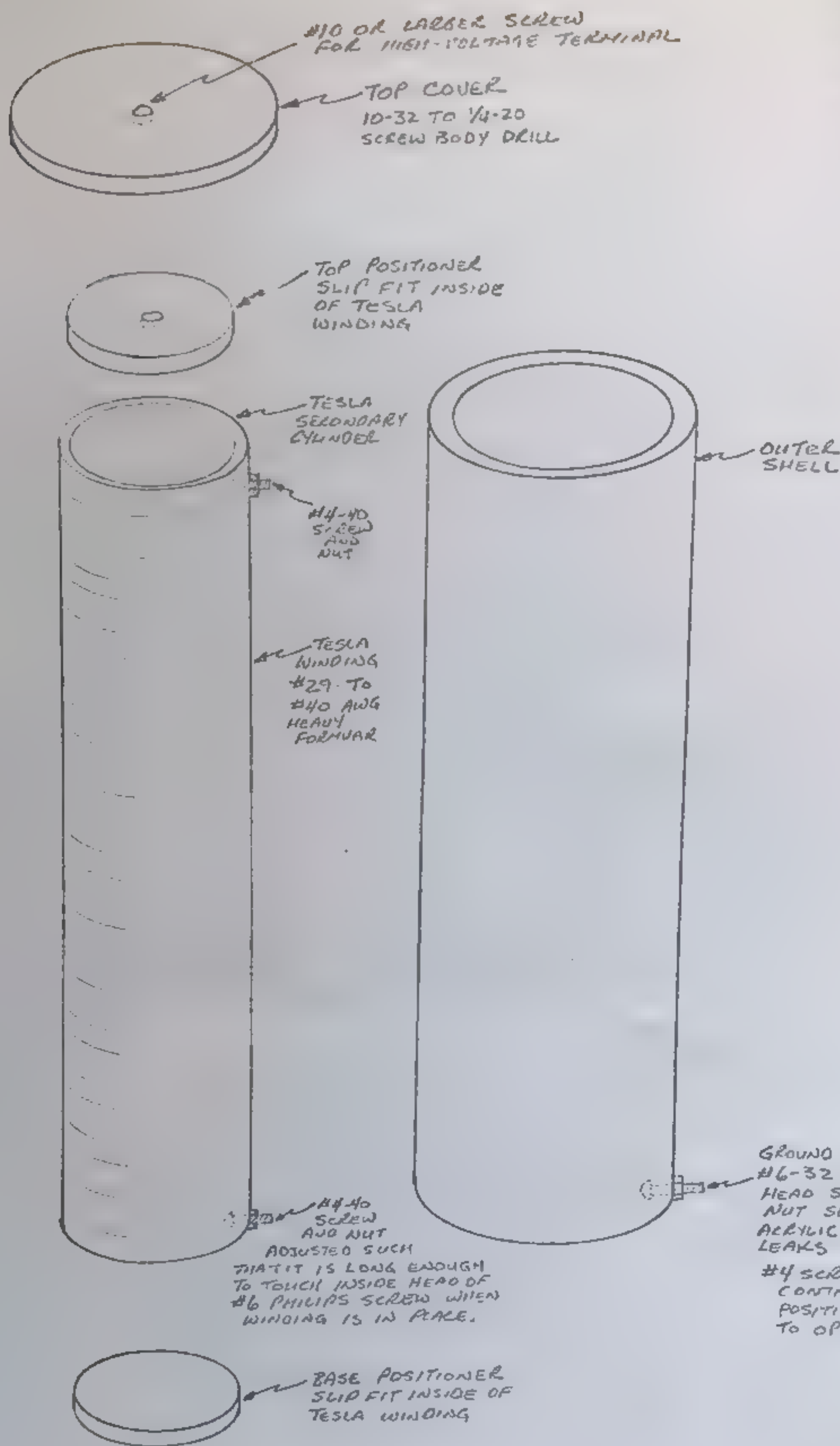
(ELECTRONIC DESIGN NEWS)

APRIL 20, 1976 pg 17, 18

TWO COLOR PICTURES OF RECONSTRUCTED AND OPERATING MAGNIFYING TRANSMITTER 20 MEGAVOLTS

DRAWING FOUR.

TESLA COIL SECONDARY MECHANICAL CONSTRUCTION



NOTES

1. ALL MATERIAL = 1/8" ACRYLIC SHEET AND TUBING
2. FILL COMPLETED ASSEMBLY WITH COLORLESS MINERAL OIL
3. FASTEN BASE OF OUTER SHELL TO BASE PLATE WITH EXCESS OF ACRYLIC CASTING RESIN TO PREVENT LEAKING
4. FASTEN TESLA WINDING TO POSITIONERS AND TOP COVER TO OUTER SHELL WITH CLEAR SILICONE RUBBER SO THAT THEY MAY BE REMOVED IF NECESSARY.

45 4970
45 4970
45 4970

NATURAL
100KHz
50
30
20
10KHz

FREQUENCY
1MHz
2MHz
5MHz

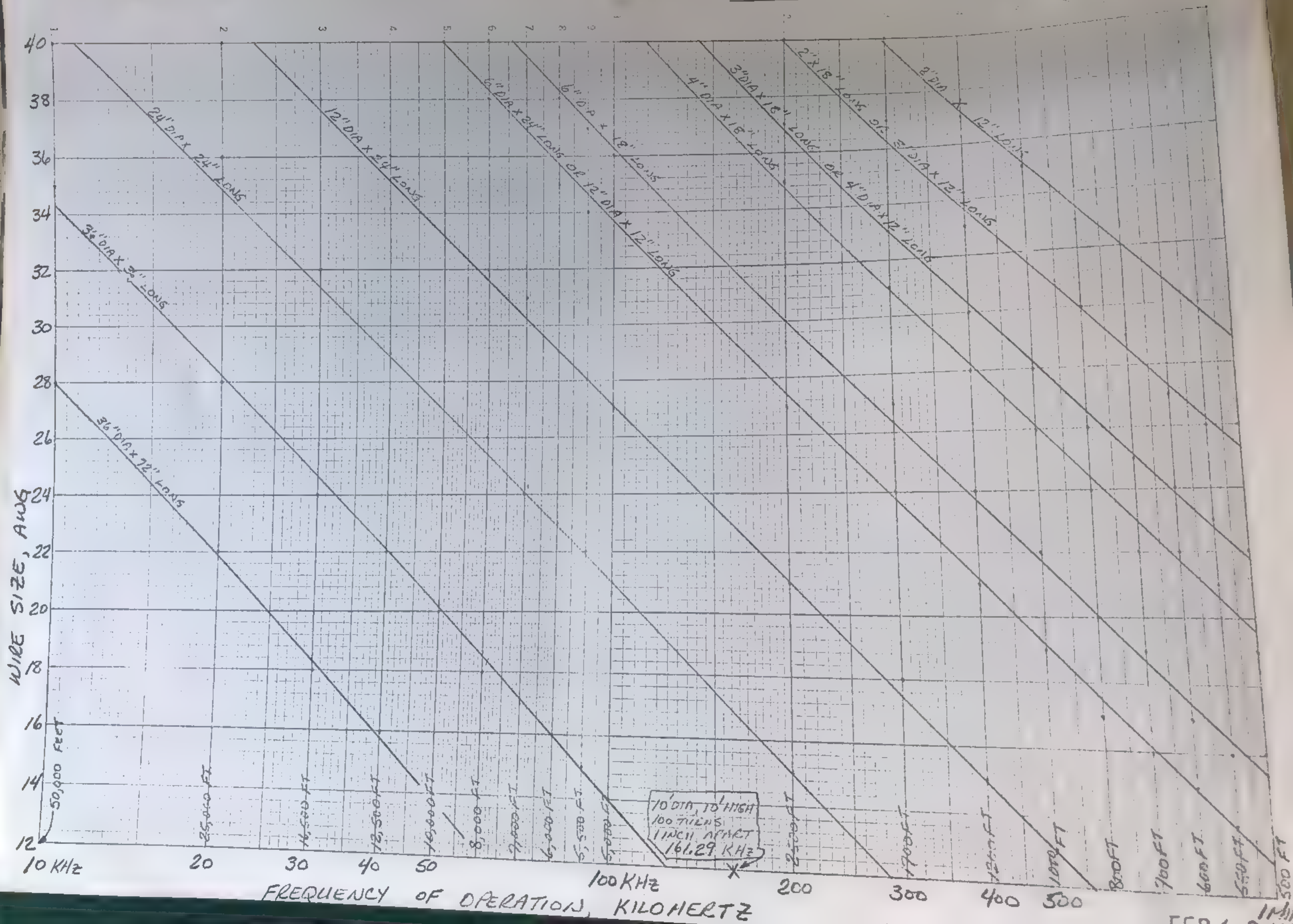
LENGTH OF SECONDARY
WINDING VS NATURAL
FREQUENCY FOR
TESLA COIL
SECONDARIES

CHART 3

45 4970
45 4970
45 4970

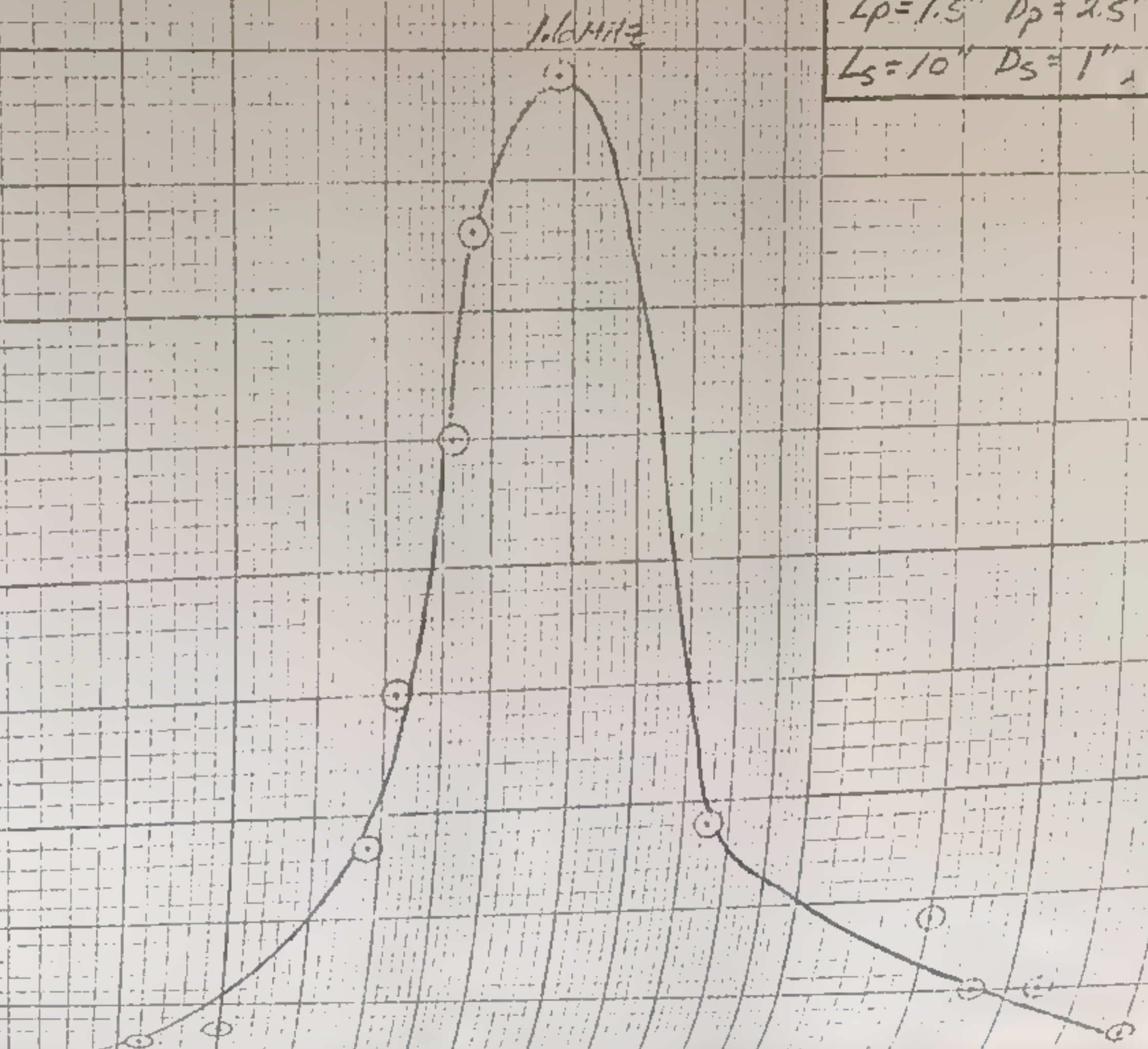
WINDING LENGTH, FEET.

CHART 3



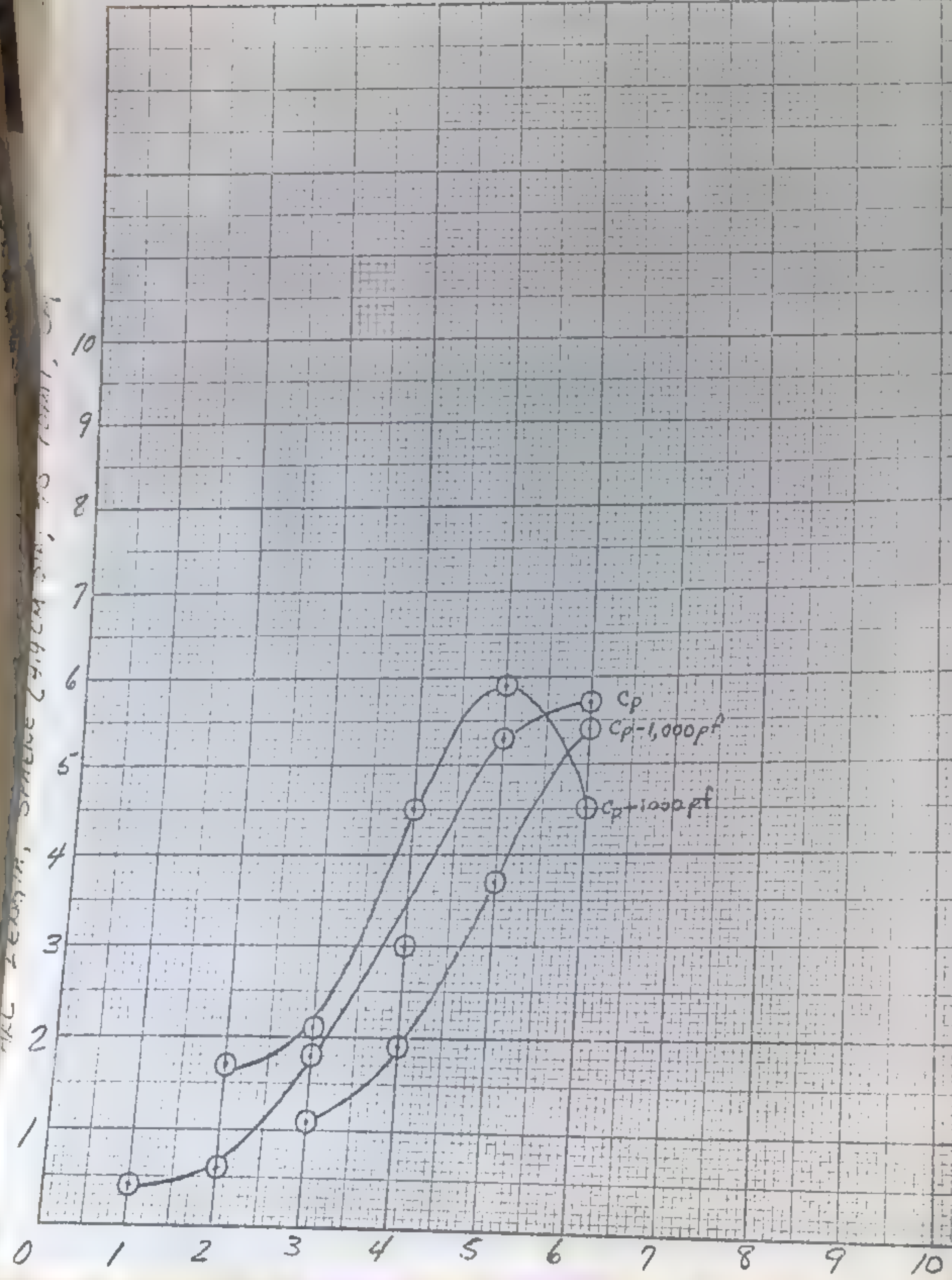
RELATIONSHIP BETWEEN
 ARC LENGTH AND PRIMARY
 MICA CAPACITANCE FOR
 TESLA COIL
 $L_p = 1.5''$ $D_p = 2.5''$ $N_p = 6$
 $L_s = 10''$ $D_s = 1''$ $N_s = 1430$

10
9
8
7
6
5
4
3
2

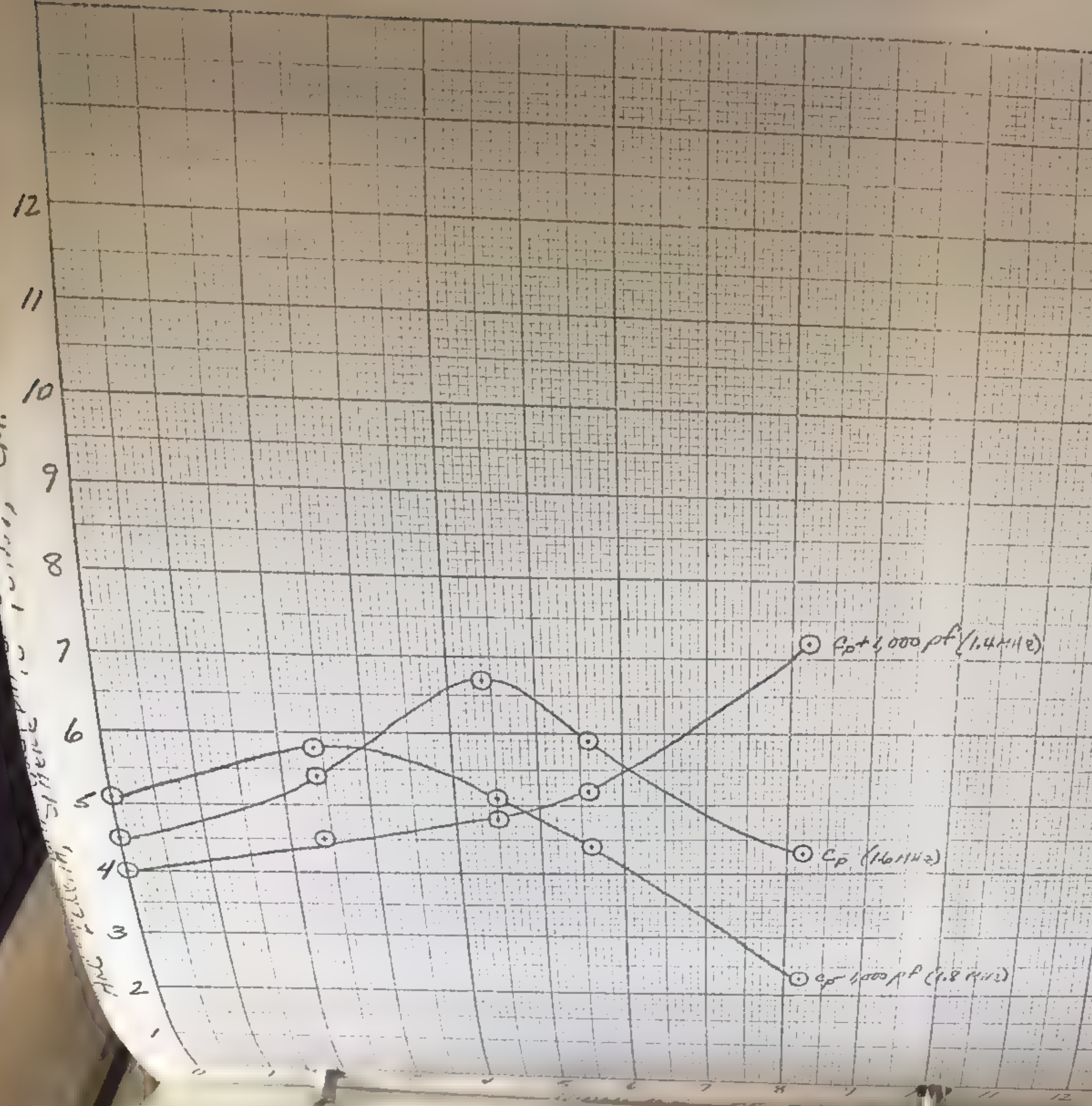


RELATIONSHIP BETWEEN
 N_p AND ARC LENGTH
 FOR TESLA COIL
 L_p (VAR) $D_p = 2.5"$ N_p (VAR)
 $L_s = 10"$ $D_s = 1"$ $N_s = 1430$
 C_p = OPTIMIZED BY
 EXPERIMENT

ARC LENGTH, INCHES (4.9 INCHES)



RELATIONSHIP BETWEEN
 SPHERE DIAMETER AND
 ARC LENGTH FOR
 TESLA COIL
 $L_p = 1.5''$ $D_p = 2.5''$ $N_p = 6000$
 $L_s = 10''$ $D_s = 1''$ $N_s = 1430$
 $C_p =$ OPTIMIZED BY
 EXPERIMENT



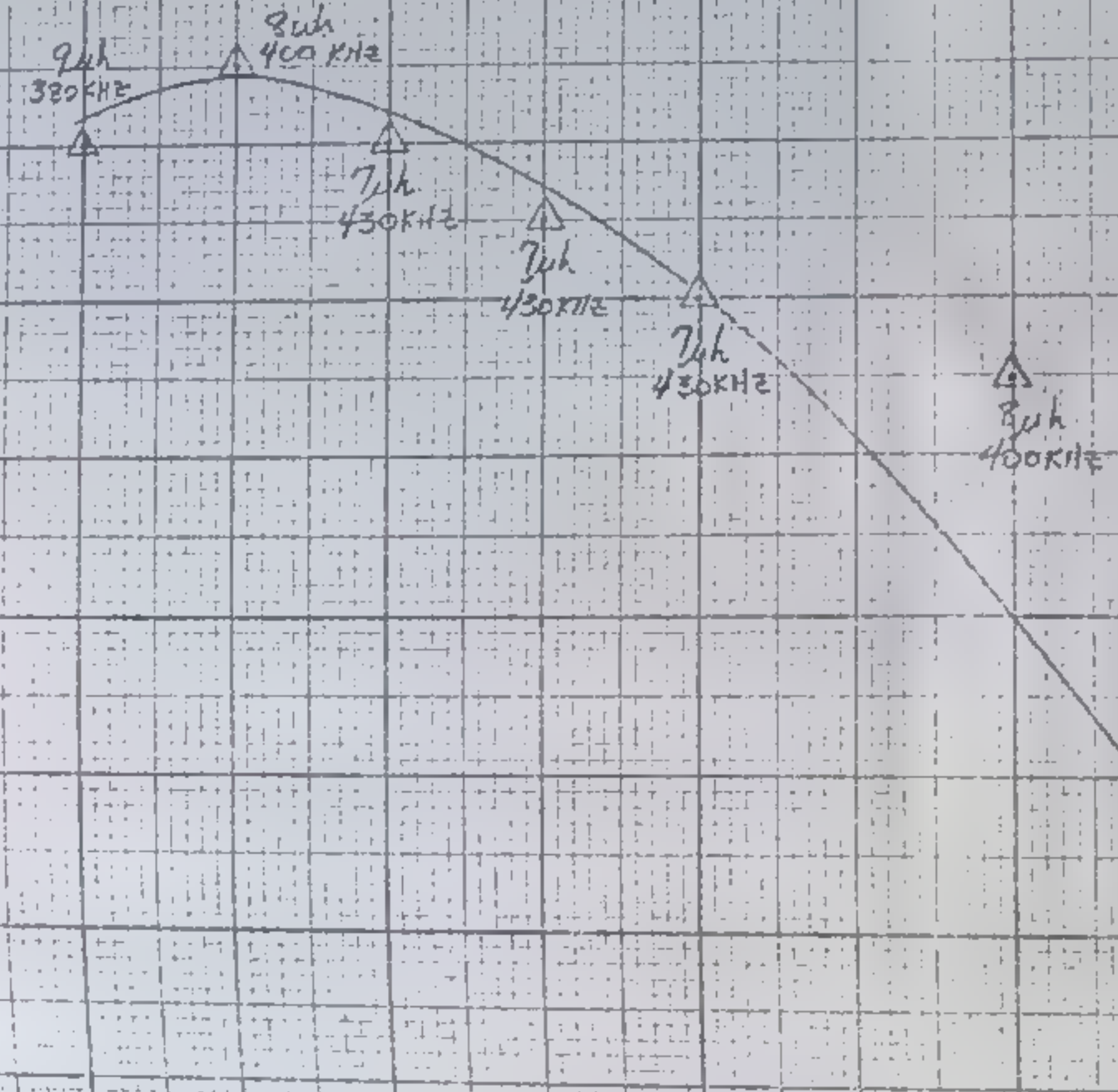
PARAMETERS OF COILS CONSTRUCTED

	DESIGN 1	DESIGN 2	DESIGN 3	DESIGN 4	DESIGN 5
DIAMETER OF PRIMARY, INCHES	2.5	5	9		
LENGTH OF PRIMARY, INCHES	1.5	2	5		
GAUGE PRIMARY	6	6	5		
GAUGE WIRE PRIMARY, AWG	16	14	3/16		
PRIMARY INDUCTANCE, MICROHENRIES	2	8	5.6		
PRIMARY RESONATING CAPACITOR, μF	0.007	0.022	0.037		
PRIMARY AND CAPACITOR RESONANT FREQUENCY, KHZ	1400	400	360		
DIAMETER OF SECONDARY, INCHES	1	2	3		
LENGTH OF SECONDARY WINDING, INCHES	10	12	18		
TURNS SECONDARY	1430	1900	1300		
GAUGE WIRE SECONDARY, AWG	34	35	28		
SECONDARY WIRE LENGTH, FEET	375	1000	1000		
SECONDARY D.C. RESISTANCE, OHMS	100	340	14		
SECONDARY INDUCTANCE, MH	5.1	25.7	17.7		
SECONDARY NATURAL FREQUENCY, KHZ	1400	500	500		
SECONDARY MAXIMUM Q @ 500 KHZ	160	237	840		
SECONDARY AND SPHERE RESONANT FREQ., KHZ	1500	430	520		
SPHERE TERMINAL DIAMETER, INCHES	1.7	4	6		
SPHERE CAPACITANCE, μF	2.4	5.7	8.5		
TRANSFORMER SECONDARY VOLTAGE, VOLTS	4000	2500	6000		
TRANSFORMER SECONDARY CURRENT, MA	18	30	60		
TRANSFORMER SECONDARY D.C. RESISTANCE, OHMS	18K	15K	—		
TRANSFORMER NAMEPLATE RATING, KVA	0.09	0.225	0.360		
SECONDARY COIL FORM MATERIAL	PLEXIGLAS TUBING				
SECONDARY INSULATING MEDIUM	COLORLESS MINERAL OIL				
MAXIMUM DISCHARGE LENGTH, SPHERE TO POINT, IN.	4	8	18		
MAXIMUM RECTIFIED (1/2 WAVE) OUTPUT, KILOVOLTS	55	—	—		
HEIGHT OF SECONDARY COLUMN, INCHES	12	12	24		
OUTSIDE DIAMETER SECONDARY COLUMN, INCHES	2	3	5		

ARC LENGTH IN INCHES
SPHERE TO POINT

10
9
8
7
6
5
4
3
2
1
0

ARCS ALONG CURVE OF SPHERE
CASE 3" DIA OIL FILLED



RELATIONSHIP BETWEEN NUMBER
OF TURNS AND DIAMETER OF
PRIMARY WINDING OF TESLA
COIL AND SECONDARY ARC
LENGTH

4" DIA SPHERE
 $L_s = 12"$
 $D_s = 2"$
#34 WIRE

METER READ WIRE
ALL PRI. COILS
CONTAIN 133"
OF WIRE
 $L = 7$ to 9 in
 $f_o \approx 400$ kHz
 $C_p = 0.022 \mu F$
 $i_p = 30$ mA

11 12 DIAMETER OF PRIMARY, INCHES
3 NUMBER OF TURNS

ALL COMBOS
CONTAIN 133 INCH

UN 1976

KENNETH J. STRICKFADEN

853 - 26th Street

Santa Monica, California

~~EX 5-2435~~

26 July 1976.

Dear Prof. Wysock:

The enclosed air fare
is for the return of Mr. Morecraft.
Will you please send him home.

Also, there was an article from
Popular Mechanics -- several pages.

regards, Ken.

KENNETH J. STRICKFADEN

853 - 26th Street

Santa Monica, California

~~EX-5-2435~~

828-4256

Dear Prof:

Book rec'd O.K. Here is some information which might be of value to you. It concerns a young man associated with Lucas Films.

His name is Ben Burtt, Res. Tel. 747-5178,

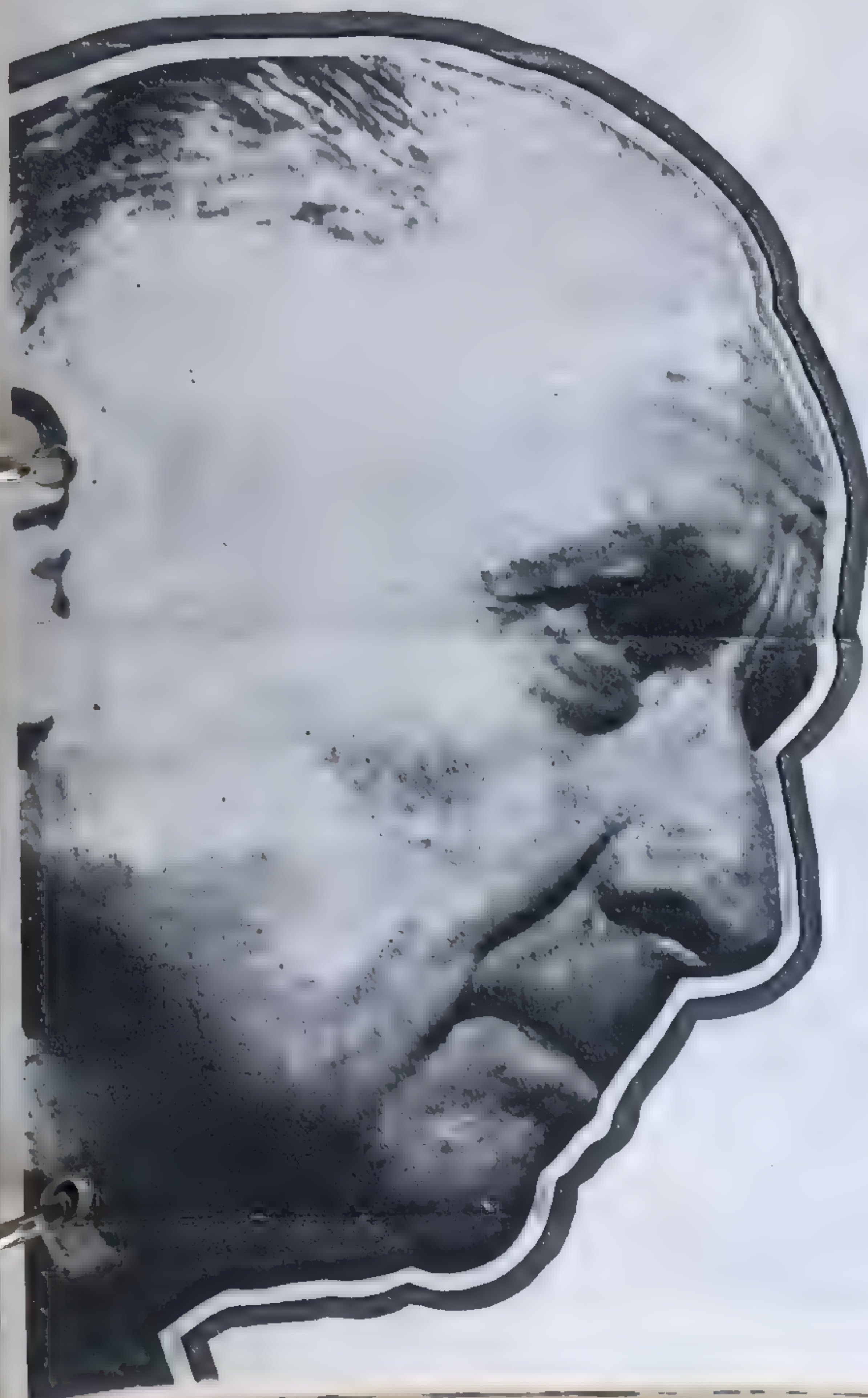
He is interested in recording sounds of electrical effects. Perhaps you could get together and possibly make a couple of bucks.

Enclosed are some pictures for you and Dick, the murder cycle should be put in cold storage.

regards & keep smiling.

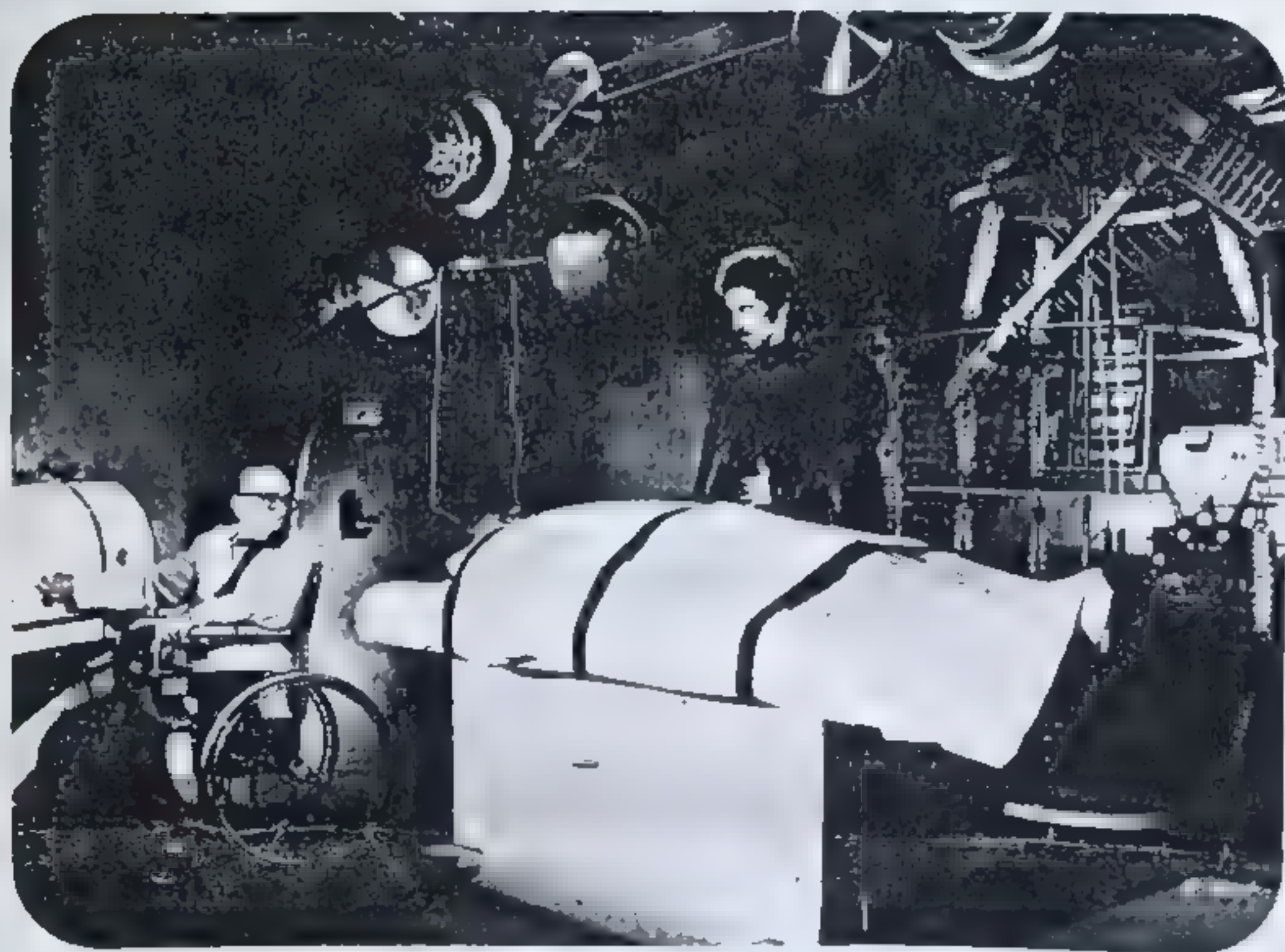
Ken

THE ELECTRICAL WIZARD OF THE MOTION PICTURES



■ Back in 1934, when sound films were still in their infancy, Brother Kenneth "Ken" Strickfaden, member of Local 40, Hollywood, Calif., was adding to motion pictures special visual effects that attracted worldwide attention.

Already known as the "Electrical Wizard of the Motion Pictures," Ken, through his special effects, kept audiences sitting on the edge of their seats, sending chills up their spines, with his startling, blood-curdling effects in such films as *Dracula*, *Dracula vs Frankenstein*, etc. These effects—and others—he produced through the application of electricity and his knowledge of the principles of physics. Ken also produced effects that gave an image of a million volts, metal rings floating through air, black light, and many others. Having incorporated his most startling effects into an intriguing lecture, Ken was in great demand as an entertainer and educational lecturer. His obvious knowledge of the subject of physics, displayed in his effects which seemed to defy the law of gravity, made him a sought-after speaker before the Association of Physics Teachers. Born on May 23, 1896, Ken was initiated into Local 40 on October 31, 1927, and went on pension in June, 1961. And his spectacular effects in the blood-thirsty *Dracula* films, often shown after the spooky midnight hour, are still sending chills up viewers' spines.

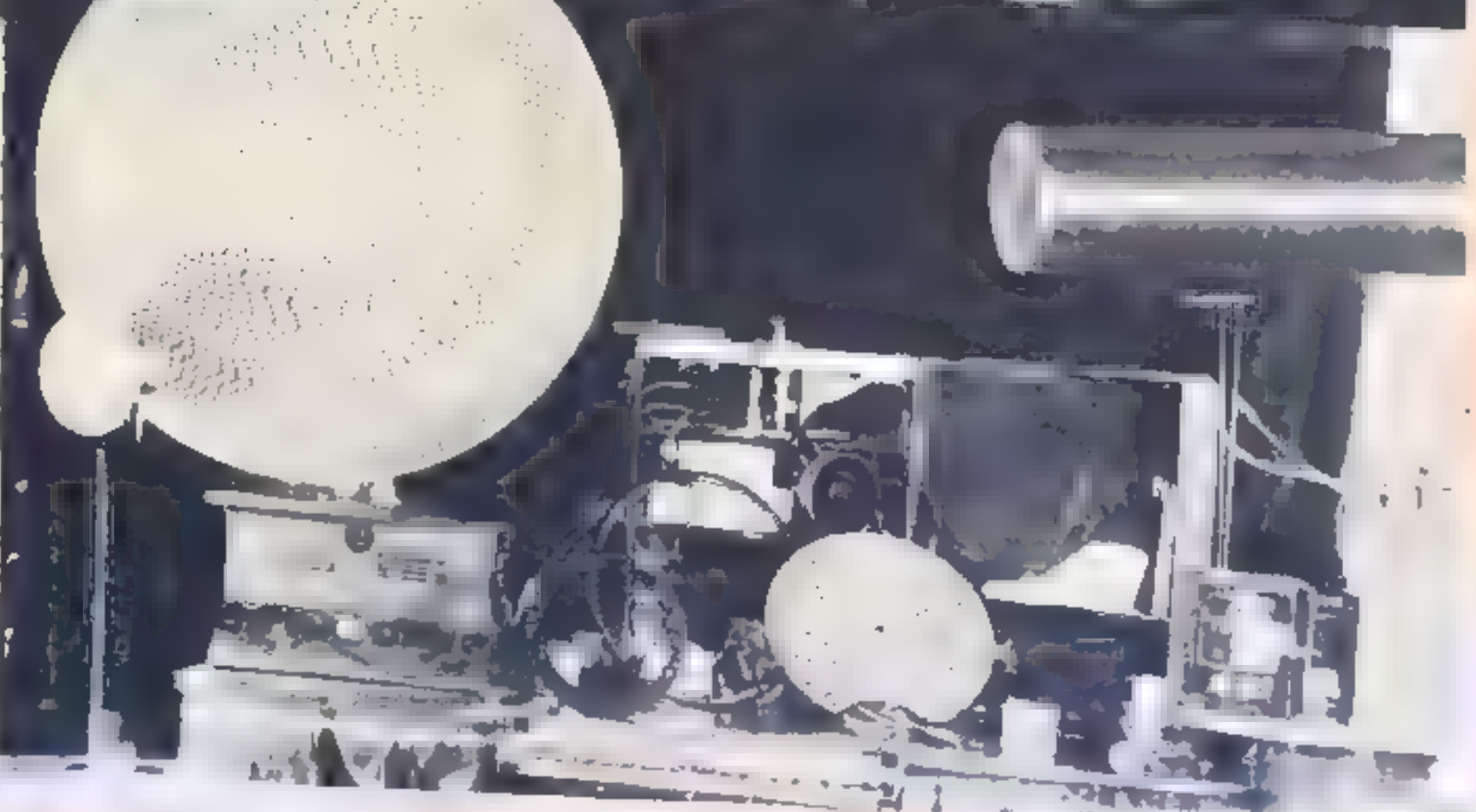
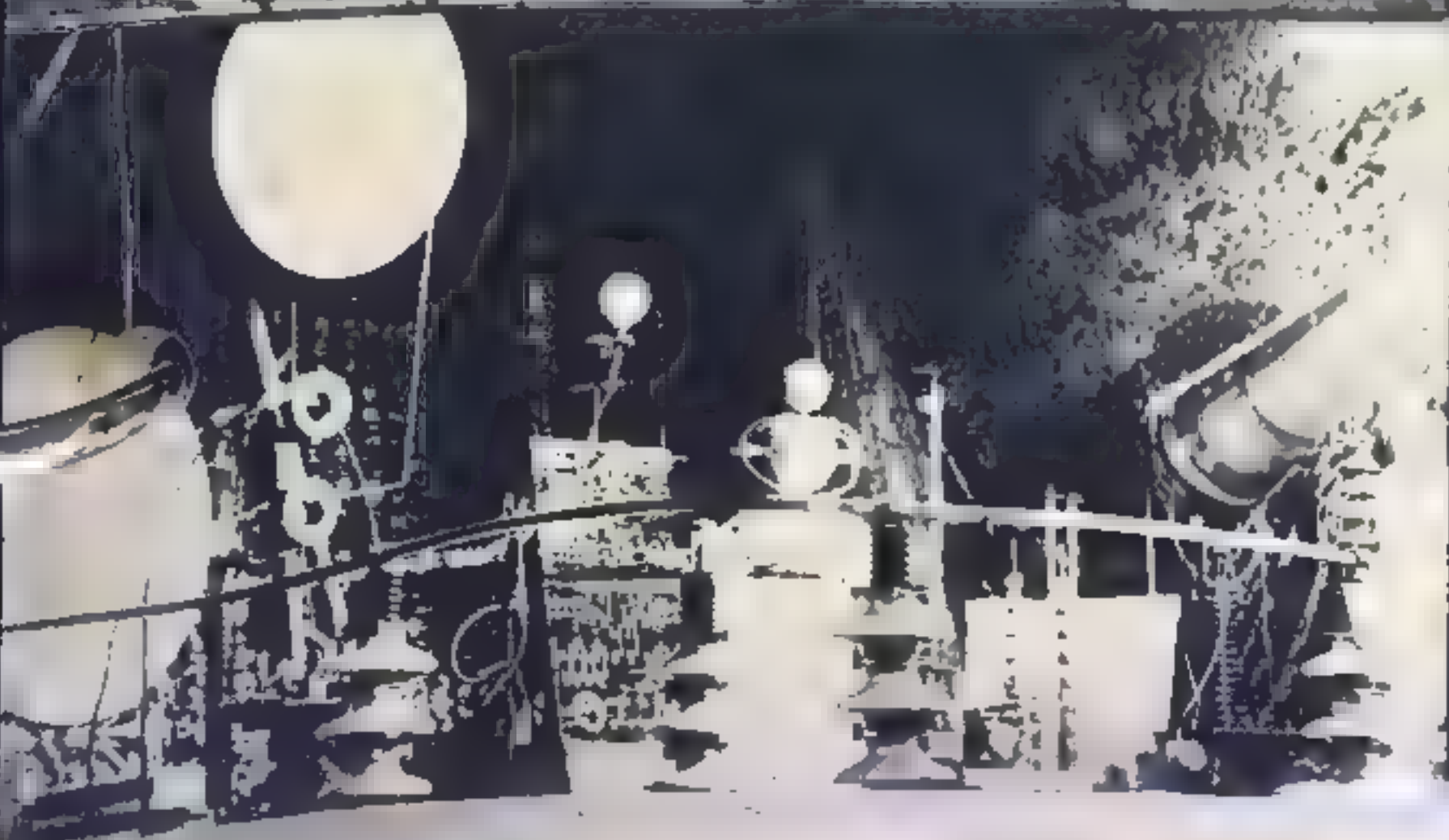
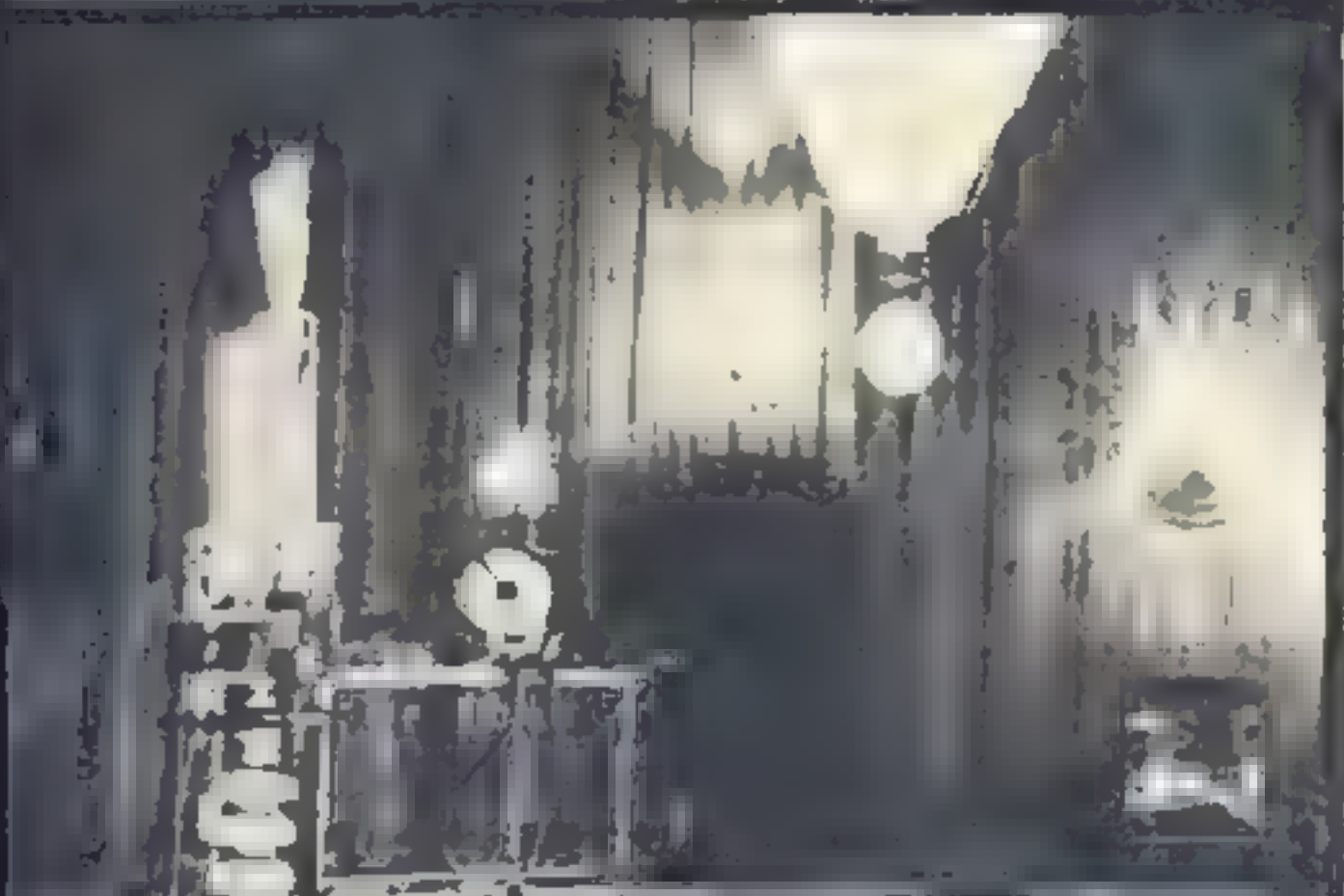
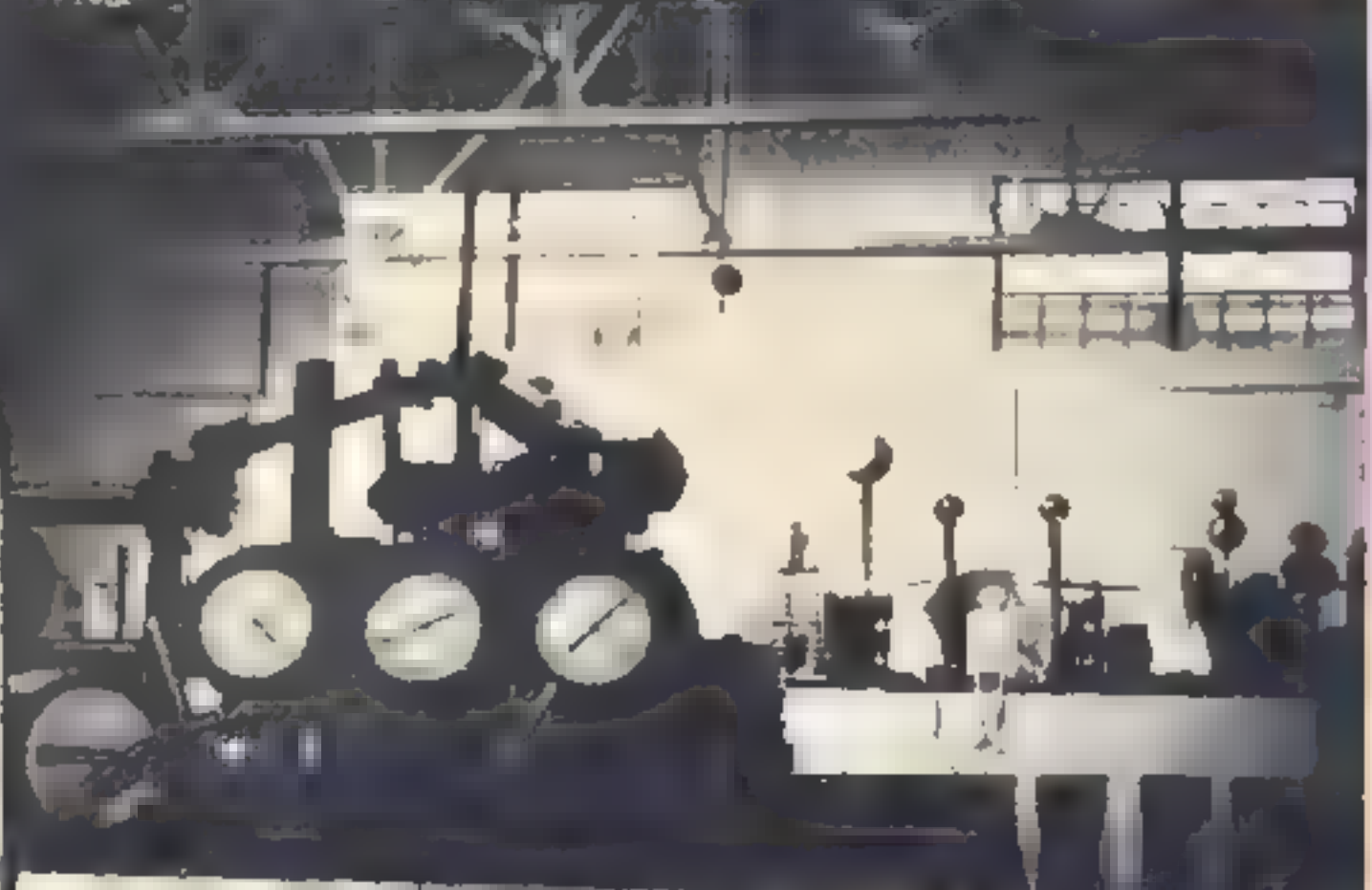


Brother Kenneth Strickfaden's electrical machines bringing the Frankenstein monster to life.

In the motion picture *Dracula vs. Frankenstein*, Dr. Frankenstein (J. Carol Naish) and Count Dracula (Zandor Vorkov) prepare to revive the Frankenstein monster with the aid of the special effects lab Brother Strickfaden created.

INTERNATIONAL EXPOSITIONS

PALACE OF ELECTRICITY
ELECTRICAL AGE
CALIFORNIA PACIFIC
GOLDEN GATE
EASTERN STATES





KENSTRIC SPACE AGE SCIENCE SHOW

SPECTACULAR DEMONSTRATIONS

BEAUTIFUL DISPLAYS

CREATIVE IDEAS

HUMOR

THE MATHE-MAGICAL

MELODYNE

MUSIC WITH COLOR

GRAVITY NEUTRALIZER

CELESTIAL MECHANICS AT WORK

MAGNETIC MISSILE LAUNCHER

HUMAN SATELITE

THE WORLD'S OLDEST MECHANISM

MAN'S GREATEST DISCOVERY

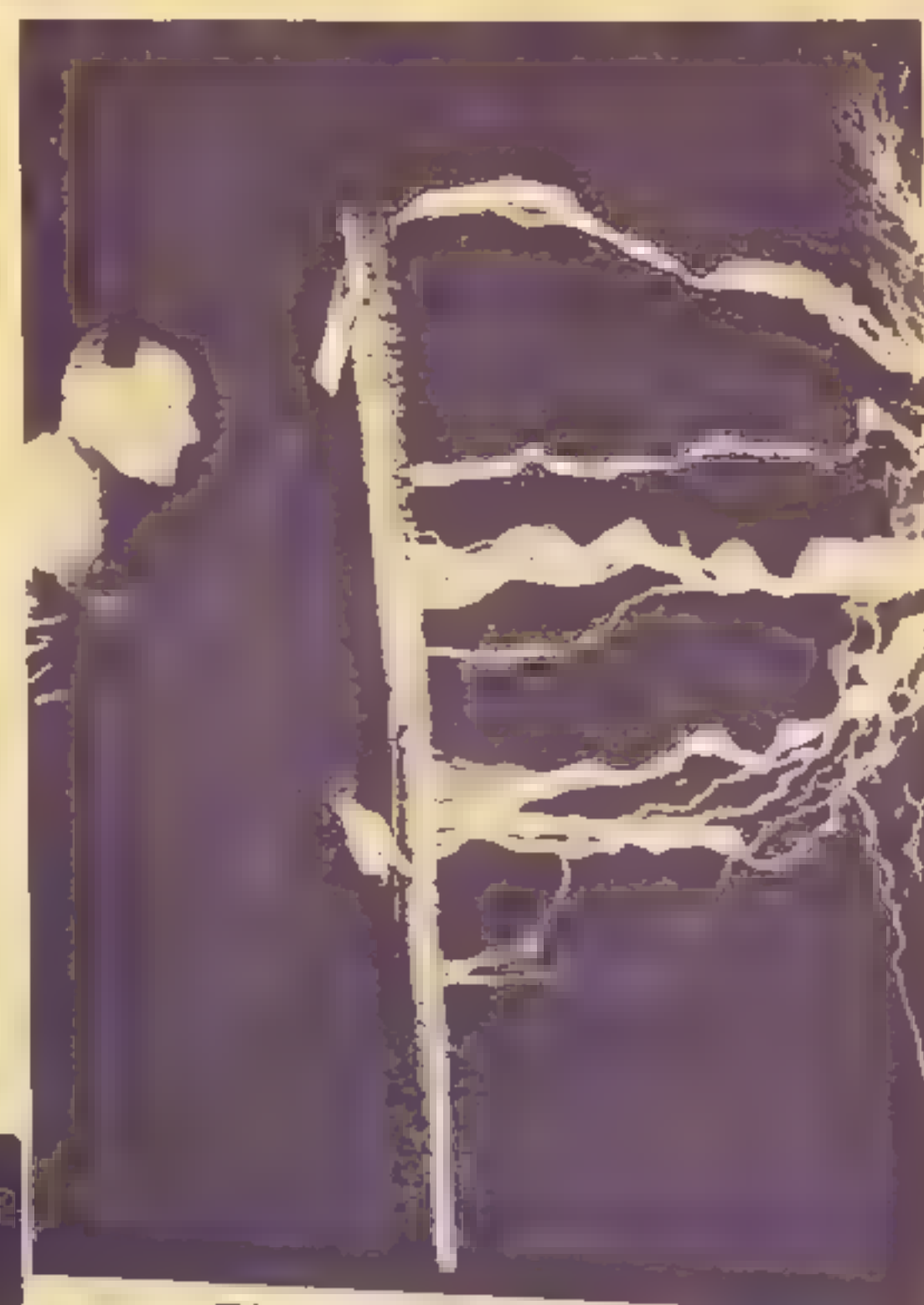
WHEELS WITHIN WHEELS

OUT OF THIS WORLD

WIZARDRY



SPACE AGE MARVELS



TESLA'S RESONATOR

FANTASTIC FUTURISTIC PHENOMENA

DESIGNED TO PLEASE THE AVERAGE PERSON . . . FUN FOR THE WHOLE FAMILY

Ken Strickfaden

WUM:dy ENCL.

GOVERNOR
EDMUND G. BROWN, JR.

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TESLA'S RESONATOR

OMENA

Ken Stueckfader

THE WHOLE FAMILY



nt, G. E. Kinsey • Stephen C. Bilheimer •
t, Jr. • Ernest J. Loebbecke • John V. Vaughn



PHOTO CELL ORGAN



ELECTRICAL LACE



SYNTHETIC MUSIC

KENSTRIC
APPLIES SCIENCE TO
INTERPRETAINMENT

SPECIAL ELECTRICAL EFFECTS FOR MOVIES

KENSTRIC has provided the "FIREWORKS" for more than 60 "THRILLER" type films at the major studios. His "IMAGINEERING" appears in such MAD LAB creations as WAR OF THE WORLDS, WIZARD OF OZ, JUST IMAGINE, SHERLOCK HOLMES, FRANKENSTEIN, FLASH GORDON, UNDERSEAS KINGDOM, INVISIBLE RAY, LOST CITY.

BOQUETS

WILSHIRE MASONIC LODGE: "...a spectacle of electronic and scientific display. Kenstric Science Show kept the gang awed and in stitches for an hour." SAN DIEGO HI-HATTERS: "...rare entertainment...inspiring music with color". U.S. DEPT. of INTERIOR, Sherman Institute: "...very much worthwhile...recommend". SANTA MARIA J.C. "...demonstrations enthusiastically received...please return." LYNWOOD J.M.S. "...the best program we have had this year." DOWNEY ROTARY: "...over a period of ten years, this was the most interesting." LODI FESTIVAL: "...one of the highlights of our entertainment program." UTAH CENTENNIAL: "...wonderful show...extensive equipment...greatly pleased." ELECTRICAL AGE EXPO. L.A. "splendid show...personal co-operation" CALIF. PACIFIC EXPO. "...Main attraction at PALACE of ELECTRICITY... increased attendance 88%...don't hesitate to use me as a reference..." UTAH STATE AGRICULTURAL COLLEGE: "...hope students everywhere might have the opportunity to enjoy your demonstrations." ALHAMBRA H.S.: "...expressing our admiration for your program." LOS ANGELES VETERANS ADMINISTRATION: "...performance intrigued interest." SO. PASADENA H.S. "exceptional from magnet to lightning." LA SIERRA COLLEGE: "...had our audience in the hollow of your hand." U. of A. ARIZONA: "...most favorable response...stimulating and instructive." "...every university community...should have opportunity to witness your exhibition." PAN PACIFIC AUDITORIUM: "...one of the most unusual...we had ever seen." L.A. EXPOSITION: "...interesting and entertaining...a highlight of Industrial demonstration period." EDISON CO. "...delighted...one of the highlights of our exposition...splendid show...personal cooperation." BEVERLY HILLS "spellbound...real productions of science." MAY CO. L.A. "...Frankly, we have never seen a more spectacular display...audience expressed a wish for your return." BOY SCOUTS "...excellent program...high calibre...educational." GLENDALE ACADEMY "...one of the most unusual...outstanding impression...looking forward to return visit." TUSTIN H.S. "...Hope to have you again...superior." REDLANDS "...most talked about show of the year." HOLLYWOOD U.S.O. "...amazing electrical demonstration...our compliments...masterful showmanship." NORWALK H.S. "...enjoyed the program...held their attention from beginning to end...hope to have...again" SOUTH PASADENA "...highly pleased...exceptional...appreciated wit and humor." ARLINGTON "...how thoroughly we enjoyed your program." DEMOREST "enthusiastic...demonstrations are fitting for any school or church program." VAN NUYS "...ability to adapt your program...different age levels." I.B.E.W. "...magnificent and spectacular display of electricity..." ORANGE H.S. "...extremely well received...recommending this program...unusual and spectacular." TULARE "...well received by all ages. We were well pleased." INSTITUTE "...finest of comments concerning your demonstration and lecture...glad to recommend you." RIVERSIDE "...very much worthwhile and gladly recommend program." WASCO "...most interesting and instructive...entirely different..." SANTA MARIA "...most worthwhile...recommend to any school..." VISALIA H.S. "...received most enthusiastically...commend you upon your ability to hold the interest...clever personality...real showman...fascinating...this was one of the finest we have ever had." TURLOCK H.S. "...unanimous opinion of students, faculty and adults...program one of the most interesting and instructional..." DOWNEY ROTARY "...thoroughly appreciated by all...of ten years, this was the most interesting!"

DESIGNED TO PLEASE

EX 52435



CALIFORNIA MUSEUM OF SCIENCE AND INDUSTRY

700 STATE DRIVE, LOS ANGELES, CALIFORNIA 90037 • EXPOSITION PARK 749-0101

MUSEUM DIRECTOR
WILLIAM J. McCANN

December 5, 1975

Mr. Nick Basura
3414 Alice Street
Los Angeles, California 90065

Dear Mr. Basura:

It was very interesting talking to you about Nikola Tesla. You may be interested in knowing the response Bruce Burdick would have about your inquiry.

X We at the California Museum of Science and Industry are certainly receptive to the idea of an exhibit of the inventions of Nikola Tesla.

We are very proud of what our Museum has accomplished and our present plans call for more and more exciting and attendance drawing exhibits. We are able to provide from 1,500 to 18,000 square feet of inside exhibit space, adequate security, related activities tied to the exhibit with great public relations impact, and an assured exposure to over 300,000 people per month. Thus, we are consistently drawing well over three million a year and such a figure is seldom encountered in the museum world.

Some ideas relative to such an exhibit could be graphics or photos; possibly working models of his inventions; scientific acknowledgements, manuscripts and documents (patents, calculations, drafts, notes....), personal and biographical data; and possibly a slide or a film presentation, if reduced to six or seven minutes, would be extremely useful.

There is also a possibility that this could be tied in with an exhibit from Yugoslavia, where Mr. Tesla was born, which would point up Yugoslavia as having had a great scientist.

[If you and your associates would consider an exhibit at our Museum, we would be delighted to correspond with the appropriate persons and hopefully this would lead to an exhibit of great mutual benefit, and at no cost to you for your exhibit space.

Enclosed are some items of interest for your study which hopefully will motivate an early reply.

Sincerely,

William J. McCann

William J. McCann
Museum Director

WJM:by Encl.

GOVERNOR
EDMUND G. BROWN, JR.

Board of Directors: President, J. Howard Edgerton • Vice President, G. E. Kinsey • Stephen C. Bilheimer • Maurice J. Dahlem • Arnold Eddy • Philip M. Hawley • George Hearst, Jr. • Ernest J. Loebbecke • John V. Vaughn

PAGE TWO OF TWO

See smaller coils also lend themselves to more readily demonstrating the working of the units and show in close detail their technique of construction.

I have a fair amount of lecture experience with this equipment in high schools, and most recently, a mini-documentary on television station KABC-TV CH. 7 in August of 1975 as a news item on their six p.m. broadcast. I should like to therefore propose that periodic demonstrations of this equipment be conducted by myself as a regular feature of the exhibit format.

Referencing the telephone conversation with Mr. Pavy prior to the writing of this letter, I was given the understanding that there is a lengthy waiting period of available exhibit space and high cost to cover pamphlets, public relations et.al. Again referring to your December 5, 1975 letter to Mr. Basura, you stated therein the sixth paragraph that you are interested in an exhibit of this nature and that ample exhibit space could readily be provided by the museum complete with defrayed expenses to the exhibitor. The subject material of the exhibit that I am proposing requires approximately five hundred square feet of floor space and if the large Tesla coil is to be operated, a minimum height clearance of nine meters is required. Also necessary is an alternating current outlet of 240 volt 60 hertz single-phase of a sixty amp capacity and a good earth ground, (steel frame of the building.) The above mentioned large apparatus is undoubtedly the main attraction of the entire exhibit and I can well assure you, will fast become a crowd-gathering attraction of outstanding merit in your museum!

I believe the erection of this exhibit should be considered time-date correlated and should therefore be run commensurate with the other Tesla projects being conducted in full activity this year.

I would greatly appreciate your prompt attention and advice in this matter. Pending the financial and time requirements, if any, and other museum policies and specifications I can be completely ready for exhibit in two month's time as of this writing. Mr. Pavy has encouragingly informed me of the museum's position and interest for this exhibit. Therefore, I will anxiously await your reply.

Sincerely yours,

William C. Wysock

William C. Wysock

c/c Mr. Carl Pavy
WCH: by Encl.



MUSEUM DIRECTOR
WILLIAM J. McCANN

CALIFORNIA MUSEUM OF SCIENCE AND INDUSTRY

700 STATE DRIVE, LOS ANGELES, CALIFORNIA 90037 • EXPOSITION PARK 749-0101

October 8, 1976

Mr. William C. Wysock
Professional Sound Systems
4914 Baldwin Avenue
Temple City, California 91780

Dear Mr. Wysock:

I am in receipt of your letter and we are very much interested in the exhibit.

For your information, I am attaching the Temporary Exhibit contract, and as indicated in my letter of December 5, there is no cost for your exhibit space. As you will see, there are other costs that must be borne by the exhibitor. This is a standard contract and used by all exhibitors. I am sure that with your association and the people interested in this project that such funds could be secured.

If you decide to proceed with the exhibit, please contact Carl Pevey here at the museum relative to the exhibit space. An early reply would be appreciated because at least two of our galleries are booked at this time up through 1978.

Sincerely appreciate your interest and am looking forward to the possibility of the exhibit you suggested.

Sincerely,

William J. McCann
Museum Director

WJM:by
Attach.

california

museum

foundation

a non-profit corporation affiliated with the california museum of science and industry

No. _____

TEMPORARY EXHIBIT AGREEMENT

The following agreement is entered into this _____ day of _____, 19____, between the California Museum of Science and Industry, hereafter called "Museum", and _____ hereafter called "Exhibitor", for the exhibit entitled _____.

IT IS AGREED THAT

1. Museum will:

a) -- permit Exhibitor to install an exhibit in the area referred to as _____ for the following period:

Install: _____

Open: _____

Press: _____

Close: _____

Reception: _____

Dismantle: _____

- b) -- provide professional services of coordinator;
c) -- provide Museum security for exhibit;
d) -- provide professional public relations coordination;
e) -- provide professional services of an exhibit designer and graphic artist if desired;
f) -- provide the coordination of educational programs and symposia relating to the exhibit in the event this is desirable and sponsored by the Exhibitor.

2. Exhibitor will:

a) -- within four (4) weeks, return these two copies of the Agreement (signed). One will be returned to you upon signature of the Museum Director. We also require a synopsis of the exhibit and a proposed title and theme at this time.

b) -- pay the major costs of exhibit, which includes manpower and materials needed to install and dismantle said exhibit unless otherwise negotiated and reflected in contract addenda.

c)--follow all directions of the Museum concerning public relations. At least sixteen (16) weeks in advance of the exhibit an authorized representative of the Exhibitor will request a meeting with members of the Museum Public Relations Department, to work out details of the exhibit. At that time a decision will be reached as to who will write and plant news releases on the exhibit and when and where they shall be distributed. In no circumstances will exhibit promotion be undertaken without the full knowledge and approval of the Museum Public Relations Department. Exhibitor must also submit advanced roughs of any proposed handout materials ten (10) weeks prior to the exhibit opening to the Exhibit Coordinator for approval.

d)--submit to Museum Designer a preliminary design blueprint of the exhibit fifteen (15) weeks prior to scheduled installation date.
e)--submit to Museum Designer final exhibit design thirteen (13) weeks prior to scheduled installation date.

f)--complete the installation and dismantling of the exhibit within the Museum working hours, i.e. 8:30 a.m. to 5:00 p.m.

g)--not remove items from the exhibit area prior to 5:00 p.m. on the closing date.

h)--indemnify and hold harmless the officers, agents and employees of Museum from any and all liability which may directly or indirectly arise out of any act or omission by the Exhibitor in the exhibit area during the time period of permit as set forth in Paragraph 1, Section a.

i)--submit three (3) copies of an itemized list of exhibit items (sizes, weights and values) to the exhibit designer (who will distribute copies to Security, California Museum Foundation office, and Exhibit Coordinator) one week prior to the installation.

j)--Exhibitor must cover said exhibit with 1) adequate insurance (liability, loss or damage), and 2) provide certificate of coverage, or 3) submit a waiver of insurance before installation commences.

k)--provide the Museum with 10,000 copies of an exhibit brochure invitation (combination piece) eight (8) weeks in advance of the exhibit opening and forward \$230.00 upon signature of this Agreement for postage. If this brochure-invitation deadline is not met, the Exhibitor will supply the Museum with \$1,300 to cover first class mailing or forfeit the exhibit space and the \$230.00. In the event there is no reception, the Exhibitor will furnish the Museum with 15,000 brochures and \$345.00 to cover the postage.

l)--adhere to the production schedule and composition guidelines with regard to the brochure-invitation as outlined in the following Brochure-Invitation Information. If Exhibitor prints his own mailer, items No. 5 and 6 are not applicable.

3. The exhibit reception is the responsibility of the Exhibitor and details relating to it are subject to Museum approval. The Coordinator will obtain these details and record them on the Reception Checklist two (2) weeks prior to the reception for distribution to appropriate persons. The Exhibitor will return the reception area to its original condition prior to 10:00 a.m. the next morning. In the event there is abnormal debris in the Museum's judgment, the Museum will hire personnel to clean up the area and the Exhibitor will pay the cost of the cleaning.

4. Exhibitor will instruct caterer to familiarize themselves with the reception area and Museum facility in advance of the reception date.
5. No entry fee, registration fee, hanging fee, or any other charge to participate or to the public may be made without the written consent of the Museum Director. Any such charge without Museum approval will be forfeited to the Museum.
6. In the event of any breach of this Agreement by Exhibitor, the permit under Paragraph 1 of this Agreement is null and void, at the option of the Museum.

BROCHURE-INVITATION INFORMATION

Museum Policy regarding Temporary Exhibit Brochure-Invitation:

1. Within one month of receipt of the signed contract, a meeting will be held with Public Relations and the Coordinator to confirm theme and final title of the exhibit, established at least 16 weeks prior to exhibit.
2. The Brochure-Invitation consists of the following:
 - a. Title of exhibit
 - b. Subtitle (if necessary to explain title)
 - c. A short synopsis describing the exhibit content and objective
 - d. A short cordial paragraph inviting guests to the premiere or opening night
 - e. Opening and closing dates, including dates of related activities
 - f. Area in which exhibit will occur
 - g. Complete address of Museum
 - h. Open Daily 10:00 a.m. to 5:00 p.m. free admission, ample parking
 - i. Museum logo (supplied camera-ready by Museum), return address and bulk-rate stamp #27171
 - j. Hours of reception (usually 7:00-9:00 p.m.)
 - k. R.S.V.P. (optional) to a phone number outside the Museum
 - l. "Please present this invitation for admission"

3. Exhibitor shall deliver rough art and rough copy of layout of brochure 14 weeks prior to opening for Public Relations and Graphics Department approval.
Due date: _____
4. Exhibitor shall deliver typeset camera-ready art to Exhibit Coordinator 12 weeks prior to opening for Graphic Artist's and Public Relations approval.
Due date: _____
5. If printing is to be done in Museum Printshop; Graphics Department prepares camera-ready art and negatives 12 weeks prior to opening. All cost will be invoiced to Exhibitor.
6. Graphics Department forwards Public Relations the brown line for approval, then to Printshop 10 weeks prior to opening for printing.
7. Printed material to arrive at Mail Room no later than 8 weeks prior to opening as stated under 2. k) in Agreement.
8. Printed material for reception and exhibit opening will be mailed by Museum no later than 3 weeks prior to opening.
9. The Exhibitor absorbs all costs which include: paper, typesetting, lithoplates, ink and postage relative to this Brochure-Invitation.
10. The Museum will mail additional copies (beyond 10,000) of the Brochure-Invitation, addressed by the Exhibitor, if they have our bulk-rate stamp, are zip coded, sorted by zip codes, and in amounts of 200 or more.
11. Individuals cannot mail Brochure-Invitations with our bulk-rate stamp unless they place suitable postage over the indicia.
12. Failure of Exhibitor to comply with this schedule will mandate that all mailings be mailed First Class at the Exhibitor's expense as per 2. k) in Agreement.

Museum Director

Exhibitor's Name

Organization

Address

Person responsible for exhibit installation

Phone

Original - Exhibitor
Duplicate - Museum Director
Triplicate - Exhibit Office
Quadruplicate - Public Relations
Quintuplicate - Foundation

Original CMSI Contact:



MUSEUM DIRECTOR
WILLIAM J. McCANN

CALIFORNIA MUSEUM OF SCIENCE AND INDUSTRY

700 STATE DRIVE, LOS ANGELES, CALIFORNIA 90037 • EXPOSITION PARK 749-0101

GENERAL INFORMATION ON TEMPORARY EXHIBITS

Exhibitor must submit idea for the proposed Temporary Exhibit to the California Museum of Science and Industry at least six (6) months (26 weeks) prior to the proposed opening date. This exhibit presentation should include overall concept, plan and educational value as well as samples of actual items.

After the initial meeting, CMSI will notify the Exhibitor in writing should CMSI choose to have the exhibit and will also issue the Temporary Exhibit Agreement at that time.

Within 30 days the Exhibitor will sign and return both copies of the Agreement. If the proposed exhibit space and dates are still available, the Museum Director will sign both copies and return one to the Exhibitor.

CMSI has twelve areas in which we allocate space to potential Exhibitors. They range in size from the 200 square foot area in the East Foyer to the 9,000 square foot area in either the north or south halves of the Space Museum.

The space is allocated free of charge. Some of these areas are presently booked two years in advance. Museum personnel will have the final determination as to the area in which the proposed exhibit will be displayed.

CMSI provides services of Security in the exhibit area, an Exhibit Coordinator, a Public Relations Coordinator, and an Exhibit Designer and Graphic Artist if one is needed.

We are also willing to assist in coordinating educational programs and symposia relating to the exhibit in the event this is desirable and sponsored by the Exhibitor.

CMSI expects every Exhibitor to supply us with 10,000 copies of the brochure-invitation (bulk rate mailer) and host an evening reception to premiere the exhibit. We also expect the Exhibitor to order any number of additional mailers to send either bulk rate or first class to their own list of associates or friends. Costs relative to brochure-invitation are the responsibility of the Exhibitor.

If desired, Exhibitor may supply CMSI with 34,000 brochure-invitations to cover the entire mailing list, and will subsequently be billed for the cost of additional brochure-invitations and postage.

CMSI-62 (12/75)

Sept. 1, 1976

Plenum Publishing Corporation
227 West 17th Street
New York, N.Y. 10011

Gentlemen:

Enclosed please find my personal check #872 in the sum of \$ 12.50 for the purchase of a book entitled, THE NATURE OF BALL LIGHTNING, by Stanley Singer. This book is referred to as a stock number 494.

Also, should you have any books relating to lightning whether natural or man made, or any books pertaining to any type of high voltage material, I am very interested and would appreciate it very much if you would let me know. I am working in the research area on Ball Lightning and very much appreciate your prompt co-operation.

Sincerely yours *W. C. Wysock*
William C. Wysock

Sept. 1, 1976

Henry A. Clausen
Henry A. Clausen Bookshop
224 North Tejon Street
Colorado Springs, Colo. 80902

Dear Mr. Clausen:

Thankyou for the telephone conversation the other day and for sending the book ELECTRICAL GENIUS, NIKOLA TESLA by Backhard and Auther J. Julian Messner. Enclosed, please find my check number 873 in the sum of \$ 5.50 for the above book. I would like to place an open order for any material on Tesla you may have for sale now, or at any point in the future. Of particular interest to me is THE TESLA HIGH FREQUENCY COIL, by Haller and Cunningham, D. Van Nostrand Company, 1910 and also the book entitled, EXPERIMENTS WITH ALTERNATING CURRENTS OF HIGH POTENTIAL AND HIGH FREQUENCY, by Nikola Tesla, McGraw-Hill Co., 1904.

Refferencing our phone conversation, I mentioned that I am a friend and long-time admirer of Inez Hunt's great work in Tesla research. The last letter I had written to her was some 18 months ago. I still have not received any reply. I understand she is very busy with her many areas of work and will again write to her very soon.

I am engaged in ball lightning phenomena research, ultra high potential-high frequency Tesla resonators, and applicable power transmission techniques. Thankyou for your prompt co-operation. I hope to hear from you soon.

Respectfully yours,

William C. Wysock

Sept. 1, 1976
PAGE 1 of 2

Robert K. Golka
Project Tesla-BOX 354
Wendover Air Force Base
Wendover, Utah, 84083

Dear Bob,

I am writing this letter to you because I feel that personalities should not jeopardize scientific investigation. I can well appreciate your anxiety in trying to get things done around the project, especially items which are necessary, but do not directly relate to the investigation of ball lightning.

I further realize that I came on "strong" in our discussion last week on Tuesday. I am now at a point of mind where I sincerely wish to transcend any personal differences of opinion and again offer my help to Project Tesla. The name of Tesla is revered by many today, but not enough to suit my tastes. I feel that one of the important tasks at hand is the emancipation of Tesla before today's public awareness as one of this world's truly great men of science and engineering. Further, I feel that one giant step in this direction is the effort you are forging in your investigation of ball lightning. Indeed, your efforts must succeed for many important reasons. Fusion power technology will become reality and I for one sincerely hope that Tesla's early investigations and yours will underwrite a new generation of technology.

Both Greg and I have thoroughly read all the available scientific data on ball lightning phenomena that we could find, (including your own report co-authored with Dr. Robert W. Bass.) On our eleven hour trip back home, we carried on a lengthy discussion on this subject. We found ourselves seeking what seemed to be a common missing link in all of the reports ranging from the 100 kilovolt submarine battery experiments of Dr. James Tuck to the "brillo-pad incident!" We theorized that in part, the common missing link may be the temporary formation of a "localized" R.F. cavity. Furthermore, that it may be such a manifestation that is wholly responsible for the embryonic stages of BL.

From your report it may then logically follow to an advanced or "adult" stage.. Clearly, there must be some common ingredient(s) to allow the explanation of BL under so many diverse conditions.

Bob, let me know what status the project is in. If you are in need of technical assistance for the project, again I stand ready to answer your call.

Obviously I was disappointed at not having the opportunity to see the extra coil generating forty foot long discharges. If you now have the equipment working efficiently or will have in the foreseeable future, I would most definitely like to drive up to the project to take those pictures that I was planning to take. I have had much experience exposing various film to electrical discharges, and I feel confident that I can do an outstanding job. I could drive up on any Friday late afternoon and arrive early Saturday morning. I would not have to return until late Sunday evening. In this kind of situation, I have a reputation for going without rest or sleep for over seventy hours!

Please let me know as soon as possible to when we may get together again. Also, if you need hard-to-find parts, I have excellent local sources for many items. I am still very interested in purchasing that antique voltmeter from you. I have a newer type replacement as well as your asking price to offer. You had mentioned that it might be possible to obtain a copy of that Tesla poster. I am very much still interested in that too!

Recalling much reading on interrupters, spark gaps, et al, plus personal experience, I recall a design of gap which I have modified for ultra-high power applications; a combination of rotary and quenched types. This type has all the advantages of a standard rotary gap but will allow more capacitor discharges-- per rotary point to effect a much higher R.F. energy field being induced into the secondary of a resonant transformer, due to the "quenched" style rotary discs. I have enclosed a thumb-nail sketch for your review. Should you be interested in constructing this type of gap, may I offer either to supply exact specifications, or I will be happy to build a unit for you here.

Bob- keep the faith and I hope to hear from you real soon. Should you wish to contact me by telephone, feel free to call me anytime of day or night.
From 8 P.M. PST to 8:30 A.M. PST (213) 442-2120
From 10:00 A.M. PST to 6:30 P.M. PST (213) 469-1173 or (213) 466-0662

Respectfully yours,

William C. Wysock

October 4, 1976
Morris and Lee Scientific Co.
1685 Elmwood Ave.
Buffalo 7, N.Y. 14207

Gentlemen:

It has been quite some time since I last wrote to your company, (June 1966)
At that time, I purchased a 500 KV Van de Graaf generator in kit form from you.
To this very day it is still in fine working order, and used regularly in my high voltage research work.

The purpose of this letter is to inquire as to your current available list of high voltage components. In specific, I am now interested in purchasing an assortment of aluminum oblates ranging in outside diameter from 14 inches, (used on the 500KV generator) up to the 34 inch unit you had at one time informed me was still available.

I am currently engaged in BALL LIGHTNING RESEARCH. I have already been to PROJECT TESLA in Wendover, Utah and have seen a one-to-one scale size re-creation of Tesla's MAGNIFYING TRANSMITTER in full operation. My efforts are concerned with the utilization of somewhat lesser amounts of power, but still trying to achieve the same results. The largest of the high frequency-high potential oscillators that I am now employing have outputs ranging up to 3 megavolts. These devices require a rather large size high voltage terminal for capacitive coupling to the secondary of the resonators. Hence, my interest in your 34 inch terminal may be realized.

I would be very anxious to correspond with any individuals that you may know of who are currently interested in any type of high voltage technique. My own interests cover a vast area from natural lightning to radio frequency discharges to impulse voltage multipliers.

Please let me know if you are able to supply me with any of the above as soon as possible. It is very likely that in the near future I may give an exhibit at the Los Angeles Museum of Science and Industry, relating to the equipment for which I need to procure pieces from your firm. Also, should you have any interest in what I am now trying to accomplish, I would be delighted to correspond with you.

Sincerely yours,

William C. Wysock
William C. Wysock

WCW:bw

Del Electronics Corp.

250 E. SANDFORD BLVD.
MOUNT VERNON, NEW YORK 10550

914 699-2000
TWX: 710-562-0130

October 13, 1976

Professional Sound Systems
4914 Baldwin Avenue
Temple City, Cal. 91780

Attention: Mr. William C. Wysock

Dear Mr. Wysock:

Enclosed is a copy of the Del Electronics high voltage power supply & equipment catalog. Del Electronics specializes in the high voltage equipment product line & we have designed & manufactured equipment rated from 500V to 400,000V.

Del Electronics has a standard catalog line as noted in our catalog, however a major portion of our business is related to custom design. Del Electronics has a reputation in the industry for well engineered & high quality products.

There are a couple of references I can provide that may be of interest:

- 1) Electronics Design - June 21, '76 Issue - Special feature on high voltage power supplies. We show a picture of our view x-ray power supply.
- 2) Dielectric Phenomena in High Voltage Engr. - F.W. Peeic, Jr. - McGraw-Hill 1929 - This is an old book, however, the information is current.

There are many other references & specific power supply design information we can provide, however we need more specific information on your requirements.

Please feel free to call if you want to discuss any of your special requirements.

Very truly yours,
DEL ELECTRONICS CORP.


Bob A. Michalak
Technical Sales Manager

BAM:gb

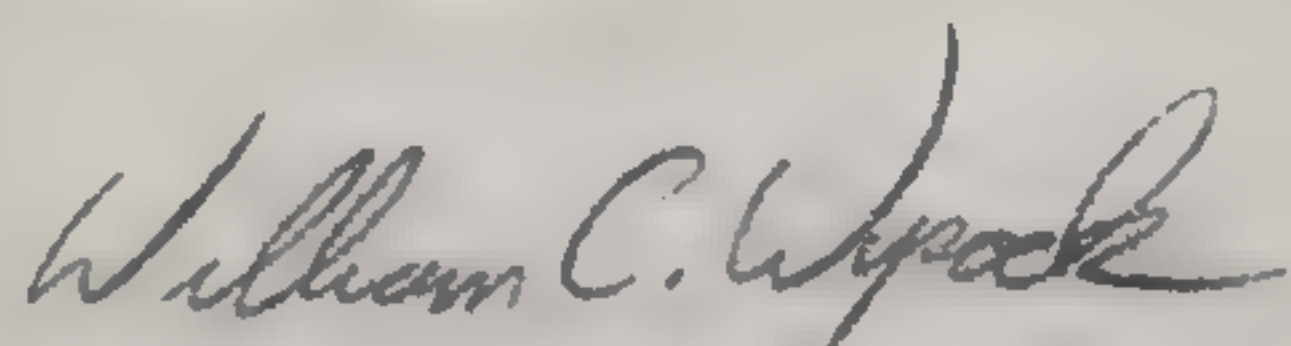
October 4, 1976
Deltaray Corporation
South Bedford Street
Burlington, MA. 01803
Attn: W. Bygrave

Dear Mr. Bygrave:

I am interested in receiving any information you may have on high voltage equipment and related components. My interests are in the extreme and ultra-high voltage region. I am involved in BALL LIGHTNING research and am investigating various types of power supplies which may be applicable to my work requirements. I am also interested in any type of literature pertaining to high voltage technique, such as brochures, articles in trade publications, books, etc.

Thankyou for your co-operation.

Sincerely yours,



William C. Wysock

WCW:bw



DELTARAY
A DIVISION OF HIGH VOLTAGE ENGINEERING CORPORATION

P.O. Box 416, South Bedford Street, Burlington, Mass. 01803 · 617-273-1513 · 617-272-1313

October 19, 1976

Mr. William C. Wysock
Professional Sound Systems
4914 Baldwin Avenue
Temple City, CA 91780

Dear Mr. Wysock:

Thank you very much for your recent request for information on the dc power supplies which we manufacture. A catalog is enclosed.

There are three basic product lines: (1) Series S with maximum voltages 50 kV to 425 kV, output power 400 watts; (2) Series L with maximum voltages 50 kV to 1 MV, output power 1000 watts; (3) Series M with maximum voltages 50 kV to 1 MV, output power 10000 watts.

In Series L and M units, the voltage is generated by using the Deltatron principle which has the following advantages over conventional voltage multipliers: very low ripple, excellent regulation, little stored energy, small dimensions, and light weight.

Ripple is specified as peak to peak at all frequencies from dc upwards and is 0.01% on most models, with 0.002% or better as an option. Regulation is $\pm 0.01\%$ for zero to full load, and $\pm 10\%$ line fluctuations. Response time of the stabilizer is less than 200 microseconds. All L and M units include built in surge limiting resistors between the power unit and the HV output.

Options include external voltage control by a signal 0 to 10 V dc, connection for digital voltmeter or strip chart recorder, rapid polarity reversal, and voltage measuring resistors with a temperature co-efficient of 80 ppm/ $^{\circ}$ C.

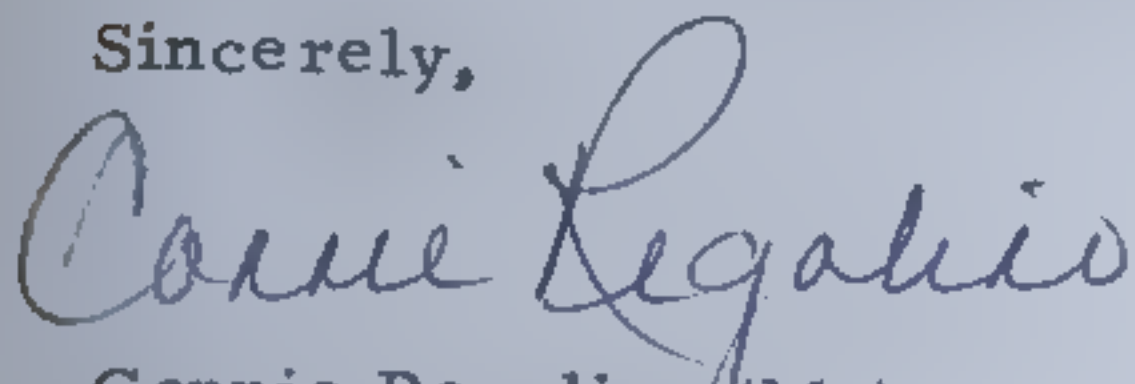
Mr. William C. Wysock
October 19, 1976
Page 2

Series S units are RF voltage multipliers with many of the features of L and M units, but with regulation 0.05% and ripple 0.5% peak to peak.

Since we introduced these units in 1971, we have sold two hundred units with voltages from 50 kV to 1 MV, primarily for use with electron and positive ion accelerators, x-ray generators, electron microscopes, isotope separators, and high voltage studies.

Besides our standard products, we design and build power supplies to meet customer's specifications; so, whatever your needs for dc, high voltage, please do not hesitate to contact us. We appreciate your interest in our products.

Sincerely,

A handwritten signature in cursive script that reads "Connie Regolino". The signature is written in dark ink and is positioned above the printed name and title.

Connie Regolino (Ms)
Sales Administrator

Enclosure: Catalog

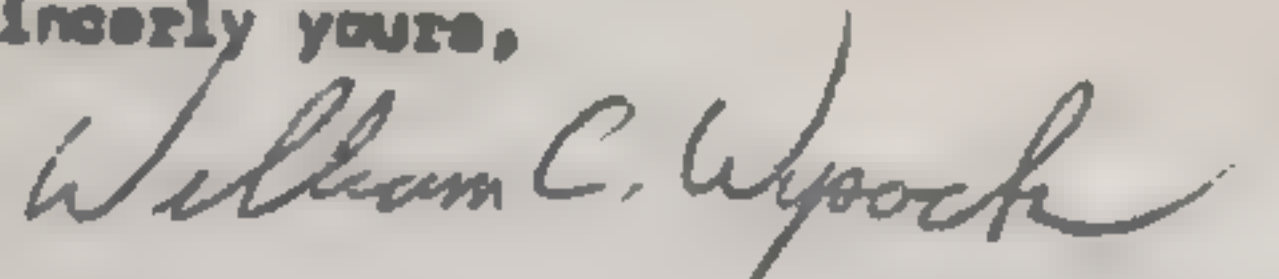
October 4, 1976
EMCO HIGH VOLTAGE
2444 Old Middlefield Way
Mountain View, Ca. 94043

Gentlemen:

I am interested in receiving any information you may have on high voltage equipment and related components. My interests are in the extreme and ultra-high voltage region. I am involved in BALL LIGHTNING research and am investigating various types of power supplies which may be applicable to my work requirements. I am also interested in any type of literature pertaining to high voltage technique, such as brochures, articles in trade publications, books, etc.

Thankyou for your co-operation.

Sincerely yours,



William C. Wysock

WCW:bn

October 4, 1976
SORENSEN COMPANY
676 Island Pond Road
Manchester, N.J. 03103
ATTN: R.J. McCUE

Dear Mr. McCue:

I am interested in receiving any information you may have on high voltage equipment and related components. My interests are in the extreme and ultra-high voltage region. I am involved in BALL LIGHTNING research and am investigating various types of power supplies which may be applicable to my work requirements. I am also interested in any type of literature pertaining to high voltage technique, such as brochures, articles in trade publications, books, etc.

Thankyou for your co-operation.

Sincerely yours,

William C. Wysock
William C. Wysock

WCW:bw

October 8, 1976
R D X Corporation
110 South Euclid Avenue
Pasadena, Ca. 91101
Thomas M. French-PRESIDENT

Dear Mr. French,

Thankyou for the telephone conversation yesterday afternoon. As per your request, this letter shall constitute an order to Hipotronics for the following spheres and toroids;

1 EA. TD-12 toroid.....\$40.00total.....\$40.00
4 EA. SP-1 spheres.....\$ 3.50.....total.....\$14.00...drilled, tapped-#10-32
4 EA. SP-2 spheres.....\$ 6.00.....total.....\$24.00...drilled, tapped-#1/4-20

All of the above items are taxable. I understand the nature of this order to be C.O.D. Please let me know when you receive the order in your office by telephoning me at 466-0662 or 469-1173.

As I explained to you on the phone, my company is now engaging in the study and research of BALL LIGHTNING phenomena. The tools required for this type of research involve extremely high voltage potentials and peak surge currents. As it is most practicle to employ the use of resonant high frequency oscillators to produce this power, the insulation problems of the ultra-high potential terminals becomes very critical, (high frequency at high potential exhibits the tendency to emit heavy corona discharge streamers-100 KHz @ approx. 5 megavolts)

As the potential is anticipated to go even higher in future experiments, I am sure that I will need to order larger diameter toroids from Hipotronics in the future.

Regarding my inquiry as to any observance of "unusual discharge phenomena" at Hipotronics in any of their testing experience, I will greatly appreciate anything you may be able to send to me, i.e., company newsletter articles, technical publications, brochures, references to any books available and so on. Thankyou for your time and help.

Sincerely yours,

William C. Wysock
William C. Wysock

WCH/bw

THORN L. MAYES

21120 SULLIVAN WAY
SARATOGA, CA. 95070

Jan. 23, 1977

Mr. Bill Wysock,
4914 Baldwin Ave.,
Temple City, Calif. 91780

Dear Mr. Wysock:-

Recently I sent Mr. Nick Basura a copy of an article on the design and construction of small Tesla Coils powered by a 6000. volt .030 Amp. neon sign transformer that generates sparks 10-12 inches long. This material will be published in the Bulletin of the Antique Wireless Association for June 1977.

In this paper I make the statement--" A Frenchman named Oudin was impressed with the displays, copied Tesla's equipment which he took to France where he gave exhibits. Oudin used the vertical secondary design and unfortunately this construction is now usually referred to as an Oudin coil tho it was originated by Tesla."

This statement is based upon a letter to me from Leland Anderson of April 5, 1976 which I quote--"I don't use the term "Oudin" to describe the vertical configuration of Tesla coil. Oudin, a Frenchman, took Tesla's work and demonstrated the use of this coil under his (Oudin's) name. Tesla shows the vertical configuration in his patents and also numerous photographs exist of this configuration of coil in Tesla's laboratories."

Mr. Basura says that The Oudin coil was not named for a man that the name was for a part of the coil , that I should write you to get the correct story which I would appreciate knowing.

Sincerely,

Thorn Mayes

Jan. 31, 1977

Dear Mr. Mayes;

As to your referred inquiry I can only answer that Nick Basura, who is a very good friend of mine, possibly is mistaken in what he thought I had said to him in regards to the difference between "Oudin" and "Tesla" coil design. I believe that Mr. Anderson's account of this little known subject is correct in so far as it seems to align with what data I have accumulated in my own researches. From a book, HIGH FREQUENCY MANUAL, by Noble M. Eberhart, circa 1920, the author states on page 40; "Oudin discovered that with a coil of wire properly tuned or adjusted to the course coil or solenoid of D'Arsonval the electrical currents of the latter produced currents of such strength that they might be taken from the terminal of the larger solenoid and applied to the body. They are of high frequency, high voltage, and low amperage, resembling the Tesla Secondary. As ordinarily constructed, the D'Arsonval apparatus and the resonator are combined in one instrument the resonator proper consisting of a large coil of fine wire placed above the course solenoid of the D'Arsonval machine."

Again, referring to Eberhart's book, the author makes the distinction between "Tesla," "Dudin," and "D'Arsonval," by implying that the former two kinds are characterized by high frequency-high potential at low milliamprage while the latter exhibited high frequency-high milliamperage at comparatively low voltage.

I have myself built many coils of all sizes and configurations, the largest of which in final form will produce discharges of over twelve feet in length. I am currently starting to secure a research grant to do Ball Lightning research, which will be based on Tesla's Colorado Springs experiments. Also, I am slated to exhibit much of my equipment at the Los Angeles Museum of Science and Industry latter this year. I hope that the foregoing may be of some help to you and I look forward to more in-depth communication with you.

Sincerely yours,

poss

William C. Wysock
4914 Baldwin Ave.
Temple City, Ca. 91780
Feb. 1, 1977

Mr. Mark May
NOBA Ship Fairweather
Navel Support Activity
Long Beach, Ca. 90822

Dear Mr. May;

I very much enjoyed hearing from you the other day by telephone. It is amazing how strange links in communication can bring individuals from such varied backgrounds into close contact. If I recall correctly, you had stated that you will be in the local area for the next two months. I am sure that on a week-end in the near future, if you can arrange for transportation to my house, we could get together. Possibly you could stay for dinner. My wife is an excellent cook. Nick Basura is a close friend of mine. He has been of great help to me in the past and continues to be of even greater assistance now. I feel that he is a unique person-much as Tesla himself was. Nick has such a vast network of contacts that I barely manage to keep up any correspondence from his references.

To tell you a bit about myself: let me state that my interests are quite diversified and in each case very intense. Vocationally speaking to date I make my living in the professional audio industry. I am an acoustical and electronic design engineer, a disc-mastering engineer, a technical maintenance engineer, and last but not least a mixing engineer. I've been in this line of work for over eleven years now and things are always speeding up. In any "spare time," I manage to continue my work on various sizes and designs of high frequency, high potential resonators. The current series of coils now almost complete in construction, are primarily intended for exhibit at the Museum of Science and Industry later this year, which I think I mentioned to you on the Phone. Building these oscillators is a relatively simple task except if one is trying to get an efficiency of performance that is rarely if ever obtained. By example, my "#5coil" has a secondary winding consisting of only 350 turns of AWG #20 solid formvar insulated copper wire on a vinyl tube measuring 5.5x22.0 inches. I am exciting the primary, (3 turns formed by .25 inch copper tubing arranged as a helix at the base of the secondary,) with an oscillator running at a first harmonic frequency of 240 Khz at approximately 3.5 Kw. Now in standard Tesla coil design, any reference will tell you that a discharge length which approximates the length of the secondary is approaching "theoretical maximum" output. My 22 inch winding is currently giving of continuous streamer discharges of over 50 inches in length. A high price must be paid for this type of outrageous performance though, for I have had to re-wind the coil twice in the last six months due to the unavoi-

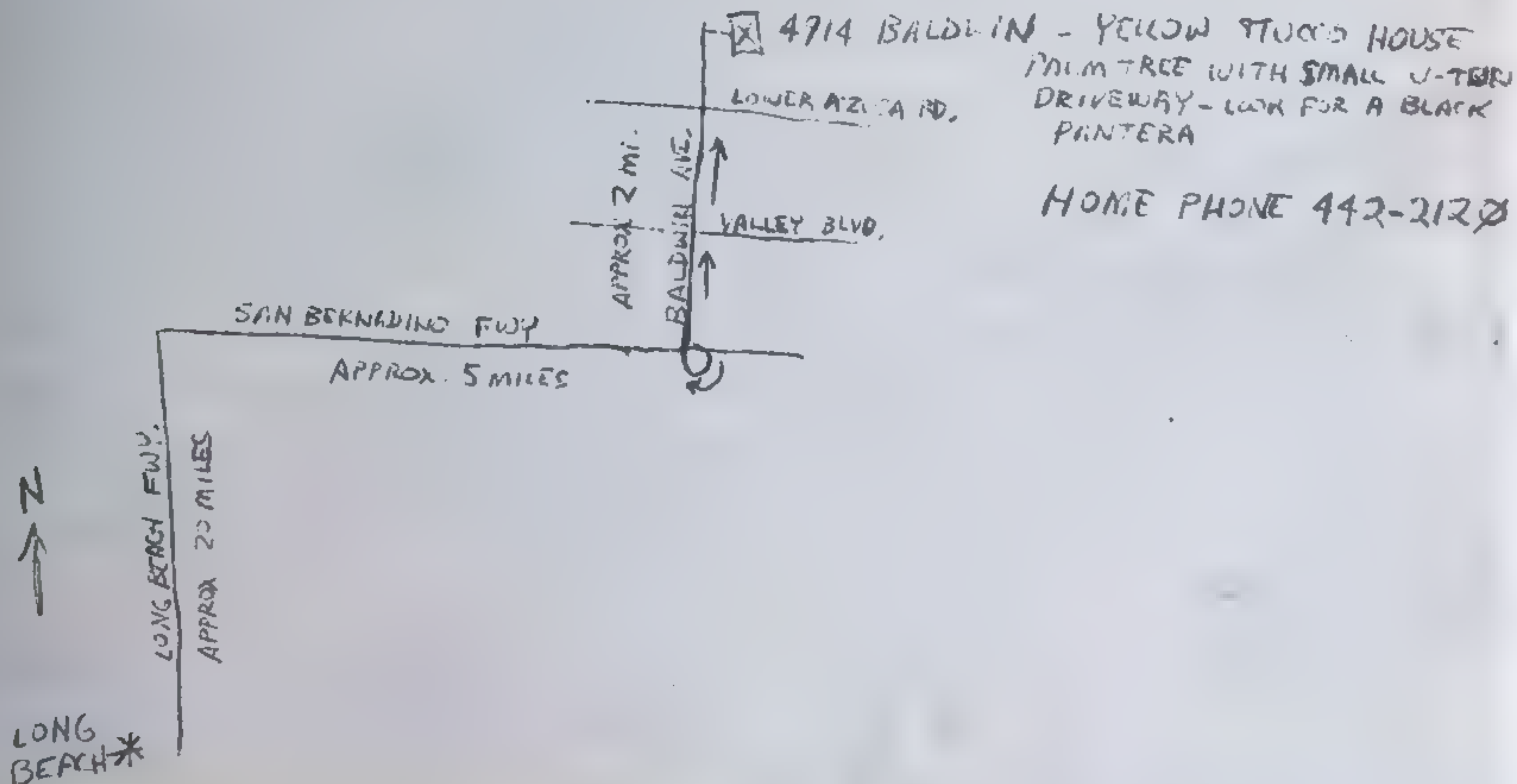
PAGE TWO

able break-down of insulation between the individual turns of wire. Oscillator design is another area in which I have spent much design time. While I will agree with anyone that in theory a vacuum tube unit will be more efficient in the aspects of unity power factor and narrow band frequency group, it is extremely expensive and bulky to order up a triode oscillator that is capable of giving 20-50 Kw in a frequency band ranging from 500Khz down to 75 Khz. Since I am not a stockholder in Varian (Eimac,) it is quite simply out of the question where I am demanding high power levels. I did at one time construct successfully an oscillator that used four Eimac 4-400 A's in a twin push-pull configuration. I felt that that unit was not to be long lived as I had a considerable amount of difficulty in coping with plate dissipation below 500 Khz with an input power of 5 Kw.

Mark, I could go on typing (with typos) for hours and it is possibly better left to our getting together for further discussion. Below is a simple map of where I am located in this "concrete jungle"----I trust that you will find your way. As for a time to suit us both may I suggest that you call me during any week day at the studio, (Gold Star,) 469-1173 at least two days in advance. That should be sufficient for me to make plans.

Sincerely yours,

B. E. Phelps



William C. Wysock
4914 Baldwin Ave.
Temple City, Ca.
91780

Jan. 31, 1977

Honorable John H. Rousselot
United States Congressman, 26th District
735 W. Duarte Rd.
Arcadia, Ca. 91006

Dear Congressman Rousselot:

I am interested in acquiring a financial grant in order to complete a project of scientific research in the field of Ball Lightning research. My goal is to artificially produce ball lightning by man-made equipment, manifest its creation by the same means in order to thoroughly analyze its properties, and utilize the accumulative data for the advancement of thermo-nuclear fusion techniques.

I have organized this project into three major phases. Phase one is the building of the necessary equipment on a laboratory test site. Phase two is the development of techniques in artificially producing ball lightning at will, and the ability to control the process in such a manner as to facilitate a complete analysis of its composition, thereby making known for the first time ever, the secrets of this unique phenomenon. Phase three is the practical application of this research towards new energy systems based on fusion.

I anticipate no longer than one year to successfully complete the first two phases of work. The calculated expense of the first two phases will be in the range of \$75,000.00 to \$100,000.00, depending primarily on the availability of necessary equipment components. Pending the success of phases one and two, the third and final phase will inevitably require active involvement of other governmental agencies currently involved in new energy resource programs.

It is my sincere desire to execute this research as my contribution towards a solution of our energy needs now and for a more prosperous future.

I look towards you for guidance and assistance in helping me to achieve this great goal.

Yours very truly,

William C. Wysock
William C. Wysock

NATIONAL

ENQUIRER

March 3, 1977

Mr. William C. Wysock
4914 Baldwin Avenue
Temple City, Calif. 91780

Dear Mr. Wysock:

Thank you for submitting the enclosed photograph (s) for possible publication.

However, we are not in a position to use the enclosed at the present time, so I am returning it to you.

Again, thanks for contacting the ENQUIRER.

Sincerely,

Niels Paulsen
NIELS PAULSEN
PHOTO EDITOR

NP/d1

Enclosure (s)

Convenient Formulae and Units for Use in Design Calculations

**USEFUL . . .
INFORMATION**

FORMULAE FOR DETERMINING AMPERES, HORSEPOWER, KILOWATTS AND KILOVOLT-AMPERES

To Find the Value	When Value Below is Known	SYSTEM			
		Direct Current	Single-Phase	Two-Phase Four Wire	Three-Phase
		FORMULAE			
Amperes (I)	Horsepower (hp)	$I = \frac{746 \text{ hp}}{E \times \text{eff}}$	$I = \frac{746 \text{ hp}}{E \times \text{eff} \times \text{pf}}$	$I = \frac{746 \text{ hp}}{2 \times E \times \text{eff} \times \text{pf}}$	$I = \frac{746 \text{ hp}}{1.73 \times E \times \text{eff} \times \text{pf}}$
Amperes (I)	Kilowatts (kw)	$I = \frac{1000 \text{ kw}}{E}$	$I = \frac{1000 \text{ kw}}{E \times \text{pf}}$	$I = \frac{1000 \text{ kw}}{2 \times E \times \text{pf}}$	$I = \frac{1000 \text{ kw}}{1.73 \times E \times \text{pf}}$
Amperes (I)	Kilovolt-Amperes (kva)		$I = \frac{1000 \text{ kva}}{E}$	$I = \frac{1000 \text{ kva}}{2 E}$	$I = \frac{1000 \text{ kva}}{1.73 E}$
Kilowatts (kw) Input		$\text{kw} = \frac{I \times E}{1000}$	$\text{kw} = \frac{I \times E \times \text{pf}}{1000}$	$\text{kw} = \frac{I \times E \times 2 \times \text{pf}}{1000}$	$\text{kw} = \frac{I \times E \times 1.73 \times \text{pf}}{1000}$
Kilovolt-Amperes (kva)			$\text{kva} = \frac{I \times E}{1000}$	$\text{kva} = \frac{I \times E \times 2}{1000}$	$\text{kva} = \frac{I \times E \times 1.73}{1000}$
Horsepower (hp) Output		$\text{hp} = \frac{I \times E \times \text{eff}}{746}$	$\text{hp} = \frac{I \times E \times \text{eff} \times \text{pf}}{746}$	$\text{hp} = \frac{I \times E \times 2 \times \text{eff} \times \text{pf}}{746}$	$\text{hp} = \frac{I \times E \times 1.73 \times \text{eff} \times \text{pf}}{746}$

I = Amperes.
E = Volts.
eff = Efficiency in decimals.
pf = Power Factor in decimals.

kw = Kilowatts Input.
kva = Kilovolt-Ampere Input.
hp = Horsepower Output.

For two-phase, three wire, balanced circuits the amperes in common conductor = $1.41 \times$ that in either of the other two.

EQUIVALENT VALUES OF ELECTRICAL, MECHANICAL, AND HEAT UNITS

Unit	Equivalent Value in Other Units	Unit	Equivalent Value in Other Units
1 Kw.-hour =	1,000 watt-hours. 1,341 horsepower-hours. 2,655,200 ft.-lb. 3,600,000 joules. 3,415 heat-units. 367,100 kilogram-meters. 0.234 lb. carbon oxidized with perfect efficiency. 3.52 lb. water evap. from and at 212° F. 22.77 lb. of water raised from 62° to 212° F.	1 Watt =	1 joule per second. 0.001341 hp. 3.415 heat-units per hour. 0.73756 ft.-lb. per second. 0.0035 lb. water evap. per hour. 44.254 ft.-lb. per minute.
1 Hp.-hour =	0.7457 kw.-hour. 1,980,000 ft.-lb. 2,546.5 heat-units. 273,740 kilogram-meters. 0.174 lb. carbon oxidized with perfect efficiency. 2.62 lb. water evap. from and at 212° F. 17.0 lb. water raised from 62° F. to 212° F.	1 Watt per Sq. In. =	8.20 heat-units per sq. ft. per minute. 6.373 ft.-lb. per sq. ft. per min. 0.1931 hp. per sq. ft.
1 Kilowatt =	1,000 watts. 1.3410 horsepower. 2,655,200 ft.-lb. per hour. 44,254 ft.-lb. per minute. 737.56 ft.-lb. per second. 3,415 heat-units per hour. 56.92 heat-units per minute. 0.9486 heat-units per sec. 0.234 lb. carbon oxidized per hour. 3.52 lb. water evap. per hr. from and at 212° F.	1 Heat-Unit =	1,054.2 watt-seconds. 777.54 ft.-lb. 107.5 kilogram-meters. 0.0002928 kw.-hour. 0.0003927 hp.-hour. 0.0000685 lb. carbon oxidized. 0.001030 lb. water evap. from and at 212° F.
1 Hp. =	745.7 watts. 0.7457 kw. 33,000 ft.-lb. per minute. 550 ft.-lb. per second. 2,546.5 heat-units per hour. 42.44 heat-units per minute. 0.707 heat-units per second. 0.174 lb. carbon oxidized per hour. 2.62 lb. water evap. per hour from and at 212° F.	1 Heat-unit per Sq. Ft. per Min. =	0.1920 watt per sq. in. 0.01757 kw. per sq. ft. 0.02356 hp. per sq. ft.
1 Joule =	1 watt second. 0.000000278 kw.-hour. 0.10197 kilogram-meter. 0.0009486 heat-units. 0.73756 ft.-lb.	1 Kilogram-meter =	7.233 ft.-lb. 0.00003653 hp.-hour. 0.000002724 kw.-hour. 0.009302 heat-unit.
1 Ft.-lb. =	1.3558 joules. 0.13826 kilogram-meter. 0.000003766 kw.-hour. 0.0012861 heat-unit. 0.0000005 hp.-hour.	1 lb. Carbon Oxidized with Perfect Efficiency =	14,600 heat-units. 1.11 lb. anthracite coal oxidized. 2.5 lb. dry wood oxidized. 22 cu. ft. illuminating gas. 4.75 kw.-hour. 5.733 hp.-hour. 11,352,000 ft.-lb. 15.05 lb. of water evap. from and at 212° F.
		1 Lb. Water Evap. from and at 212° F. =	0.2841 kw.-hour. 0.3811 hp.-hour. 970.4 heat-units. 104,320 kilogram-meter. 1,023,000 joules. 754,525 ft.-lb. 0.066466 lb. carbon oxidized.

WIRE CALCULATIONS

Ohm's Law

Ohm's Law: $I = \frac{E}{R}$, where I is current;

E is voltage; and R is resistance.

Example: With a voltage of 112 and a resistance of 8 ohms, what current would flow?

$$I = \frac{112}{8} \text{ or } 14 \text{ amperes.}$$

Example: What resistance is necessary to obtain a current of 14 amperes at 112 volts?

$$R = \frac{E}{I} \text{ or } R = \frac{112}{14} \text{ or } 8 \text{ ohms.}$$

Example: What voltage would be required to produce a flow of 14 amperes through a resistance of 8 ohms.

$$E = IR \text{ or } E = 14 \times 8 \text{ or } 112 \text{ volts.}$$

Voltage Drop

The resistance of a copper wire one foot long and one circular mil in cross section is approximately 10.8 ohms.

In Ohm's law $I = \frac{E}{R}$, R is equal to: Length of conductor in feet $\times 10.8$ divided by the circular millage of the conductor or,

$$R = \frac{2 \times \text{feet (length of circuit)} \times 10.8}{CM}$$

Using Ohm's law, $E = IR$,

$$E = \frac{\text{Amps.} \times 2 \times \text{feet} \times 10.8}{CM}$$

where the term "feet" indicates the length of the circuit, the number of feet of wire in the circuit being double the length of the circuit.

Example: What would be the volts loss in a circuit of No. 12 wire carrying 20 amperes a distance of 50 feet?

$$E = \frac{20 \times 2 \times 50 \times 10.8}{6530} \text{ or } 3.3 \text{ volts drop, or } 3\% \text{ on a } 110\text{-volt circuit.}$$

Example: What size of conductor would be necessary to give a 3% drop on a 110 volt circuit carrying 20 amperes a distance of 50 feet?

$$CM = \frac{\text{Amps.} \times 2 \times \text{feet} \times 10.8}{E} \text{ or}$$

$$CM = \frac{20 \times 2 \times 50 \times 10.8}{3.3} \text{ or } 6530 \text{ CM or a No. 12 wire.}$$

Example: What current can a No. 12 wire carry on a 50 foot circuit with a voltage drop of 3.3 volts?

$$I = \frac{\text{Amp.} \times 2 \times \text{feet} \times 10.8}{CM \times E} \text{ or}$$

$$I = \frac{6530 \times 3.3}{50 \times 2 \times 10.8} \text{ or } 20 \text{ amperes.}$$

Current Calculations

The formula $W = EI$, where W = watts; E = voltage and I = current, can be used to determine the watts $W = EI$; the voltage, $E = \frac{W}{I}$; or the current; $I = \frac{W}{E}$. This formula is applicable where the power-factor is unity. To determine the current:

$$\text{2-wire, Direct Current: } I = \frac{W}{E}$$

$$\text{3-wire, Direct Current: } I = \frac{W}{2E} \text{ where } E \text{ is the voltage between the outside wire and the neutral.}$$

$$\text{2-wire, Single-phase: } I = \frac{W}{E \times PF} \text{ where } PF \text{ represents the power factor of the circuit.}$$

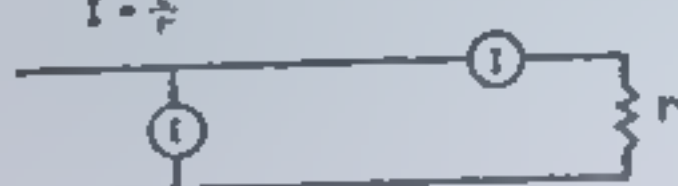
$$\text{3-wire, Single-phase: } I = \frac{W}{2E \times PF} \text{ where } E \text{ is the voltage between the outside wire and the neutral.}$$

$$\text{3-wire, Three-phase: } I = \frac{W}{1.73E \times PF} \text{ where } E \text{ is the voltage between outside wires.}$$

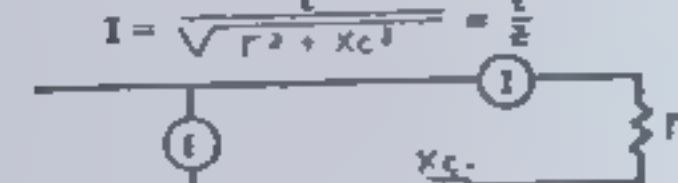
$$\text{4-wire, Three-phase: } I = \frac{W}{3E \times PF} \text{ where } E \text{ is the voltage between one outside wire and the neutral.}$$

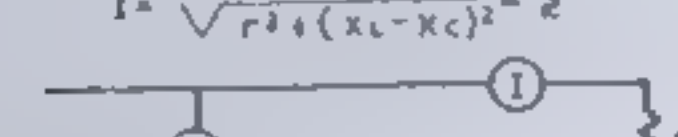
(Courtesy of International Association of Inspectors)

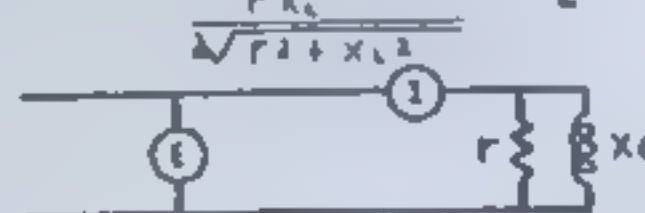
FORMULAE FOR DETERMINING ALTERNATING CURRENT in Alternating Current Circuits

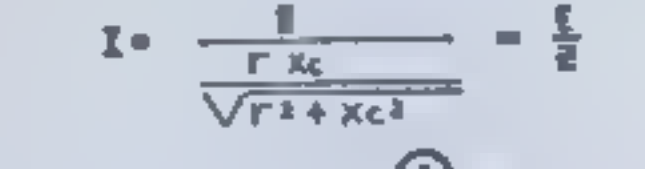
$$I = \frac{E}{r}$$


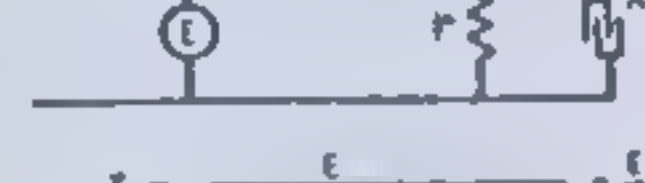
$$I = \frac{E}{\sqrt{r^2 + X_L^2}}$$

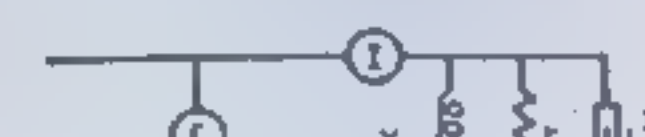

$$I = \frac{E}{\sqrt{r^2 + X_C^2}}$$


$$I = \frac{E}{\sqrt{r^2 + (X_L - X_C)^2}}$$


$$I = \frac{E}{\frac{r X_C}{\sqrt{r^2 + X_L^2}}} = \frac{E}{r} \times \frac{\sqrt{r^2 + X_L^2}}{X_C}$$


$$I = \frac{E}{\frac{r X_C}{\sqrt{r^2 + X_C^2}}} = \frac{E}{r} \times \frac{\sqrt{r^2 + X_C^2}}{X_C}$$


$$I = \frac{E}{\frac{r X_L X_C}{\sqrt{X_L^2 X_C^2 + r^2 (X_L - X_C)^2}}} = \frac{E}{r} \times \frac{\sqrt{X_L^2 X_C^2 + r^2 (X_L - X_C)^2}}{X_L X_C}$$


$$I = \frac{E}{\frac{r X_L X_C}{\sqrt{X_L^2 X_C^2 + r^2 (X_L - X_C)^2}}} = \frac{E}{r} \times \frac{\sqrt{X_L^2 X_C^2 + r^2 (X_L - X_C)^2}}{X_L X_C}$$


r = Resistance in Ohms

X_L = Inductive reactance in Ohms $= 2\pi fL$

X_C = Condensive Reactance in Ohms $= \frac{1}{2\pi fC}$

Z = Impedance in Ohms

I = Current in Amperes

E = Pressure in Volts

f = frequency in cycles per second
 L = ind. in Henrys
 C = capacity in Farads

CONVENIENT TABLES AND FORMULAE

FORMULA FOR COMBINING RESISTANCE AND REACTANCE

$R = r$

$R = \frac{1}{\frac{1}{r_1} + \frac{1}{r_2}} = \frac{r_1 r_2}{r_1 + r_2}$

$R = \frac{1}{\frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3}} = \frac{r_1 r_2 r_3}{r_1 r_2 + r_1 r_3 + r_2 r_3}$

$Z = \sqrt{r^2 + x_L^2}$

$Z = \sqrt{r^2 + x_C^2}$

$Z = \sqrt{r^2 + (x_L - x_C)^2}$

$Z = \frac{1}{\sqrt{\left(\frac{1}{r}\right)^2 + \left(\frac{1}{x_L}\right)^2}} = \frac{r x_L}{\sqrt{r^2 + x_L^2}}$

$Z = \frac{1}{\sqrt{\left(\frac{1}{r}\right)^2 + \left(\frac{1}{x_C}\right)^2}} = \frac{r x_C}{\sqrt{r^2 + x_C^2}}$

$Z = \frac{1}{\sqrt{\left(\frac{1}{r}\right)^2 + \left(\frac{1}{x_L - x_C}\right)^2}} = \frac{r x_L x_C}{\sqrt{x_L^2 x_C^2 + r^2 (x_L - x_C)^2}}$

r = Resistance in Ohms
 x_L = Inductive reactance in Ohms = $2\pi f L$
 x_C = Condensive Reactance in Ohms = $\frac{1}{2\pi f C}$
 Z = Impedance in Ohms
 I = Current in Amperes
 E = Pressure in Volts

f = frequency
 L = ind. in Henrys
 C = capacity in Farads

DETERMINATION OF TEMPERATURE by Resistance Measurements

Based on a temperature co-efficient for copper wire of .00427 at 0°C, the following relations exist between resistance and temperature:

R = Resistance of winding at T° C (Final Temp.)
 r = Resistance of winding at t° C (Initial Temp.)

then $\frac{R}{r} = \frac{234.5 + T}{234.5 + t}$ or $T = \frac{R}{r}(234.5 + t) - 234.5$

USEFUL ELECTRICAL FORMULAE FOR DETERMINING AMPERES, HORSEPOWER, KILOWATTS, AND Kv-a.

To Find	Direct Current	ALTERNATING CURRENT		
		Single Phase	2 Phase *—Four Wire	Three Phase
Amperes when Horsepower is known	$\frac{Hp. \times 746}{E \times \% \text{ Eff.}}$	$\frac{Hp. \times 746}{E \times \% \text{ Eff.} \times P.F.}$	$\frac{Hp. \times 746}{2 \times E \times \% \text{ Eff.} \times P.F.}$	$\frac{Hp. \times 746}{1.73 \times E \times \% \text{ Eff.} \times P.F.}$
Amperes when Kilowatts is known	$\frac{Kw. \times 1000}{E}$	$\frac{Kw. \times 1000}{E \times P.F.}$	$\frac{Kw. \times 1000}{2 \times E \times P.F.}$	$\frac{Kw. \times 1000}{1.73 \times E \times P.F.}$
Amperes when Kv-a. is known		$\frac{Kv-a. \times 1000}{E}$	$\frac{Kv-a. \times 1000}{2 \times E}$	$\frac{Kv-a. \times 1000}{1.73 \times E}$
Kilowatts	$\frac{I \times E}{1000}$	$\frac{I \times E \times P.F.}{1000}$	$\frac{I \times E \times 2 \times P.F.}{1000}$	$\frac{I \times E \times 1.73 \times P.F.}{1000}$
Kv-a.		$\frac{I \times E}{1000}$	$\frac{I \times E \times 2}{1000}$	$\frac{I \times E \times 1.73}{1000}$
Horsepower—(output)	$\frac{I \times E \times \% \text{ Eff.}}{746}$	$\frac{I \times E \times \% \text{ Eff.} \times P.F.}{746}$	$\frac{I \times E \times 2 \times \% \text{ Eff.} \times P.F.}{746}$	$\frac{I \times E \times 1.73 \times \% \text{ Eff.} \times P.F.}{746}$

I = Amperes; E = Volts; $\% \text{ Eff.}$ = Percent Efficiency; $P.F.$ = Power Factor; $Kw.$ = Kilowatts; $Kv-a.$ = Kilovolt-amperes;
 $Hp.$ = Horsepower.
 * For three-wire, two-phase circuits the current in the common conductor is 1.41 times that in either of the other two conductors.

HANDY FORMULAS

Power Transmission by Shaft

$$Hp. = \frac{\text{Torque (in ft. lb.)} \times \text{Rpm.}}{5250}$$

Hydraulics

$Hp. \text{ of Water Fall} = .114 \times \text{cu. ft. per sec.} \times \text{head in ft.} \times \text{Eff.}$ Assuming 88% eff. of water wheel, then:
 100 cu. ft. per sec. with 10 ft. head = 100 Hp.

Power to Drive Pumps

$$Hp. = \frac{\text{Gal. per min.} \times \text{Total head (inc. friction)}}{3960 \times \text{Eff. of Pump}}$$

Fans and Blowers

$Hp. \text{ to drive fans} = \frac{K \times \text{cu. ft. min.} \times \text{water gage pressure in in.}}{33000 \times \text{Eff. of fan}}$
 Water gage inches = 1.728 oz. per sq. in.
 $K = 5.2$
 Eff. = .5 for ordinary fans to .65 for Sirocco type

Rotating Mass Formula

Useful in estimating time to start-stop or change speed of fly-wheels, motors, etc. with certain applied torque =

$$\text{Time (Sec.)} = \frac{WR^2 \times \text{change in Rpm.}}{322 \times \text{torque (ft. lb.)}}$$

MENSURATION OF SURFACES AND VOLUMES

Area of Rectangle = length $\times$ breadth.
 Area of Triangle = $\frac{1}{2}$ base $\times$ perpendicular height.
 Circumference of Circle = diameter $\times$ 3.1416.
 Area of Circle = square of diameter $\times$.7854.

To Find Diameter of a Circle of Given Area

Divide area by .7854 and extract square root.

To Find Volume of a Cylinder

Area of section in square inches $\times$ length in inches = Volume in cubic inches.
 Cubic inches $\div 1728$ = Volume in cubic feet.
 Surface of a Sphere = Square of diam. $\times$ 3.1416.
 Volume of a Sphere = Cube of diam. $\times$.5236.
 Diameter $\times$.8862 = Side of square of equal area.
 Diameter $\times$.7071 = Side of inscribed square.
 Circumference = 3.5449 $\times$ $\sqrt{\text{Area of circle.}}$
 Diameter = 1.1284 $\times$ $\sqrt{\text{Area of circle.}}$

NUMBER OF CONDUCTORS IN CONDUIT OR TUBING*

Lead-Covered Types RL and RHL—600 V.

Size AWG MCM	NUMBER OF CONDUCTORS IN ONE CONDUIT OR TUBING											
	Single Conductor Cable				2-Conductor Cable				3-Conductor Cable			
	1	2	3	4	1	2	3	4	1	2	3	4
14	1 1/2	3/4	3/4	1	3/4	1	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4
12	1 1/2	3/4	3/4	1	3/4	1	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4
10	1 1/2	3/4	3/4	1	3/4	1	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4
8	1 1/2	3/4	3/4	1	3/4	1	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4
6	1 1/2	3/4	3/4	1	3/4	1	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4
4	1 1/2	3/4	3/4	1	3/4	1	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4
3	1 1/2	3/4	3/4	1	3/4	1	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4
2	1 1/2	3/4	3/4	1	3/4	1	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4
1	1 1/2	3/4	3/4	1	3/4	1	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4
0	1 1/2	3/4	3/4	1	3/4	1	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4
00	1 1/2	3/4	3/4	1	3/4	1	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4
000	1 1/2	3/4	3/4	1	3/4	1	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4
0000	1 1/2	3/4	3/4	1	3/4	1	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4
250	1 1/2	3/4	3/4	1	3/4	1	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4
300	1 1/2	3/4	3/4	1	3/4	1	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4
350	1 1/2	3/4	3/4	1	3/4	1	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4
400	1 1/2	3/4	3/4	1	3/4	1	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4
500	1 1/2	3/4	3/4	1	3/4	1	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4
600	2	3/4	3/4	4	3/4	4	3/4	4	3/4	4	3/4	4
700	2	3/4	3/4	4	3/4	4	3/4	4	3/4	4	3/4	4
750	2	3/4	3/4	4	3/4	4	3/4	4	3/4	4	3/4	4
800	2	3/4	3/4	4	3/4	4	3/4	4	3/4	4	3/4	4
900	2	3/4	3/4	4	3/4	4	3/4	4	3/4	4	3/4	4
1000	2 1/2	4	4	5	2 1/2	4	4	5	2 1/2	4	4	5
1250	3	5	5	6	3	5	5	6	3	5	5	6
1500	3	5	5	6	3	5	5	6	3	5	5	6
1750	3	5	5	6	3	5	5	6	3	5	5	6
2000	3 1/2	6	6	6	3 1/2	6	6	6	3 1/2	6	6	6

The above sizes apply to straight runs or with nominal offsets equivalent to not more than two quarter-bends.
(* 1947 N. E. Code, Table 5)

PROPERTIES OF COPPER CONDUCTORS*

Size AWG	Area Cir. Mils	Concentric Lay Stranded Conductors		Bare Conductors		D.C. Resistance Ohms/M Ft. At 25 C. 77 F.	
		No. Wires	Diam. Each Wire Inches	Diam. Inches	*Area Sq. Inches	Bare Cond.	Tin'd. Cond.
18	1624	Solid	.0403	.0403	.0013	6.510	6.77
16	2583	Solid	.0508	.0508	.0020	4.094	4.25
14	4107	Solid	.0641	.0641	.0032	2.575	2.68
12	6530	Solid	.0808	.0808	.0051	1.619	1.69
10	10380	Solid	.1019	.1019	.0081	1.018	1.06
8	16510	Solid	.1285	.1285	.0130	.641	.660
6	26250	7	.0612	.184	.027	.410	.426
4	41740	7	.0772	.232	.042	.259	.269
3	52640	7	.0867	.260	.053	.205	.213
2	66370	7	.0974	.292	.067	.162	.169
1	83690	19	.0664	.332	.087	.129	.134
0	105500	19	.0745	.373	.109	.102	.106
00	133100	19	.0837	.418	.137	.0811	.0844
000	167800	19	.0940	.470	.173	.0642	.0668
0000	211600	19	.1055	.528	.219	.0509	.0524
	250000	37	.0822	.575	.260	.0431	.0444
	300000	37	.0900	.630	.312	.0360	.0371
	350000	37	.0973	.681	.364	.0308	.0318
	400000	37	.1040	.728	.416	.0270	.0278
	500000	37	.1162	.814	.520	.0216	.0225
	600000	61	.0992	.893	.626	.0180	.0185
	700000	61	.1071	.964	.730	.0154	.0159
	750000	61	.1109	.998	.782	.0144	.0148
	800000	61	.1145	1.031	.835	.0135	.0139
	900000	61	.1215	1.093	.938	.0120	.0124
	1000000	61	.1280	1.152	1.042	.0108	.0111
	1250000	91	.1172	1.289	1.305	.00864	.00890
	1500000	91	.1284	1.412	1.566	.00719	.00740
	1750000	127	.1174	1.526	1.829	.00617	.00636
	2000000	127	.1255	1.631	2.089	.00539	.00555

* Area given is that of a circle having a diameter equal to the over-all diameter of a stranded conductor.

The values given in the table are those given in Circular 31 of the National Bureau of Standards except that those shown in the last column are those given in Specification B33 of the American Society for Testing Materials.

The resistance values given in the last two columns are applicable only to direct current.

(* 1947 N. E. Code, Table 18.)

COPPER WIRE TABLE

GAGE No.	DIAM. Inches	CROSS SECTION		RESISTANCE at 68° F.	
		Circular Mils	Square Inches	Ohms per 1,000 Ft.	Feet per Ohm
0000	0.4600	211,600	.1662	0.0490	20,400
000	.4096	167,800	.1318	.0618	16,180
00	.3648	133,100	.1045	.0779	12,830
0	.3249	105,500	.08289	.0983	10,180
1	.2893	83,690	.06573	.1239	8,070
2	.2576	66,370	.05213	.1563	6,400
3	.2294	52,640	.04134	.1970	5,075
4	.2043	41,740	.03278	.2485	4,025
5	.1819	33,100	.02600	.3133	3,192
6	.1620	26,250	.02062	.3951	2,531
7	.1443	20,820	.01635	.4982	2,007
8	.1285	16,510	.01297	.6282	1,592
9	.1144	13,090	.01028	.7921	1,262
10	.1019	10,380	.008155	.9989	1,001
11	.09074	8,234	.006467	1.260	.794
12	.08081	6,530	.005129	1.588	.630
13	.07196	5,178	.004067	2.003	.499.3
14	.06408	4,107	.003225	2.525	.396.0
15	.05707	3,257	.002568	3.184	.314.0
16	.05082	2,583	.002028	4.016	.249.0
17	.04526	2,048	.001608	5.064	.197.5
18	.04030	1,624	.001276	6.385	.156.6
19	.03589	1,288	.001012	8.051	.124.2
20	.03196	1,022	.000802	10.15	.98.5
21	.02846	810.1	.000636	12.80	.78.11
22	.02535	642.4	.000505	16.14	.61.95
23	.02257	509.5	.000400	20.36	.49.13
24	.02010	404.0	.000317	25.67	.38.96
25	.01790	320.4	.0002517	32.37	.30.90
26	.01594	254.1	.0001996	40.81	.24.50
27	.01420	201.5	.0001583	51.47	.19.43
28	.01264	159.8	.0001255	64.90	.15.41
29	.01126	126.7	.0000995	81.83	.12.22
30	.01003	100.5	.0000789	103.2	.9.691
31	.008928	79.70	.0000626	130.1	.7.685
32	.007950	63.21	.0000496	164.1	.6.095
33	.007080	50.13	.0000394	206.9	.4.833
34	.006305	39.75	.0000312	260.9	.3.833
35	.005615	31.52	.0000248	329.0	.3.040
36	.005000	25.00	.0000196	414.8	.2.411
37	.004453	19.83	.0000156	523.1	.1.912
38	.003965	15.72	.0000124	659.6	.1.516
39	.003531	12.47	.0000098	831.8	.1.202
40	.003145	9.88	.0000078	1049.	.953
41	.00280	7.645	.0000062	1323	.756
42	.00250	6.250	.0000049	1659	.603
43	.00220	4.850	.0000038	2138	.467
44	.00200	4.000	.0000031	2592	.386
45	.00175	3.063	.0000024	3390	.295
46	.00150	2.250	.0000018	4610	.217

RESISTANCE WIRE - NICHROME

660 ohms per circular mil-foot at 68° F.

SIZE A.W.G.	Ohms per Foot	Ohms per Pound	Feet per Pound	Lbs. per 1000 Ft.
8	.0408	.903	22.2	45.0
9	.0509	1.416	27.8	36.0
10	.0639	2.205	34.5	29.0
11	.0805	3.500	43.5	23.0
12	.1018	5.66	55.6	18.0
13	.1278	8.93	69.9	14.3
14	.1610	14.25	88.5	11.3
15	.2036	22.19	109	9.18
16	.2556	35.50	139	7.19
17	.3220	57.62	179	5.58
18	.4072	92.00	226	4.42
19	.5112	142.6	279	3.58
20	.6485	228.3	353	2.83
21	.8175	364.6	446	2.24
22	1.031	582.3	565	1.77
23	1.292	916.0	709	1.41
24	1.634	1455	893	1.12
25	2.060	2310	1123	.890
26	2.611	3729	1429	.700
27	3.274	5830	1786	.560
28	4.159	9438	2273	.490
29	5.168	14740	2857	.350
30	6.600	23870	3623	.276
31	8.333	37950	4566	.219
32	10.31	58190	5650	.177
33	13.10	94160	7194	.139
34	16.62	150700	9091	.110
35	21.02	240900	11490	.0871
36	26.40	381700	14490	.0690
37	32.67	583000	17860	.0560
38	41.24	916300	22220	.0450
39	54.10	1591000	29410	.0340
40	73.33	2566000	40000	.0250
41	87.30	4140000	47600	.0210
42	105.6	6230000	58900	.0169
43	130.4	9310000	71500	.0140
44	165.0	15000000	91000	.0110
45	215.7	26900000	125000	.0080
46	293.3	48700000	166700	.0060

RESISTANCE WIRE - MANGANIN

270 ohms per circular mil-foot at 68° F.

SIZE A.W.G.	Ohms per Foot	Ohms per Pound	Feet per Pound	Lbs. per 1000 Ft.
10	0.026	0.88	34.8	28.6
12	.041	2.22	54.5	18.2
14	.066	5.62	89.5	11.5
15	.083	9.40	109.0	9.20
16	.103	14.9	139	7.20
17	.133	23.8	179	5.60
18	.168	39.6	226	4.42
19	.203	60.4	279	3.58
20	.263	96.6	353	2.83
21	.332	153	446	2.24
22	.421	247	565	1.77
23	.528	379	709	1.41
24	.668	653	893	1.12
25	.843	983	1123	.89
26	1.068	1580	1429	.70
27	1.339	2380	1786	.56
28	1.700	4020	2273	.440
29	2.114	6250	2857	.350
30	2.700	10100	3623	.276
31	3.409	16100	4566	.219
32	4.219	24700	5656	.177
33	5.357	39500	7194	.139
34	6.801	64000	9091	.110
35	8.598	102000	11490	.087
36	10.80	162000	14490	.069
37	13.36	238000	17860	.056
38	16.87	389000	22220	.045
39	22.13	675000	29410	.034
40	30.00	1240000	40000	.025

CONDUCTOR AND RESISTOR MATERIALS

Kind of Material or Trade Name	Ohms per Circ. Mil-ft. at 68° F.	Temperature Coefficient of Resistance per Degree F.
Advance	2914	0.00001
Aluminum	17	.0022
Brass, common	49	.001
high brass	41	
low brass	35	
Carbon	21000	- 0.00028
Chromel	540	
Constantan	294	.000005
Copper, annealed	10.4	.00218
USS	10.55	.002
hard drawn	10.65	.00212
German silver, 18%	198	.00018
Graphite	4800	
Ideal	295	.000005
Iron, pure	60	.0031
cast	540	
wrought	84	
Lead	115	.0023
Lucerno	275	.001
Magnesium, pure	277	.0022
Manganin	270	.00001
Nickel	52	.0027
Nickel silver, 30%	240	.0001
Nichrome II	660	.00013
III	540	.0001
IV	625	.00006
Novar	296	
Platinum	72	.0021
Silver	9.75	.0021
Steel, crucible	115	.0017
galvanized	67	.001
hard	162	.0005
manganese	420	
Tungsten	33.2	.0025
Zinc	38	.0021

ALLOWABLE CURRENT-CARRYING CAPACITIES OF CONDUCTORS IN AMPERES*

Not More Than Three Conductors in Raceway or Cable
(Based on Room Temperatures of 30 C. 86 F.)

Size AWG MCM	Rubber Type RW Type RU (14-6)	Rubber Type RH	Paper		Impreg- nated Asbestos Type AI (14-8) Type AIA	Asbestos Type A (14-8) Type AA
			Thermo- plastic Asbestos Type TA	Asbestos Var-Cam Type AVA Type AVL		
	Thermo- plastic Type T (14-4/0) Type TW (14-4/0)		Var-Cam Type V	Asbestos Var-Cam Type AVB		
14	15	15	25	30	30	30
12	20	20	30	35	40	40
10	30	30	40	45	50	55
8	40	45	50	60	65	70
6	55	65	70	80	85	95
4	70	85	90	105	115	120
3	80	100	105	120	130	145
2	95	115	120	135	145	165
1	110	130	140	160	170	190
0	125	150	155	190	200	225
00	145	175	185	215	230	250
000	165	200	210	245	265	285
0000	195	230	235	275	310	340
250	215	255	270	315	335	...
300	240	285	300	345	380	...
350	260	310	325	390	420	...
400	280	335	360	420	450	...
500	320	380	405	470	500	...
600	355	420	455	525	545	...
700	385	460	490	560	600	...
750	400	475	500	580	620	...
800	410	490	515	600	640	...
900	435	520	555	...	...	...
1,000	455	545	585	680	730	...
1,250	495	590	645	...	...	...
1,500	520	625	700	785	...	...
1,750	545	650	735	...	...	...
2,000	560	665	775	840	...	...

NOTES ON THE TWO PRECEDING TABLES

1. **Aluminum Conductors.** For aluminum conductors, the allowable current-carrying capacities shall be taken as 84 per cent of those given in the table for the respective sizes of copper conductor with the same kind of insulation.

2. **Bare Conductors.** If bare conductors are used with insulated conductors, their allowable current-carrying capacity shall be limited to that permitted for the insulated conductor with which they are used.

3. **Application of Table.** For open wiring on insulators and for concealed knob-and-tube work, the allowable current-carrying capacities of Table 2 shall be used. For all other recognized wiring methods, the allowable current-carrying capacities of Table 1 shall be used, unless otherwise provided in this code.

4. **More Than Three Conductors in a Raceway.** Table 1 gives the allowable current-carrying capacity for not more than three conductors in a raceway or cable. If the number of conductors in a raceway or cable is from 4 to 6, the allowable current-carrying capacity of each conductor shall be reduced to 80 per cent of the values in Table 1. If the number of conductors in a raceway or cable is from 7 to 9, the allowable current-carrying capacity of each conductor shall be reduced to 70 per cent of the values in Table 1.

5. **Neutral Conductor.** A neutral conductor which carries only the unbalanced current from other conductors, as in the case of normally balanced circuits of three or more conductors, shall not be counted in determining current-carrying capacities as provided for in the preceding paragraph.

In a 3-wire circuit consisting of two phase wires and the neutral of a 4-wire, 3-phase system, a common conductor carries approximately the same current as the other conductors and is not therefore considered as a neutral conductor.

ALLOWABLE CURRENT-CARRYING CAPACITIES OF CONDUCTORS IN AMERES*

Single Conductor in Free Air

(Based on Room Temperature of 30 C. 86 F.)

Size AWG MCM	Rubber Type R Type RW (14-6)	Rub- ber Type RH	Thermo- plastic Asbestos Type TA	As- he- tos Var- Cam Type AVA Type AVL	Impreg- nated As- bestos Type AI (14-8) Type AIA	As- bestos Type A (14-8) Type AA	Slow- Burn- ing Type SB
	Thermo- plastic Type T Type TW		Var-Cam Type V	Asbestos Var-Cam Type AVB			Weather- proof Type WP Type SBW
14	20	20	30	40	40	45	30
12	25	25	40	50	50	55	40
10	40	40	55	65	70	75	55
8	55	65	70	85	90	100	70
6	80	95	100	120	125	135	100
4	105	125	135	160	170	180	130
3	120	145	155	180	195	210	150
2	140	170	180	210	225	240	175
1	165	195	210	245	265	280	205
0	195	230	245	285	305	325	235
00	225	265	285	330	355	370	275
000	260	310	330	385	410	430	320
0000	300	360	385	445	475	510	370
250	340	405	425	495	530	...	410
300	375	445	480	555	590	...	460
350	420	505	530	610	655	...	510
400	455	545	575	665	710	...	555
500	515	620	660	765	815	...	630
600	575	690	740	855	910	...	710
700	630	755	815	940	1005	...	780
750	655	785	845	980	1045	...	810
800	680	815	880	1020	1085	...	845
900	730	870	940	...	...	...	905
1000	780	935	1000	1165	1240	...	965
1250	890	1065	1130	...	...	...	1215
1500	980	1175	1260	1450	...	...	...
1750	1070	1280	1370	...	...	...	...
2000	1155	1385	1470	1715	...	...	1405

6. **Ultimate Insulation Temperature.** In no case shall conductors be associated together in such a way with respect to the kind of circuit, the wiring method employed, or the number of conductors, that the limiting temperature of the conductors will be exceeded.

7. **Use of Conductors With Higher Operating Temperatures.** If the room temperature is within 10 degrees C of the maximum allowable operating temperature of the insulation, it is desirable to use an insulation with a higher maximum allowable operating temperature; although insulation can be used in a room temperature approaching its maximum allowable operating temperature limit if the current is reduced in accordance with the table of correction factors for different room temperatures.

8. **Voltage Drop.** The allowable current-carrying capacities in Tables 1 and 2 are based on temperature alone and do not take voltage drop into consideration.

9. **Overcurrent Protection.** If the standard ratings and settings of overcurrent devices do not correspond with the ratings and settings allowed for conductors, the next higher standard rating and setting may be used, but not exceeding 150 per cent of the allowable carrying capacity of the conductor.

10. **Deterioration of Insulation.** It should be noted that even the best grades of rubber insulation will deteriorate in time, so eventually will need to be replaced.

CORRECTION FACTOR FOR ROOM TEMPERATURES OVER 30 C. 86 F.

C. F.	.82	.88	.90	.94	.95	...	...
40 104	.82	.88	.90	.94	.95	...	...
45 113	.71	.82	.85	.90	.92	...	...
50 122	.58	.75	.80	.87	.89	...	...
55 131	.41	.67	.74	.83	.86	...	...
60 140	...	.58	.67	.79	.83	.91	...
70 158	...	.35	.52	.71	.76	.87	...
75 167	...	...	.43	.66	.72	.86	...
80 176	...	...	.30	.61	.69	.84	...
90 194	...	...	...	.50	.61	.80	...
100 212	...	...	...	...	.51	.77	...
120 248	...	...	...	...	...	.69	...
140 284	...	...	...	...	...	.50	...

* 1947 N. E. Code.

**DIMENSIONS OF ASBESTOS-VARNISHED-
CAMBRIC INSULATED CONDUCTORS***
Types AVA AVB, and AVL

Size AWG MCM	TYPE AVA		TYPE AVB		TYPE AVL	
	Approx. Diam. Inches	Approx. Area Sq. In.	Approx. Diam. Inches	Approx. Area Sq. In.	Approx. Diam. Inches	Approx. Area Sq. In.
14	.245	.017	.205	.033	.320	.080
12	.265	.055	.225	.040	.340	.091
10	.285	.064	.245	.047	.360	.102
8	.310	.075	.270	.057	.390	.119
6	.395	.122	.345	.094	.430	.145
4	.445	.155	.395	.123	.480	.181
2	.595	.200	.460	.166	.570	.255
1	.585	.268	.540	.229	.620	.300
0	.625	.307	.580	.264	.660	.341
00	.670	.351	.625	.307	.705	.390
000	.720	.406	.675	.358	.755	.447
0000	.780	.478	.735	.425	.815	.521
250	.885	.616	.855	.572	.955	.715
300	.940	.692	.910	.619	1.010	.800
350	.995	.778	.965	.731	1.060	.885
400	1.010	.850	1.010	.800	1.105	.960
500	1.125	.995	1.095	.945	1.190	1.118
550	1.165	1.065	1.135	1.01	1.265	1.26
600	1.205	1.140	1.175	1.09	1.305	1.34
650	1.240	1.21	1.210	1.15	1.340	1.41
700	1.275	1.28	1.245	1.22	1.375	1.49
750	1.310	1.35	1.280	1.29	1.410	1.57
800	1.345	1.42	1.315	1.36	1.440	1.63
850	1.375	1.49	1.345	1.43	1.470	1.70
900	1.405	1.55	1.375	1.49	1.505	1.78
950	1.435	1.62	1.405	1.55	1.535	1.85
1,000	1.465	1.69	1.435	1.62	1.565	1.93

NOTE: No. 14 to No. 8, solid, No. 6 and larger, stranded; except AVL where all sizes are stranded.
(* 1947 N. E. Code, Table 17.)

CABLES ABOVE 600 VOLTS, ALSO CONTROL CABLES
Cables of Equal Diameter

EXAMPLE: A 1½" conduit will accommodate 3 cables with diam. .52" to .60".

* Conduit sizes are based on a straight run of 200', 100' with 2-90° bends or 50' with 3-90° bends. For installations exceeding these limiting conditions use one or two conduit sizes larger.

SPACE REQUIREMENTS FOR CONDUITS—DIAMETERS IN INCHES

Conduit Sizes	1/2"		3/4"		1"		1 1/4"		1 1/2"		2"		2 1/2"		3"		3 1/2"	
	D	W	D	W	D	W	D	W	D	W	D	W	D	W	D	W	D	W
1/2"	1 1/8	2 5/8	1 5/8	2 7/8	1 3/4	3 3/8	1 7/8	3 1/2	1 7/8	3 3/4	2 1/8	4 3/8	2 3/8	5	2 3/4	5 5/8	3 1/8	6 3/8
3/4"	1 1/4	2 7/8	1 5/4	3 3/8	1 3/4	3 3/8	1 7/8	3 3/4	1 7/8	3 3/4	2 1/8	4 3/8	2 3/8	5 1/2	3	6 1/8	3 1/4	6 3/8
1"	1 3/8	3 1/8	1 5/8	3 3/8	1 3/4	3 3/8	1 7/8	4	2 1/8	4 3/4	2 3/8	4 7/8	2 3/8	5 1/2	3	6 1/8	3 3/8	6 3/8
1 1/4"	1 7/8	3 3/4	1 5/8	3 3/8	1 3/4	4	2 1/8	4 3/8	2 1/8	4 3/8	2 3/8	5 1/2	2 1/8	5 7/8	3 1/4	6 3/8	3 3/8	7 1/8
1 1/2"	1 7/8	3 3/4	1 5/8	4	2 1/8	4 3/8	2 1/8	4 3/8	2 3/8	4 3/8	2 3/8	5 1/2	3	6 1/8	3 3/8	6 7/8	3 3/8	7 1/8
2"	2 1/8	4 3/8	2 3/4	4 3/8	2 3/4	4 7/8	2 3/8	4 7/8	2 3/8	5 1/2	3	6 1/8	3 3/8	6 3/8	3 3/8	7 3/8	4	8 1/8
2 1/2"	2 3/8	5	2 3/8	5 1/4	2 1/8	5 3/8	2 1/8	5 7/8	3	6 1/8	3 3/8	6 3/8	3 3/8	7 3/8	3 3/8	7 3/8	4 3/8	8 1/8
3"	2 3/4	5 5/8	3	6 1/8	3	6 1/8	3 1/4	6 3/8	3 1/8	6 3/8	3 3/8	7 3/8	3 3/8	8	4 3/8	8 3/8	4 3/8	9 3/8
3 1/2"	3 1/8	6 3/8	3 1/4	6 3/8	3 3/8	6 3/8	3 3/8	7 3/8	3 3/8	7 3/8	4	8 3/8	4 3/8	8 3/4	4 3/8	9 3/8	5	10 3/8

WIRING - WIRE, CABLE AND CONDUIT

VOLTAGE DROP TABLE*
Circuit Footage for 3 Per Cent Drop

Size A.W.G.	3 Amp.	6 Amp.	15 Amp.	20 Amp.	25 Amp.	35 Amp.	50 Amp.	70 Amp.	80 Amp.	90 Amp.	100 Amp.	125 Amp.
18	83											
16	131	66										
14	209	104	42									
12	330	166	66	50								
10	528	264	105	79	63							
8	840	420	168	126	100	72						
6	1336	668	267	200	160	114	80					
4	2125	1062	424	318	255	182	127	91				
3	2680	1340	536	402	321	229	160	114	100			
2	3379	1689	679	507	405	289	202	144	126	112		
1	4262	2131	852	639	511	365	255	182	159	142	127	
0	5372	2686	1074	806	644	460	322	230	201	179	161	128
00	6778	3389	1355	1016	813	581	405	290	254	225	203	162
000	8543	4272	1709	1281	1025	732	512	366	320	284	256	205
0,000		5387	2155	1616	1293	923	646	461	404	359	323	258
250,000			2546	1911	1527	1091	763	545	477	424	381	305
300,000			3055	2291	1833	1309	916	654	572	509	458	366
350,000				2673	2138	1526	1069	763	667	594	534	427
400,000				3055	2444	1746	1222	873	763	679	611	488
500,000					3055	2182	1527	1091	934	848	763	611
600,000						2619	1833	1309	1145	1018	916	733
700,000						3055	2138	1527	1336	1188	1069	855

* Compiled by A. M. Miller, Richmond, Va.

Size A.W.G.	150 Amp.	175 Amp.	225 Amp.	250 Amp.	275 Amp.	300 Amp.	325 Amp.	400 Amp.	450 Amp.	500 Amp.	525 Amp.
00	135										
000	170	146									
0,000	215	184	143								
250,000	254	218	169	152							
300,000	305	261	203	183	166						
350,000	356	305	237	213	194	178					
400,000	407	349	271	244	220	203	188				
500,000	509	436	339	305	277	254	235	190			
600,000	611	523	407	366	333	305	282	229	203		
700,000	712	611	475	427	389	356	329	267	237	213	
750,000	763	654	509	458	416	381	352	286	254	229	218
800,000	814	698	543	488	444	407	376	305	271	244	232
900,000	916	785	611	550	500	458	423	343	305	275	261
1,000,000	1018	873	679	611	555	509	470	381	339	305	291
1,100,000	1120	960	746	672	611	560	517	420	373	336	320
1,200,000	1222	1047	814	733	666	611	564	458	407	366	349
1,300,000	1324	1134	882	794	722	662	611	496	441	397	378
1,400,000	1425	1222	950	855	777	712	657	534	475	427	407
1,500,000	1527	1309	1018	916	832	763	705	572	509	458	436
1,600,000	1628	1396	1064	976	888	814	752	611	532	488	465
1,700,000	1728	1484	1154	1038	944	864	799	649	577	519	495
1,800,000	1832	1571	1222	1110	1000	916	846	687	611	555	523
1,900,000	1932	1664	1290	1160	1054	966	892	725	645	580	555
2,000,000	2036	1746	1358	1222	1110	1018	940	763	679	611	582

Size A.W.G.	550 Amp.	600 Amp.	650 Amp.	690 Amp.	730 Amp.	770 Amp.	810 Amp.	850 Amp.	890 Amp.	930 Amp.	970 Amp.	1010 Amp.	1050 Amp.
800,000	222												
900,000	250	229											
1,000,000	277	254	235										
1,100,000	305	280	258	243									
1,200,000	333	305	282	265	251								
1,300,000	361	331	305	287	272	258							
1,400,000	388	356	328	309	292	277	264						
1,500,000	416	381	352	332	313	297	282	269					
1,600,000	444	407	376	354	334	339	301	287	274				
1,700,000	472	432	399	376	355	361	320	305	291	279			
1,800,000	500	458	423	398	376	382	339	323	308	295	283		
1,900,000	527	483	446	420	397	403	358	341	325	312	299	287	
2,000,000	555	509	470	442	418	424	377	359	343	328	315	302	291

Notes: Table calculated for 110 volts, direct current. The footages shown are approximate for single-phase and two-phase at unity power factor. For 3-phase the above footage may be increased by approximately 12 per cent.

The following factors may be used for other voltages: 220 volts, multiply by 2; 440 volts, multiply by 4; 550 volts, multiply by 5; 2200 volts, multiply by 20.

For 1 per cent drop allow one-third the footage shown. For 2 per cent drop allow two-thirds the footage shown.
(By Courtesy of International Association of Inspectors.)



Aluminum Solid Wire Hard Drawn

Resistance (61% at 20° C.)

Am. Gauge B. & S. No.	Ohms per 1000 Feet	Ohms per Mile	Feet per Ohm	Ohms per Pound
0000	.0804	.4245	12400.	.000414
000	.101	.5333	9860.	.000656
00	.128	.6758	7820.	.001043
0	.161	.8501	6200.	.001659
1	.203	1.072	4920.	.002636
2	.256	1.352	3900.	.004195
3	.323	1.705	3090.	.006676
4	.408	2.154	2450.	.010617
5	.514	2.714	1950.	.016821
6	.648	3.421	1540.	.026859
7	.817	4.314	1220.	.042755
8	1.03	5.438	970.	.067806
9	1.30	6.864	770.	.107595
10	1.64	8.660	610.	.171465
11	2.07	10.93	484.	.272450
12	2.61	13.78	384.	.433023
13	3.29	17.37	304.	.689730
14	4.14	21.86	241.	1.09708
15	5.22	27.56	191.	1.74555
16	6.59	34.80	152.	2.76589
17	8.31	43.88	120.	4.41782
18	10.5	55.44	95.5	6.99992
19	13.2	69.70	75.7	11.1355
20	16.7	88.18	60.0	17.7155
21	21.0	110.9	47.6	28.1586
22	26.5	139.9	37.8	44.7100
23	33.4	176.4	29.9	71.2819
24	42.1	222.3	23.7	113.400
25	53.1	280.4	18.8	180.255
26	67.0	353.8	14.9	286.806
27	84.4	445.6	11.8	456.211
28	106.0	559.7	9.39	723.676
29	134.0	707.5	7.45	1150.10
30	169.0	892.3	5.91	1828.09
31	213.0	1125.	4.68	2910.66
32	269.0	1420.	3.72	4618.20
33	339.0	1790.	2.95	7342.85
34	428.0	2260.	2.34	11672.4
35	540.0	2851.	1.85	18615.6

Aluminum and Copper Solid Wire Dimensions and Weight

Am. Gauge B. & S. No.	Diam. Mils.	AREA		Pounds per 1000 Feet Aluminum	Pounds per 1000 Feet Copper	Feet per Pound Aluminum	Feet per Pound Copper
		Circular Mils. (d ²) 1 mil. = .001 inch	Square Mils. (d ² x .7854)				
0000	460.000	211600.00	166190.	195.	641.	5.120	1.560
000	409.640	167805.00	131790.	154.	509.	6.490	1.965
00	364.800	133079.40	104520.	122.	403.	8.200	2.480
0	324.860	105534.00	82886.	97.1	320.	10.30	3.125
1	289.300	83694.20	65733.	77.0	253.	12.98	3.950
2	257.630	66373.00	52130.	61.1	202.	16.35	4.950
3	229.420	52634.00	41339.	48.4	159.	20.66	6.290
4	204.310	41742.00	32784.	38.4	126.	26.04	7.930
5	181.940	33102.00	25998.	30.4	100.	32.90	10.00
6	162.020	26250.50	20617.	24.2	79.	41.30	12.65
7	144.280	20816.00	16349.	19.2	63.	52.10	15.88
8	128.490	16509.00	12966.	15.2	50.	65.70	20.00
9	114.430	13094.00	10284.	12.1	39.	82.60	25.06
10	101.890	10381.00	8153.2	9.55	32.	104.8	31.25
11	90.742	8234.00	6467.0	7.57	25.	132.2	40.00
12	80.808	6529.90	5128.6	6.00	20.	166.7	50.00
13	71.961	5178.40	4067.1	4.76	15.7	210.0	63.70
14	64.084	4106.80	3146.9	3.78	12.4	264.5	80.64
15	57.068	3256.70	2557.8	2.99	9.8	334.4	102.1
16	50.820	2582.90	2028.6	2.38	7.9	420.2	126.6
17	45.257	2048.20	1608.6	1.88	6.2	531.9	161.3
18	40.303	1624.30	1275.7	1.495	4.9	668.8	208.3
19	35.890	1288.10	1011.66	1.185	3.9	843.0	256.4
20	31.961	1021.50	802.28	.940	3.1	1063.	322.6
21	28.462	810.10	636.25	.745	2.5	1343.	400.0
22	25.347	642.70	504.78	.590	1.9	1695.	526.3
23	22.571	509.45	400.12	.469	1.5	2132.	666.5
24	20.100	404.01	317.31	.372	1.2	2688.	813.0
25	17.900	320.40	251.64	.294	.97	3402.	1031.
26	15.940	254.01	199.50	.234	.77	4273.	1298.
27	14.195	201.50	158.26	.185	.61	5405.	1640.
28	12.641	159.79	125.50	.147	.48	6802.	2083.
29	11.257	126.72	99.526	.117	.39	8540.	2564.
30	10.025	100.50	78.933	.0924	.31	10808.	3226.
31	8.928	79.71	62.604	.0733	.24	13643.	4167.
32	7.950	63.20	49.637	.0582	.19	17182.	5263.
33	7.080	50.13	39.372	.0461	.15	21692.	6670.
34	6.304	39.74	31.212	.0365	.12	27397.	8333.
35	5.614	31.52	24.756	.0290	.095	34483.	10526.

Hiipotronics inc.

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Brewster, N.Y. 10509
Twx 710-574-2420

TELEPHONES: SALES (914) 279-8031
SERVICE (914) 279-8035
GENERAL (914) 279-8091

sales order

OUR P.O. verbal

PLEASE REFER TO THIS NO. IN ALL CORRESPONDENCE

76-27057

DATE

10/13/76

S
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Gold Star Recording
Studios
4914 Baldwin Avenue
Temple City, CA 91780

S
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RDX Corporation
110 South Euclid Avenue
Pasadena, CA 91101 Attn: Mr. French
RF: Gold Star

TERMS NET 30 DAYS

INVOICE COPIES

SHIP VIA

*special

TAXABLE RATE

TAX EXEMPT

EXEMPT NO

by, RPY & add

F.O.B. BREWSTER, N.Y.

DATE REQUIRED

X

X

comp

ACCOUNT

WE EXPECT TO SHIP THIS ORDER WEEK OF:

SALESMAN

114.05

COPIES

FOR FURTHER INFORMATION, CALL

EXT.

ITEM QUANTITY MODEL NUMBER

DESCRIPTION

1 1 T012

Toroid

2 4 SP-1

RV sphere, untagged
drilled/tapped 10-32

3 4 SP-2

RV sphere
drilled/tapped 4-20

BUYER: William C. Wysock

TEL: 466-0662

PER
TELECON

SPECIAL NOTES:

TYPED
BY:

FOR INTERNAL USE ONLY

*Customer to pay RDX upon receipt of goods.

Hipotronics Inc.

Route 22/PO Box A
Brewster, N.Y. 10509
Twx 710-574-2420

TELEPHONES: SALES (914) 279-8031
SERVICE (914) 279-8035
GENERAL (914) 279-8091

sales order

YOUR P.O. **verbal**

PLEASE REFER TO THIS NO. IN ALL CORRESPONDENCE

76-37057

DATE **10/13/76**

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**Gold Star Recording
Studios
4914 Baldwin Avenue
Temple City, CA 91780**

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**EMI Corporation
110 South Basile Avenue
Burbank, CA 91501 Attn: Mr. French
Re: Gold Star**

TERMS: NET 30 DAYS		# INVOICE COPIES	SHIP VIA	
Special			Inc. 100% & add	
TAXABLE RATE	TAX EXEMPT	EXEMPT NO.	F.O.B. BREWSTER, N.Y.	DATE REQUIRED
11			11	10/13/76
ACCOUNT			WE EXPECT TO SHIP THIS ORDER WEEK OF:	
SALESMAN			FOR FURTHER INFORMATION, CALL	
114.05			EXT.	

ITEM	QUANTITY	MODEL NUMBER	
1	2	7012	Tape
2	4	SP-1	1/4" sphere, cutaway drilled/tapped 10-32
3	4	SP-2	1/4" sphere drilled/tapped 1-20

*Rec'd 10-2-76
William C. French*

BUYER: **William C. French**

TEL: **445-0002**

PER
TELECON:

TYPED
BY:

SPECIAL NOTES:

***customer to pay tax upon receipt of goods.**

FOR INTERNAL USE ONLY

PACKING LIST

500,000 VOLT KIT

Due to size and weight, these kits are shipped in two packages. The charge collector or terminal package contains a completed aluminum charge collector. The other package contains all other components.

<u>BOX, 15" x 15" x 12":</u>	<u>Part No.</u>	<u>Cat.No.</u> <u>K-4-AL</u>
One welded aluminum cblate 14" dia.	1	
One piece steel wire 1/8" x 18"	14	
Plans, directions, etc.		

<u>BOX, 4" x 5" x 26": Ball Bearing Kit</u>		<u>Cat.No.</u> <u>K 5 Ball</u>
Vinyl chloride tube, 3 1/2" dia. x 24"	2	
Aluminum Frame	3	
Aluminum pillowblock	4	
Veo Pulley 1 1/2" dia.	5	
Ball Bearing shaft assy. N.D. # 885807	6	
Polyethylene Pulley 2" x 2"	8	
Neoprene belt 2" x .05" x 43"	10	
Package bolts for Parts 3, 4 & 7 and shaft collars	11	
Upper pulley assy.	12,13	

DIRECTIONS FOR CONSTRUCTION OF 500,000 VOLT KIT

ALUMINUM CHARGE COLLECTOR: Part No. 1

The aluminum charge collectors are formed to a shape which permits high potential with little corona discharge around the re-entrant hole. They are formed to final shape and require no additional work other than removing excess bonding resin that was overlooked during assembly. Scratches and lint should be removed with steel wool or fine sandpaper. Occasionally it is necessary to enlarge the re-entrant hole a few thousandths of an inch to permit entry of the insulator. This operation may be accomplished by forcing the insulator into the hole and gyrating slightly to enlarge it.

Deep scratches, dents, etc. cause very little reduction in voltage attainable. Projections, however, are different. A sharp projection $1/16$ " long will reduce voltage to about 100,000 volts. Rounded projections are much less serious. The bottom half of the collector is most vulnerable to this type of defect, particularly around the re-entrant hole. No noticeable improvement is noted when the collector is carefully polished. Dust and lint attracted to the collector during its operation often reduce voltage greatly, but wiping with a damp cloth will restore the performance immediately.

TUBE HOLDER: Part No. 3

This part shown in drawing 6 is a two-piece aluminum casting. Assemble using two $4-1/2$ inch long bolts and set aside until needed. Remove sharp burrs or projections from the upper surface which might cause corona discharge.

BEARING BLOCK: Part No. 4

This part holds the lower ball bearing. Ball bearing is locked in place with set screw which engages screw which engages groove in outer edge of bearing.

Procedure for Assembly

Part No. 7

Obtain one piece of $3/4$ " thick plywood $14" \times 17"$. Nail two wood cleats to the bottom to raise the base $3/4$ " and allow clearance for bolts, etc. Lay out one pencil line down the center of the board ($7"$ from two edges and $17"$ long). Lay out another line perpendicular to the first and $7"$ from the left hand edge ($10"$ from right). The first line will be referred to as the X axis. The second as the Y axis.

Drill holes as follows:

for part no.3

one $5/16$ " hole	$1-1/16$ " above X axis,	$2-3/8$ " left of Y axis
" "	" "	" "
" "	" "	" "
" "	below " "	right " "
" "	" "	" "
" "	" "	left " "

for part no.4

one $7/16$ " hole	$2-3/8$ " above X axis,	$1-5/8$ " left of Y axis
" "	" "	" "
" "	" "	right " "

The extra space at the right is for mounting the drive motor. There is sufficient space for a $1/4$ or $1/3$ hp. motor.

Part No. 2

Refer to drawing 5 which shows the top edge of the plastic tube. Drill holes as shown and cut a pair of notches $\frac{5}{8}$ " wide $\frac{1}{2}$ " deep as indicated. Attach part No. 3 loosely to part No. 7 using $\frac{1}{4}$ " bolts $1\frac{1}{4}$ " long and washers. Do not tighten bolts yet. Loosen $4\frac{1}{2}$ " long bolts in part No. 3 and spread halves enough to admit plastic tube. Twist tube until notches line up parallel with Y axis. A rod or ruler held against the side of the notch should appear parallel to axis when viewed from above. The tube should be firmly grasped by both curved surfaces of the clamp but should not extend more than $\frac{1}{8}$ " below the lower set of curved clamping surfaces. Tighten $4\frac{1}{2}$ " bolts as much as is required for a good grip. The parts of the clamp need not come together but the gaps should be about the same on both sides. Tighten the bolts holding part No. 3 to part No. 7 as much as necessary to secure a tight fit and do this while $4\frac{1}{2}$ " bolts are being tightened. Properly done, the tube will stand exactly perpendicular to the base. Paper or metal shims under the feet of part No. 1 will correct minor dislocations.

Part No. 8 Polyethylene Pulley

Hold ball bearing in vertical position against a flat surface with the thickest end upward. Slide the pulley on the bearing and hammer it down with a mallet or wide faced hammer. When pulley comes within $\frac{3}{16}$ " of bearing edge, stop. NOTE: Pulley has been enlarged on one side for ease of starting on shaft.

Part No. 6 Ball Bearing and Shaft Assy.

File off brass sleeve or peel off with pliers. Insert bearing in part No. 4. If the room is warm, it should slide in easily. If not, enlarge the hole with sandpaper. Use care as less than .0003 of metal must be removed. Heating the aluminum 150°F or both parts 50°F will do the same. File a point on the lock screw and insert enough to meet the groove in the bearing. The screw should not apply force against the bearing. Lock the screw by tightening the nut on it until it is tight against the casting.

Part No. 5 Drive Pulley

Install drive pulley on shaft as close to bearing as possible. Tighten set screw to lock it. Install 5" V pulley on driving motor. A $\frac{1}{4}$ hp. appliance motor is recommended although a smaller one will usually do. Set motor on base and measure the required belt length with a tape measure. You will need an 18" to 22" circumference belt.

Lower Shaft Assy Part No. 4, 5, 6 and 8

Install lower bearing assy. on base using $\frac{7}{16}$ " holes drilled for this purpose, and $\frac{3}{8}$ " carriage bolts. The pulley should be in the exact center of part No. 3. Parts No. 3 and 4 will be almost touching. Later when adjusting the belt it may be necessary to tilt the shaft slightly by applying shims under one edge of part No. 4.

Upper Pulley Part No. 13

Slip shaft collars over pulley shafts and place pulley in its notch in Part 2. Center pulley in notch and tighten set screws in collars to lock in place. Install belt, either side inward. Belt is undersize for reasons discussed elsewhere and may present some difficulty in installing. Belt will ride in center of tube only if pulley axis are parallel. Correct any misalignment if necessary by cutting one notch in part 2 a little deeper or by applying shims under one edge of part 4.

Part No. 14 Collector Support and Upper Comb.

Fabricate this piece from $1/8$ " dia steel wire or wire coat hanger. When complete, it should fit in the $1/8$ " holes in part 2 and extend 5 or 6" above part 2. The apex should be in line with the tube axis. Install a cross bar and wire tuft which comes within $1/16$ or $1/8$ " of the belt but does not touch.

Superior stability of current and voltage may be obtained if static charge is removed from part No. 2 near the pulley. Use a soft pencil dipped in shellac and blacken a 1" square near the $1/3$ " holes in part 2 on the inside ($1/2$ " each side of hole and 1" down). Under no circumstances, should the blackened area come within $1-1/4$ " of the edge of the notch. Also, do not use so much shellac that it drips down the tube.

Part No. 15 Booster

This part is only required where humidity is higher than normal. It can be made from copper wire to which is attached a whisker of fine wire.

Part No. 16 Lower Comb.

Bend a piece of steel, so that it clamps firmly to the legs of part 3. Install a wire tuft or piece of window screen $1-1/4$ " wide to wire and clip ends to come within $1/16$ or $1/8$ " of belt. Tuft should come toward belt at a point $1-1/2$ " above base.

Housing:

It may be desirable for the sake of appearance to enclose the lower part of the generator. One can make a 14 " x 17 " outside dimension box that is deep enough to cover the motor and has a hole for the plastic tube. The top edge of the box should be sanded smooth and the corners rounded. Adequate ventilation must be provided since the motor heat drives water from the wood which would condense in cooler areas and cause short circuits. For best results make a 5" diameter hole for part 2 and cut several 2" holes in part 7. Line the housing and base with aluminum foil or other moisture proof material.

Electrical:

It is sometimes necessary to connect parts No. 3 and 4 to ground, to motor frame or thru a 1 meg resistor to one wire of the power line.

CHARGE CARRYING BELT: Part No. 10

The neoprene belt provided is as nearly resistant to ozone, oil and flexing as can be obtained in one material. Test belt have been run hundreds of hours without deterioration. There is, however, a tendency for the belt to relax its initial tension, with most of this relaxation coming in the first few days. Over a years' time it will reduce to about $1/2$ of its original tension. The belts are tight enough to retain proper tension at 5000 RPM for at least a year, and for lower speeds, considerably longer. Releasing the belt when not in use will counteract this relaxing tendency a great deal. Belt will usually last at least 300 operating hours and test belts have lasted over 1500 hours in some cases.

The electrical conductivity of the belt is somewhat dependent upon humidity and at humidities over 75% the conductivity may become high enough to interfere with the belt's function. Allowing the belt to run a while will generally generate enough heat to evaporate the absorbed water film and allow operation at relative humidities to 85%.

The charge is applied to the belt and removed at the location indicated in the electrical circuit drawing. The exact location of the points is not too critical, nor is the number of points - one point being $3/4$ as effective as 10.

Many materials are satisfactory for belts as long as the bearing capacities are not exceeded. Ball bearings will permit belt tensions of 150 lbs. at 5000 RPM. More detailed information may be had by consulting any suitable catalog for precision radial ball bearings.

LUBRICATION:

The ball bearing units supplied have lubricant sealed in, which is sufficient for several thousand operating hours. They require no further attention during their life.

THEORY OF OPERATION OF VAN DE GRAAF GENERATOR

CURRENT YIELD:

Two surfaces of area A square centimeters, D centimeters apart and at a potential difference of E volts in air will hold a charge of

$$8.85 \times 10^{-14} \frac{AE}{D} \text{ coulombs.}$$

For a moving surface where A may be expressed in square centimeters per second, a current will flow, which amounts to

$$8.85 \times 10^{-14} \frac{AE}{D} \text{ amperes.}$$

For air, $\frac{E}{D}$ is limited to about 30,000 volts per centimeter and the current flow becomes

$8.85 \times 10^{-14} \times 3 \times 10^4 \times A$ amperes
or $2.66 \times 10^{-9} A$ amperes where A is expressed in area of belt in square centimeters passing over a pulley per second. Since the belt carries current on both upward and downward passes, the theoretical current becomes 5.3×10^{-9} amperes per each square centimeter of belt per second. Actual yields will be about 50% of the theoretical.

VOLTAGE LIMITATION:

An isolated sphere will have a voltage gradient at its surface of E/r where E is EMF in volts and r is radius in centimeters. For air, the maximum voltage gradient is 30,000 volts per centimeter. The theoretical voltage of a 12 inch sphere (15.2 centimeter radius) is $30,000 \times 15.2$ volts or about 450,000 volts. Actual potentials will be from 80 to 85% of this figure due to the charge concentration around the re-entrant hole and proximity of other objects.

OPERATING PRINCIPLES:

The polyethylene pulley when rubbed against the neoprene belt, acquires a static negative charge. In dry weather the charge generates immediately and will remain for hours. The belt passing over the pulley has a negative charge induced in its outer surface and positive charge on its inner surface by the polyethylene pulley. The negative charge on the outside of the belt is neutralized by the zone of ionized air around the lower comb. When the belt passes away from the pulley it still has the positive charge on the inside which is carried up to the collector. A somewhat similar phenomenon takes place at the upper pulley.

The belt functions as an electrophorous, the pulley functions as the source of static charges and the combs function as the charge removing finger in the use of the electrophorous assembly.

BELT DESIGN

Two important items must be considered in the selection of a belt:

1. The belt must be under sufficient tension so that centrifugal force will not cause it to leave the pulley.
2. The belt must be of a non-conducting material.

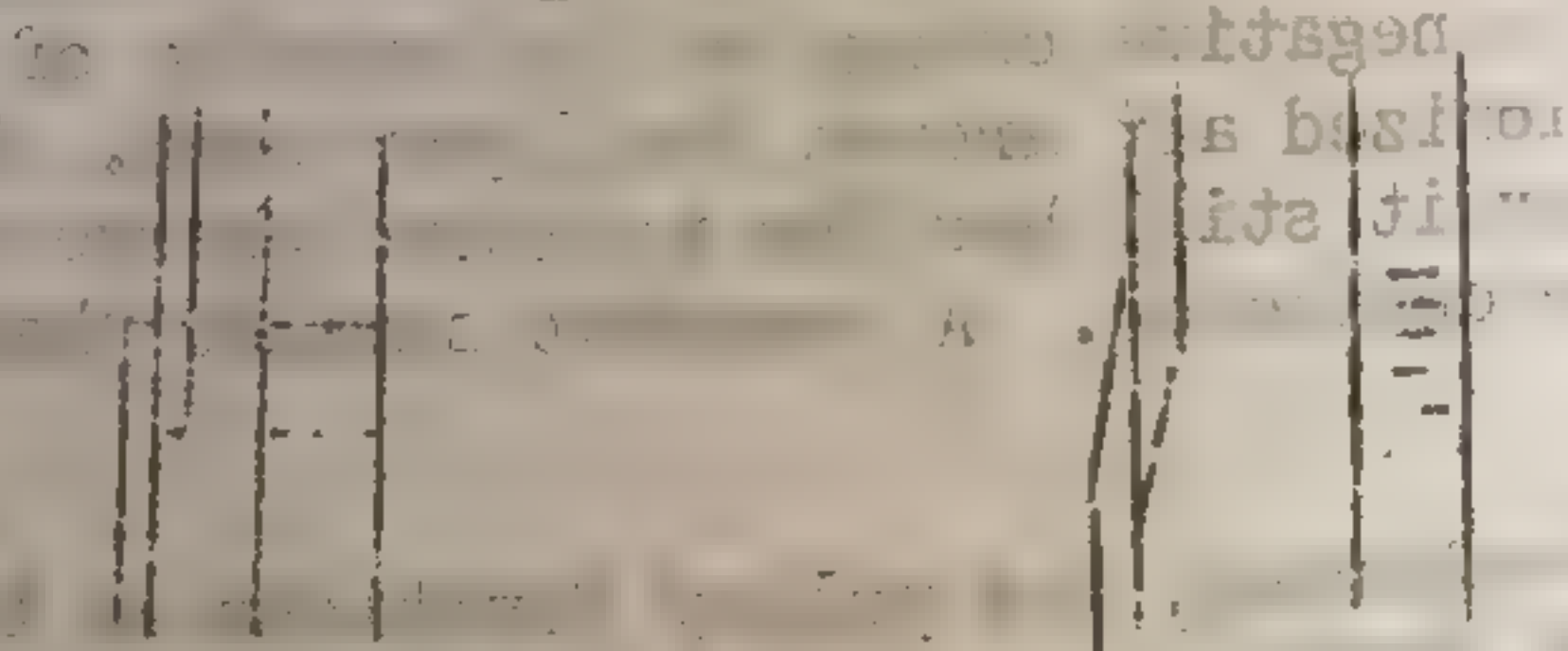
For a speed of 5000 RPM, a belt tension of 25 lbs. per square inch of cross section will be sufficient. For example, a belt 2" wide, 1/16" thick, has 1/8 square inch cross section and should exert 3 1/8 lbs. force on the pulley. Considering both sides of the belt, this becomes 6 1/4 lbs. The loads on the pulley bearings should not exceed manufacturer's recommendations. (See Boston Gear Catalog, Engineering Section, Bronze Bearings.)

The belt must be undersize enough to meet the first condition yet not exceed the second. Rubber stretches 1/4 to 1% for each lb. per square inch tension.

Where there is doubt as to the electrical properties of a belt material, it may be tested quite simply. Rub a sample against the polyethylene pulley and test sample with an electroscope. If the material holds a charge for 30 seconds or more, it is very likely suitable. Some varieties of rubber, notably those filled with the more expensive carbon blacks, are fair electrical conductors and hence useless belts.

Length of service, cost, and availability of material cannot be covered adequately here. However, the most important item limiting the life of a belt is the ozone and nitrogen oxides produced by corona. Natural rubber has poor resistance to these agents.

Rubber is best spliced together using a suitable rubber cement to prepare a lap joint in which one piece is placed over the other 1/2" or more. The double thickness of rubber resulting can be thinned with sand paper to produce a nearly uniform thickness in the joint. The lap joint is stronger and will pass over the pulleys more quietly if it is a long diagonal one.



Simple Lap

Feathered Lap



Diagonal Lap

* Tensile stress in belt
Lb. / Sq. Inch

$$= \frac{V^2 D}{144 g}$$

where

V = belt speed ft./sec.
D = density lb./ft.³
g = 32 ft./sec.²

FABRICATION
High Impact Rig
chemical resist
It is superior
tions and is ea
corrosion prod
electrical ins

1. CUTTING -
band saws
be used w

2. DRILLING
work ver

3. HOT FORM
electric
or radi
4000F.
into a
materi

4. CEMENT
using

5. MACHIN
steel

6. TURN
and
Cutt

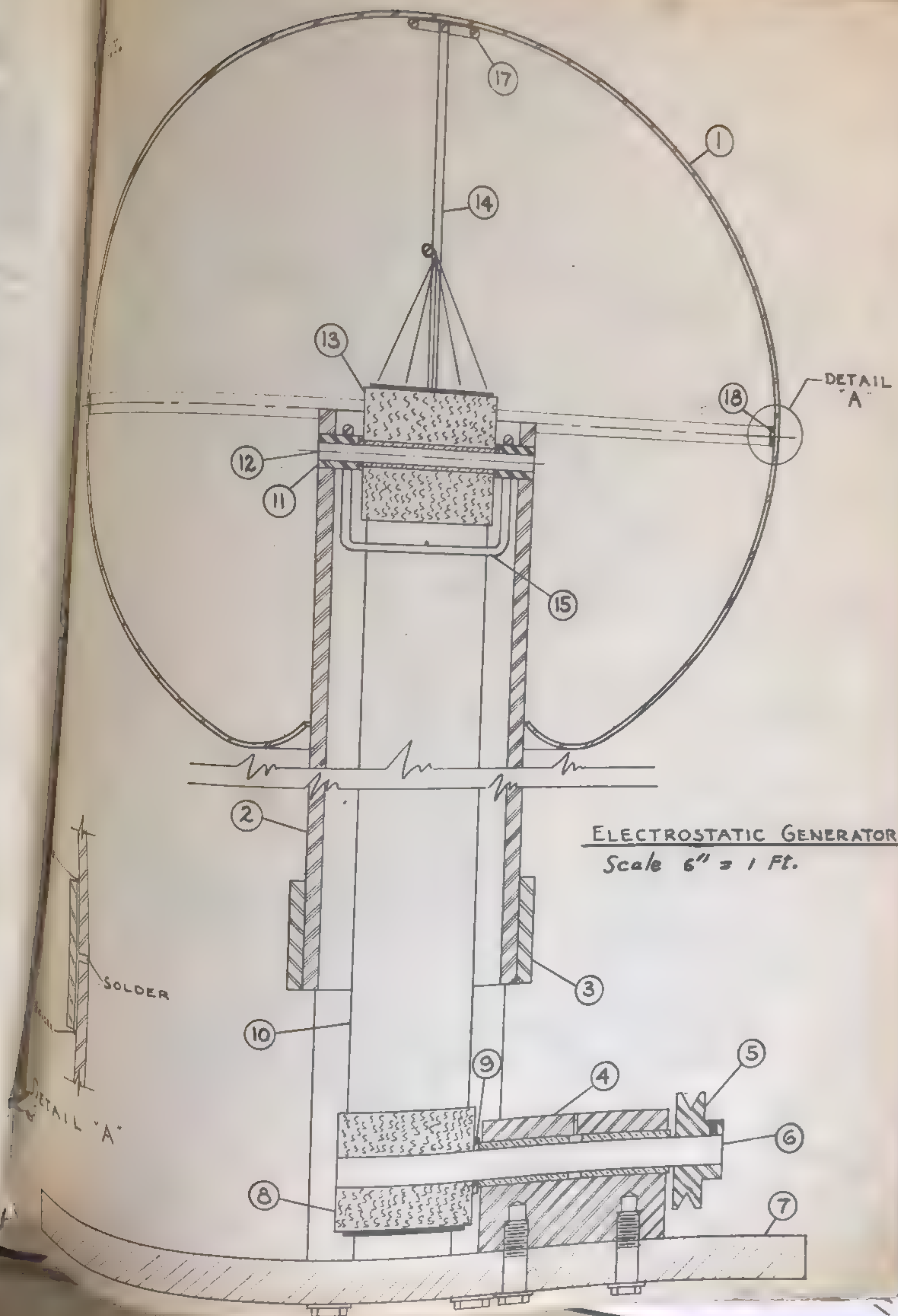
FABRICATION OF HIGH IMPACT RIGID KOROSEAL PRODUCTS

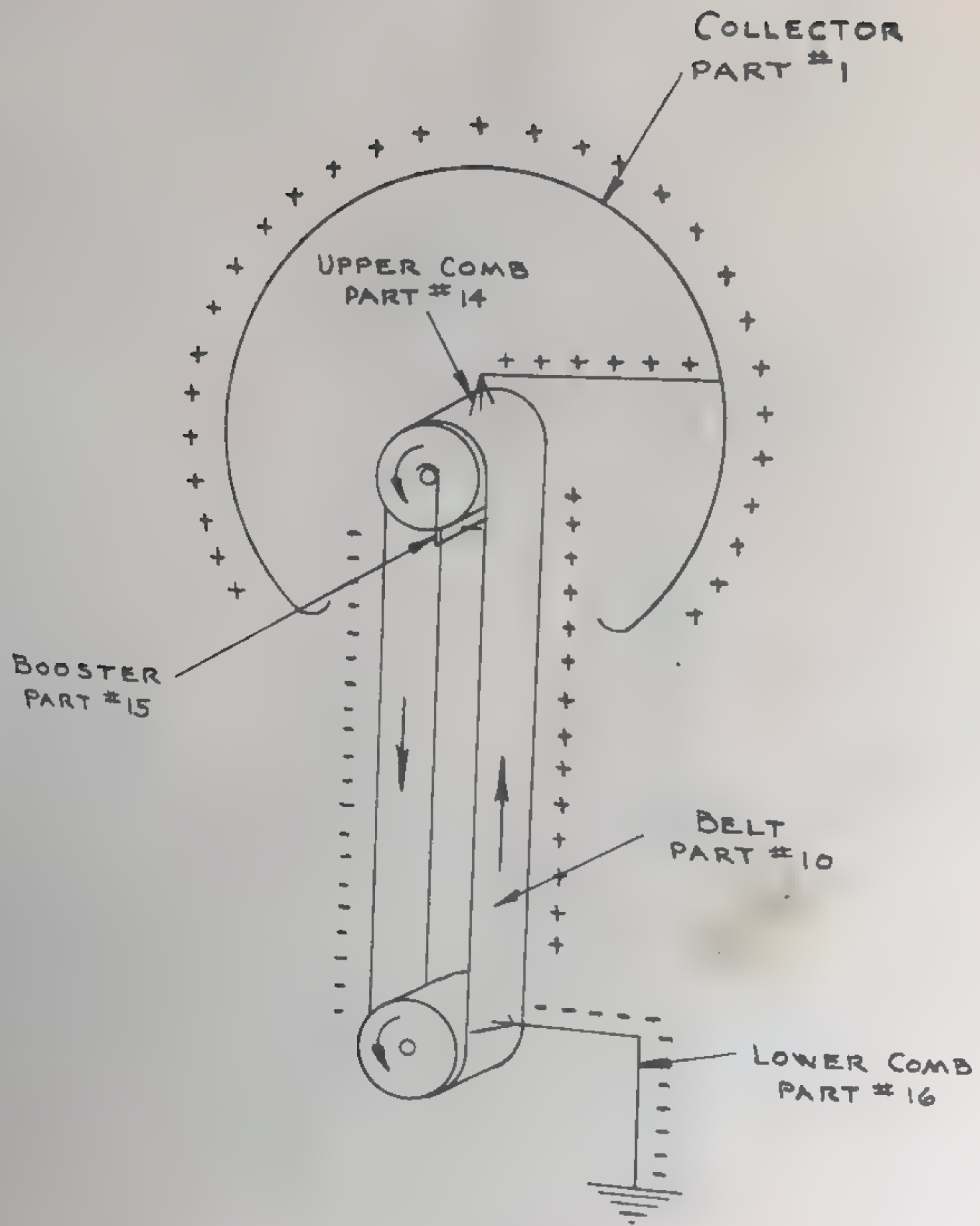
High Impact Rigid Koroseal has high strength, lightness and high chemical resistance to a great variety of corrosive chemicals. It is superior to any existing material for a variety of installations and is easier to install and maintain than other industrial corrosion product. Rigid Koroseal is an excellent thermal and electrical insulator.

Fabrication of rigid Koroseal is very simple when the following procedures are used:

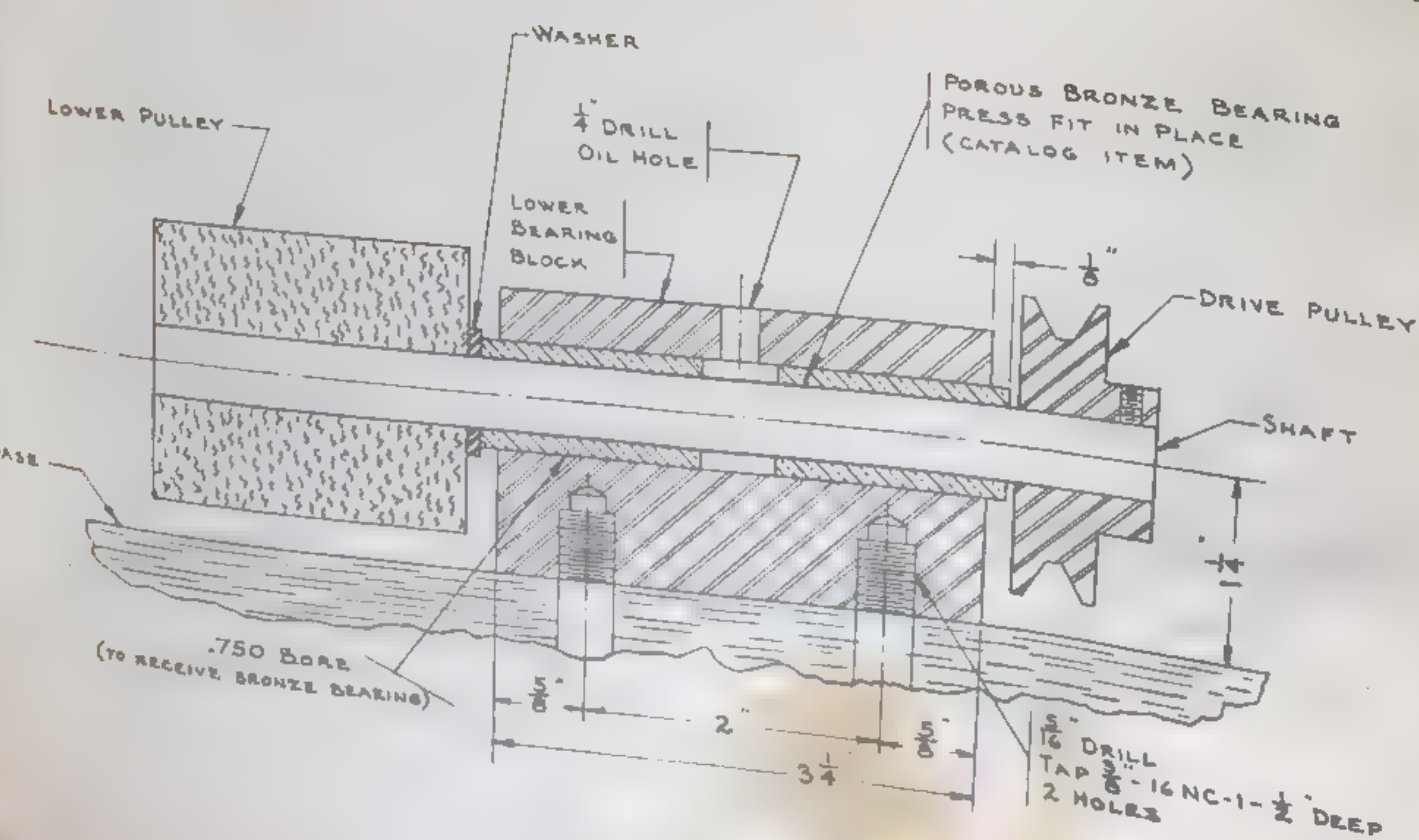
1. CUTTING - Use standard hand saws, hack saws, scroll saws, band saws or table saws. Regular wood-working equipment can be used without any special precautions.
2. DRILLING - Bench drill presses and electric hand drills work very easily.
3. HOT FORMING - Equipment which can be used include calrod electric strip heaters, circulating air oven, hot paraffin, or radiant heating blanket. At temperatures between 350 and 400°F. rigid Koroseal becomes quite soft and can be formed into a variety of shapes. The shapes are retained after the material has cooled to room temperature.
4. CEMENTING - Rigid Koroseal products can be cemented together using B.F. Goodrich Cement Grade A-541-B or methyl ethyl ketone.
5. MACHINING AND CUTTING - Use same machines and methods as with steel, light metals or wood. Excessive speed should be avoided.
6. TURNING AND MILLING - Standard lathes are used. Turning speeds and cutting tools correspond to those used on light metals. Cutting speeds are about 2,000 to 3,000 feet per minute.

The B.F. Goodrich
Industrial Products Company
Plastic Products
Marietta, Ohio





ELECTRICAL CIRCUIT
NO SCALE

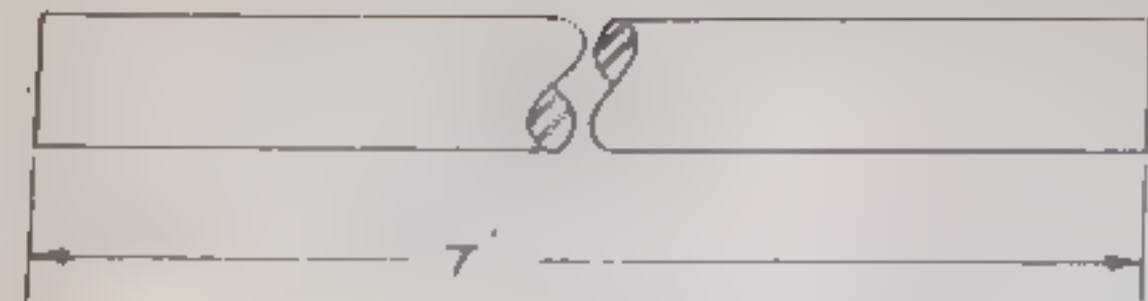


LOWER PULLEY ASSEMBLY
Standard Kit

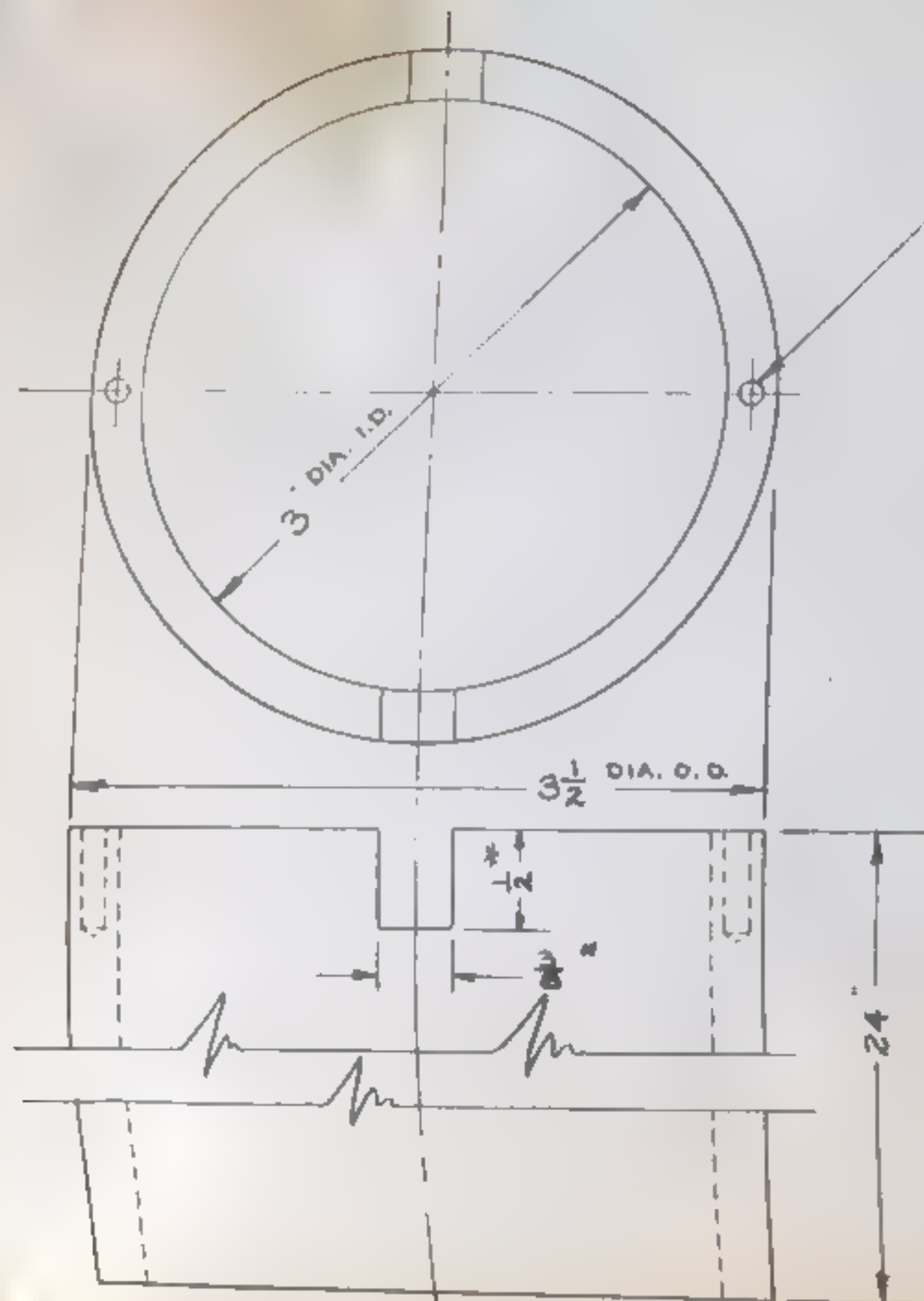
VER COMB
RT # 16

T

5



LOWER SHAFT
PART #6 - 1 REQ'D.
MAT'L. - GROUND STEEL SHAFTING

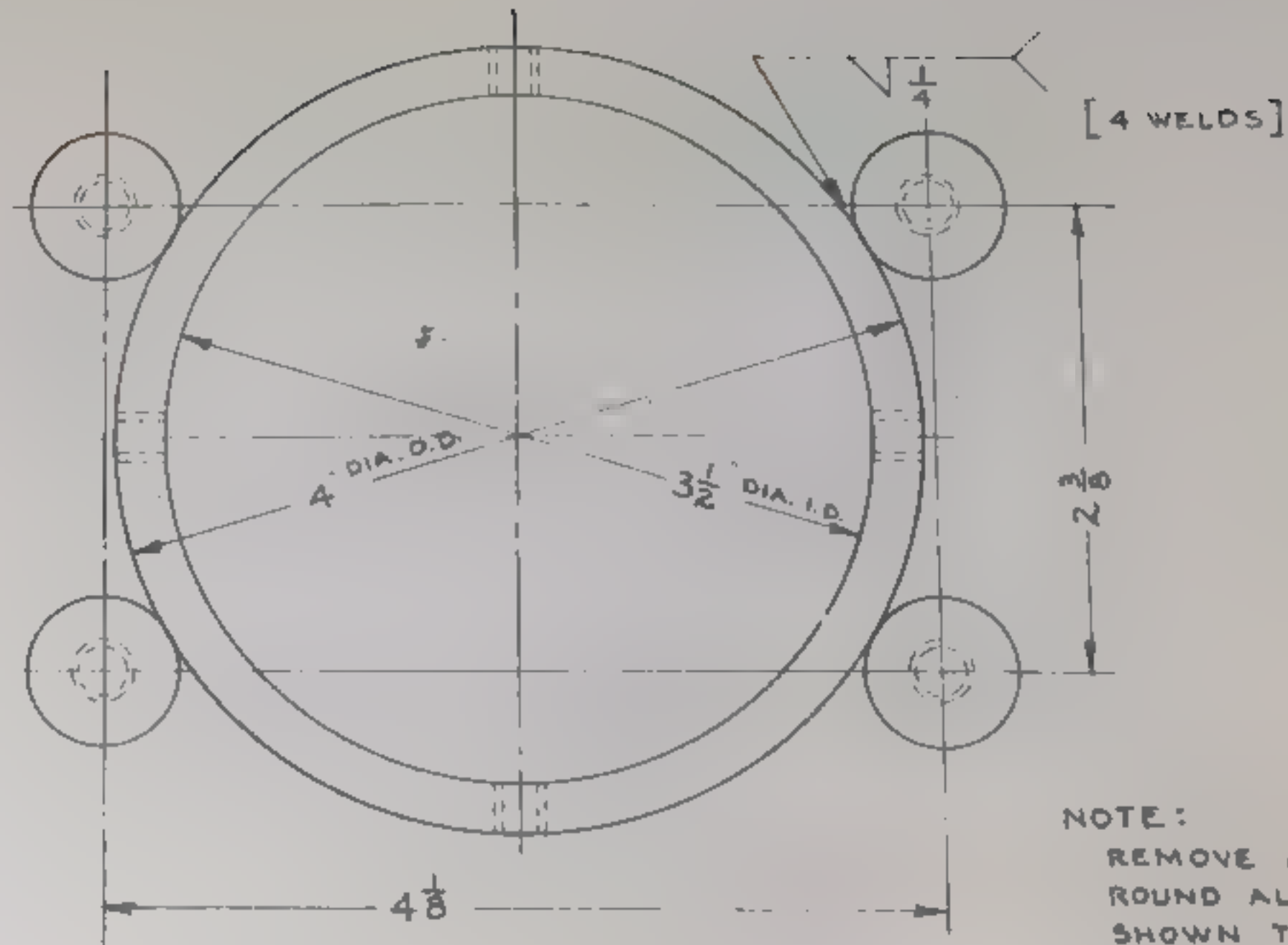


1/8 DRILL - 1/2 DEEP
2 HOLES

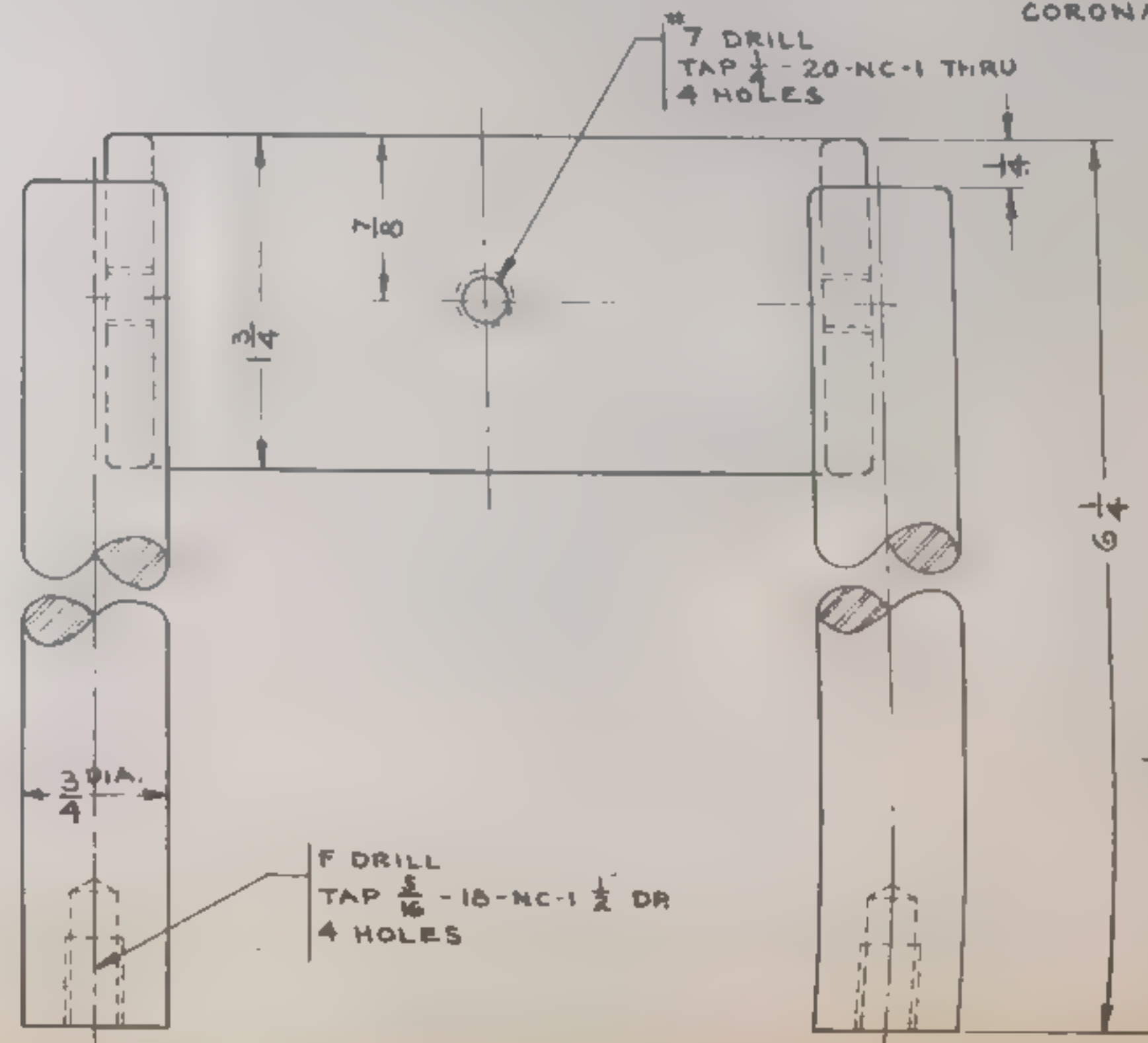
INSULATOR
PART #2 - 1 REQ'D
MAT'L. - VINYL CHLORIDE

* 5/8" for ball bearings

6



NOTE:
REMOVE ALL BURRS AND
ROUND ALL CORNERS AS
SHOWN TO MINIMIZE
CORONA LOSS.



*7 DRILL
TAP 1/4 - 20-NC-1 THRU
4 HOLES

*F DRILL
TAP 5/16 - 18-NC-1 1/2 DR
4 HOLES

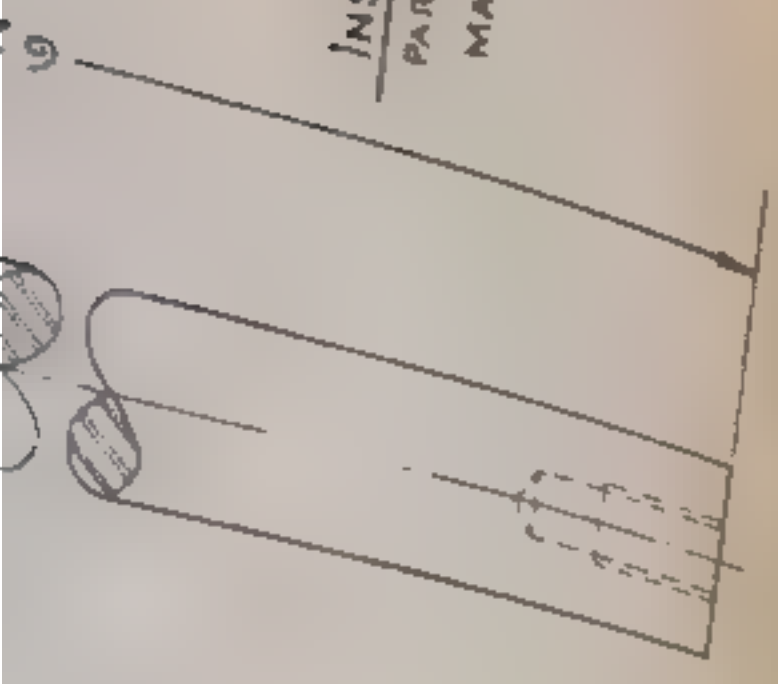
INSULATOR HOLDER
PART #3 - 1 REQ'D
MAT'L. - STEEL

203A

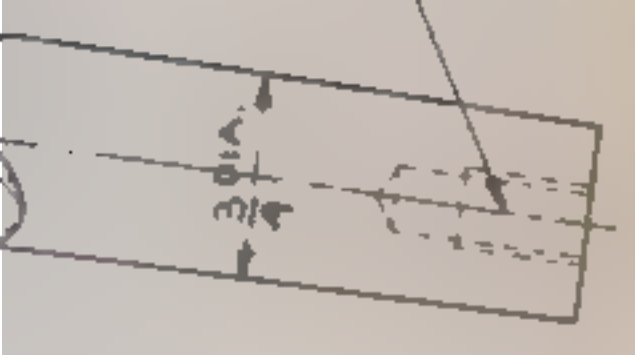
NOTES

- PARTS SHOWN ON THIS SHEET TO BE MADE FROM $\frac{1}{8}$ ϕ STEEL WIRE
- PARTS ARE SHOWN FULL SIZE - SOME BENDING MAY BE NECESSARY DURING ASSEMBLY.

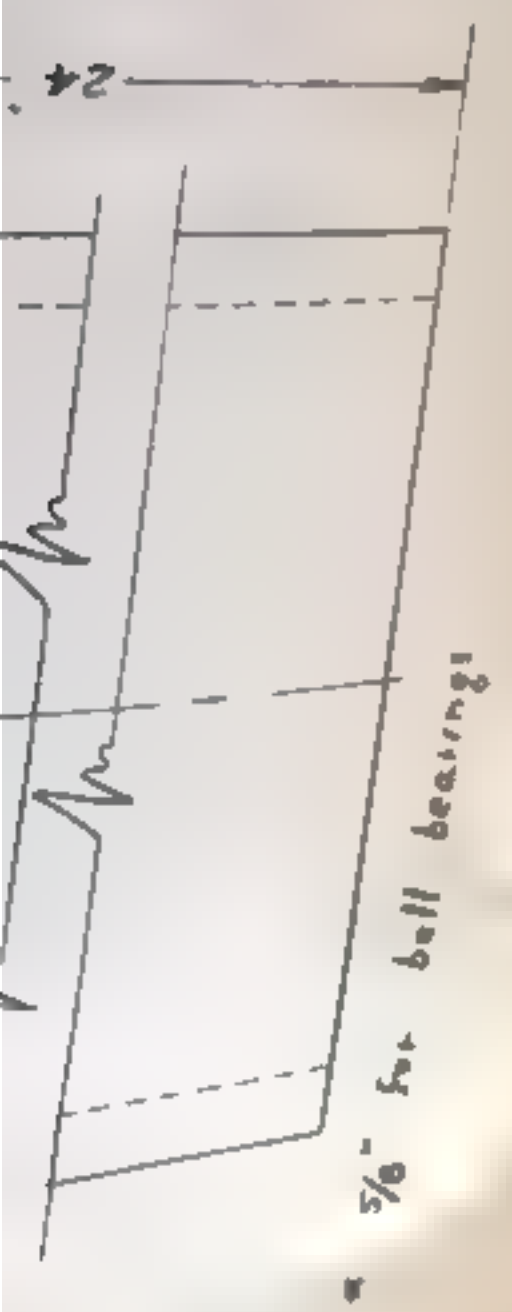
INSULATOR HOLDER
PART #3 - 1 REQ'D
MAT'L - STEEL



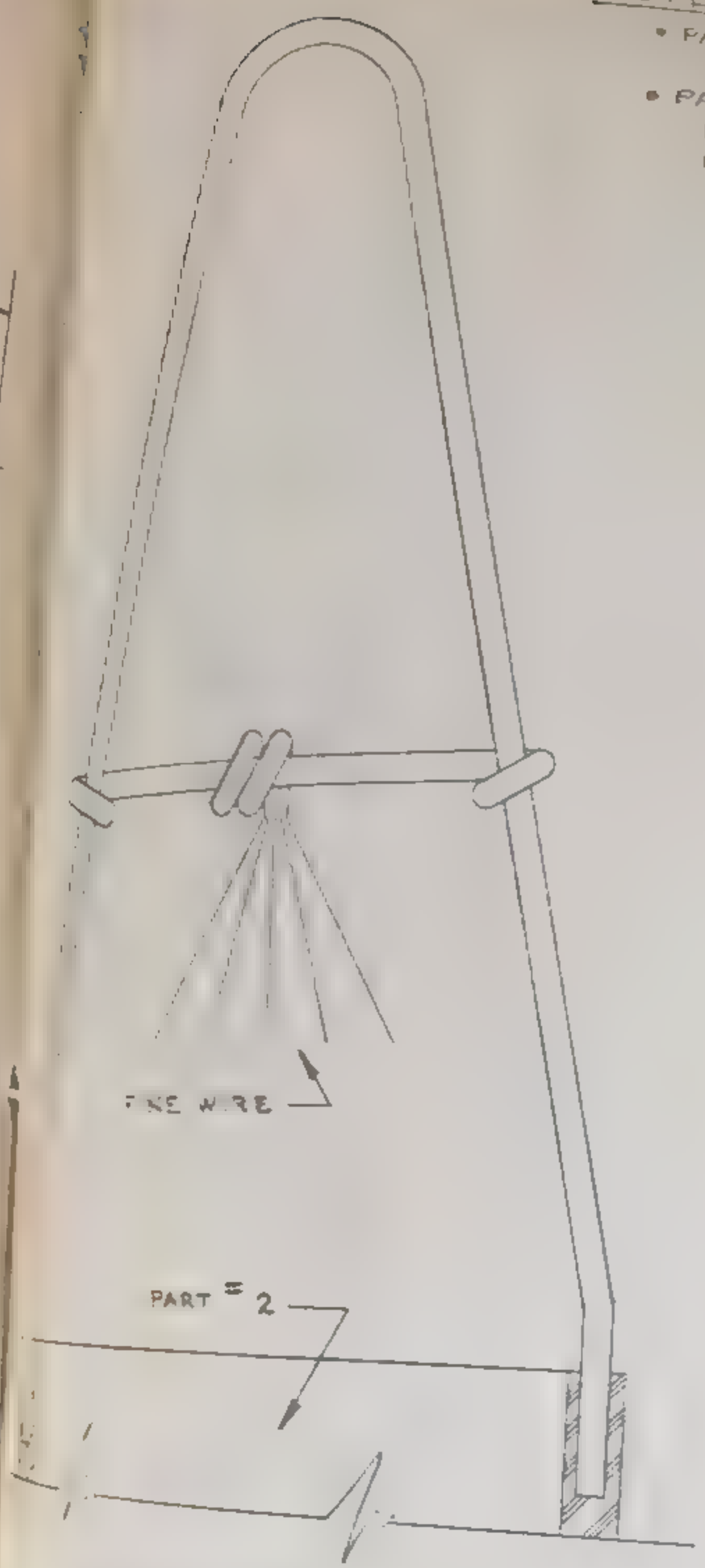
F DRILL
TAP $\frac{1}{8}$ - 10-NC-11 $\frac{1}{2}$ DR
4 HOLES



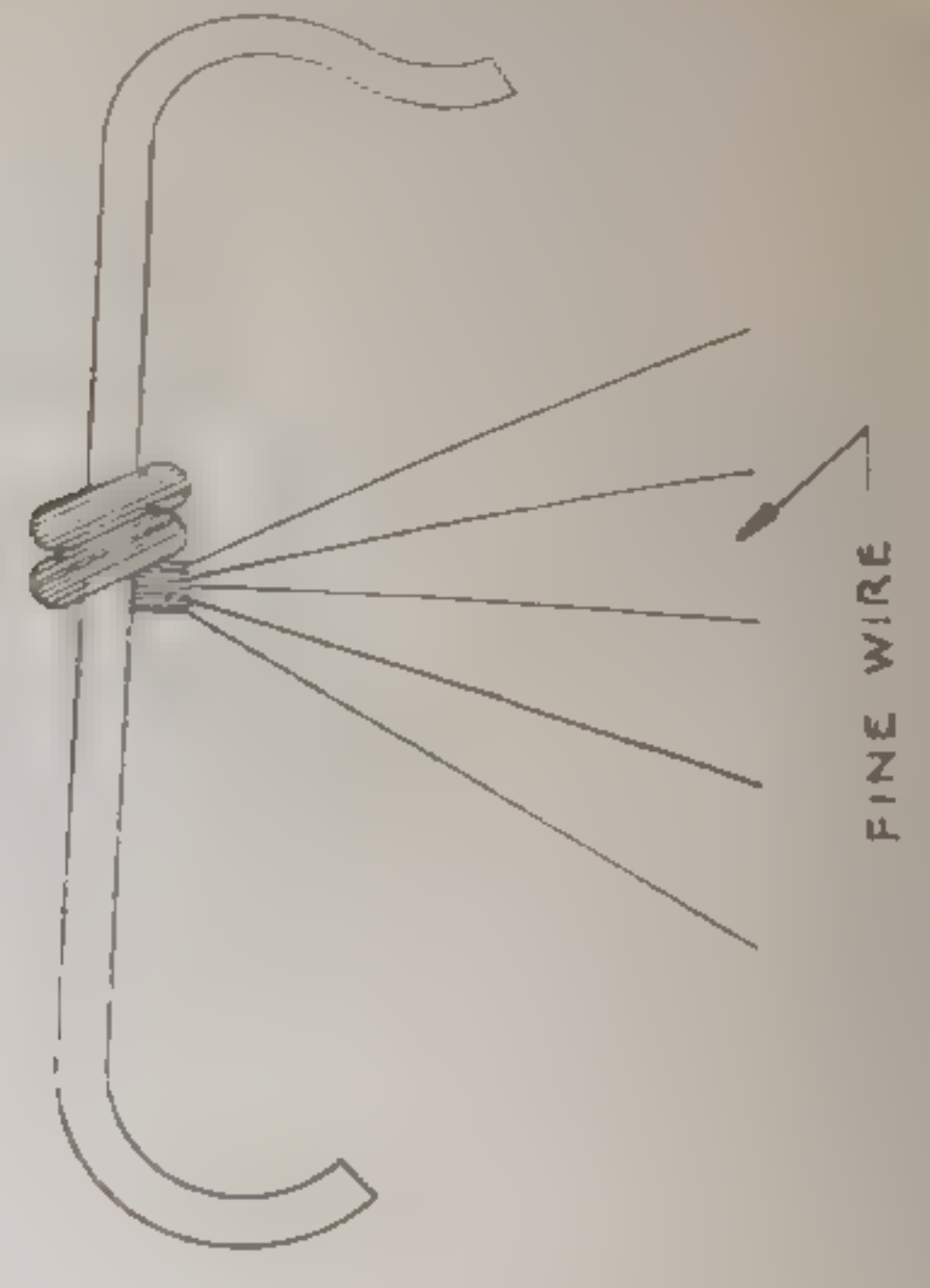
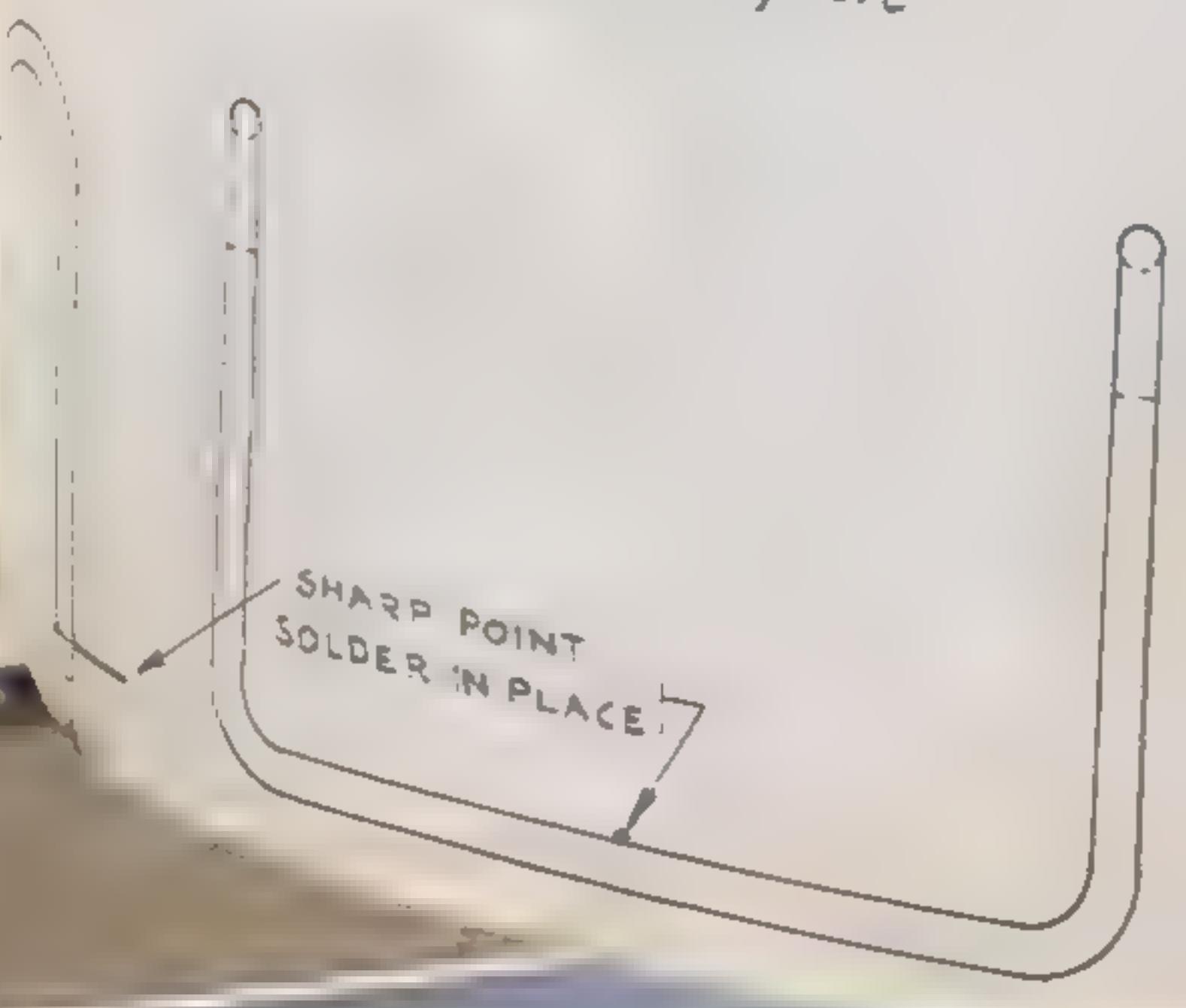
INSULATOR
PART #2 - 1 REQ'D
MAT'L - VINYL CHLORIDE



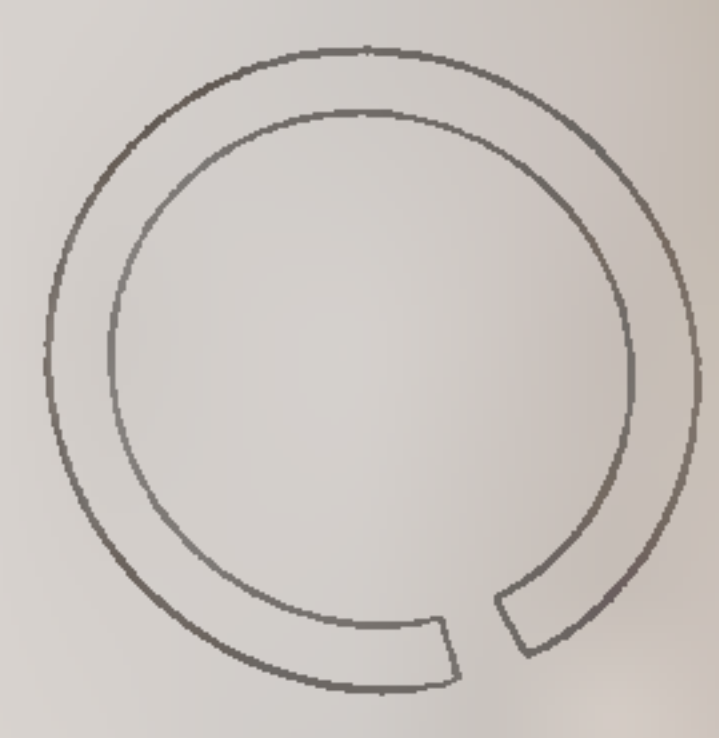
$\frac{5}{8}$ " for ball bearings



UPPER COMB
PART #14 - 1 REQ'D.
full size for 12" sphere
make 3" higher for 15" sphere



LOWER COMB
PART #16 - 1 REQ'D.



RETAINER
PART #17 - 1 REQ'D.

BOOSTER
PART #15 - 1 REQ'D.

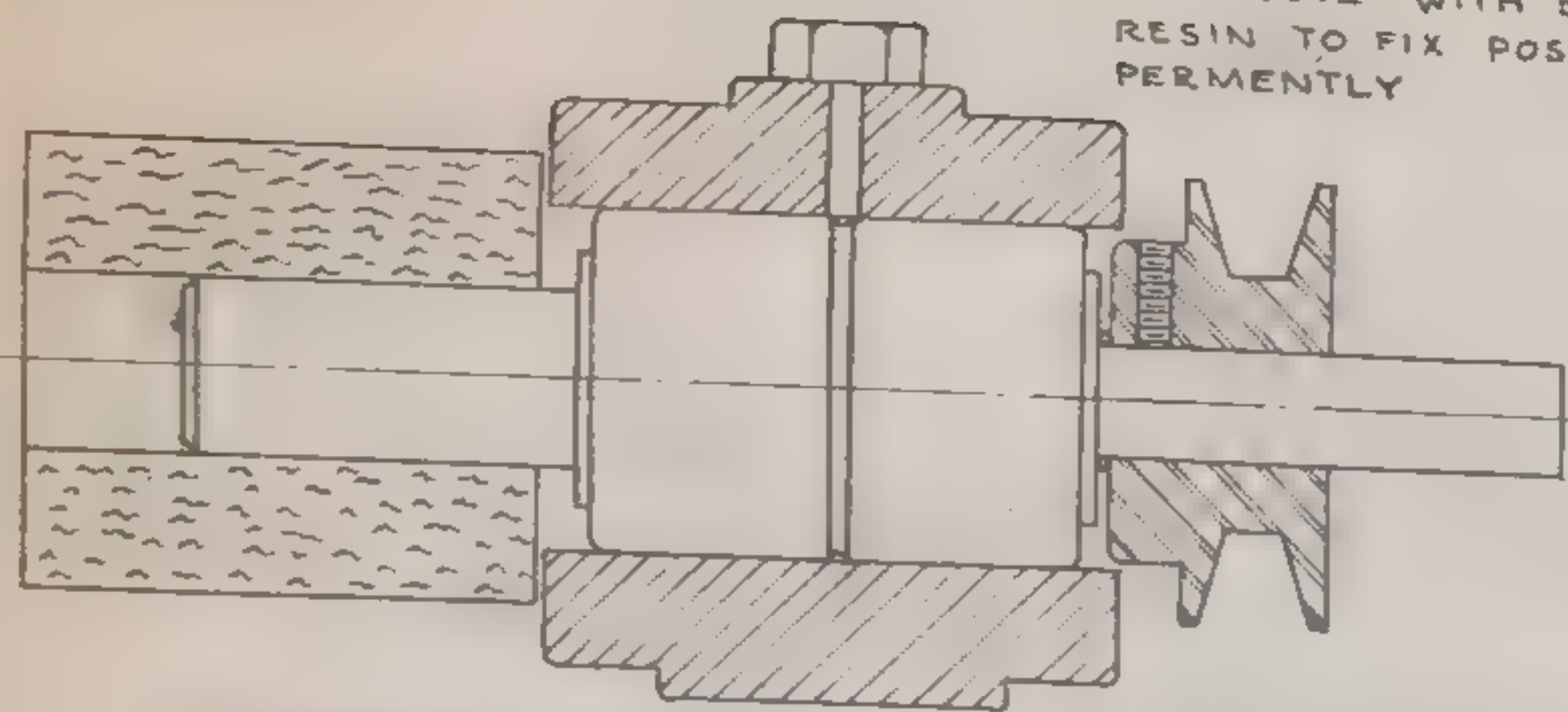
Casters

(4 required)

Base 1" Plywood

8

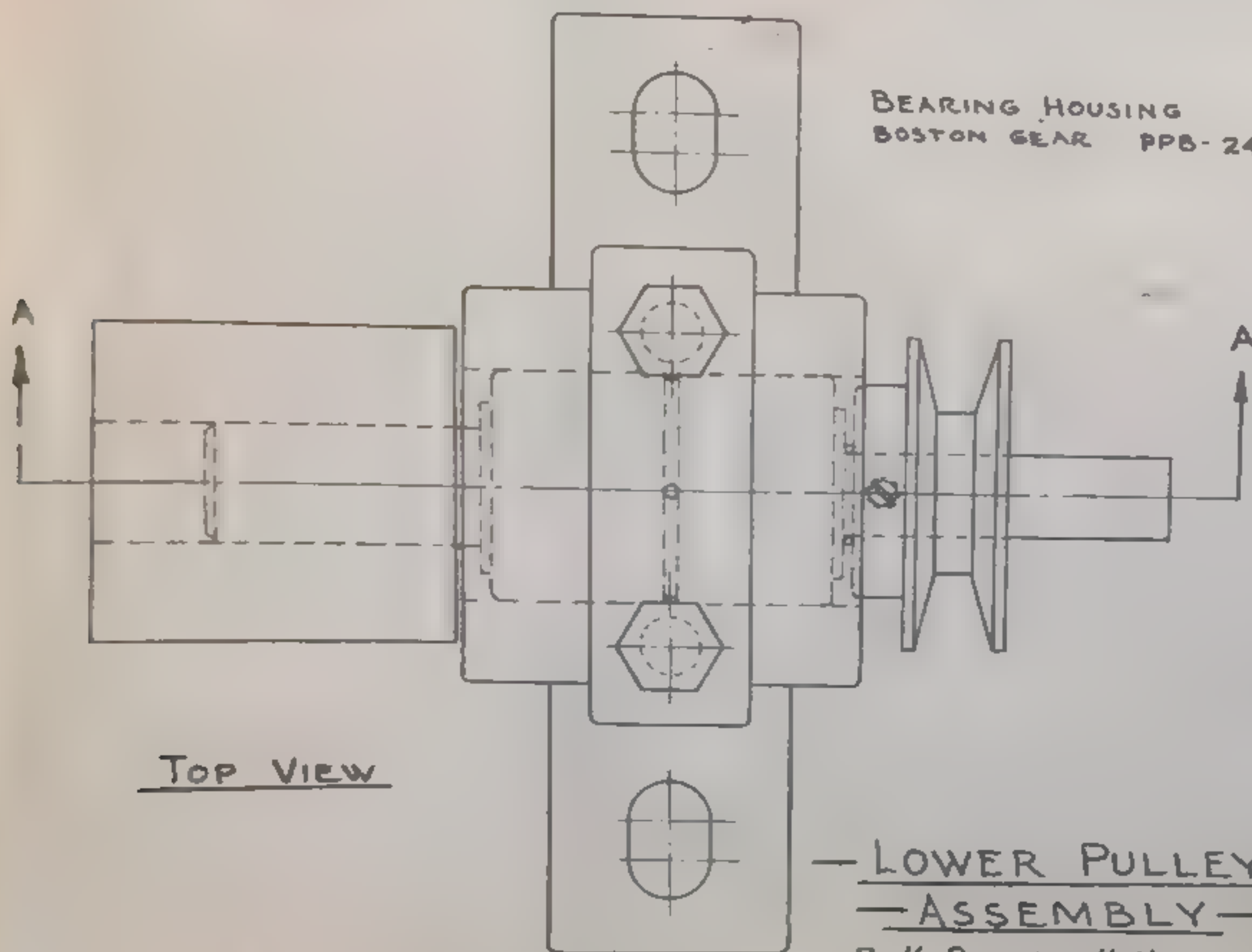
FILL GROOVE WITH BONDING
RESIN TO FIX POSITION
PERMENTLY



SECTION A-A

BALL BEARING UNIT
NEW DEPARTURE # 885-807

BEARING HOUSING
BOSTON GEAR PPB-24



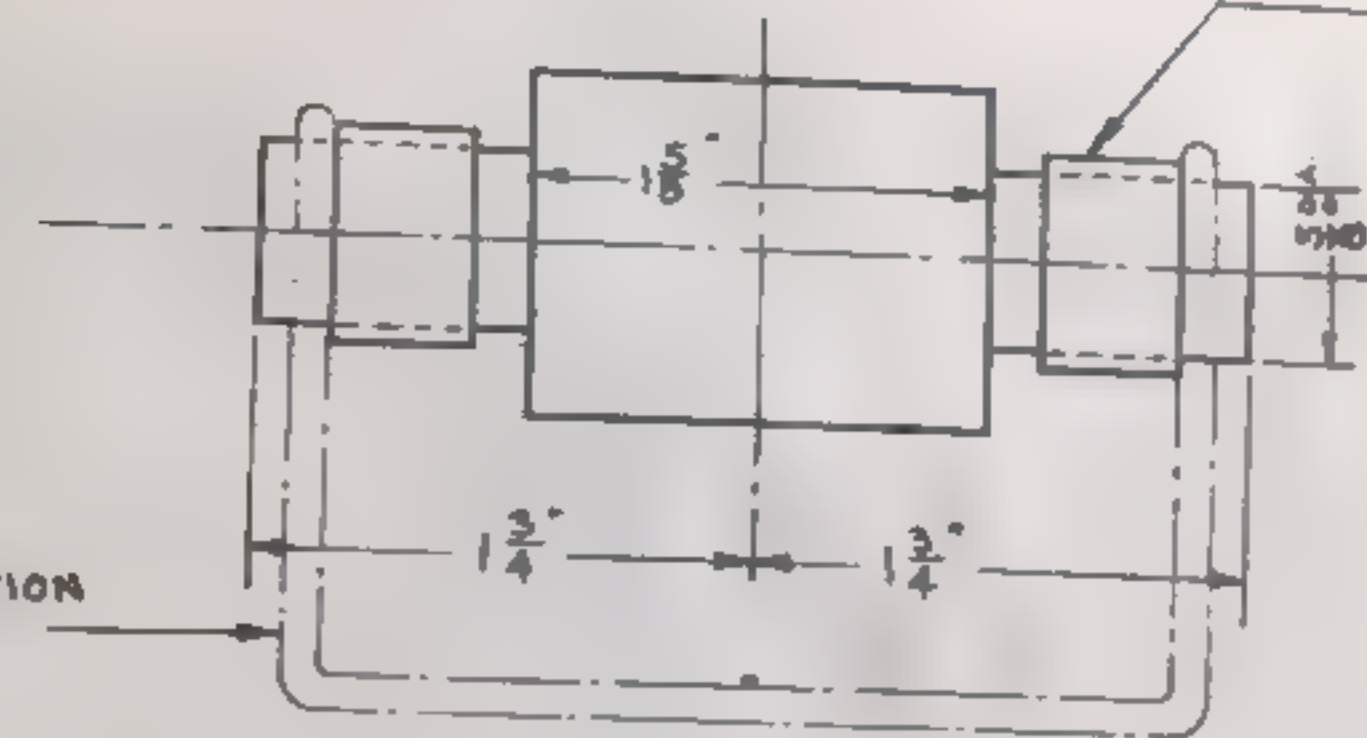
TOP VIEW

— LOWER PULLEY —
— ASSEMBLY —
Ball Bearing Units

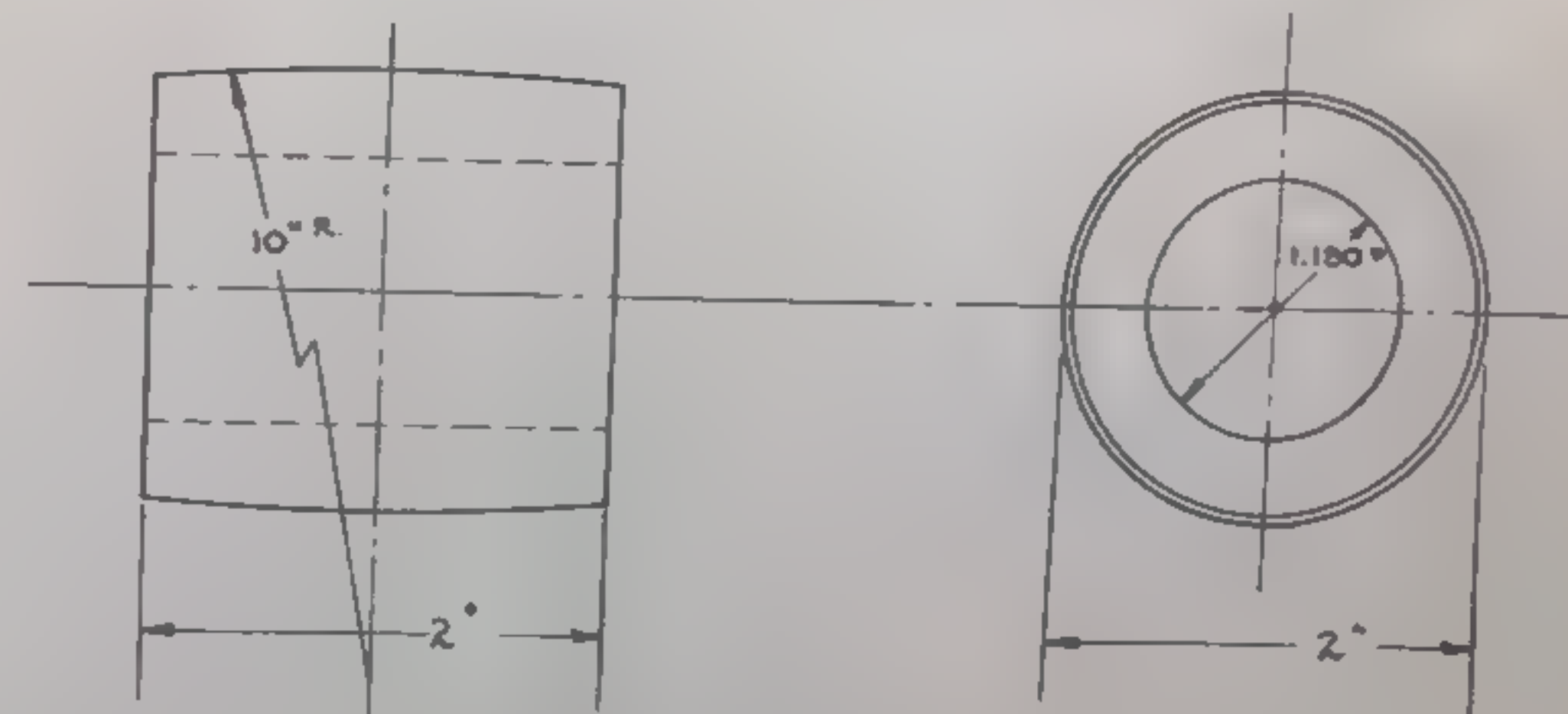
9

$\frac{3}{4}$ " O.D. x $\frac{1}{2}$ " SHAFT COLLAR
PRESS FIT TO SHAFT

RELATIVE POSITION
OF PART # 15



BALL BEARING
NEW DEPARTURE 885-141-C
O.D. = 1.1811"



UPPER PULLEY
— PRESS FIT TO BEARING
MATERIAL: MICARTA - PAPER BASE

UPPER PULLEY & BEARING
(Ball Bearing Units)

INFORMATION UNLIMITED
MILFORD, N.H. 03055

JACOB'S LADDER JL-1

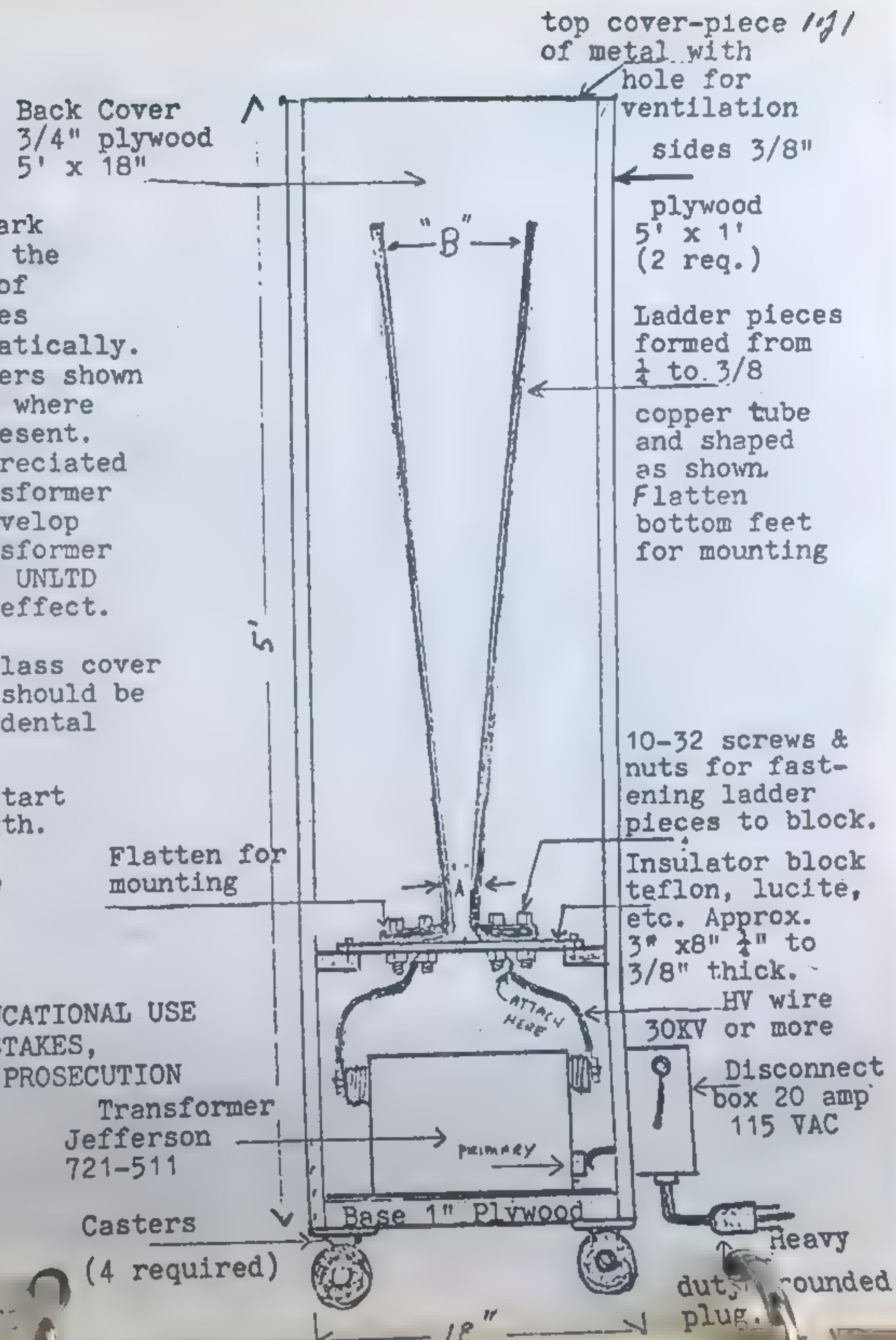
I. INTRODUCTION- Your jacob's ladder when constructed will supply hours of fascination. Proper operation will start off as a small spark occurring at "A" and climbing up the length of the ladder to "B" as a mass of electrical plasma of 6" - 10" in length. As soon as it extinguishes at "B" it repeats itself completely automatically. It should be noted that the sizes and parameters shown here are for a giant unit at tremendous power where extremely lethal voltages and currents are present. The same effect on a smaller scale can be appreciated by using smaller transformers, etc. The transformer shown is a 15,000 V @ .120 A unit and will develop up to a 10" column of plasma. A smaller transformer of 5,000 V @ .015 A is available through INFO UNLTD for \$15.00 and will develop an impressonable effect.

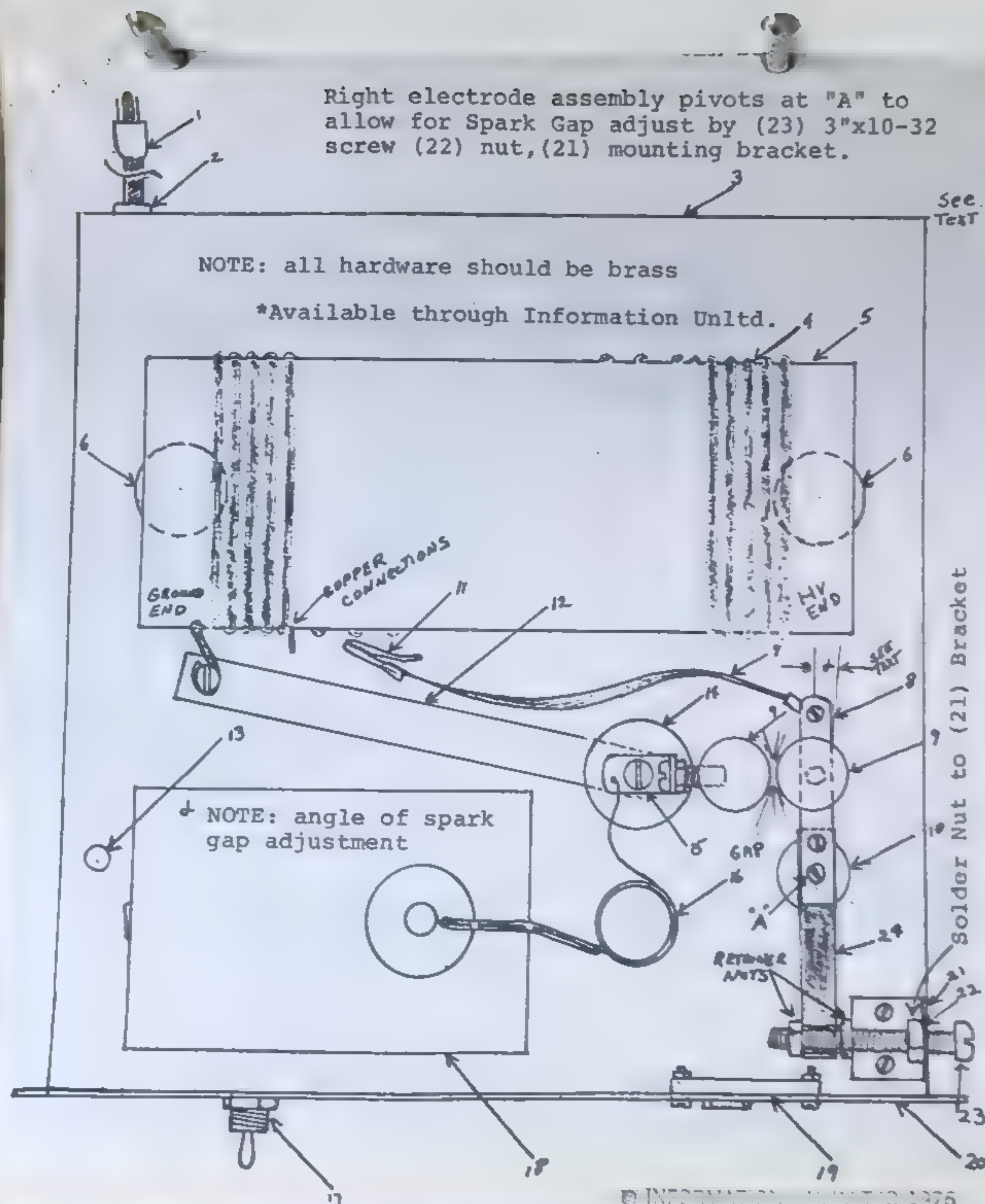
The unit shown should be fitted with a plexiglass cover over the ladder section. The bottom section should be covered with a piece of plywood to avoid accidental contact.

NOTE "A" adjusted for positive ignition start
"B" adjusted for maximum plasma length.

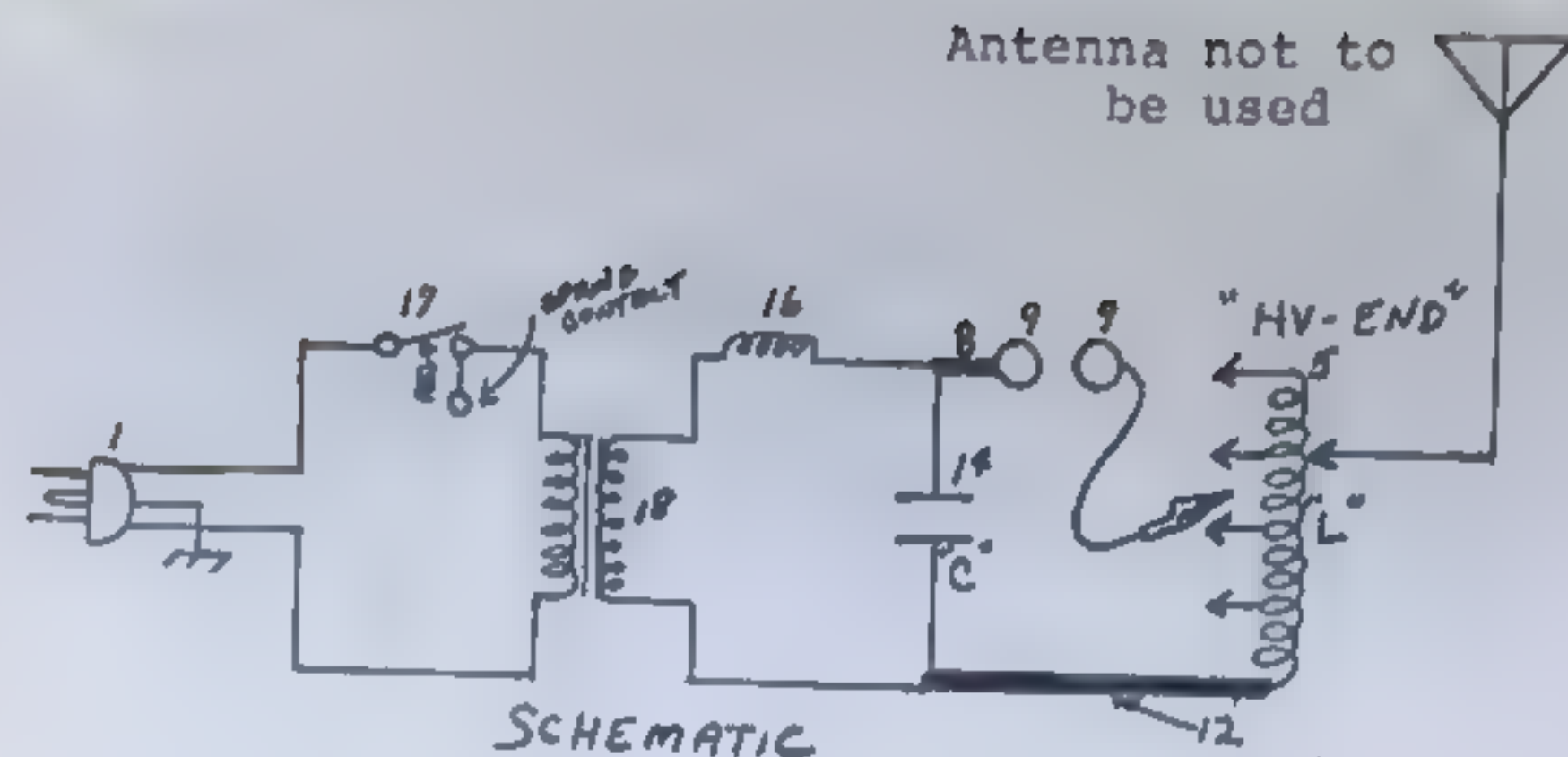
CAUTION - MAKE NO ADJUSTMENT UNTIL POWER CORD IS REMOVED FROM RECEPTACLE,

NOTICE - INFO UNLTD OFFERS THIS DATA FOR EDUCATIONAL USE ONLY. WE DISCLAIM ANY RESPONSIBILITY FOR MISTAKES, OMISSIONS OR FOR DAMAGE, INJURY OR CRIMINAL PROSECUTION RESULTING FROM USE OF THESE PLANS.





- Electric supply house
2. Cord Bushing-Heyman MFG. CO.
1/2" hole
3. Chassis 12"x12"x3" Bud #AC1424
4. Copper tubing 1/8" capillary approximately 40'
5. PVC tubing 3"IDx1/4" wall 11" long.
6. Ceramic insulators 2-1/16" EP Johnson 135-0503-001 (2)
7. 18" tinned copper braid 3/8-1/2" wide Alpha #1232
8. 1/2"x2-3/4"x1/16" copper fabbed per sketch.
9. 1/2" spherical electrodes (2) Yorkville Ind. #1846, Farmingdale, N.Y.
10. Ceramic stand off approximately 1/2"x1-1/32" E P Johnson #135-0501-001
11. Alligator clip
12. 1/2"x7"sl/16" copper grounding piece
13. Transformer primary wire bushing 1/4" Heyman
14. Capacitor 1000 pfd @ 20KV Sprague #715C series
15. Bracket 1"x1"x1/2"x1/16" copper-right angle bend
16. RF choke coil-1000 turns #36 magnet wire close wound on 1" diameter lucite, polystyrene or equivalent form 1000 turns to be started 1" from (ground) mounting end and continued for 5". Dope and mount in place. Inductance = to approximate 4 mh.
17. Switch SPDT-momentary on for one position. JBT#ST42H
- *18-Transformer-Jefferson 5000V @ 20ma SATURABLE CORE #638-1001-112.
19. Plexiglass or equivalent window for observing spark gap
20. Aluminum front panel.
24. Insulator 1/2"x1/2"x3" suitable material-fabbed as shown.



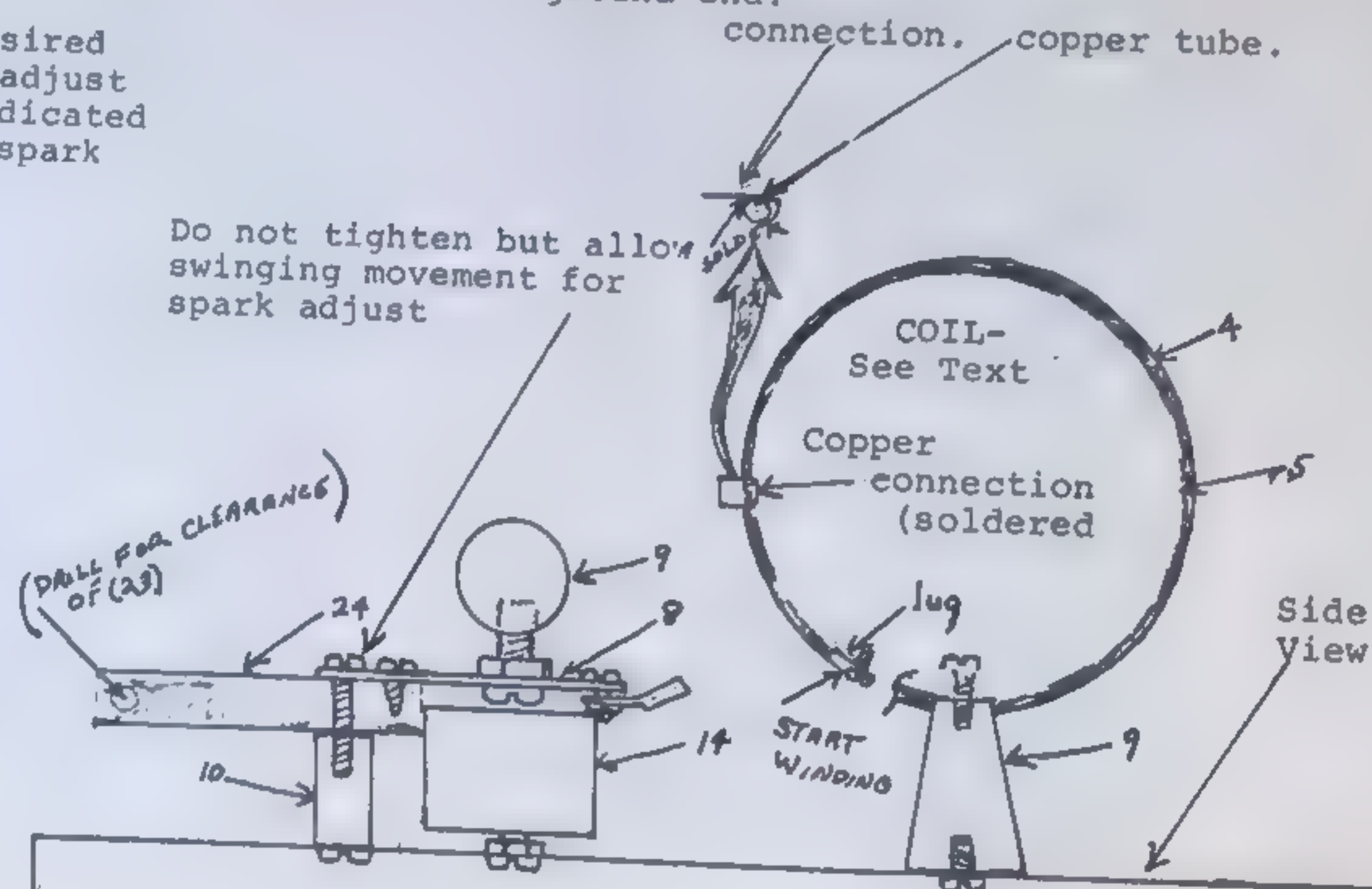
To Transmit turn on AM radio to desired frequency-Turn switch to "on" and adjust gap for maximum output which is indicated by the widest gap possible before spark extinguished

- * Plumb wind-Parallel dummy winding for even spacing to be removed when actual winding is secured.

Turns "L"	Cap "C"	Inductance	Freq
10	1000pt	7.4μh	1.90 MHz
20	1000pt	17.5μh	1.20 MHz
30	1000pt	26 μh	950 KHZ
36	1000pt	35μh	850 KHZ

COIL TAP CHART

1. Carefully wind 36-40 turns of 1/8" copper tube on PVC tubing. Start winding by securing end of copper in lug which is screwed into tubing to anchor.
- *Plumb wind with an equivalent thickness insulated wire until 36-40 turns or 1" is reached from end of form, secure end of winding and fasten like start.
2. Coat winding with several layers of dope. Let dry and remove spacer winding carefully and redope.
3. Carefully solder copper connection at "HV END" of coil and at every 10 turns to ground end.



IF YOU CONNECT AN ANTENNA TO THIS DEVICE TOTAL DISABLING OF THE BROADCAST BAND CAN RESULT UP TO SEVERAL MILES DEPENDING ON THE ANTENNA AND COUPLING USED. THIS IS A DIRECT VIOLATION OF FCC RULES.

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HIGH VOLTAGE-VAN DE GRAAF GENERATOR

1. COLLECTOR (SPHERE SPHEROID, ETC.) This is the heart of the device. It is actually a plate of a capacitor (other plate ground) which is charged at a constant current rate until the current leakage equals the current collected. Where this takes place determines the amount of voltage the sphere can accumulate. A quality factor of the device in respect to voltage is the radius of the sphere. A rule of thumb is to equate the maximum voltage of the sphere as equal to the radius in inches times 70,000. The sphere should be machined in two sections (hemispheres). The top section can be a perfect hemisphere with a slight indented flange for sleeving under the bottom hemisphere. The entrance hole for the belt in the bottom hemisphere must have a large radius of smooth curvature formed inwards. This hole should be no more than half the size of the diameter of the sphere. Selection of the sphere is a function of voltage desired and obviously cost. One must also consider using substitution such as metal bowls, pots, etc., for the lower power models. Once size is selected obtain a quote from some local metal spinning houses. Your best bet is to befriend one and hope that he is not too busy to be helpful in your request. For maximum results keep sphere smooth, clean and free of lint and dust.

BELT means supplying a constant current to the sphere. In these designs we try to approach a linear belt speed of 100'/second. Belts must be of insulating material such as NYLON, DACRON, RAYON, RUBBER OR NEOPRENE, ETC. These designs shown use a rubber inner tube fashioned together with appropriate rubber cements and diagonal type splices to obtain the necessary size. When using cloth type, care must be taken to prevent fraying along the edges. This can be reduced by coating with lacquer. Always use a diagonal splice when piecing belts together and an appropriate cement depending on material. One must however, realize that rubber inner tube belts have a short life expectancy due to their poor resilience to ozone but are economical. If cost is not a factor, neoprene is an excellent material for belts. USE INGENUITY IN FABRICATING YOUR BELT. NOTE-for 1 microamp of current it takes 50 sq inches of belt surface passing a given point per second. For the accompanying plans where the belt is 8" wide this means that in one second at a belt speed of 100 feet per second that approximately 200 micro amps accumulate on the sphere. BE CAREFUL!!

- 2&4. UPPER AND BOTTOM PULLEYS-8" X 8" wooden pulleys constructed from eight, 8" diameter 1" thick plywood discs glued together. Turn in lathe with a slight crowning at center (1/8") drill hole for drive shaft at true center (Typical 15/16" for model shown). Coat with lacquer.

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- 6 & 7. COLLECTOR, APPLIER, NEUTRALIZER COMBS-Form from strips of common window screen equal in length to width of belt (8") and soldered to copper strips. Usual widths of screen are approximately 1". Adjust all combs for even homogeneous gap along width of belt. Just to point of touching usually is best for optimum results. The collector comb (5) which transfers current from the top of the belt to the sphere is soldered to a copper strip or heavy wire formed as shown to support collector, (35). Staples (34) are used to position comb assembly. The applier comb is formed to inside of belt and mounts under insulator (37). It is connected to ground return of power supply. The neutralizer comb assembly (7) mounts on standoffs (37) and is connected to HV+ terminals of power supply and charged bar(9). All combs are considered to be adjustable and must be built so as to be flexible in adjustment relative to belt. Also, trimming will be necessary to prevent arc over, etc. The final tune up of your machine will result in adjusting location of combs for maximum output. It should also be noted that combs can be needles, tufts of wire, etc.
8. INSULATING COLUMN- 4-5" diameter X 48" long poly vinyl chloride pipes.
9. CHARGE BAR-8" length of $\frac{1}{4}$ " copper with tabs of flexible copper sheet soldered for mounting to insulator (37). Connect to +HV terminal of power supply.
10. UPPER BEARINGS-15/16" Dodge 4 bolt SC flange type (two required)
1. BOLTS, NUTS AND WASHERS FOR BEARINGS. 7/16X2" (twelve sets required)
 2. SHAFT UPPER-15/16"X12" pressed into upper pulley and pinned, as shown
 3. LOWER BEARINGS-15/16 Dodge 2 bolt SC flange type (2 required)
 4. SHAFT LOWER DRIVE-15/16X24" threaded for nut(note-shaft must rotate to tighten)
 5. 15/16" Hex Nut
 6. 15/16" Flat washers add to reduce shaft end play
 7. 15/16" collar for position of drive shaft
 8. "V" belt pulley 4" on motor, 5" on drive lower pulley drive shaft.
 9. MOTOR- $\frac{1}{2}$ HP 3450 RPM Sears #9G1218C or equivalent.
 10. "V" belt of appropriate size and length (standard type)

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21. TOP AND BOTTOM-Plywood pieces, upper pulley housing 1"X9"X5" (two required)
22. SIDES-Plywood pieces bearing sets Upper pulley housing 1" X 12" X 5" (two required)
23. TUBE COLLARS-Plywood 1" X 6" X 6". center hole equal to diameter of (8) insulating tube, (four required) two top, two bottom.
24. CORNER EXTRUSIONS for reinforcing-glue in place 1" X 1" (ten required)
25. BASE- 22" X 30" X 1" plywood-2 pieces glued together for strength
26. TOP AND BOTTOM PIECES-Plywood, lower drive pulley housing 18" X 6" X 1" (two required)
27. SIDE PIECES-Plywood lower drive pulley housing 6" X 12" X 1" (two required)
28. MIDDLE PIECES-Plywood support 10" X 6" X 1" lower pulley housing.
29. MOTOR BELT, NUT, WASHER AND SPRING COMBINATION (4 required)
30. BOTTOM PULLEY HOUSING MOUNTING BOLTS, NUTS AND WASHERS (six required)
31. & 32. INSULATOR FLANGE AND COLLAR MOUNTING BOLTS, NUTS AND WASHERS 4" long (8 required)
33. WOOD SCREWS-stainless #10 X 2" (approximately 36 required)
34. STAPLES for securing top comb and sphere support (35)
35. SPHERE SUPPORT AND COMB BRACE (heavy wire or copper tubing formed as necessary-solder (5)
36. FLANGE MOUNTS FOR INSULATOR PIPE (2 required)
37. INSULATORS- Steatie 2" X 1" combs (6 required) thread in stud and drive into wood.
38. HIGH VOLTAGE IGNITION WIRE, LUGS, SCREWS, ETC., (6 feet required)
39. HEAVY DUTY 3 wire line cord (grounded)
40. TRANSFORMERS-4000-5000V @ 10-20 ma Jefferson #969-1001-140 or equivalent.

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P7 7 05 7
1121

41. PLEXIGLASS or other insulating mounting plate 3" X 4" X 1/8"
(drill and fasten to high voltage insulators on transformers)
42. HIGH VOLTAGE DIODES VARO # VG10 10,000V @ 25 ma (2 required)
43. HIGH VOLTAGE CERAMIC CAPACITORS-1300 pfd @ 15KV Sprague
712C series.

It should be noted that the plans are made as flexible as possible due to the availability of junk parts, etc., that the builder may have access to. However, the collector, belt pulley, combs and insulator columns must approach the specs and designs indicated if maximum efficiency is to be had.

Also, the output of the system can be increased by providing a smooth surface directly below the sphere. This can be a third hemisphere placed over the plywood enclosure such as noted by the dotted outline on page 1. Your machine functions best on a cold dry day. Also, to produce higher voltage two machines can be made and the combs and power supply polarities so arranged so as to develop opposite potentials between the two spheres, that is one positive and one negative.

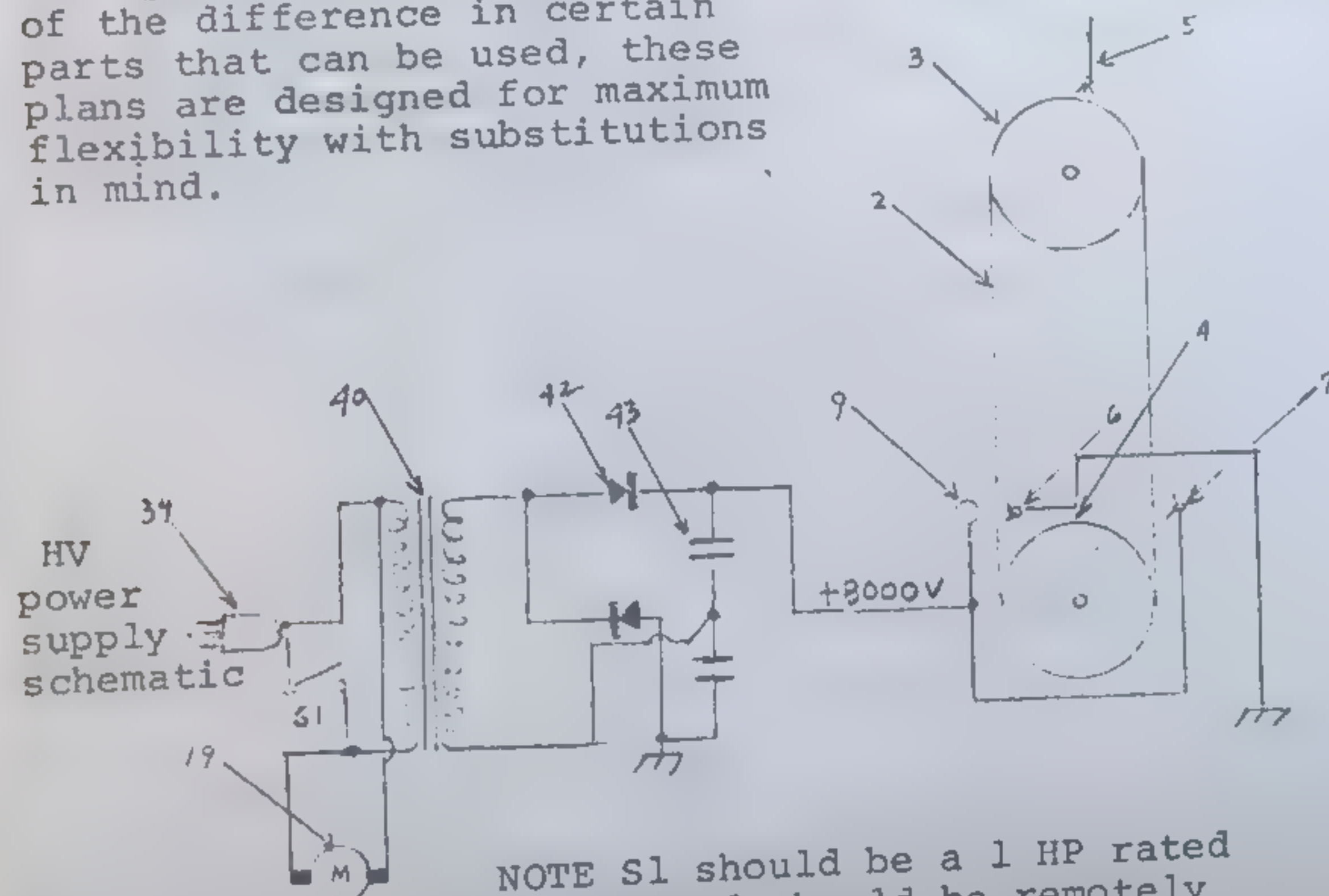
adjusting your machine for maximum efficiency one approach is to secure a grounded electrode of some distance from the sphere and note the rate of discharge and build up. Adjustments are therefore made noting the rate of above. Also it allows adjustments to be made without getting hit by a discharge while being close to the machine.

Also special care must be taken in pulley alignment, bearing alignment and all the related belt parts and functions. Remember the belt is traveling at nearly 100 feet per second.

1.5 MILLION VOLT GENERATOR HV-1 (External Belt Type)

*VOLTAGE	DIM A"	DIM B"	DIM C"	DIM D"	BELT DIM E"	HP MOTOR		OTHER
1.5 MILLION	48"	20"	96"	6"	10-12"	.5-.75	NOTE THAT COMBS MUST BE ADJUSTED FOR MAXIMUM CURRENT TRANSFER	REINFORCE COLUMN
1 MILLION	30"	15"	60"	6"	8-10"	.5		
750,000	24"	12"	48"	4-5"	6-8"	.33-.5	EXPERIMENTING WITH COMBS IS A MUST FOR MAX.	
500,000	15"	6"	36"	2-3"	2.5-3.5"	.33		
250,000	7"	3.5"	21"	2"	2.5"	.25		

*Maximum possible values depending on humidity, Belt speed and efficiency, quality of sphere, insulation, etc. Values on chart are approximate and are intended to be used as a guide. Because of the difference in certain parts that can be used, these plans are designed for maximum flexibility with substitutions in mind.

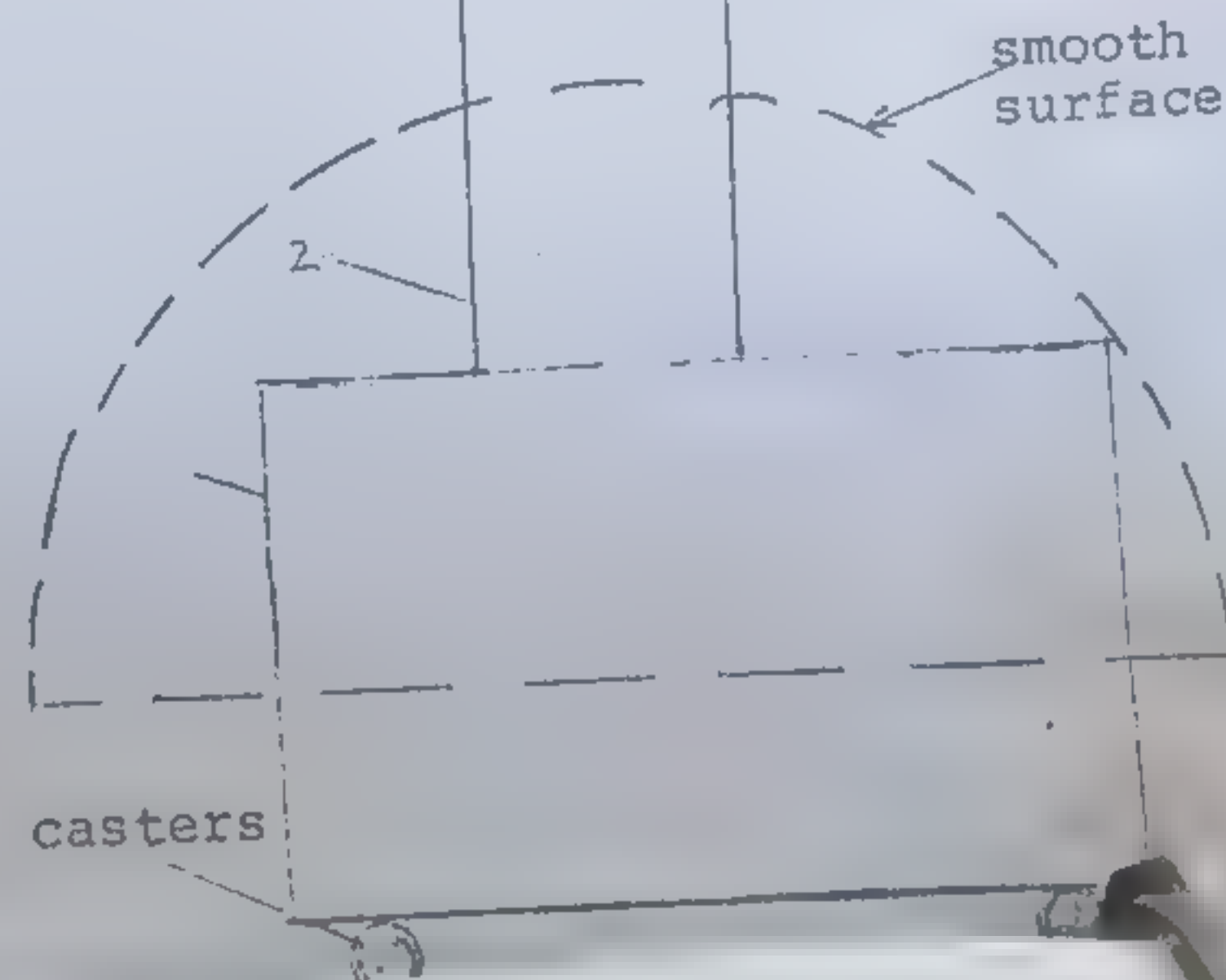


NOTE S1 should be a 1 HP rated switch and should be remotely mounted to prevent getting hit by spark.

The above plans show how to construct a potentially lethal electrical device. Also an X-Ray hazard exists. USE CAUTION ON THE HIGHER POWERED UNITS.

Large radius of smooth curvature formed inwards.

Plans shown are for 750KV model



Pg 2, 04 /
HVI

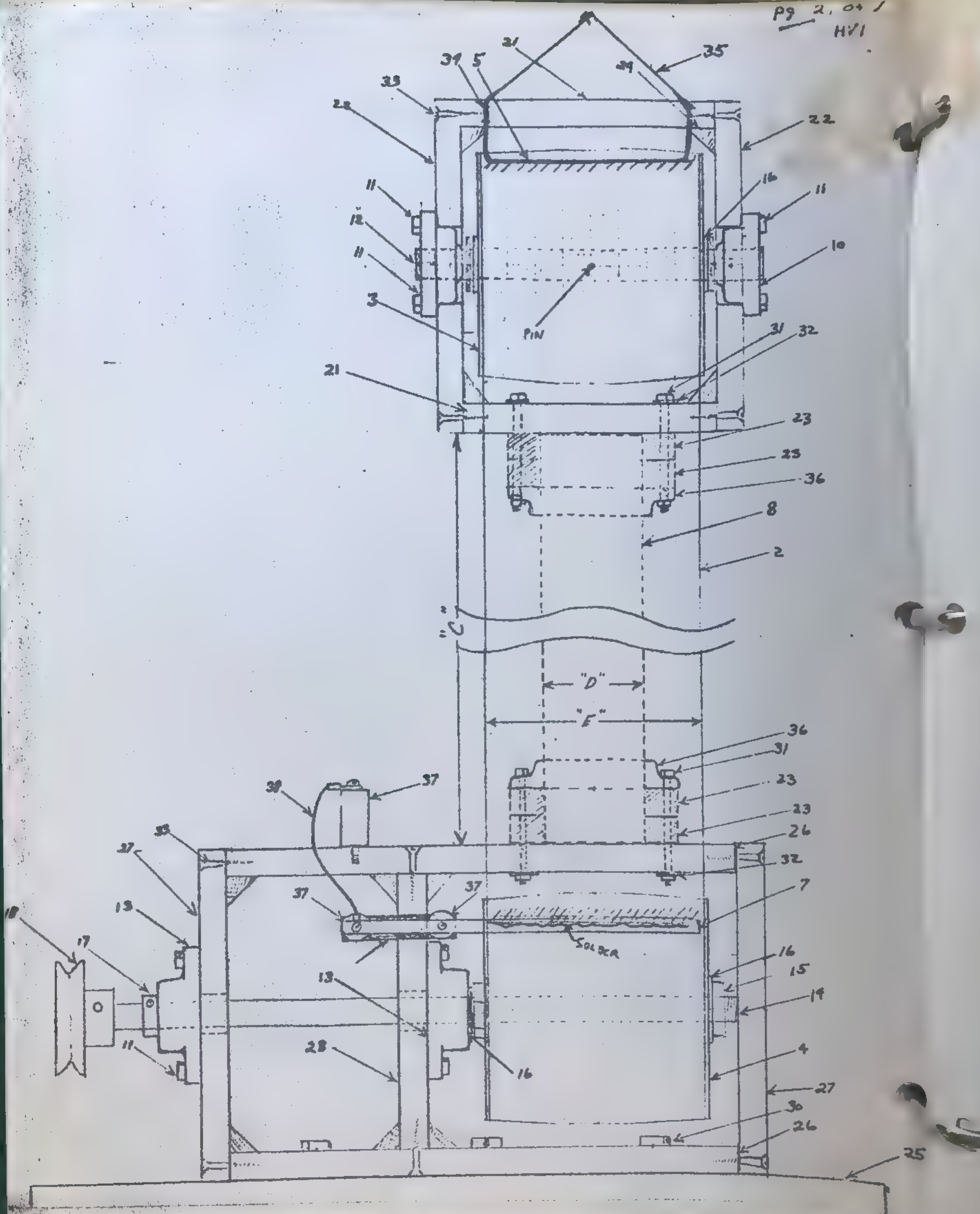
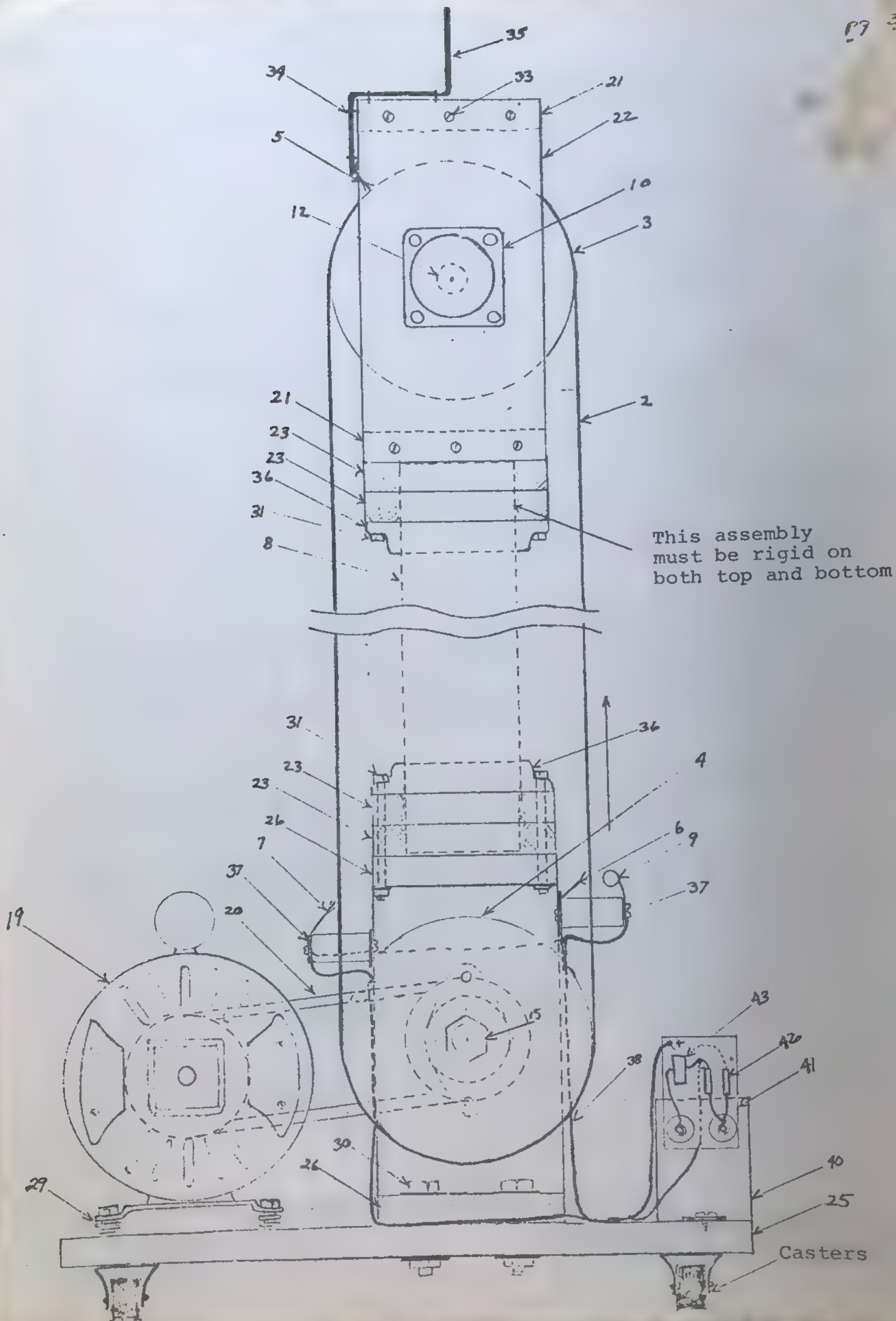


Fig. 3 of 7



This assembly must be rigid on both top and bottom

Casters

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INTRODUCTION ATOM SMASHER AS-8

Your atom smasher is a device intended for the amateur experimenter wishing to explore the world of nuclear physics.

The device is relatively simple and inexpensive to build. It can supply hours of interesting experiments providing the amateur with a valuable tool in this field.

This device for example, can transmute elements such as lithium into unstable beryllium with a release of 17 MEV upon breaking down into helium, it can speed up chemical reactions, induce mutation in living organisms, alter the physical properties of organic compounds and many other fascinating feats that otherwise would be impossible without it.

It is no toy and is intended for the serious minded individual since a radiation hazard exists with any device such as this. Caution and discretion must be used at all times.

Basically the device is nothing more than an oversized two element vacuum tube consisting of a heated filament that produces space electrons at one end and a high potential collector or plate at the other, that creates a HV field that accelerates the electrons to a high energy state. Also the system must be evacuated to an atmospheric pressure of .00001 mm of mercury to eliminate electrons from colliding with atoms of air, etc.

The HV generator is the 500 KV model from Information Unlimited.
(Note-included in plans).

The following plans describe the particle accelerator and the high vacuum system.

PARTS LIST

1. VAN DE GRAF~(see enclosed plan HV-1-Information Unlimited).
2. ACCELERATOR SPHERE-See enclosed HV-1 plans-Item 1.
3. ACCELERATOR TUBE-Pyrex glass tube 60mm x 3' long-VWR #32817-032, Corning #234600 or VWR 32817-597 for more strength.
4. MOUNTING BASE-16" x 3' x 2" hard wood or two pieces of 2" x 8" strapped together (use ingenuity).
5. CATHODE ASSEMBLY TUBE-Copper cylinder-machine and fab as shown (Drawing A & B) 2-1/2 OD x .065 wall x 3" long.
6. BASE PLATE-For cathode assembly 6 x 6 x 1/16 in copper or brass carefully solder cathode assembly tube (5) to center assuring a pressure tight solder seal (Drawing A & B).

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7. COPPER TUBE- $3/8 \times 2$ " for vacuum line, carefully solder as shown (Drawing A & B).
8. COPPER TUBE- $3/8 \times 2$ " for hot wire feed to filament (12) carefully solder as shown.
9. POSITIONERS FOR HOT WIRE-Two small non-conductive washers for positioning of hot wire from shorting to tube. Carefully insert one at a time and position wire, seal with GE Silicon RTV 118. Allow a complete seal of 1st washer then proceed, repeating with second washer, carefully filling space between the two and completely sealing. Handle and shape wire carefully. Do not twist, or seal will be no good.
10. HOT WIRE-#18 AWG-assemble and seal as shown
11. GROUND WIRE-#18 AWG-carefully solder to copper tube (8) and shape as shown.
12. FILAMENT- $1/2$ " #30 Nichrome wire-note that subminiature alligator clips can be attached to copper wire to hold filament-use ingenuity.
13. PLASTIC, WOOD, ETC., ABUTMENTS-Two or three required- $1" \times 1/4"$ D-glue in place along inside wall of cathode assembly tubes. This allows vertically positioning and support of accelerator tube (3).
14. TRANSFORMER FILAMENT-12 volts @ 3Amps. Radio Shack #273-1511.
15. VARIAC SMALL- 1 amps Superior #10B or equivalent.
16. MINATURE ALLIGATOR CLIPS-Solder and clamp to 10 & 11 and clip in filament wire (12).
17. BEAM RESTRICTION RINGS- #22 to #26 bare copper wire-3 to 4 close turns with end twisted just tight enough to hold in position on outside of accelerator tube. Space rings about 3" apart. These rings establish electrical equilibrium between them and the surrounding air. This method keeps the electron beam on axis.
18. FILAMENT WIRES POSITION DISC-Cardboard, plastic, etc., disc with holes as shown-position wire for mechanical stability.
19. MOUNTING BOLTS- $1/4 \times 2$ " hex head lag bolts.
20. SEALER-GE Silicon Rubber, RTV 118 or 108 or equivalent.

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COLLECTOR ANODE ASSEMBLY

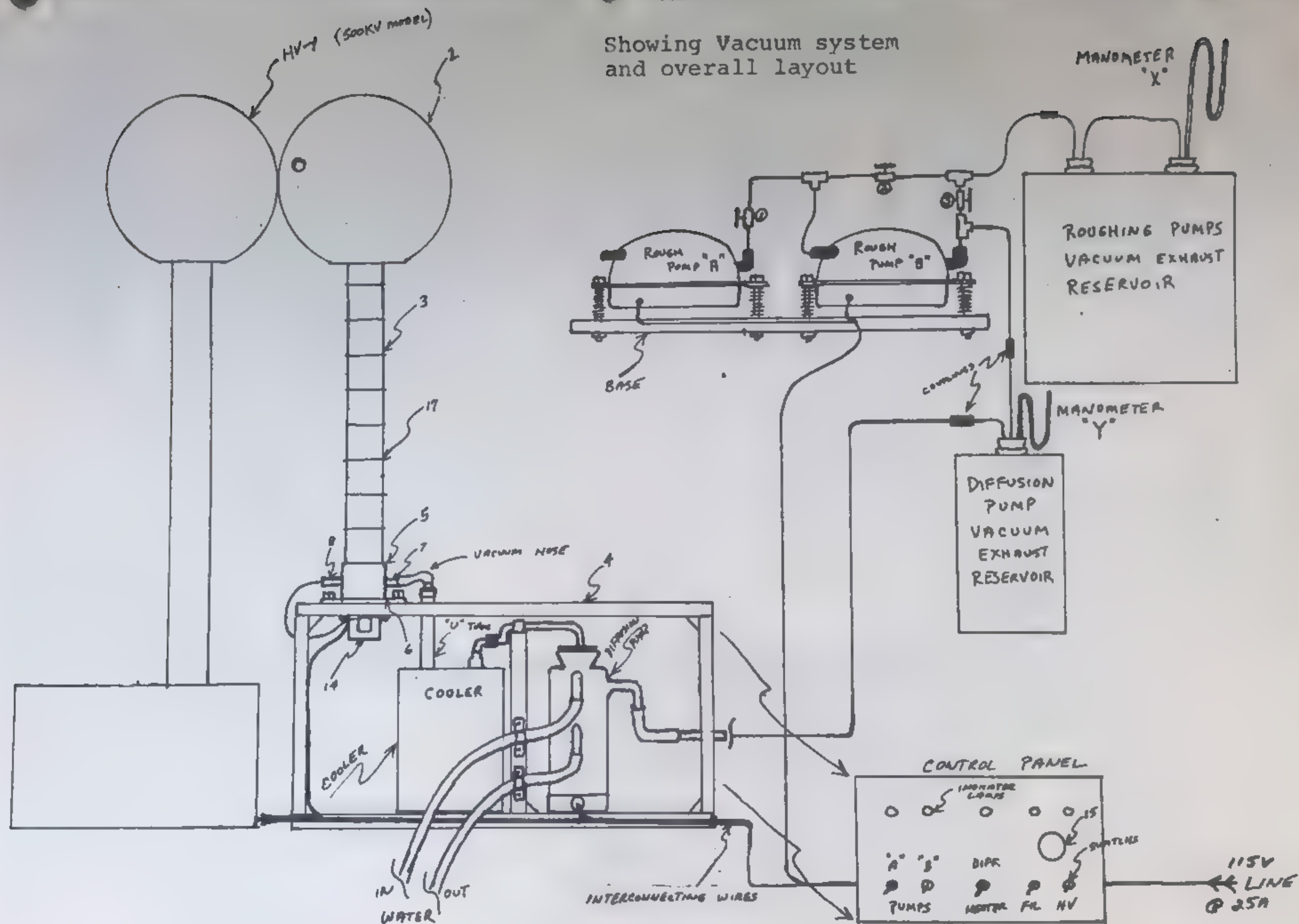
21. TARGET DISC- 1-1/2" disc of 12 gauge copper or brass or al secured by one axial lead of capacitor (22) as shown.
22. CAPACITOR- 1 mfd @ 200 wv-good quality cap-Sprague #416P-10592
23. NEON INDICATOR- 1/25 watt neon lamp, lead type bridged across cap (22) as shown.
24. SUPPORT COLLAR-Build up of tape until necessary radius is obtained to snugly fit accelerator sphere (2) or form from plastic, etc.
25. WAX MIXTURE-Make by mixing equal parts of resin and beeswax. Apply smoking hot on all sealed joints with an eyedropper. Heat surfaces to be sealed for best results.
26. WINDOW SUPPORT PIECE- 1/4 circular aluminum of a slightly less diameter than that of accelerator tube so as to allow a shoulder for sealing with wax mixture. Pierce 37 holes as shown in drawing "C".
27. WINDOW- .001" circular aluminum foil 2" diameter fastened to window support (18) by wax mixture.
28. TERMINAL SPHERE SUPPORT-Form as shown from #12 copper or brass wire-tape to accelerator tube as shown.

TO OPERATE

1. Pump down as outlined in VA2 instructions.
2. Turn on filament and verify proper operation by turning up variac (15) to a point where filament starts to glow. Return variac to zero.
3. Turn on HV generator (HV1) and verify its proper operation.
4. Once all the above is properly functioning we can proceed to verify the operating of the actual accelerator.
5. With HV generator and vacuum system operating, slowly advance filament variac (15) until indicator lamp (23) starts to flash. When this happens we are obviously accelerating electrons to a sufficient velocity to penetrate the aluminum foil window (27) and build a charge up on the plate (21) that charges capacitor (22) to a voltage high enough to fire the lamp. One will soon learn the optimum setting of the filament for maximum effect. Too many electrons will load the high voltage down to a point where the electron velocity will be too low and consequently too few electrons will have less effect due to decreased beam current. No doubt one can see the happy medium of adjustment in this setting remembering that the flash rate of the indicator lamp (23) is a direct indication of beam intensity.

ATOM SMASHER AS-8

Showing Vacuum system
and overall layout



ATOM SMASHER AS-8

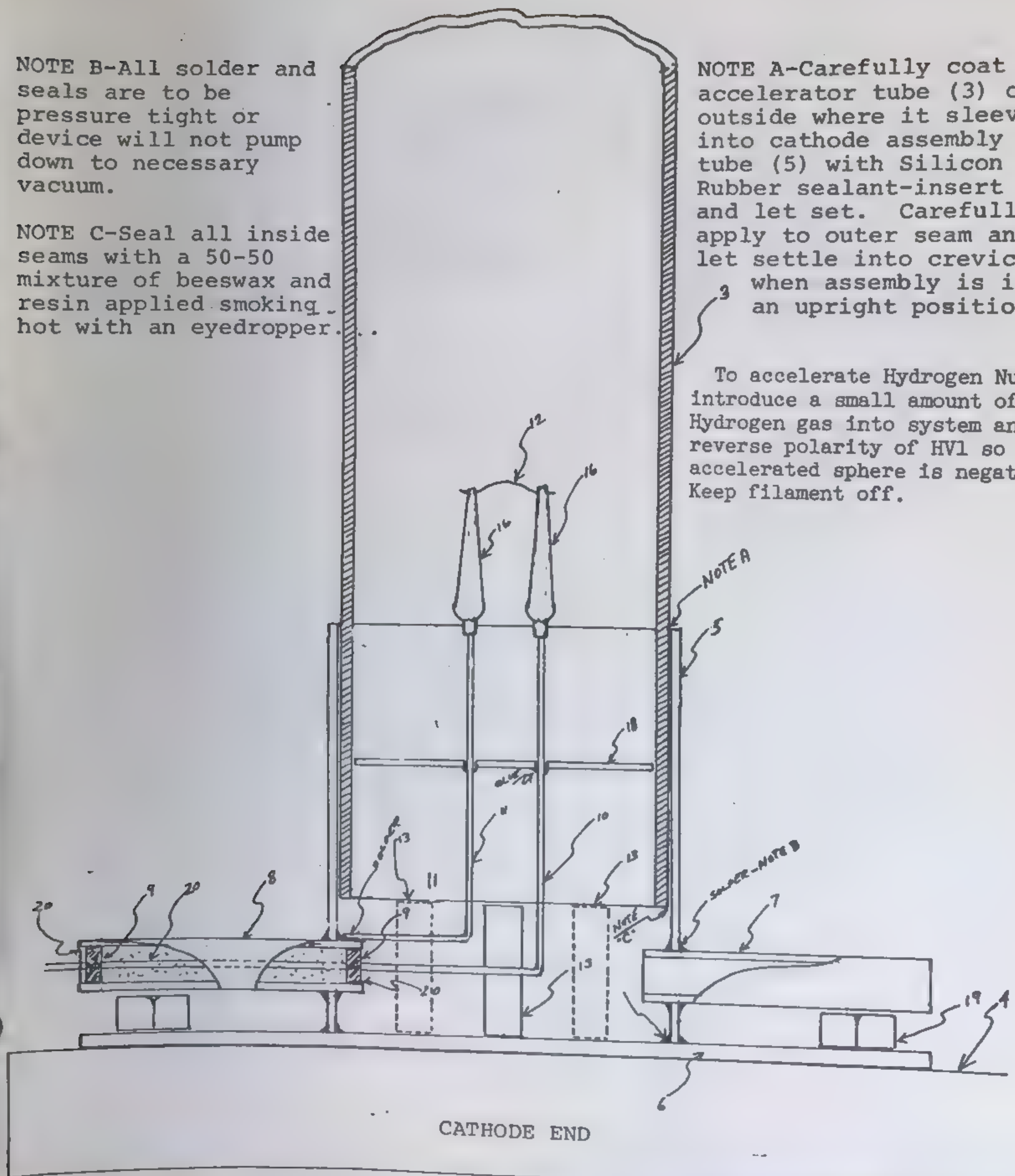
ACCELERATOR

NOTE B-All solder and seals are to be pressure tight or device will not pump down to necessary vacuum.

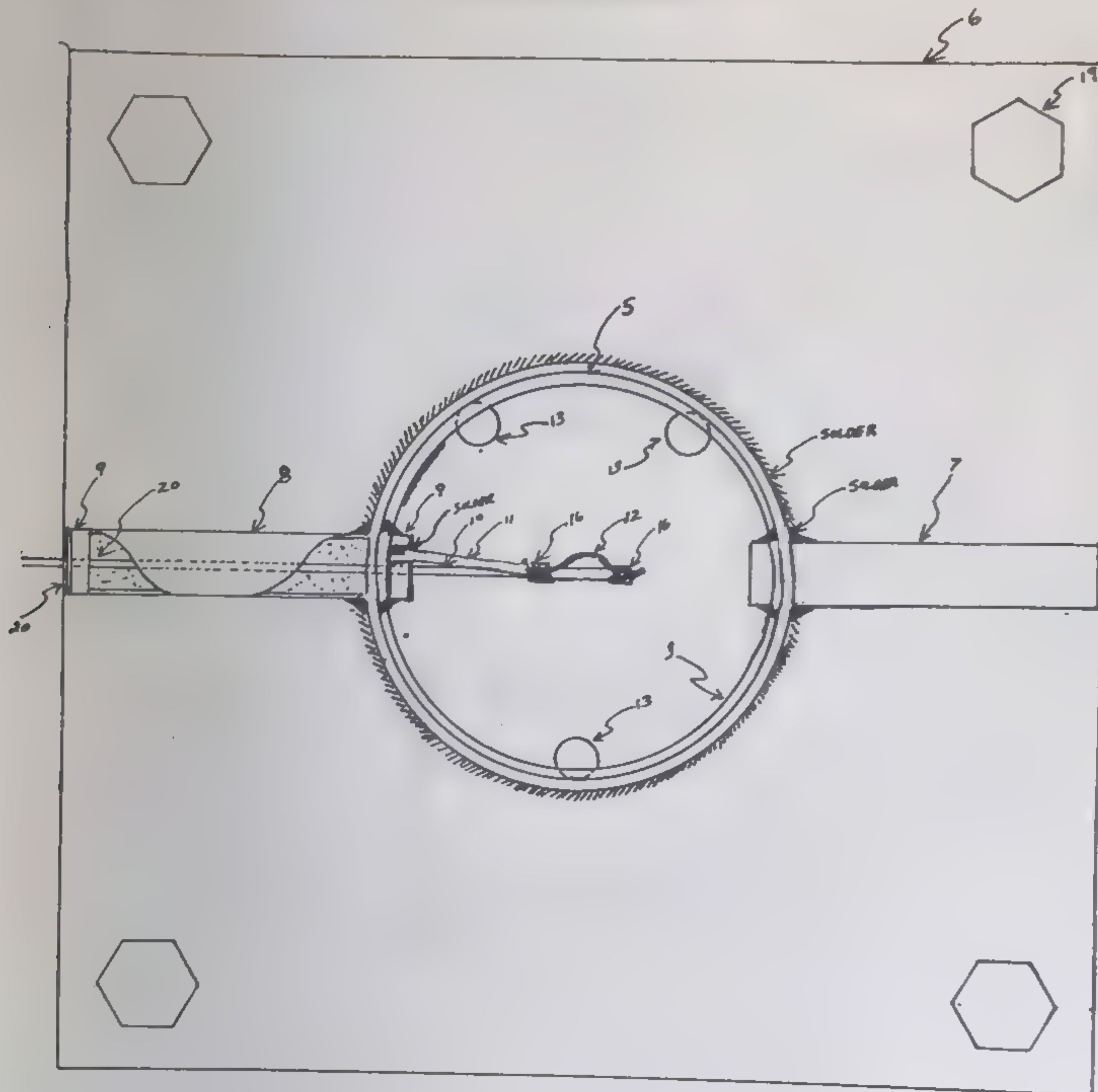
NOTE C-Seal all inside seams with a 50-50 mixture of beeswax and resin applied smoking hot with an eyedropper.

NOTE A-Carefully coat accelerator tube (3) on outside where it sleeves into cathode assembly tube (5) with Silicon Rubber sealant-insert and let set. Carefully apply to outer seam and let settle into crevices when assembly is in an upright position.

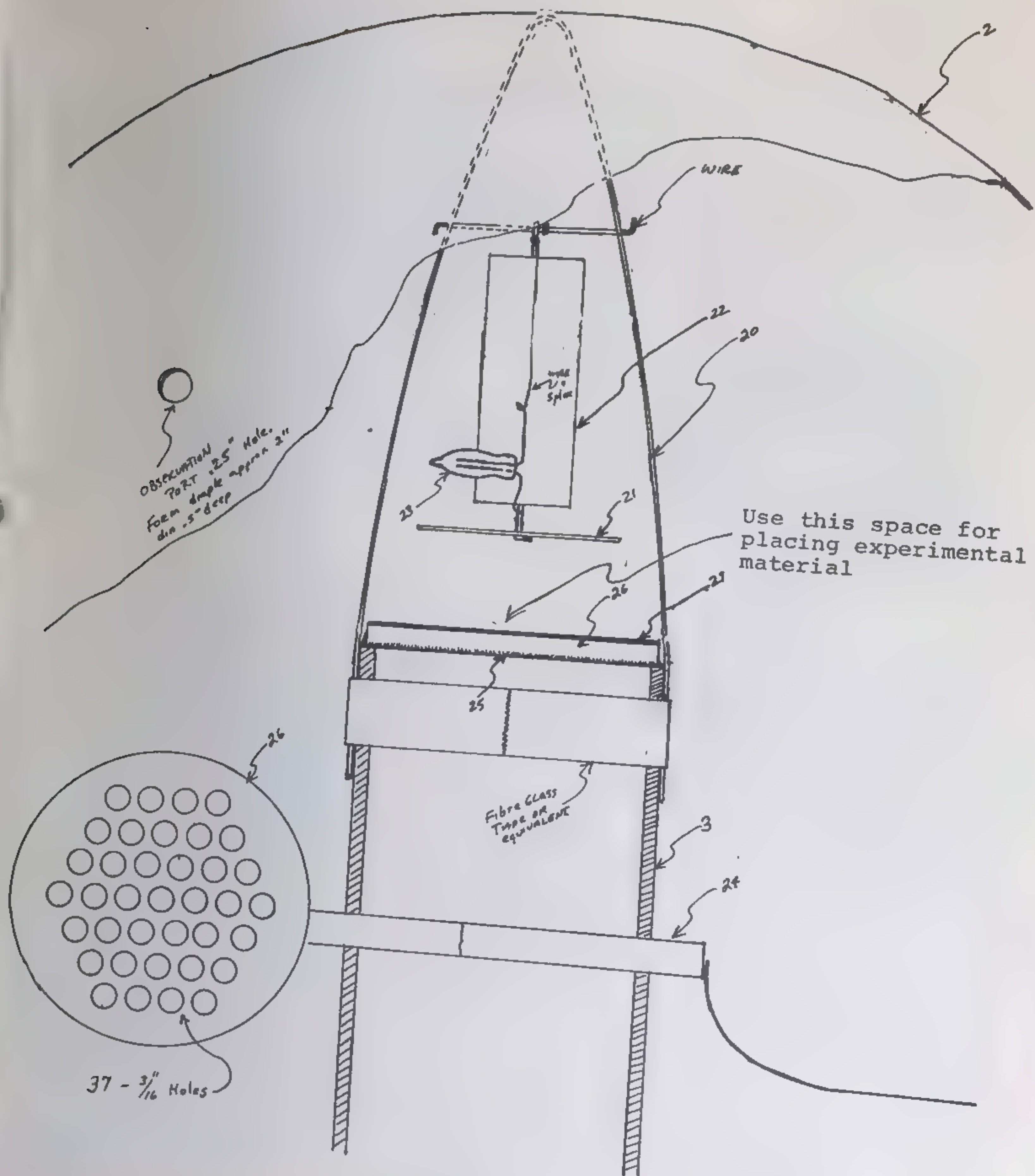
To accelerate Hydrogen Nuclei introduce a small amount of Hydrogen gas into system and reverse polarity of HV1 so accelerated sphere is negative. Keep filament off.



TOP VIEW OF ACCELEPATOR
BASE ASSEMBLY



ACCELERATOR ANODE, COLLECTOR END



INFORMATION *unlimited*

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VA-2 VACUUM SYSTEM INTRODUCTION

The following plans describe how to build a high vacuum system capable of pressures down to .01 micron (.00001 mm), from readily available and inexpensive components. The designs allow the builder maximum flexibility utilizing his own ingenuity.

The system consists of two major sections, 1st- the "roughing pump" or "Fore pump" section which is simply a mechanical system of pumps, in this case, two rotary refrigerator compressors connected in reverse and in tandem, produce a vacuum of 1.0mm initially. A system of valves and reservoirs further produce a vacuum of .1mm to be attained in the second step of pump down. The 2nd section is a mercury diffusion pump consisting of a water cooled jacket and heater for vaporizing. A cold trap further allows an ultimate vacuum of .01 micron to be achieved. The system uses several close end mercury filled manometers at points shown, for monitoring purposes. A McLeod gauge is handy in determining system leaks and will greatly aid the builder in curing these leaks.

To pump down attached system such as laser, atom smasher, etc.

1. VERIFY SYSTEM-to be pumped down is vacuum tight and of sufficient material stress so as not to implode. Remember that after 1st stage of pumping down a pressure difference of approximately 14-16 lbs/sq. inch exists on all surface areas of the evacuated enclosure.
2. Close pinchcocks 2, 4 and open 1 & 3.
3. Turn on both rotary pumps.
4. Allow system to pump down to 1 mm as -indicated on "X" manometer.
5. Close 1 & 3 - turn off rough pump "A".
6. Open 2 and allow system to further pump down to .5 - .1mm as indicated on "Y" manometer only. (approximately 1 hour).
7. Turn off rough pump "B" and allow interfaced system to set for 12-24 hours to verify the absence of leaks, etc. A McLeod gauge can limit the time necessary to evaluate the above.
8. Once the above is functioning properly, ie, system is pumped down to less than .5mm and holding as indicated by manometer "Y", we can go on to initiating the diffusion pump and cold trap. Roughing pump "B" can now be turned off until diffusion pump reservoir pressure exceeds .6mm. It should be noted that when the pressure of the roughing pump exhaust reservoir goes above 3mm indicated on manometer "X" that the reservoir should be pumped down as shown in initial pump down procedures.
9. Apply power to diffusion pump heater.
10. Allow one hour of operation or when a measure of 1-2 microns with McLeod gauge *IS INDICATED*
11. Add crushed dry ice to cold trap and allow 8-12 hours of continuous pumping to achieve final vacuum of .01 microns.

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PARTS LIST FOR HIGH VACUUM SYSTEM

1. ROTARY COMPRESSOR WITH MOTORS—from old refrigerators, freezers or small air conditioners—available through appliance repair houses usually at a fair price. Clean and remove old oil. Fill with pint of paraffin oil and let run for 10 minutes. Drain and observe no traces of the old oil. If old oil is present, repeat. Replace paraffin oil with vacuum oil. Available through VWR Scientific, catalog # 54923-124 (1 gal) or use yellow pages for vacuum equipment. Secure both pumps to a heavy wooden base via conventional mounting means. THE BETTER OF THE TWO ABOVE ROTARY PUMPS, USE CLOSEST TO DIFFUSION PUMP.
2. MOUNTING BOARD—Appropriate 2" thick plank of necessary size to install the two pumps conveniently and securely. Use ingenuity and what is available.
3. MOUNTING HARDWARE—Bolt, spring or conventional pump mounting hardware—use ingenuity.
4. VALVES—(4) for 3/8 OD copper tubing available through plumbing supply houses.
5. "T" FITTINGS (3) for 3/8 OD copper tubing available through plumbing supply houses.
6. INTERCONNECTING TUBING—3/8 soft drawn copper tubing—form as shown between cooling tube, diffusion pump, reservoirs, etc.
7. FLEXIBLE RUBBER COUPLING—3/8" x 6" or length necessary to interconnect copper tubing, etc. - allow generous sleeve over copper and use vacuum sealing grease.
8. VACUUM EXHAUST RESERVOIR—For roughing pumps (2) 1 gallon cider or wine etc., jugs encased in a hard cardboard or wooden container in case of implosion. Connect the two in series as shown.
9. VACUUM EXHAUST FOR DIFFUSION PUMP—1/2 gallon jug encased as in item (6).
10. RUBBER STOPPERS—(3 required) 2 hole for Item (6)—VWR Scientific #56382-127. Note—rework if necessary to take top 26-20 size. Seal with vacuum grease.
- 10A. RUBBER STOPPER (1 required) 3 hole for Item (7)—VWR Scientific #56382-127. Note—rework stoppers to take necessary diameter tubing—seal with vacuum grease.
11. MANOMETER—(3) form each from a 24" piece of 1/4" OD soda lime glass tube as follows: 1. heat section 6" from closed end with a bunsen burner and form into a "U" shape. 2. Heat section 6" from bight or "U" and repeat. Result should be a flat "S". Use glass tubing—VWR Scientific #32810-088 6mm OD x 1.05 mm wall. Fill with mercury completely, the closed leg of the "S" and about 20% of the center leg. This is accomplished by placing tube in a reclining position and gently rock it back and forth as the liquid mercury is carefully being added. Make certain that all air bubbles are removed.
13. DIFFUSION PUMP—Mercury or oil type water cooled with heater—VWR Scientific #55092-008 or if access to glass blowing equipment, use ingenuity and make your own.
12. WOODEN OR CARDBOARD CONTAINER—for vacuum exhaust reservoirs to protect against accidental implosion.
14. COOLING JACKET—For cold trap—use empty anti-freeze or other large metal container with top completely removed.
15. COOLANT CONTAINERS—Fruit juice can sleeved inside of cooling jacket with insulation between sides and bottom.

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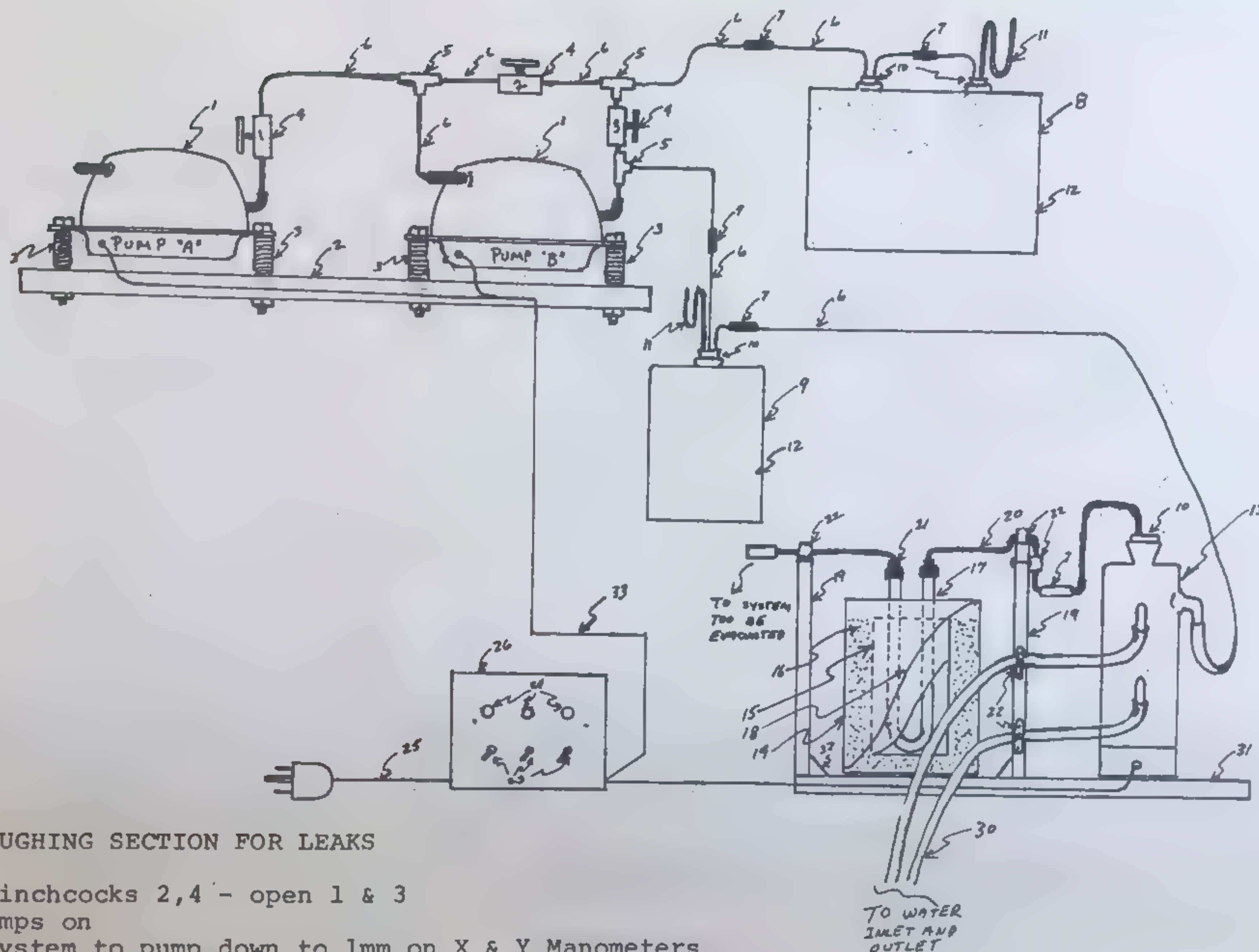
16. INSULATION-Standard fibre glass or equivalent.
 17. COOLING TUBE-Form as shown from 1/2" soft drawn copper tubing to fit inside of coolant container.
 18. COOLANT-50% water, 50% methanol and crushed dry ice. After adding dry ice, place insulated disc of cardboard over top to keep cold.
 19. COOLING TUBE SUPPORT MEMBER-2" x 4" wooden upright for supporting cooling tube.
 20. "U" TUBE SUPPORT INTERCONNECTING TUBE-Form from 3/8" copper to support "U" tube along with clamps (22).
 21. REDUCTION COUPLINGS-1/2" to 3/8" from "U" tube to interconnecting tubing.
 22. TUBING CLAMPS-To secure tubing to support assemblies.
 23. SWITCHES (3 required) SPDT Heavy Duty 10 amps-Radio Shack #275-1531.
 24. INDICATOR LAMPS-any 115V pilot lamps
 25. POWER CORD-Heavy duty 3 cond #16 AWG appliance cord.
 26. CONTROL PANEL-For switches and light and interconnecting electrical components, aluminum piece. 1/8" x 6" x 10".
 27. MERCURY FOR DIFFUSION PUMP-40 ml required
 28. VACUUM GREASE-Standard sealing grease for Hi-Vacuum systems or Silicon RTV by GE #118 & 108.
 29. OIL FOR PUMPS-Vacuum oil (1 gal) VWR #54923-124
 30. HOSE for water jacket of diffusion pump-Tygon, rubber, vinyl, etc.
 31. BASE SUPPORT-for diffusion pump and cooler-Made from convenient lengths of wood available. Use ingenuity.
 32. ANGLE PIECES- to secure cooling tube supports.
 33. WIRING-between control panel and roughing pumps and diffusion pump heater.
- OPTIONAL-McLEOD GAUGE for testing and measuring low pressures-VWR Scientific -Portable #31704-008. Adjustable closed end Gilmont-VWR #31705-102.

6. Turn off pump and
that would indicate a leak.
if leaks are suspected.

Verify system and proceed with

DO NOT
be "closed"
Heat
"fast"

VA-2 VACUUM SYSTEM



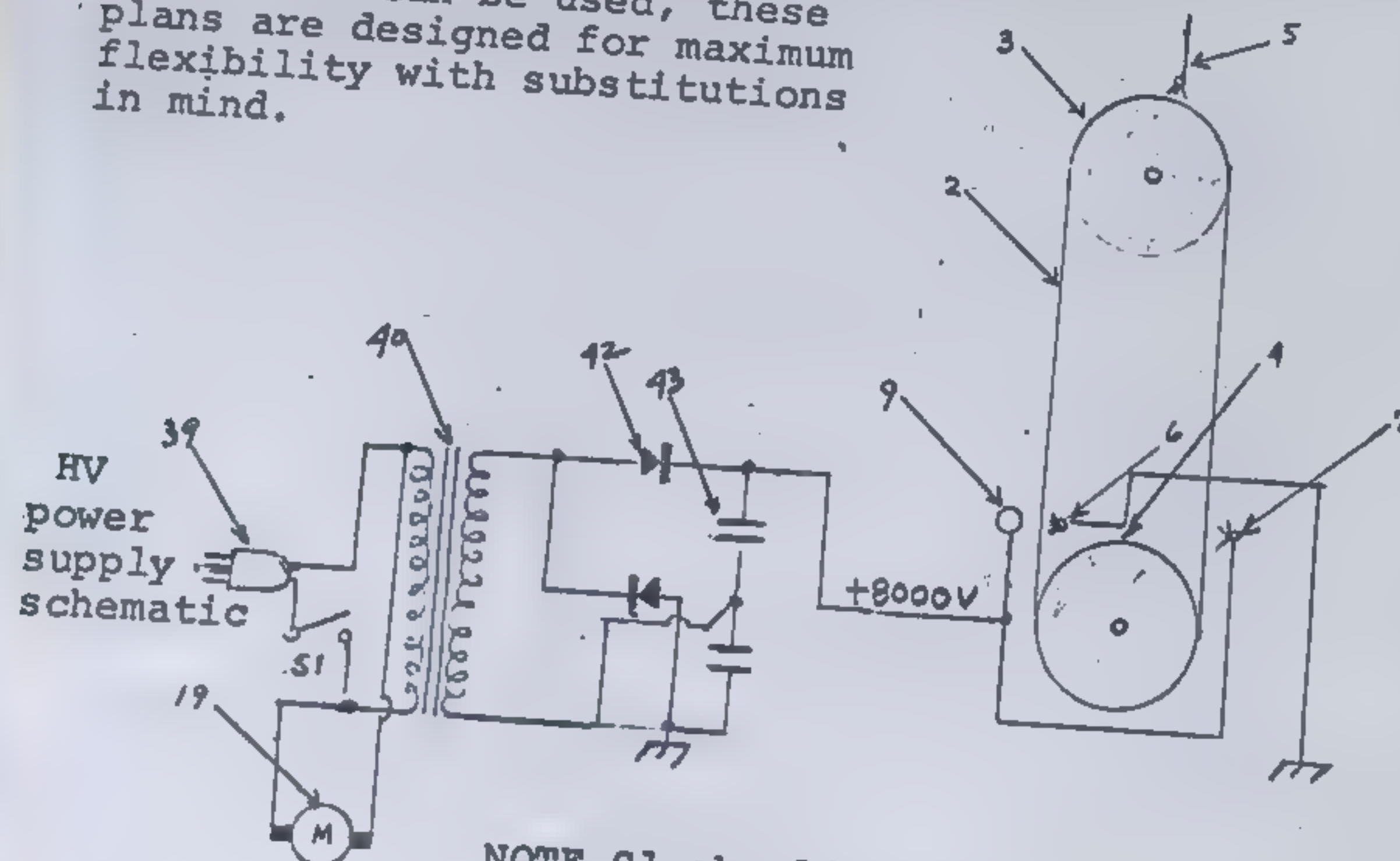
TO TEST ROUGHING SECTION FOR LEAKS

1. Close pinchcocks 2,4 - open 1 & 3
2. Turn pumps on
3. Allow system to pump down to 1mm on X & Y Manometers
4. Close 1 & 3, turn off Ruff pump "A"
5. Open 2 and allow system to further pump down to .1mm (note pressure on "Y" Manometer)
6. Turn off pump "B" and allow system to set for 24 hours noting any difference in manometers that would indicate a leak. Verify system and proceed-seal all joints with vacuum grease where and if leaks are suspected.

1.5 MILLION VOLT GENERATOR HV-1 (External Belt Type)

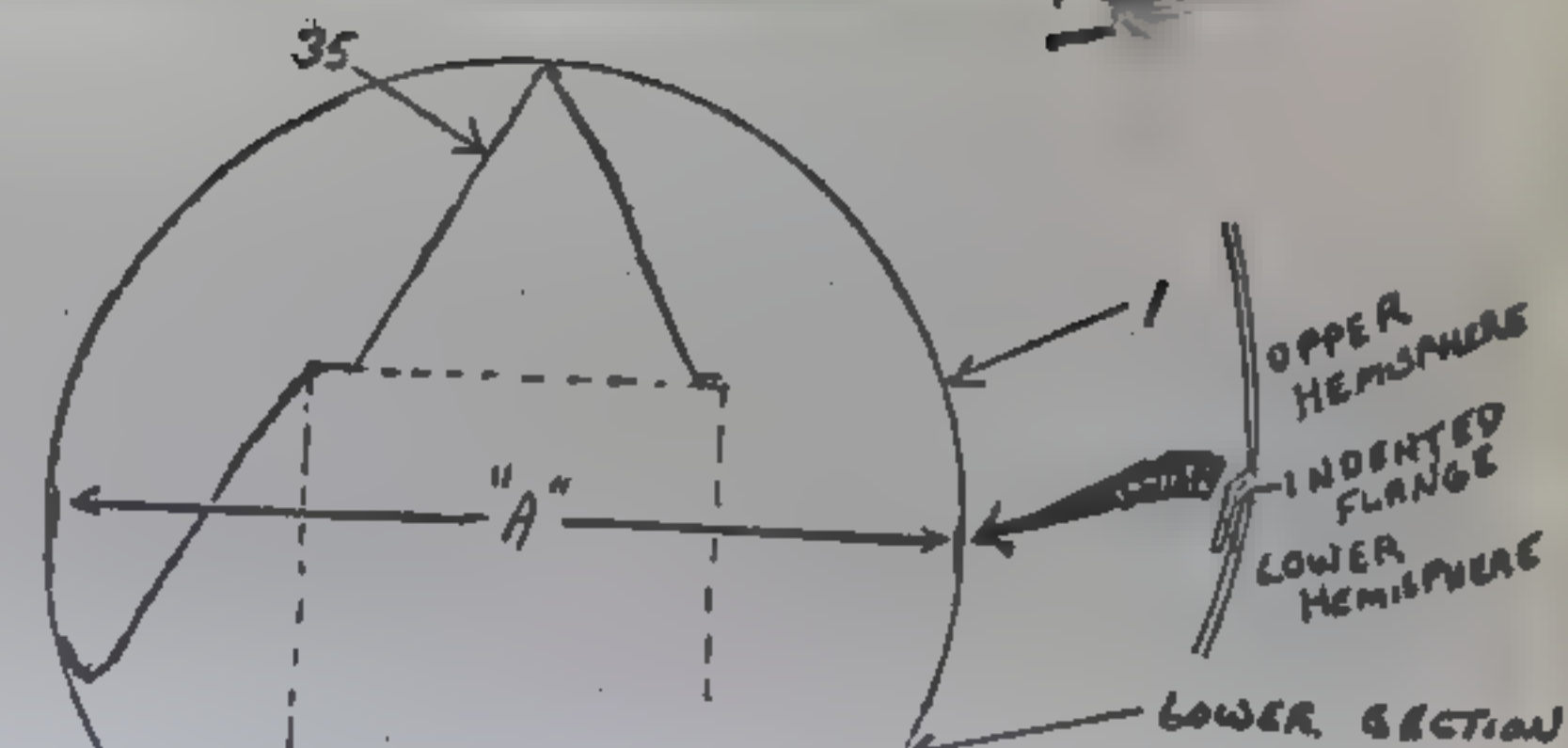
*VOLTAGE	DIM A"	DIM B"	DIM C"	DIM D"	BELT DIM E"	HP MOTOR	OTHER
1.5 MILLION	48"	20"	96"	6"	10-12"	5-7.5	NOTE THAT COMBS MUST BE ADJUSTED FOR MAXIMUM CURRENT TRANSFER EXPERIMENTING WITH COMBS IS A MUST FOR MAX.
1 MILLION	30"	15"	60"	6"	8-10"	.5	
750,000	24"	12"	48"	4-5"	6-8"	.33-5	
500,000	15"	6"	36"	2-3"	2.5-3.5	.33	
250,000	7"	3.5"	21"	2"	2.5"	.25	
							REINFORCE COLUMN

*Maximum possible values depending on humidity, Belt speed and efficiency, quality of sphere, insulation, etc. Values on chart are approximate and are intended to be used as a guide. Because of the difference in certain parts that can be used, these plans are designed for maximum flexibility with substitutions in mind.



NOTE S1 should be a 1 HP rated switch and should be remotely mounted to prevent getting hit by spark.

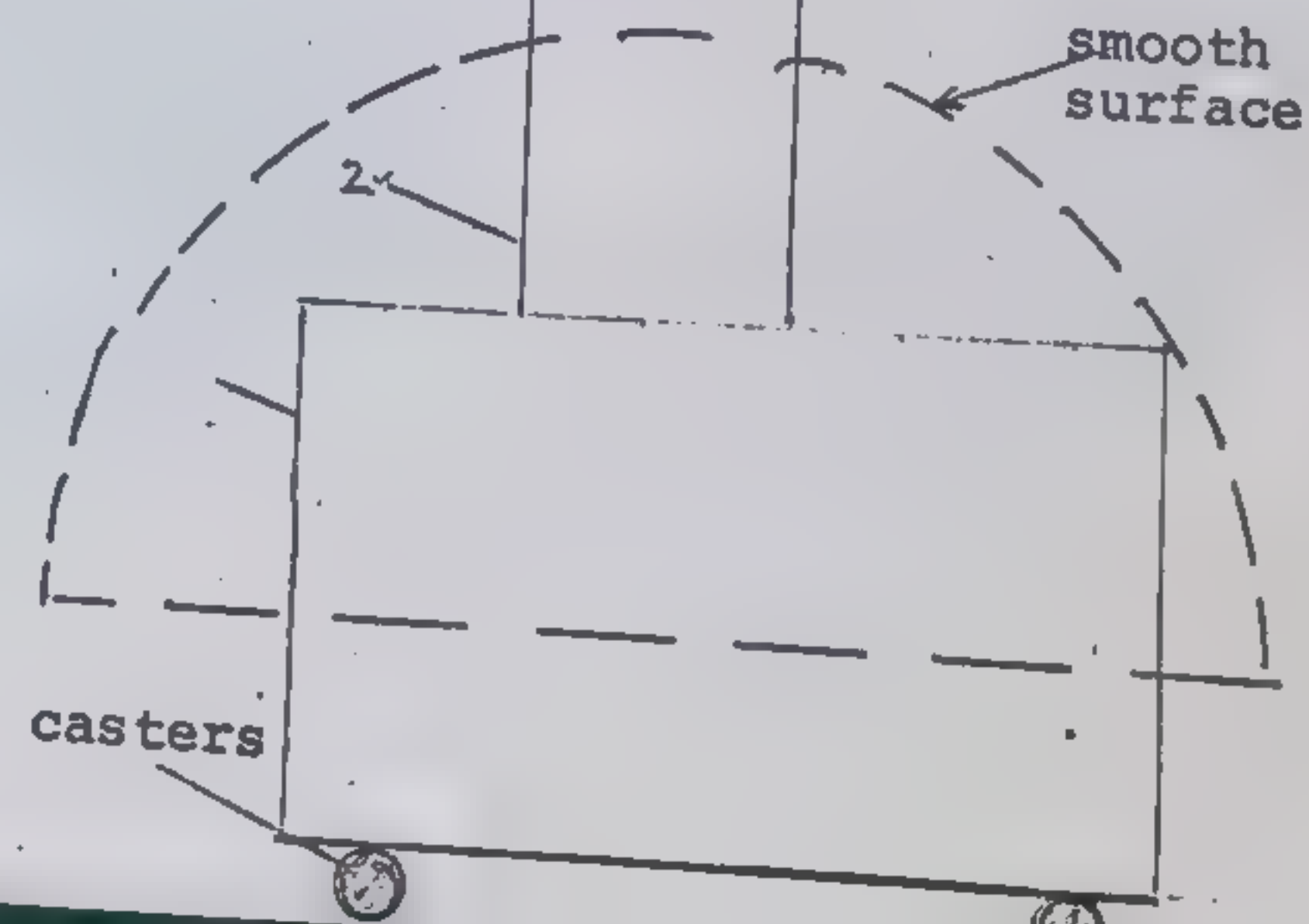
The above plans show how to construct a potentially lethal electrical device. Also an X-Ray hazard exists. USE CAUTION ON THE HIGHER POWERED UNITS.

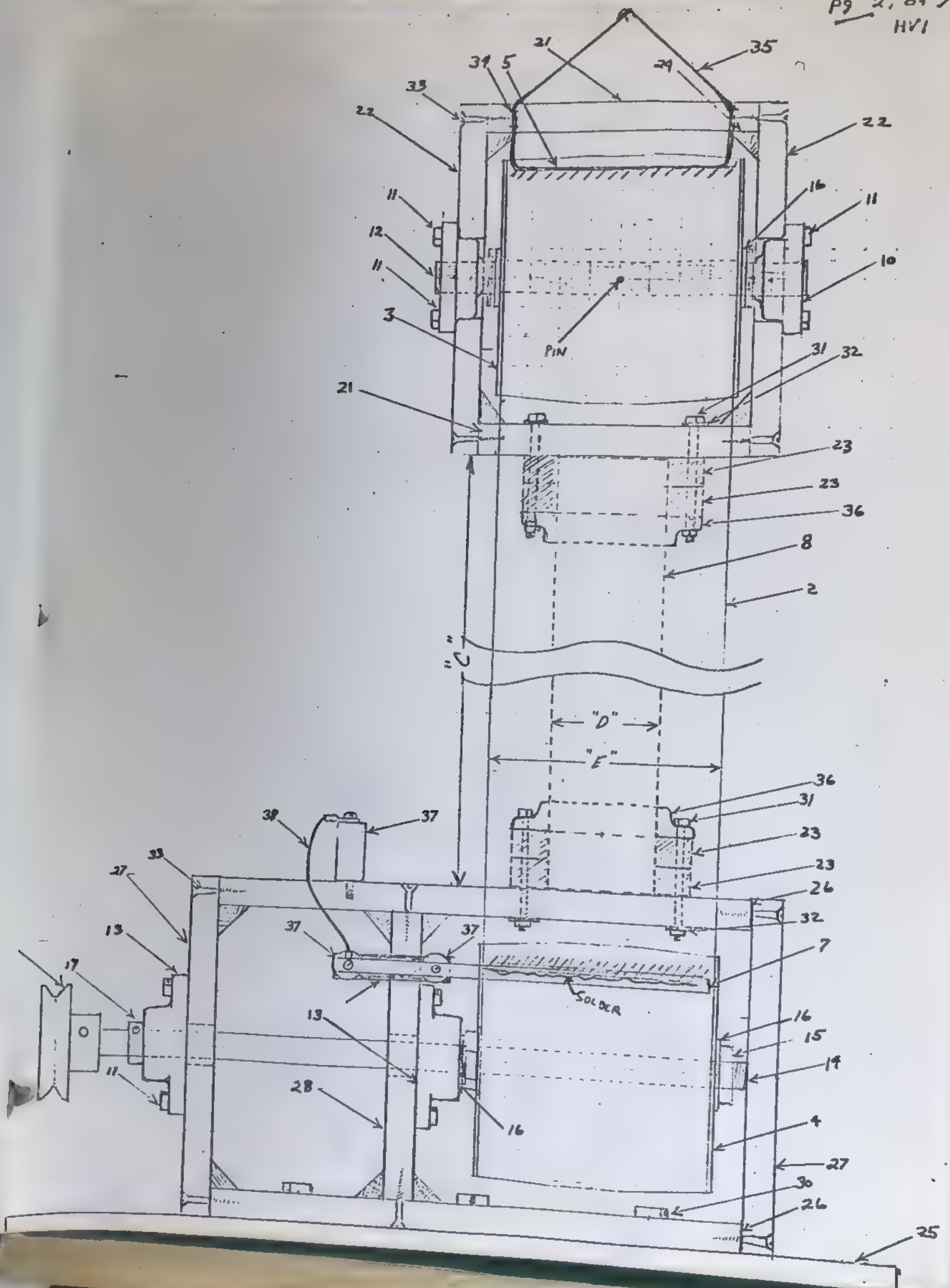


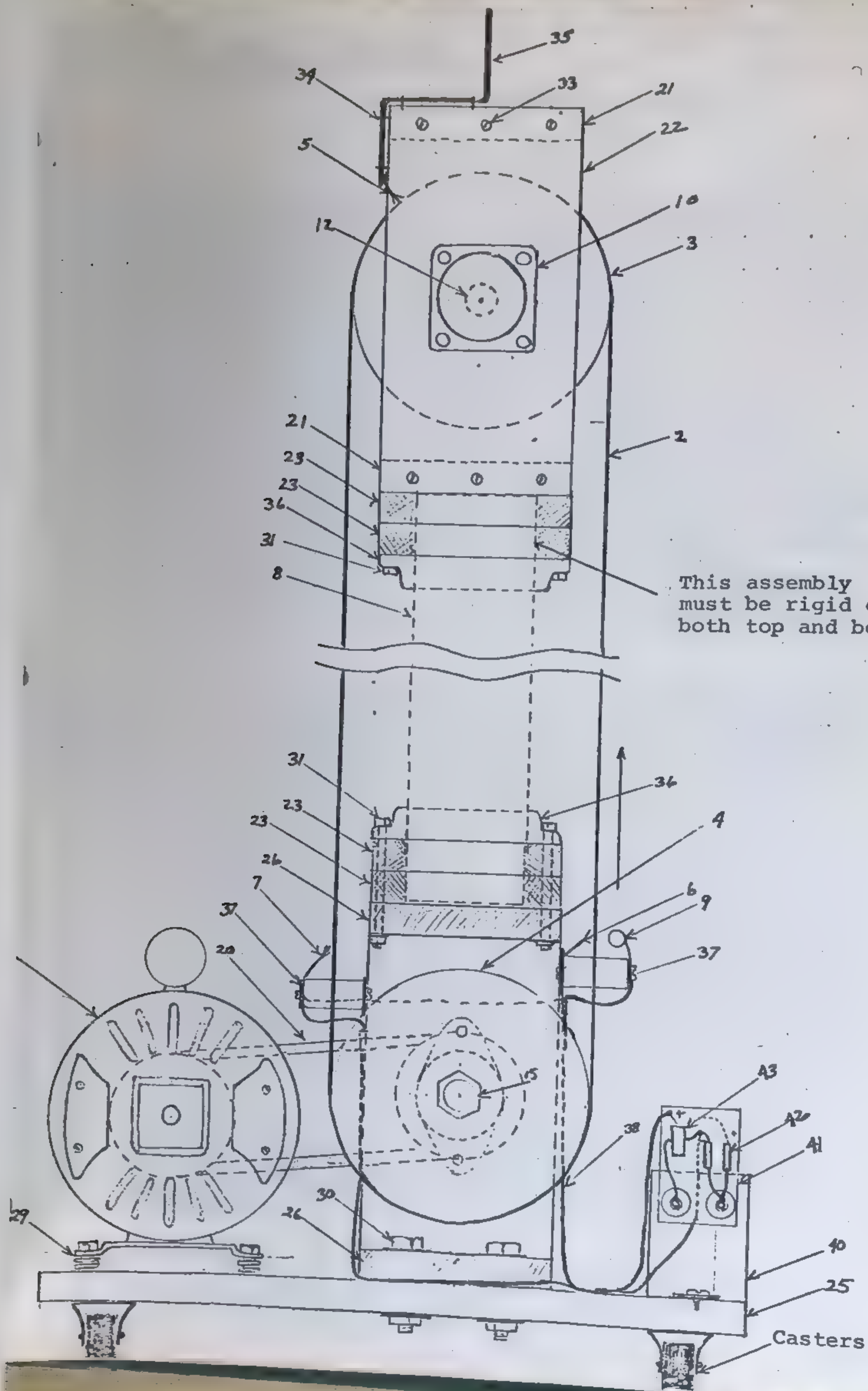
Large radius of smooth curvature formed inwards.

Plans shown are for 750KV model

LARGE RADIUS OF SMOOTH CURVATURE FORMED INWARDS







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HIGH VOLTAGE-VAN DE GRAAF GENERATOR

P7 4 9
HVI

1. COLLECTOR (SPHERE SPHEROID, ETC.) This is the heart of the device. It is actually a plate of a capacitor (other plate ground) which is charged at a constant current rate until the current leakage equals the current collected. Where this takes place determines the amount of voltage the sphere can accumulate. A quality factor of the device in respect to voltage is the radius of the sphere. A rule of thumb is to equate the maximum voltage of the sphere as equal to the radius in inches times 70,000. The sphere should be machined in two sections (hemispheres). The top section can be a perfect hemisphere with a slight indented flange for sleeving under the bottom hemisphere. The entrance hole for the belt in the bottom hemisphere must have a large radius of smooth curvature formed inwards. This hole should be no more than half the size of the diameter of the sphere. Selection of the sphere is a function of voltage desired and obviously cost. One must also consider using substitution such as metal bowls, pots, etc., for the lower power models. Once size is selected obtain a quote from some local metal spinning houses. Your best bet is to befriend one and hope that he is not too busy to be helpful in your request. For maximum results keep sphere smooth, clean and free of lint and dust.

2. BELT means supplying a constant current to the sphere. In these designs we try to approach a linear belt speed of 100'/second. Belts must be of insulating material such as NYLON, DACRON, RAYON, RUBBER OR NEOPRENE, ETC. These designs shown use a rubber inner tube fashioned together with appropriate rubber cements and diagonal type splices to obtain the necessary size. When using cloth type, care must be taken to prevent fraying along the edges. This can be reduced by coating with lacquer. Always use a diagonal splice when piecing belts together and an appropriate cement depending on material. One must however, realize that rubber inner tube belts have a short life expectancy due to their poor resilience to ozone but are economical. If cost is not a factor, neoprene is an excellent material for belts. USE INGENUITY IN FABRICATING YOUR BELT. NOTE-for 1 microamp of current it takes 50 sq inches of belt surface passing a given point per second. For the accompanying plans where the belt is 8" wide this means that in one second at a belt speed of 100 feet per second that approximately 200 micro amps accumulate on the sphere. BE CAREFUL!!

3&4. UPPER AND BOTTOM PULLEYS-8" X 8" wooden pulleys constructed from eight, 8" diameter 1" thick plywood discs glued together. Turn in lathe with a slight crowning at center (1/8") drill hole for drive shaft at true center (Typical 15/16" for model shown). Coat with lacquer.

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HVI

- 5, 6 & 7. COLLECTOR, APPLIER, NEUTRALIZER COMBS-Form from strips of common window screen equal in length to width of belt (8") and soldered to copper strips. Usual widths of screen are approximately 1". Adjust all combs for even homogeneous gap along width of belt. Just to point of touching usually is best for optimum results. The collector comb (5) which transfers current from the top of the belt to the sphere is soldered to a copper strip or heavy wire formed as shown to support collector, (35). Staples (34) are used to position comb assembly. The applier comb is formed to inside of belt and mounts under insulator (37). It is connected to ground return of power supply. The neutralizer comb assembly (7) mounts on standoffs (37) and is connected to HV+ terminals of power supply and charged bar (9). All combs are considered to be adjustable and must be built so as to be flexible in adjustment relative to belt. Also, trimming will be necessary to prevent arc over, etc. The final tune up of your machine will result in adjusting location of combs for maximum output. It should also be noted that combs can be needles, tufts of wire, etc.
8. INSULATING COLUMN- 4-5" diameter X 48" long poly vinyl chloride pipes.
9. CHARGE BAR-8" length of $\frac{1}{4}$ " copper with tabs of flexible copper sheet soldered for mounting to insulator (37). Connect to +HV terminal of power supply.
10. UPPER BEARINGS-15/16" Dodge 4 bolt SC flange type (two required)
11. BOLTS, NUTS AND WASHERS FOR BEARINGS. 7/16X2" (twelve sets required)
12. SHAFT UPPER-15/16"X12" pressed into upper pulley and pinned, as shown
13. LOWER BEARINGS-15/16 Dodge 2 bolt SC flange type (2 required)
14. SHAFT LOWER DRIVE-15/16X24" threaded for nut (note-shaft must rotate to tighten)
15. 15/16" Hex Nut
16. 15/16" Flat washers add to reduce shaft end play
17. 15/16" collar for position of drive shaft
18. "V" belt pulley 4" on motor, 5" on drive lower pulley drive shaft.
19. MOTOR- $\frac{1}{2}$ HP 3450 RPM Sears #9G1218C or equivalent.
20. "V" belt of appropriate size and length (standard type)

INFORMATION *unlimited*

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1. TOP AND BOTTOM-Plywood pieces, upper pulley housing 1"X9"X5" (two required)
2. SIDES-Plywood pieces bearing sets Upper pulley housing 1" X 12" X 5" (two required)
3. TUBE COLLARS-Plywood 1" X 6" X 6". center hole equal to diameter of (8) insulating tube, (four required) two top, two bottom.
4. CORNER EXTRUSIONS for reinforcing-glue in place 1" X 1" (ten required)
5. BASE- 22" X 30" X 1" plywood-2 pieces glued together for strength
6. TOP AND BOTTOM PIECES-Plywood, lower drive pulley housing 18" X 6" X 1" (two required)
7. SIDE PIECES-Plywood lower drive pulley housing 6" X 12" X 1" (two required)
8. MIDDLE PIECES-Plywood support 10" X 6" X 1" lower pulley housing.
9. MOTOR BELT, NUT, WASHER AND SPRING COMBINATION (4 required)
10. BOTTOM PULLEY HOUSING MOUNTING BOLTS, NUTS AND WASHERS (six required)
11. & 12. INSULATOR FLANGE AND COLLAR MOUNTING BOLTS, NUTS AND WASHERS 4" long (8 required)
13. WOOD SCREWS-stainless #10 X 2" (approximately 36 required)
14. STAPLES for securing top comb and sphere support (35)
15. SPHERE SUPPORT AND COMB BRACE (heavy wire or copper tubing formed as necessary-solder (5)
16. FLANGE MOUNTS FOR INSULATOR PIPE (2 required)
17. INSULATORS- Steatie 2" X 1" combs (6 required) thread in stud and drive into wood.
18. HIGH VOLTAGE IGNITION WIRE, LUGS, SCREWS, ETC., (6 feet required)
19. HEAVY DUTY 3 wire line cord (grounded)
20. TRANSFORMERS-4000-5000V @ 10-20 ma Jefferson #969-1001-140 or equivalent.

INFORMATION *unlimited*

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1. PLEXIGLASS or other insulating mounting plate 3" X 4" X 1/8"
(drill and fasten to high voltage insulators on transformers)
2. HIGH VOLTAGE DIODES VARO # VG10 10,000V @ 25 ma (2 required)
3. HIGH VOLTAGE CERAMIC CAPACITORS-1300 pfd @ 15KV Sprague
712C series.

It should be noted that the plans are made as flexible as possible due to the availability of junk parts, etc., that the builder may have access to. However, the collector, belt pulley, combs and insulator columns must approach the specs and designs indicated if maximum efficiency is to be had.

Also, the output of the system can be increased by providing a smooth surface directly below the sphere. This can be a third hemisphere placed over the plywood enclosure such as noted by the dotted outline on page 1. Your machine functions best on a cold dry day. Also, to produce higher voltage two machines can be made and the combs and power supply polarities so arranged so as to develop opposite potentials between the two spheres, that is one positive and one negative.

In adjusting your machine for maximum efficiency one approach is to secure a grounded electrode of some distance from the sphere and note the rate of discharge and build up. Adjustments are therefore made noting the rate of above. Also it allows adjustments to be made without getting hit by a discharge while being close to the machine.

Also special care must be taken in pulley alignment, bearing alignment and all the related belt parts and functions. Remember the belt is traveling at nearly 100 feet per second.

Dear Bill. -

6-8-77.

If you get a chance please write - Dr. Ellis about what he says in his letter.

I did write him giving your address so he might be writing you.

I also wrote him - Thomas W. Lee address.

Have you heard anymore news on the new book.

I did write - Arthur Vanos about it.

The book - *Lightning in Her Hand* - was just republished.

I will be handling the hard cover copies.

Nick Basura.

separated by 8 pages----

With this combination I was able to draw only a 4"-6" arc from the top of the secondary, and with frequent flashovers on the capacitor. Eventually I burned out the neon transformer!

It soon became apparent that the L-C ratio of the primary must be in resonance but how to arrive at exact resonance is a problem I have not yet solved.

Mrs Nick Basura
 3414 Albee St
 Los Angeles, Calif. 90065

Dear Nick:

I too am an admirer of Nicola Tesla and have been trying to build a Tesla coil without much success.

My coil's secondary is 4" diameter and 57" long, 2650 turns of #26 enameled wire. The primary was 32 turns of Belden test lead close wound on an 8" form. Excitation was provided by a neon sign transformer giving 15,000 volts at .030 amper.

I experimented with several types and combinations of capacitors and finally came up with 14 sheets of .001 brass separated by $\frac{1}{8}$ " plexiglass.

With this combination I was able to draw only a 4"-6" arc from the top of the secondary, and with frequent flashovers on the capacitor. Eventually I burned out the neon transformer!

It soon became apparent that the L-C ratio of the primary must be in resonance but how to arrive at exact resonance is a problem I have not yet solved.

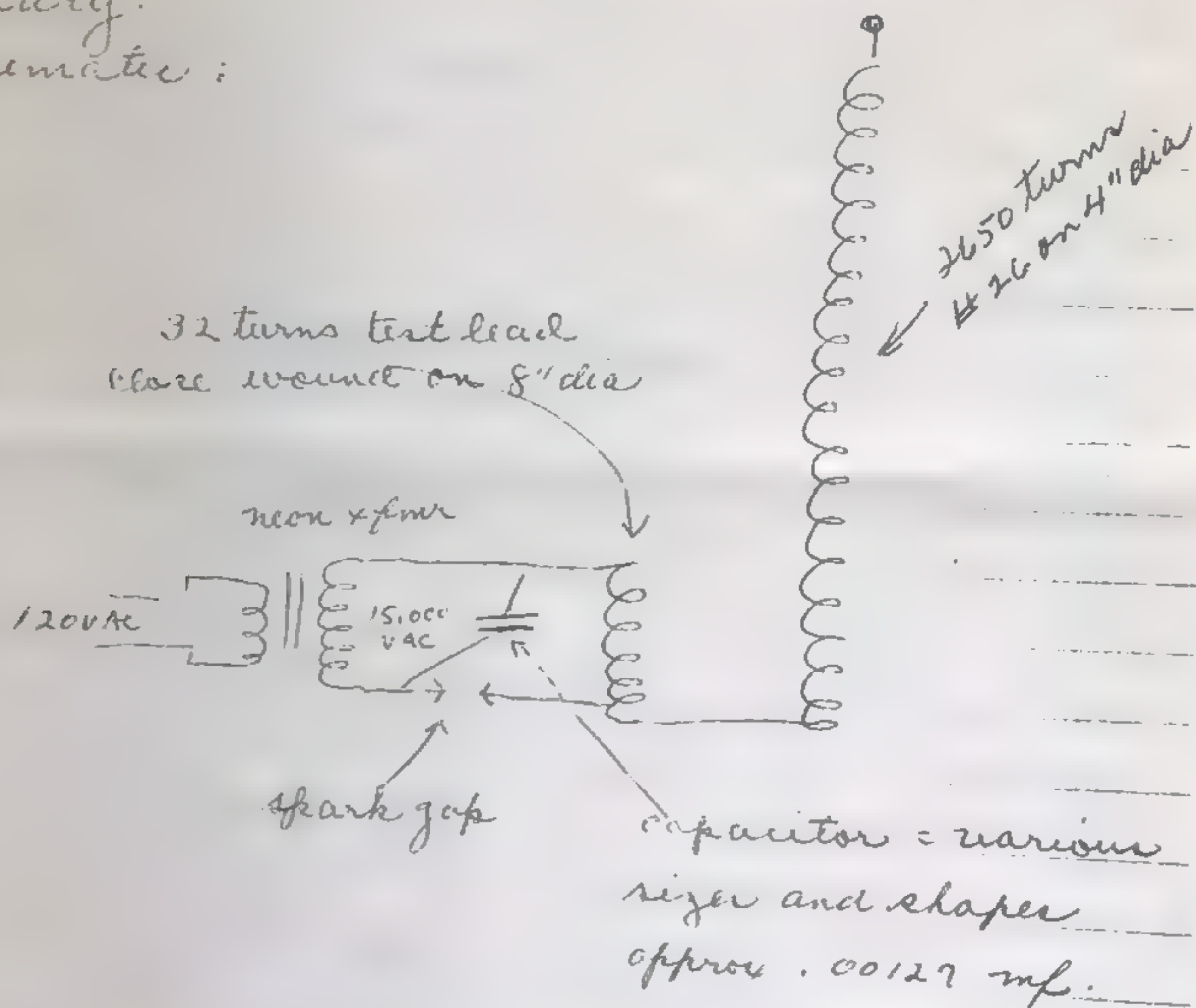
I have ordered the book *The Prodigal Genius*
The Life and Times of Nikola Tesla. However,
 four months have passed and I presume it is
 out of print.

None of the local electronic intelligentsia are
 able to offer much help.

My next attempt is to reduce the diameter
 of the primary from 8" to 7" and start all
 over again to figure the L-C ratio.

I tried a 6" primary in an attempt to
 obtain closer coupling to the secondary but
 it was too close and arced over to the
 secondary!

Schematic:



I do not have access to the library because I live out of the county, do not pay taxes there and am therefore am not eligible to use it's facilities

I am extremely interested in Tesla and his works and will be most grateful for any information regarding him that you may be able to help me with

Please excuse the hand written letter. My secretary is on vacation and my typewriter doesn't spell very well!

73

Bob Ellis

W7AAC -- W7HTX

ROBERT CLARK ELLIS
DENTIST
2330 N. W. FLANDERS ST.
PORTLAND, ORE. 97210

HOME PHONE

503-292-0225

ROBERT CLARK ELLIS, DENTIST

FLANDERS MEDICAL CENTER

2330 N. W. FLANDERS STREET

PORTLAND, OREGON 97210

13 June 77

Dear Mr. Mysock:

My stupid secretary mailed
a letter to you without my
signature

I am having trouble making
my Tesla Coil work and
Dick Basura said you might
help me

Could it be that the 8"
plexiglas form is thick onto
which the primary is wound
gives insufficient coupling to
the secondary? Should the
primary be air-wound?

I shall be most grateful
for your advice?

Bob Ellis

WTAAC - WTHTX

14, 1977

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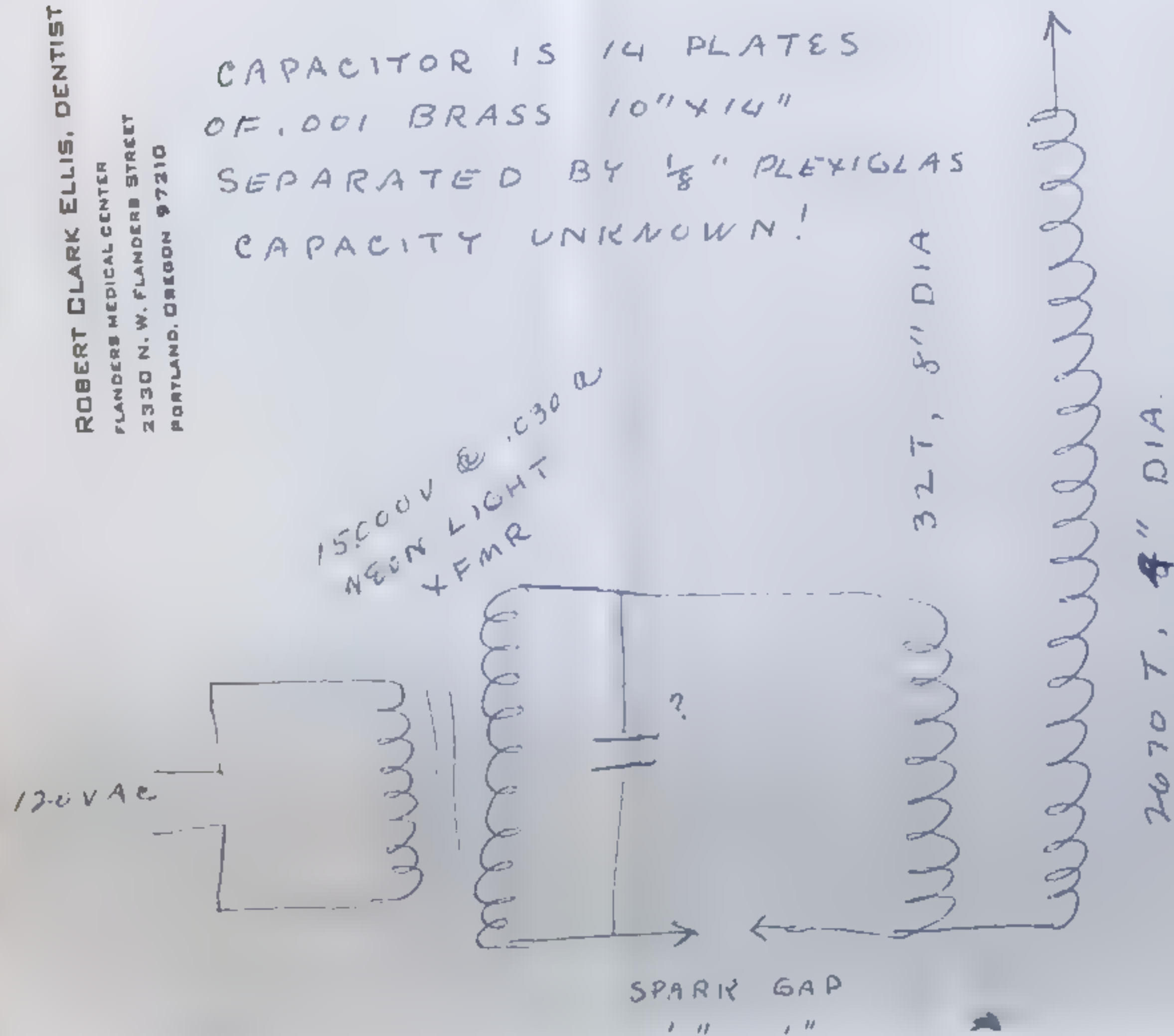
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ROBERT CLARK ELLIS, DENTIST
FLANDERS MEDICAL CENTER
2330 N. W. FLANDERS STREET
PORTLAND, OREGON 97210



PRIMARY WOUND ON
8" OD PLEXIGLAS FORM
 $\frac{1}{8}$ " WALL USING TEST LEAD (BELDEN)
CLOSE WOUND

CAPACITOR IS 14 PLATES
OF .001 BRASS 10" X 14"
SEPARATED BY $\frac{1}{8}$ " PLEXIGLAS
CAPACITY UNKNOWN!

SECONDARY WOUND
ON PLEXIGLAS FORM
4" OD 57" LONG

QUESTION:
IS THE $\frac{1}{8}$ " OF PLEXIGLAS
OF THE PRIMARY FORM
PREVENTING TRANSFER
OR COUPLING TO THE
SECONDARY?

SHOULD THE PRIMARY
BE AIR-WOUND?

WITH THIS CONSTRUCTION
I GET LITTLE OR
NO ARC FROM THE
TOP OF THE SECONDARY

WHAT HAVE I DONE
WRONG?

June 14, 1977

Dear Dr. Ellis,

I would be very happy to offer you some suggestions on Tesla Coil Design. However, I would first like to address some comments in regards to the specifications you mentioned depicting your apparatus.

It appears that after reading your letter that you must have used Popular Electronics circa July '64 article on "Big T.C." That article was written in content as a compromise of considerations for the readers' safety, relatively speaking, as well as common parts that would be comparatively easy to acquire. Hence, the Neon transformer, stationary spark gap, and low quality glass plate capacitor or as you have employed, plexiglas as a dielectric medium.

As in any case, the overall quality of a working system is only as good as the weakest "link." In your case, the transformer, capacitor, the inductive reactance of the Tesla primary, and the inductive capacitance of the Tesla secondary (relation between these two commonly referred to as "Q") are responsible for a disappointingly inefficient operation.

By way of illustration, let me state that it is possible to achieve in excess of .5 megavolt with the same power input as you used (approx. 450 watts) simply by incorporating several simple changes as follows:

1. Use mica transmitting capacitors - .01 MFD. @ 15KV RMS. Arrange 4 of these units in multiple I.E., two in series in one leg, two in series in the other leg, then the two legs in parallel. These units are commonly available as surplus for about \$15.00 each. You will now have .01 MFD @ 30KV RMS total. This is necessary for protection against impulse surges. Stay away from glasslike or pyronal oil caps because they can explode like a hand grenade should they become lossy and breakdown during operation. The best mica caps are Cornell-Doublier or Aerovox. Avoid Sprague caps.

2. Change your primary as follows: Use same height and diameter but wind 3/16" O.D. copper tubing for 10 turns. Use a heavy gauge alligator clip to adjust number of turns for resonance.

3. Your secondary coil form I presume, is of Poly-vynalchloride or Plexiglas or fiberglass. Reduce length to 40" with a spaced winding (wound in the same direction as the primary coil) of No. 20 gauge Belden forever solid copper magnet wire. The spacing should be accomplished by using 20 lb. test nylon fishing line wound continuously with the wire. You should come out with approximately 20 turns per inch. Next, shellac the finished winding with at least six light coats to dry for 24 hrs. before applying

(continued)

the next coat. Avoid air bubbles.

4. If you must use a stationary spark gap instead of a rotary or best of all a quenched gap, arrange a small squirrel cage or muffin fan to direct a powerful air blast directly at the gap. This prevents low frequency arcing and will improve tank circuit operation of L and C.

5. You would do well to use a plate transformer of approximately 8 - 10KV @ 150 - 300 MA.. Your coil needs this additional power input for maximum operation. If you are locked in with the neon unit, replace it with a 60 MA. unit or add another 30 MA. unit in parallel in phase with the existing one! Also, add a high pass filter to protect the neon units from breakdown.

Care in preparation and attention to detail will determine the degree of successful operation. I might mention here several coils which I have built. My #5 unit uses a quenched gap, 2 KW plate transformer, .04 MFD capacitor, secondary 24" long winding 6" diameter with 400 turns of #18 wire spaced, 2 turns primary 20" diameter $\frac{1}{4}$ " O.D. copper tube, 20" O.D. aluminum toroid on top of the secondary. The discharge length exceeds 45". The #7 unit, a 2X scaled-up version of #5, is driven @ 10KW and exceeds 8 foot continuous discharge. All the models from #1 thru #7 are portable and are fairly economical to build. I have many spare parts, manufactures 90% of all the components used in these coils, have complete construction plans, parts lists and color prints available, I am currently building a 10 megavolt unit for atmospheric plasma research.

I hope the above information may be helpful to you.

Sincerely Yours,

Bill Wysock

Dr. Robert Clark Ellis
Flanders Medical Center
2330 N. W. Flanders Street
Portland Ore. 97210

July 18, 1977

Dear Dr. Ellis,

Thankyou for your telephone call this evening. It is always a pleasure to hear from you.

As per our phone conversation, please find enclosed a color 35mm slide of my #5 Tesla Coil in full activity. This photograph was exposed using Kodak ectichrome ASA135 and is a one second time exposure at f/2.8. Power input was approximately 3 Kw and the Quenched Gap referred to in the enclosed xerox copies was utilized. Secondary milliamperage was measured at 750ma.

The drawing referred to as fig. 5 was an original concept which may serve here to show the general configuration of the various sections of a typical quenched gap. Figures 6 and 7 show the exacting details of the prototype quenched gap which is now being used offering power input levels in the 3-10 Kw range. It is necessary to use stainless steel or tungsten for continuous operation above 2 Kw. Above 3 Kw, regardless of the material used, a high pressure-high cfm rated air blast is necessary to adequately cool the heat dissipating flanges, so as not to burn up the gap. Also, working efficiency is greatly reduced if the gap should overheat. Should you desire to have me construct a gap to your specifications, I am able to offer you my immediate services. Most of the necessary materials are currently in my stock.

The Xerox copy of "Quenched Gap Apparatus," is from a rare old book in my reference library. It offers simplicity of construction and less cost as it consists of a single "open-air" gap. It will not perform as efficiently as a true quenched gap and the author is quick to point this handicap out. Nevertheless, it may serve as an additional reference. T3's

Bill Upack

Carl I. Jennings, Jr.
325 Love Street
Erwin, Tennessee 37650
May 3, 1977

Bill Wysock
4914 Baldwin Avenue
Temple City, California 91780

Dear Mr. Wysock:

I am currently researching the life, experiments, and accomplishments of Nikola Tesla for my future doctoral dissertation and an extensive, illustrated biography.

It is my understanding that you are interested in Tesla and have built a number of Tesla Coils. May I ask the extent of your collection of materials relating to Tesla and his experiments? Would it be possible to purchase from you Zerox copies of items in your collection that I may not have in mine? I would naturally be more than happy to pay any costs involved.

I too have built many, many coils. Do you use a rotary spark-gap? Also, I would be interested to learn what type and rating transformer you use and what type and design capacitors you use. What is the largest coil you have built and the longest discharge?

Thank you very much for your time and I look forward to hearing from you. With sincere best wishes, I remain...

Very truly yours,

Carl I. Jennings, Jr.
Carl I. Jennings, Jr.

Mr. Carl I. Jennings Jr.
325 Love Street
Erwin, Tennessee, 37650

July 18, 1977

Dear Carl,

Please forgive me for taking so long in replying to your May 3, 1977 letter. I hope this response is not too late for your purposes. I will try to answer your questions to me directly as the first order of business in this letter.

To begin; yes, I have built many, many Tesla high frequency-high potential resonators...ranging up to and soon now to include 15 million volt at 100 KHz. My first apparatus was built some seventeen years ago and produced a discharge approximately 3.5 inches long. Since that time the sparks have continued to grow in length and power. My interests cover a very broad field which includes many types of high voltage phenomenon. My technical library is likewise very extensive. I have conducted much research in all types of electrical discharge at atmospheric pressure and am soon to publish a technical book on the subject.

Recently, I have been connected with the only ball lightning project currently on going and have performed in a consultant capacity on this project. I have designed and improved upon more than one dozen different types of rotary gaps. Quenched gaps are far superior and I now have more than six different configurations using this form of gap, including one that is pressurized with SF₆. I have also several different designs using triggered gaps and thyrotrons. Currently, the longest discharge that I have produced in my lab is just over ten feet. This discharge has required a power input to the 60Hz transformer of approximately 15 kilowatts. The coil that I am currently constructing is designed to operate with a power input of 40-50 Kw @ 60Hz using a single phase 75 KVA power transformer that weighs approximately 800 pounds and requires almost 9 sq. ft. of floor space. It is a quenched gap type of apparatus, and requires a .6 MFD capacitor in the primary tank circuit. The secondary winding is #14 stranded PVC plastic insulated wire almost one mile in length wound on a fiberglass form approximately 28 inches diameter and the coil form is 8 feet tall. I strive to design peak efficiency in all my designs. As one example, my #5 coil uses 3 kw power input, has a secondary winding of 400 turns of #20 Formvar insulated solid

-- PAGE TWO--

copper wire on a PVC form 6 inches in diameter, and the winding is 20 inches tall and the coil form is 24 inches overall. The high voltage discharge is from an aluminum toroid 20 inches in diameter. The discharge length is 50 inches. No, that was not a typographical error. It is fifty inches, I.E., the discharge is more than twice as long as the length of the secondary winding. This exceeds the theoretical maximum possible by any of my published references in my entire library!!! (I am enclosing a 35 mm slide of the coil in operation) Nearly all of my coils will produce a discharge of from one and one half times to over twice the length of its corresponding secondary winding. I attribute this to very careful design criteria and uncompromising workmanship.

Carl, I am always interested in the work that other efforts, such as yours entail. My curiosity will not leave me until I hear from you on the accomplishments that you have made. As for copies of references that I might have in my library that you are interested in I would be happy to accommodate your needs with xerox copies (I actually found a machine that really does a decent job of making copies!) May I also suggest that if you have any material that I do not have that we might make this a two way exchange?

I think it appropriate to state here that I am very interested in people such as yourself. I have formed a business of manufacturing various components that are not commonly available to the hobbyist or experimenter for these types of projects. I have thousands of dollars of materials in stock and can ship any item that you might need to complete a particular coil on short notice. I have among other items in stock; mica capacitors up to 35 kv @ .006 MFD, plate and utility transformers up to 10KW, rotary and quenched gaps, primary and secondary coil forms of fiberglass and PVC and specially treated cardboard, auto transformers and reactors, insulators, hardware---you name it!

I would be glad to keep you on my mailing list of current events relating to these projects, and if you are ever out on the west coast, you are welcome to stop by for a demonstration, and possibly stay at my residence for several days.

With Nick Basura's help and with the aid of people like yourself, it is one of my great hopes to evolve a new Tesla Society, composed of all those who believe in Dr. Tesla's work and who have as individuals experienced the wonders of some of his great discoveries.

Carl, I look forward to hearing from you soon, and I sincerely hope to develop a greater friendship with you. Please feel free to contact me anytime. Should you decide to call me, I am usually reachable after 8 PM PST at the number on the letterhead. May YOU find the spark that satisfies!

B.D. Wreck

JAM C. WYSOCK, 3.25.78,
SOUND SYSTEMS,
1, BALDWIN AVE.
SAN CITY CALIF. 91780

U.S.A.

SAN MR. WYSOCK.

THANK YOU FOR YOUR NICE LETTER. I'M GOING
TO BUY ONE OF YOU'R TESLA COIL KITS. SO
I WONDERED IF YOU COULD SEND ME SOME LI-
TERATURE ON YOU'R COIL KITS , ALSO IF PO-
SSIBLE SEND A PRICE LIST AND A PICTURE OF
EACH? ALSO, I WONDERED IF YOU'R KITS INCLUDE
ALL MATERIALS TO BUILD A COIL? DO YOU
SELL ALL OF YOUR COILS IN KIT FORM?

WILL THE COIL KITS YOU SALE (NO. 5)
PUT OUT AS MUCH AS BOB GOLKAS COIL?
WHAT DO YOU MEAN BY THE "CURRENT VERSION"
ON NO. 5

THANKS AGAIN!

JACK KING. 1533w. 4505s.

S.L.C. UTAH 84107.

-or-

CALL ME COLLECT 1-801-261-4459,

P.S. ENCLOSED IS MY SIGNATURE SIGNED BY MY
MOM, HOPE TO HEAR FROM YOU SOON!

August 12, 1978

led:

and its tech-
ok as through
I serve as an
ion to operating
high frequency-
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C. Wysock
it
onal Sound Systems

Enclosed: Brochure

lcajnc

U.S.A.

Verlag F. Bruckmann
8 München 20
Abhofach, Germany

August 12, 1978

Dear Sirs;

I wish to obtain a hardbound copy of this book entitled:
FEVER, BLITZ, UND FUNKE
Herausgegeben Von Hans Prinz
Zur Eröffnung
Des Institutes Für Hochspannungs-Und Isolationstechnik
Der Technischen Hochschule München
© 1965 F. Bruckmann, KG, München

I am greatly impressed with the quality of this book and its technical comprehensiveness. My first introduction to this book was through Robert K. Golka of Project Tesla, Wendover, Utah, U.S.A. I serve as an independent consulting engineer to Project Tesla in addition to operating my own firm, Professional Sound Systems, building custom high frequency-high potential oscillators (Tesla Coils). I have built several for Project Tesla to this date, I am enclosing a copy of my first brochure for your interest. However my involvement in high voltage technique extends far beyond this point. Therefore, any subsequent publications you may have in addition to the above listed book involved in high voltage phenomena and technique would be of equal interest to me.

Please advise me on the above requests and as to cost and availability, and also in what manner of payment you prefer.

Sincerely Yours,

William C. Wysock
President
Professional Sound Systems

Enclosed: Brochure

lcw/jcu

Dr. James Galloway
G. W. Galloway Co.
5115 Azusa Canyon Road
Baldwin Park, Ca. 91706

August 12, 1978

Dear Dr. Galloway,

There is absolutely no excuse for my delaying this letter of recognition of thanks to you for your time and assistance by donation of the energy discharge capacitor. I apologize for my negligence in this matter.

Much progress has been accomplished in my work since our last meeting. I am now operating a large Tesla Coil which is model #10 in a series I am undertaking to manufacture. This coil consumes a 20KVA input power and has thus far produced over 2.5 megavolt output with corona discharges exceeding 12 feet in length.

The coil is set up on a need-to-operate basis in my front yard driveway "laboratory!" Currently, I am in the process of acquiring partial assistance from Hupotronics of Brewster, New York, in the form of a temporary loan of a 48" diameter aluminum toroid for tests with the model #10 coil. I'm still pursuing a goal of generating ball lightning phenomena with this apparatus. In the near future, I hope to secure local television news coverage of the work. Your capacitor may be employed for pulsed operation of this coil. I am enclosing a 8"X10" glossy of my model #5 coil and a brochure for your interest. I look forward to future correspondence with you.

Sincerely Yours,

William C. Wysock
President
Professional Sound Systems

Enclosed: 8" X 10" glossy and brochure

lcw:mcw

RDX CORP.
110 S. Euclid Ave.
Pasadena, CA. 91101
Attn. Mr. Thomas French, Pres.

August 20, 1978

Dear Thom,

I am acknowledging receipt for a used 48" toroid. Yellow Freight delivered the unit to my location on 18 Aug 78.

Upon unpacking the unit, I discovered the damage (dents and scratches) that were previously referred to. After close inspection, I have concluded that it will be necessary to take corrective measures on the toroid in order to assure a uniformly distributed electrostatic field for the upcoming experiments.

I am therefore proceeding with the necessary repair work, and I would like to take this opportunity to express my thanks and sincere appreciation for your interest, time and assistance in this project.

I look forward towards the anticipated results of these experiments and to future correspondence with you.

Very Truly Yours,

William C. Wysock
President

law:mcw

HIPOTRONICS INC.
Route 22
Brewster, N.Y. 10504
Attn: Mr. Rick Reid, V.P.

August 20, 1978

Dear Mr. Reid,

I am acknowledging receipt for a used 48" toroid. Yellow Freight delivered the unit to my location on 18 Aug 78.

Upon unpacking the unit, I discovered the damage (dents and scratches) that were previously referred to. After close inspection, I have concluded that it will be necessary to take corrective measures on the toroid in order to assure a uniformly distributed electrostatic field for the upcoming experiments.

I am therefore proceeding with the necessary repair work, and I would like to take this opportunity to express my thanks and sincere appreciation for your interest, time and assistance in this project.

I look forward towards the anticipated results of these experiments and to future correspondence with you.

Very Truly Yours,

William C. Wysock
President

lcw:wcw

Hipotronics inc.

Route 22/PO Dwr. A
Brewster, N.Y. 10509
Twx 710-574-2420

TELEPHONES: SALES (914) 279-8031
SERVICE (914) 279-8035
GENERAL (914) 279-8091

sales order

OUR P.O. **Verbal Request by T. French**

PLEASE REFER TO THIS NO. IN ALL CORRESPONDENCE **821404**

DATE **8/2/78**

**RDX Corporation
110 S. Euclid, Ave.
Pasadena, CA 91101**

S
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T
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**Same
c/o Tom French
for Bill Wysock**

TERMS: NET 30 DAYS		# INVOICE COPIES	SHIP VIA	
			BW Collect	
TAXABLE RATE	TAX EXEMPT	EXEMPT NO.	F.O.B. BREWSTER, N.Y.	DATE REQUIRED
ACCOUNT			WE EXPECT TO SHIP THIS ORDER WEEK OF:	
4116				
SALESMAN			FOR FURTHER INFORMATION, CALL	
114.10 RDX			EXT.	

ITEM	QUANTITY	MODEL NUMBER	DESCRIPTION
1	1	TO-48	Used 48" Toroid for Tesla Coil Experiments

BUYER:

TEL:

PER
TELECON:

TYPED
BY:

SPECIAL NOTES:

Jim May has used unit.

FOR INTERNAL USE ONLY

PACKING LIST

Capacitor Specialists Inc.
Dept. G P.O. Box 2052
Escondido, CA 092025

August 21, 1978

Gentlemen:

I am interested in obtaining data on capacitors specifically designed for high pulse-rate radio frequency discharge at high coulomb levels.

Your firm was referred to me by Robert K. Golka of Project Tesla. I have been associated with Bob Golka at Project Tesla since 1975 as an engineering consultant. Additionally, I have been building various high frequency, high potential oscillators since 1964.

Currently, I am in need of a capacitor bank comprising of six .025 MFD. @ 50K.V.A.C. RMS. These would be of the same description as your firm supplied to Project Tesla.

Unlike Project Tesla, my research is only funded by my own resources. I also have a business manufacturing custom built Tesla Coils. To date I have built several for Project Tesla.

I am enclosing a brochure for your interest. In addition to the above mentioned capacitor requirements, I am seeking a readily available supply of capacitors for O.E.M. components in my regular line. Previously, I have relied on various surplus supplies which, over recent years, have become completely depleted.

Therefore, I would greatly appreciate any data and assistance and I would entertain meeting with an engineering representative from your firm. Please advise by return letter.

Very Truly Yours,

William C. Wysock
President

lcw:mcw

R. J. Gillespie & Co.
P.O. Box 20144
Atlanta, Ga. 30325

August 12, '78

Dear Sirs,

Recently I completed a visit to Hershel J. West of the Charles E. Caray High Voltage Laboratory at the Ross Complex, Bonneville Power Administration at Vancouver, Washington.

At the lab, I was impressed with the quality of their apparatus which is predominantly manufactured by HEAFELY.

It has come to my attention that you represent Emile Haefely & Co., Ltd. Since I am involved in high voltage technique and have a broad interest in this field, I would greatly appreciate obtaining the following data sheets and brochures for my files;

HEAFELY: BE 701A, BE 701, E 171.1, E 112.1, E 143.1, E 144.3, E 143, E 143.2, Impulse Voltage Dividers, and 100-High Voltage Test Systems.

Also, should you also represent ASEA or MICAFIL, I would like to obtain any available brochures from these manufactures.

At present, I am engaged in manufacturing high frequency - high potential oscillators (Tesla Coils) for special applications.

Thank you for your co-operation. I look forward toward future correspondence and business with your firm.

Sincerely Yours,

William C. Wysock
President
Professional Sound Systems

Enclosed: Brochure

lcw:wcw

TUBE-DEUTSCHMANN LABS INC.
550 G TPKE ST.
CANTON, MD. 02021

August 21, 1978

Dear Sirs:

I represent a small research and manufacturing firm specializing in prototype and custom built high frequency - high potential oscillators (Tesla Coils).

Currently I have a project in progress utilizing six Tobe capacitors bearing Tobe part numbers RPC = 402502 and XN - 285. These are each rated at .025 MFD and 40 KV. They are being utilized for high rep rates (up to 600 PPS) and perform in a most satisfactory manner thus far.

Unfortunately, these Tobe capacitors are only in my possession on a limited - term loan basis and I will have to return them before my experiments are completed. Therefore, I am seeking to replace them with duplicate units, if they are available or their equivalent.

I am also seeking a source for somewhat smaller rated capacitors as an O.E.M. application for my standard line of Tesla Coils. I am enclosing a brochure for your interest. On the back cover you may recognize the capacitors referred to above.

Please advise me by return letter as to your prices, availability, and any data sheets on current applicable products. I look forward to future business with your firm.

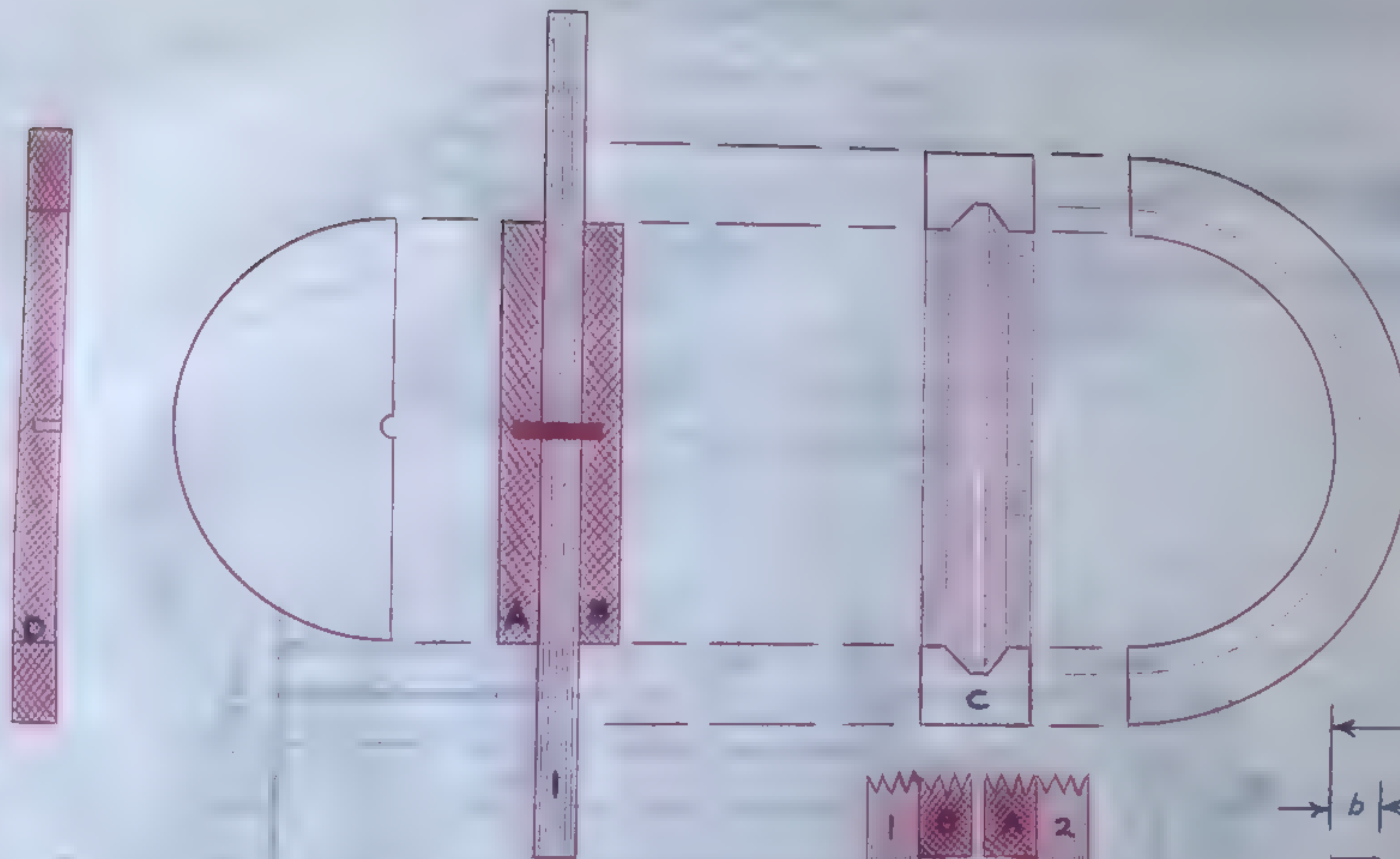
Very Truly Yours,

William C. Wysock
President

lcm: wcm

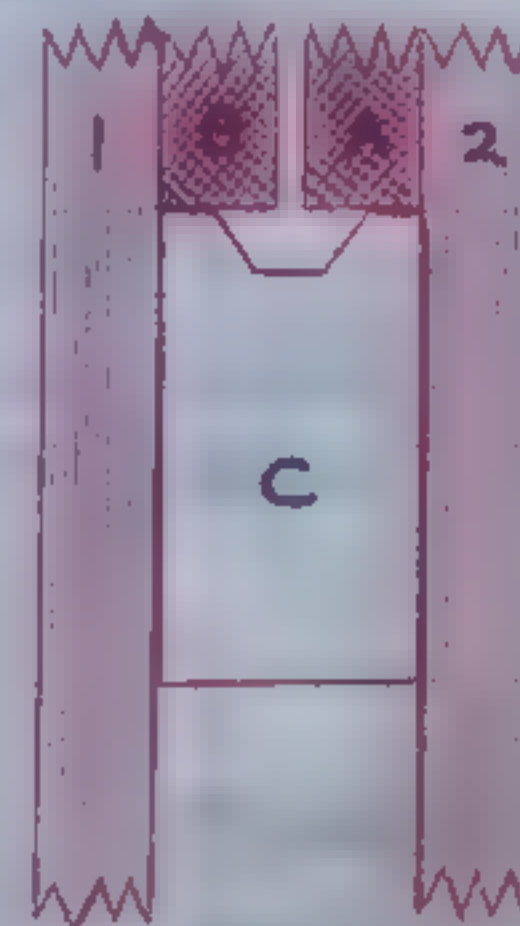
5 KW QUENCHED SPARK GAP DETAILS

BILL WYSOCK
10-8-75

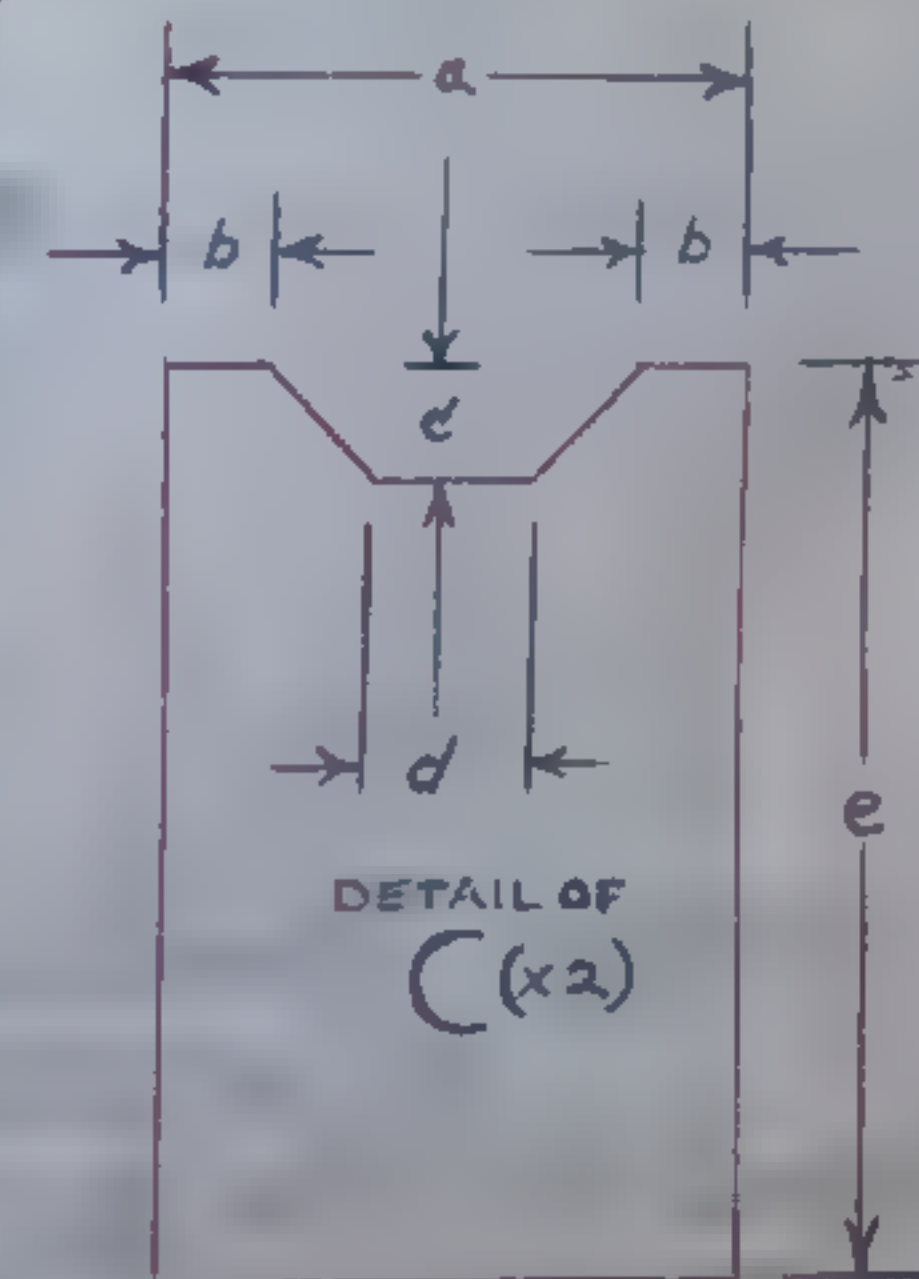


MATERIAL	QUANTITY	DEMENTIONS
T3	17	1 = 6" x 1/4"
T3	16	A = 4" x 1/4"
T3	16	B = 4" x 1/4"
T3	2	D = 5" x 1/2"
PLEXIGLAS	16	C = 5" O.D. 4 1/4" I.D.

a = 9/16"
b = 1/8"
c = 1/8"
d = 3/16"
e = 1 1/2"



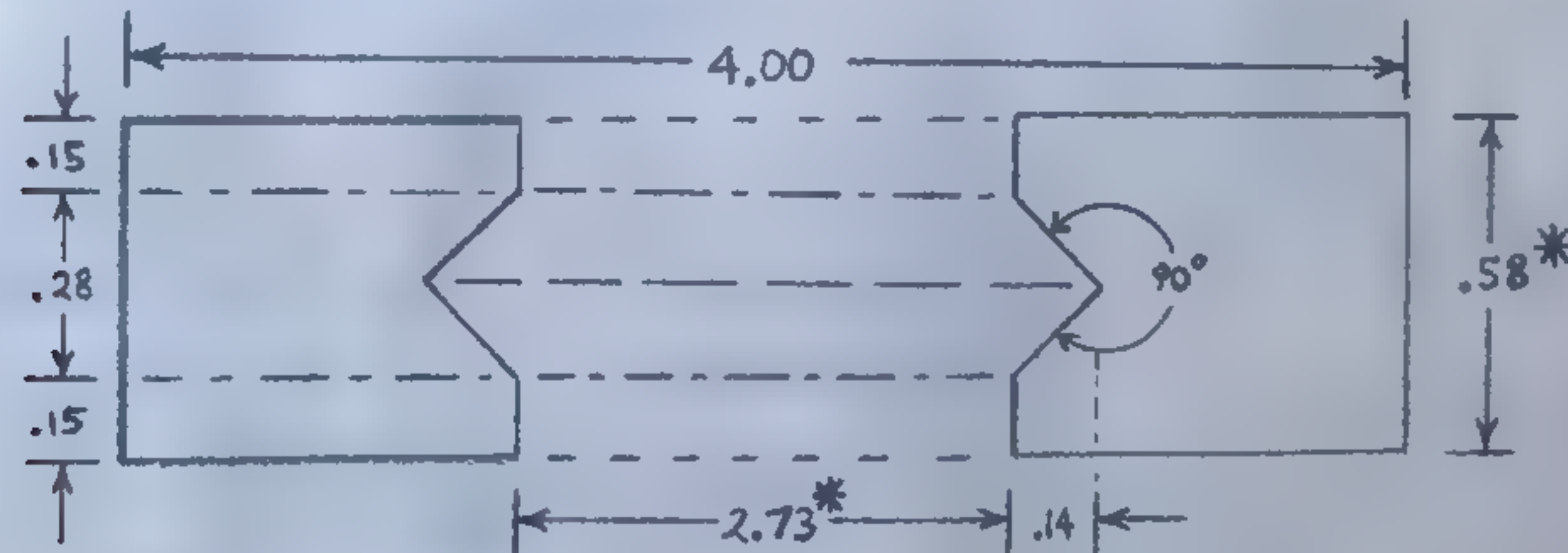
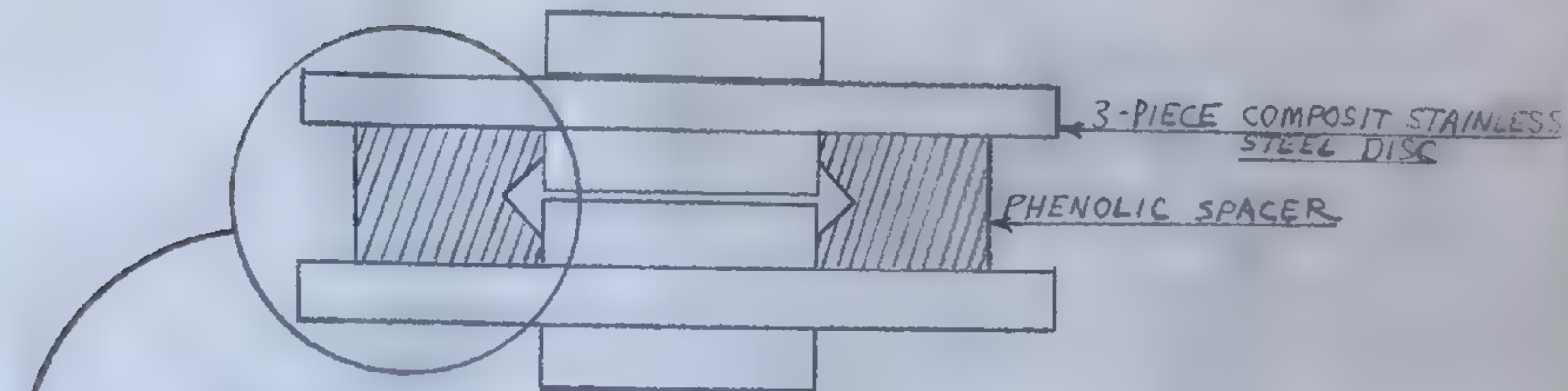
ACTUAL SIZE



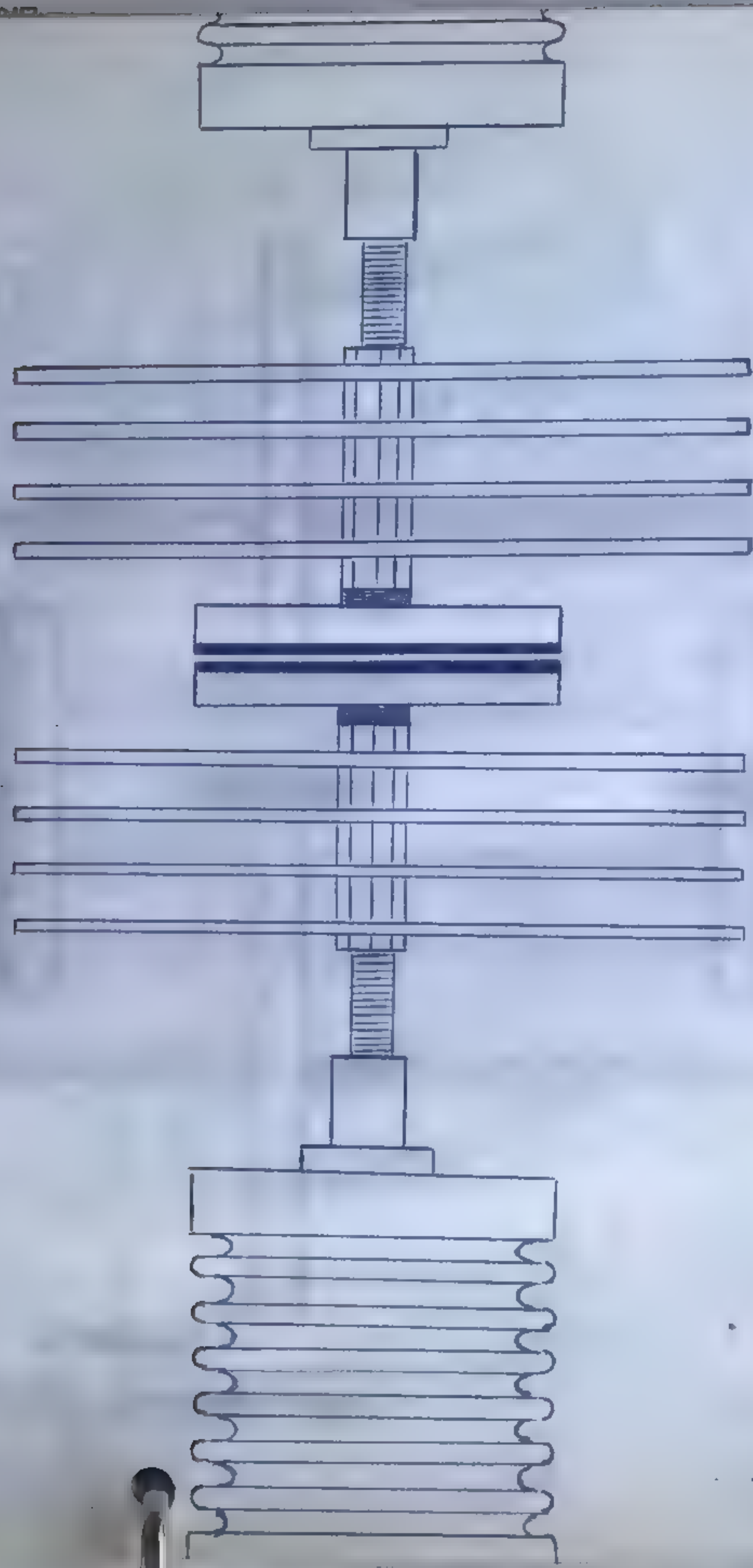
DETAIL OF
(x2)

DRAWN BY: *WY*

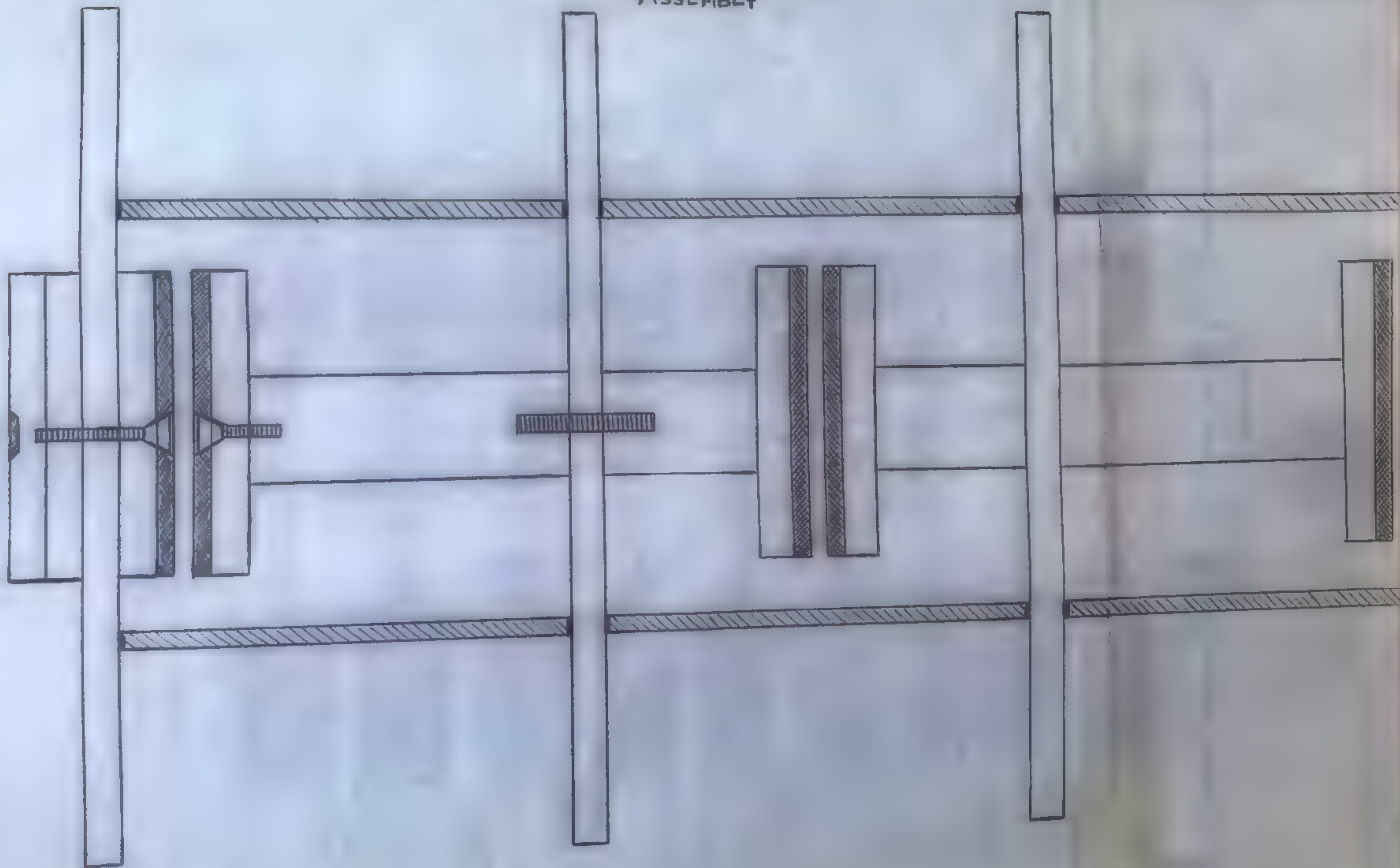
CROSS-SECTION VIEW: TWO DISCS WITH ONE SPACER

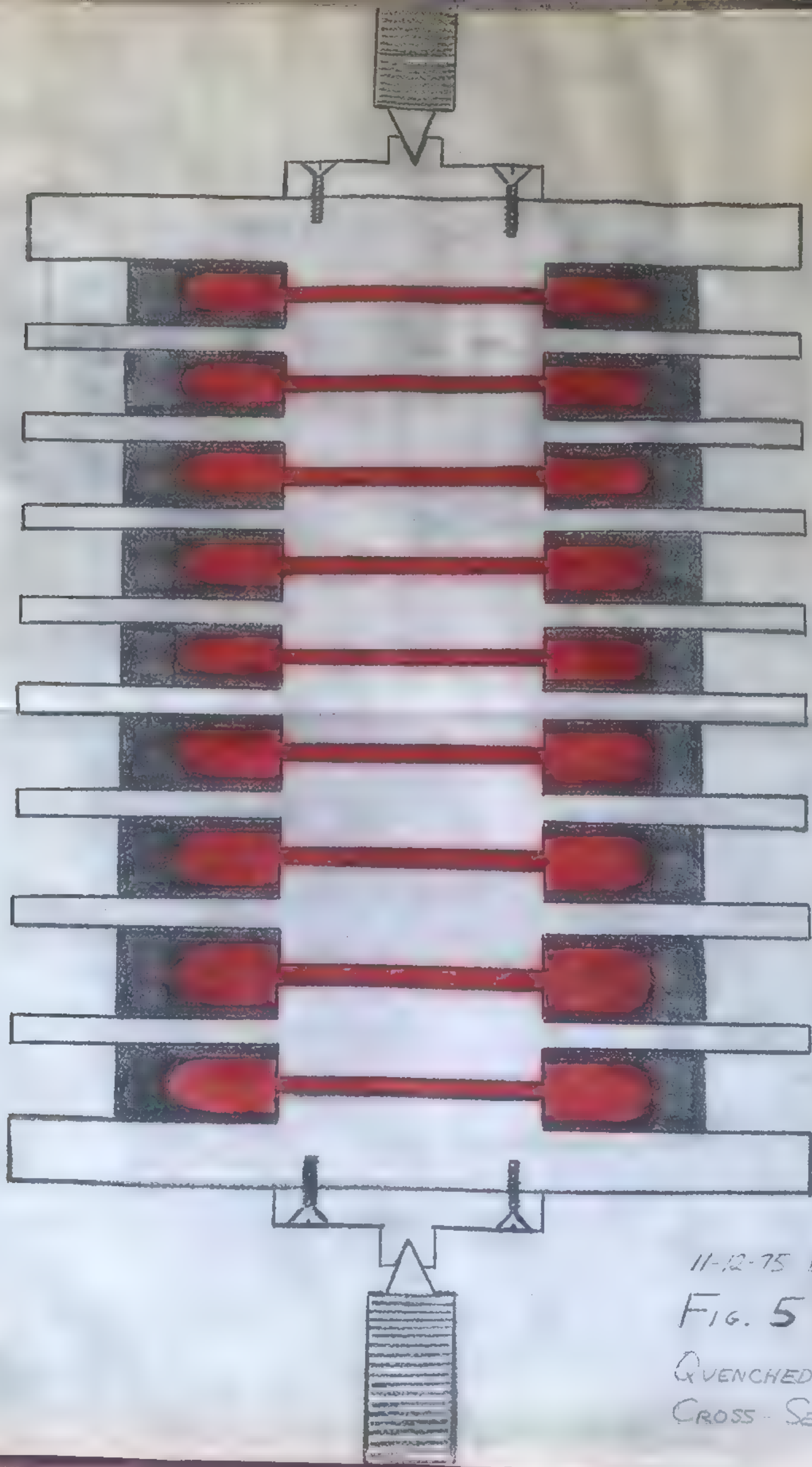


ITEM: PHENOLIC SPACER 12-28-76
 QUANTITY: 10 PIECES FINISHED
 WORK TOLERANCE: $\pm \leq .0005^*$; $\pm .01$ ALL OTHERS
 DATE REQUIRED: ASAP PHONE 466-0662/469-1173
 DRAWN BY: *www*



10 Kw QUENCHED GAP INTERIOR
ASSEMBLY

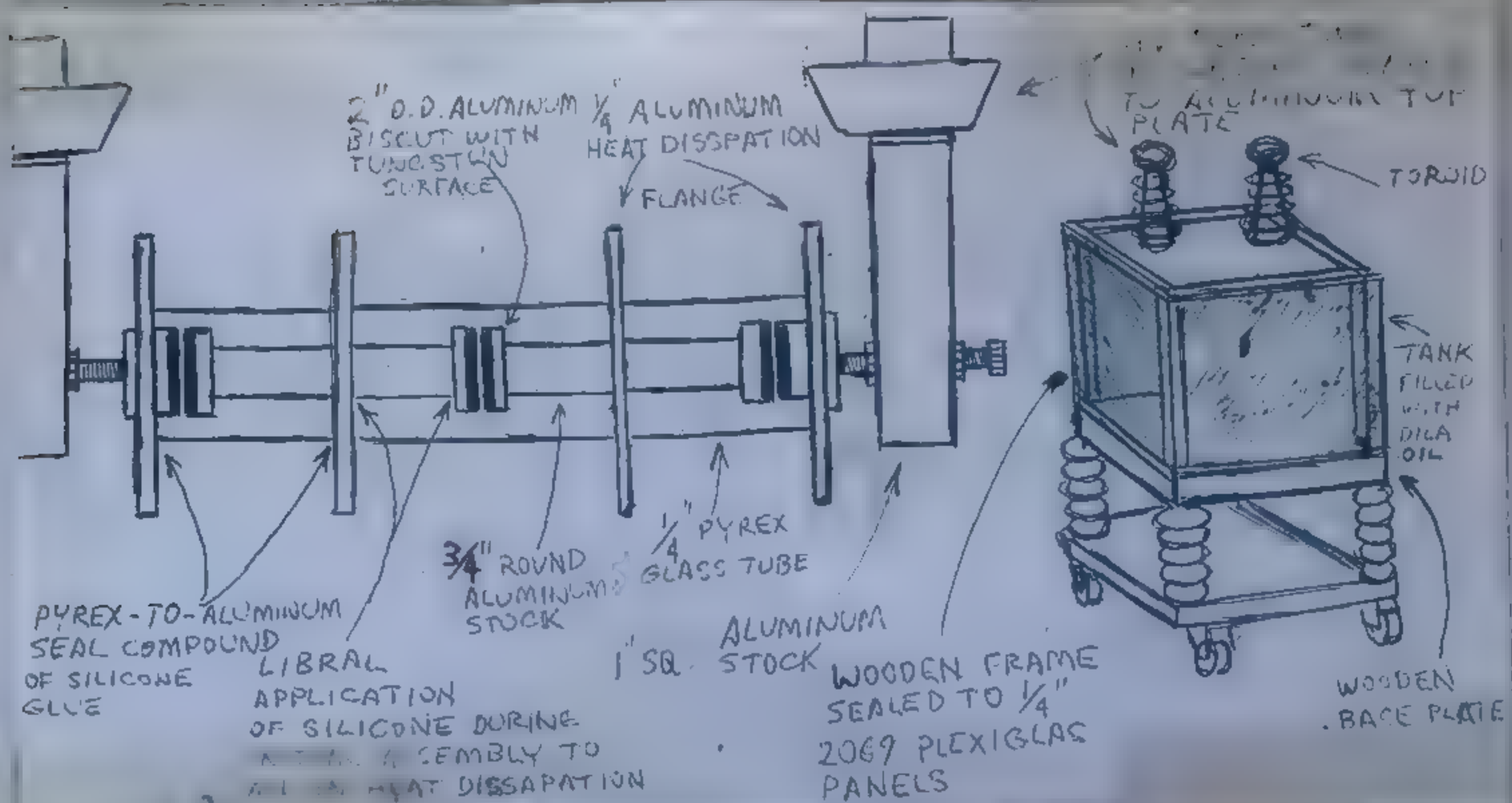




11-12-75 Bill Wicker

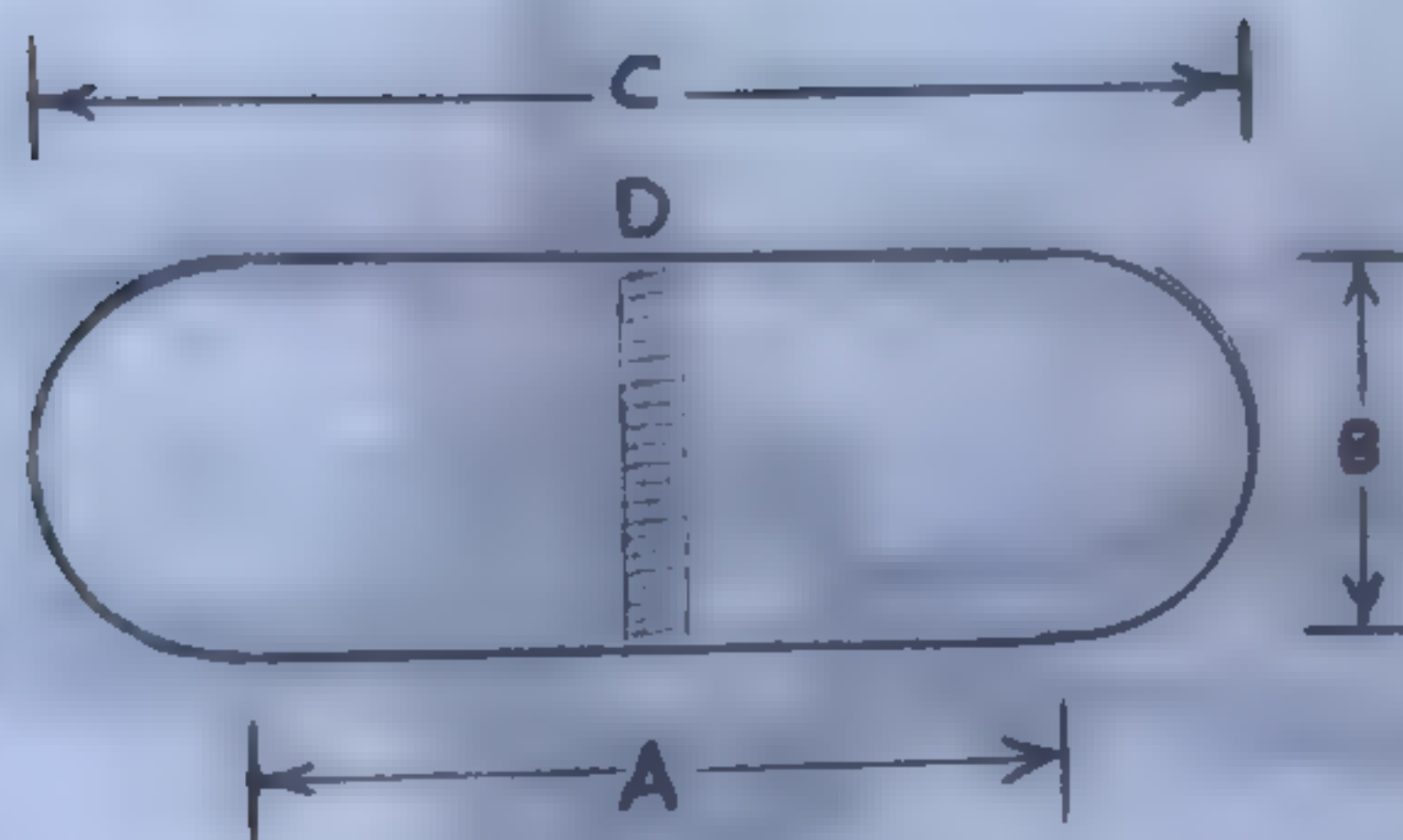
Fig. 5

QUENCHED GAP
CROSS-SECTION



HIGH VOLTAGE TOROID DETAILS

BILL WYSOCK
10-8-75

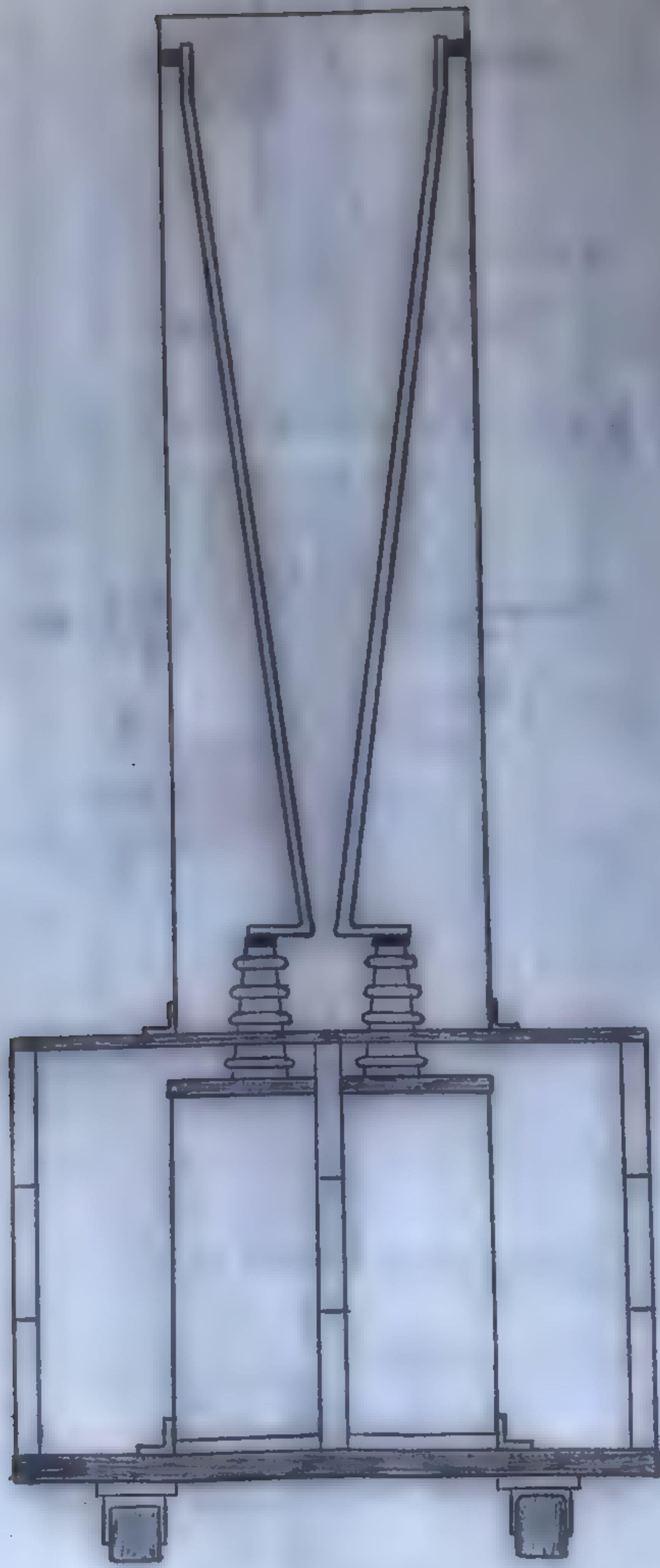


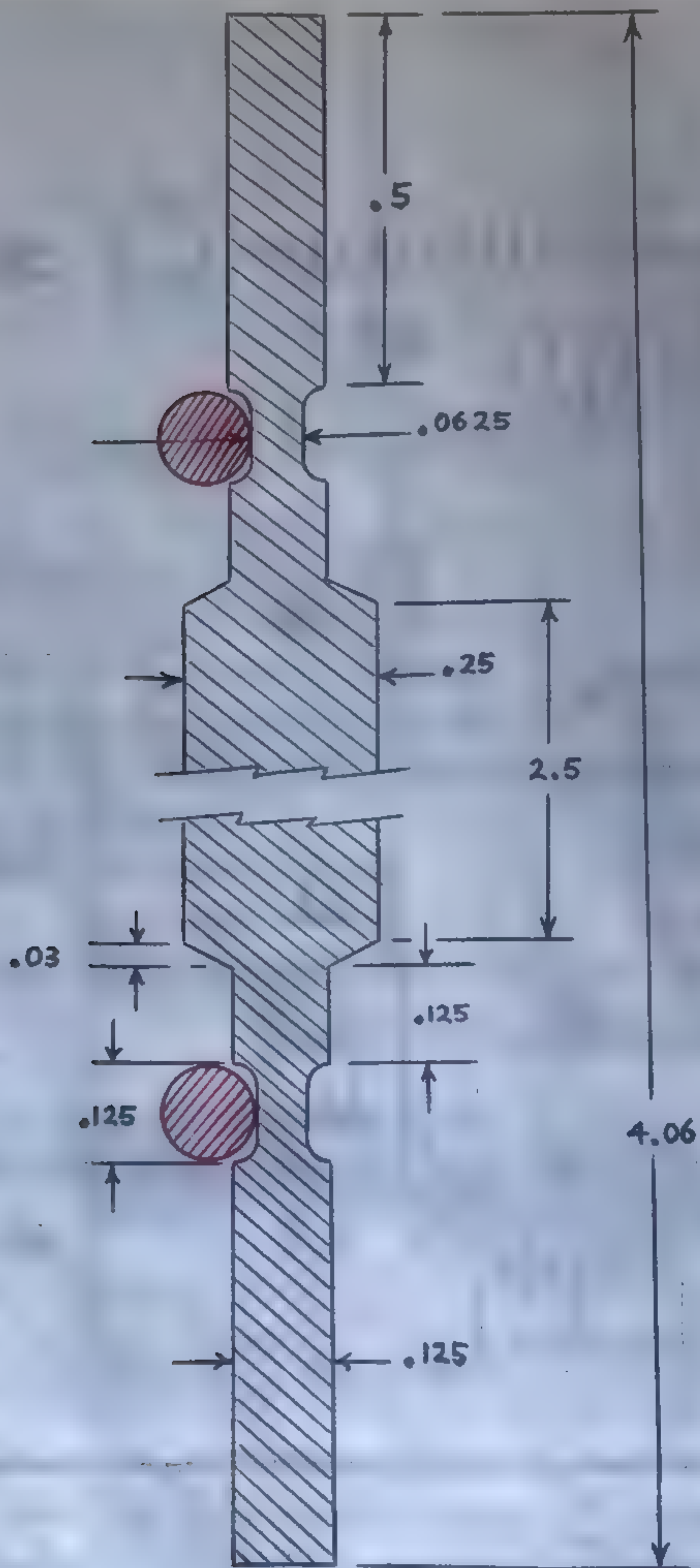
A = $1\frac{1}{2}$ "
B = $\frac{3}{4}$ "
C = $2\frac{3}{8}$ "
D = 10-32

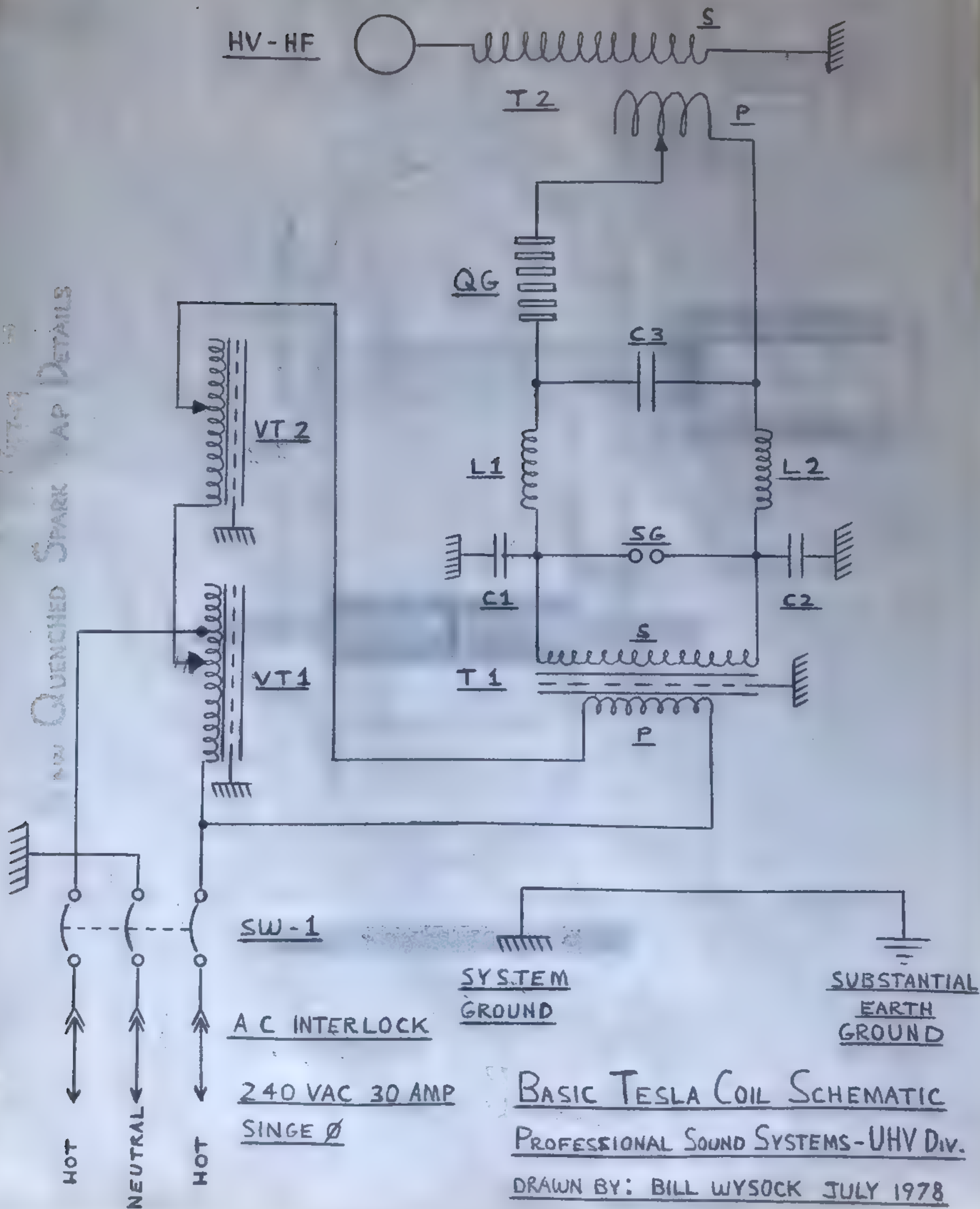
QUANTITY: 16 FINISH: POLISHED

A = $\frac{3}{4}$ "
B = $\frac{3}{8}$ "
C = $1\frac{3}{16}$ "
D = 8-32

QUANTITY : 40 FINISH: POLISHED

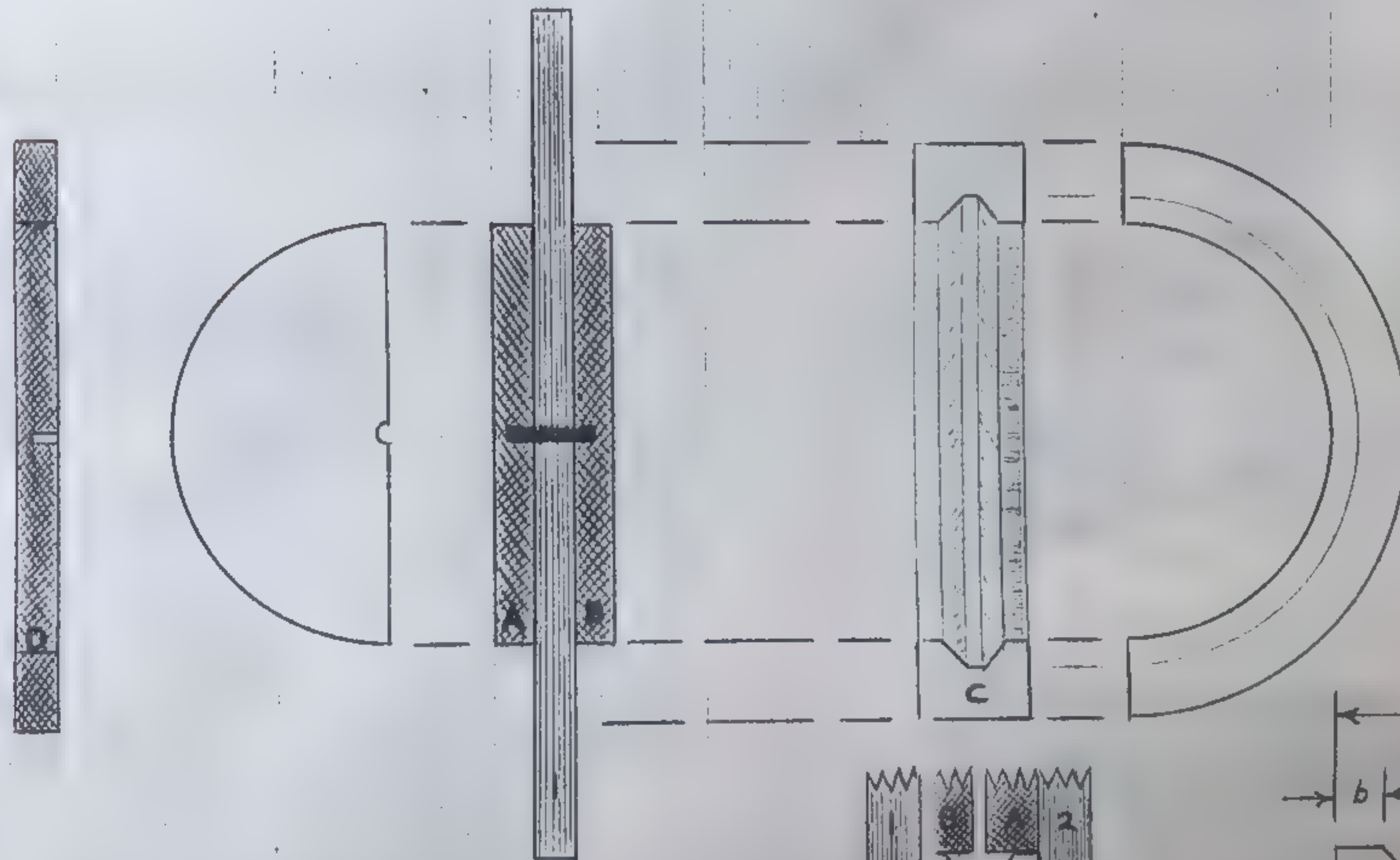






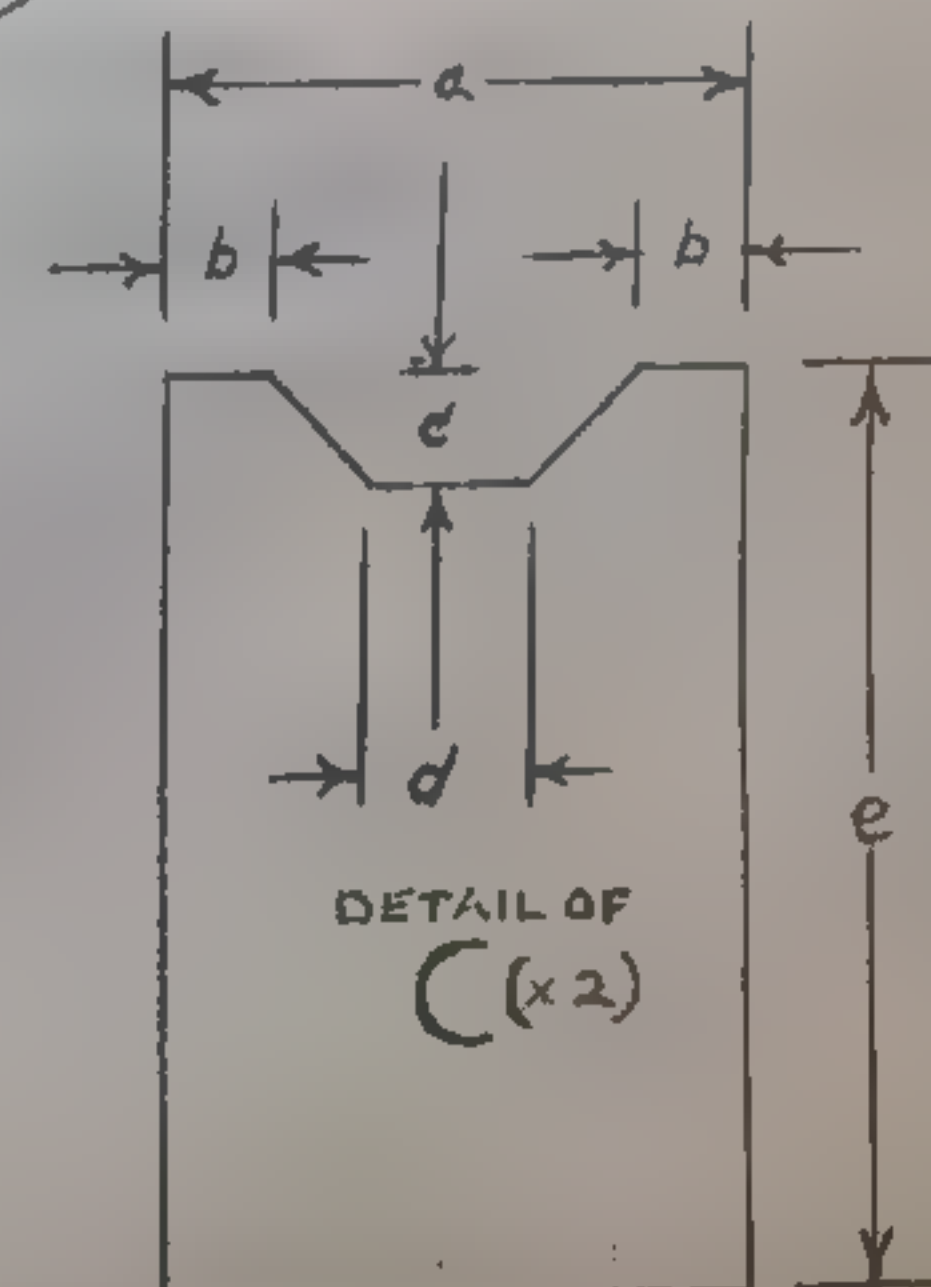
5 KW QUENCHED SPARK GAP DETAILS

BILL WYSOCK
10-8-75

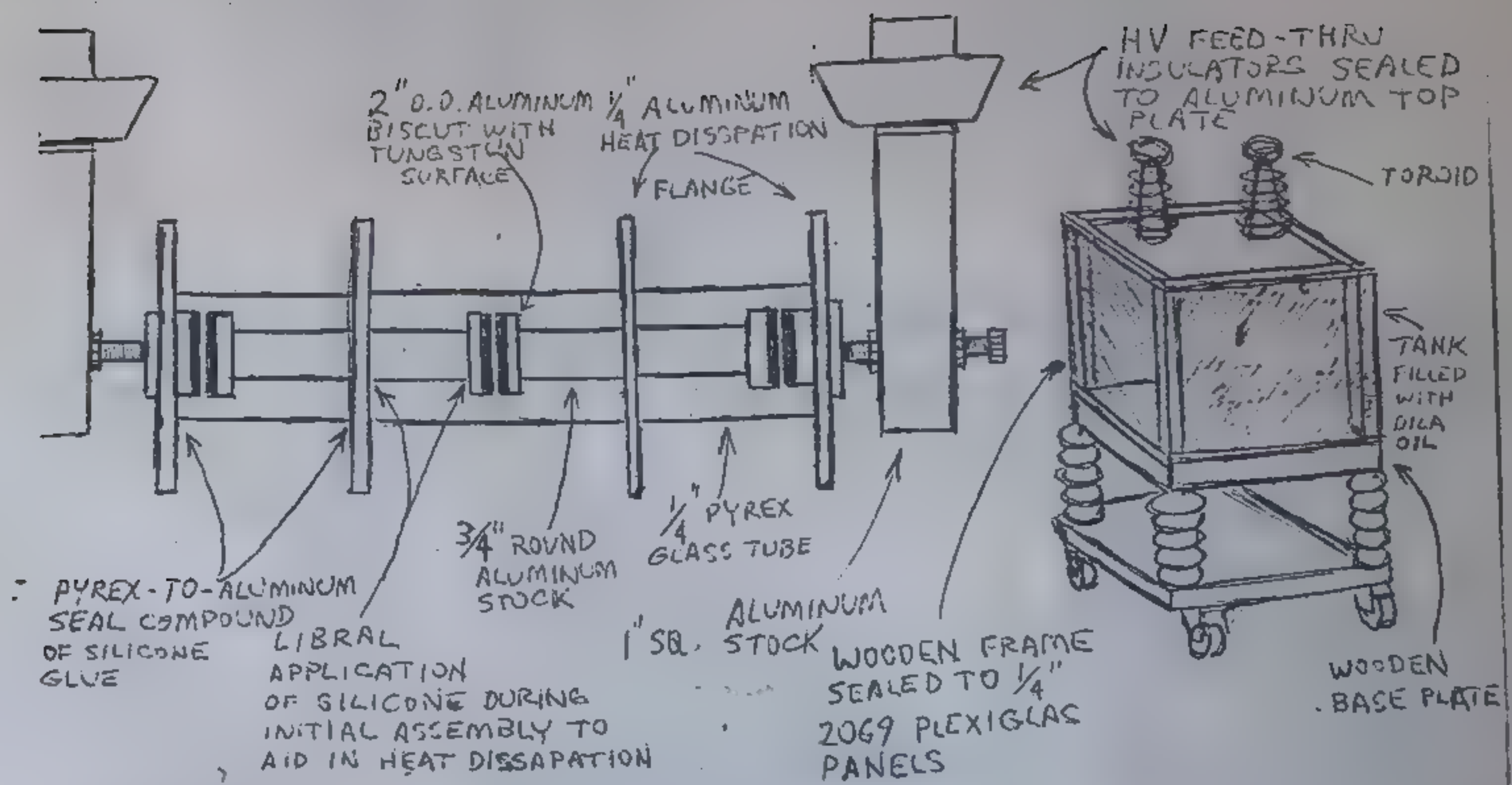


MATERIAL	QUANTITY	REMARKS
T3	17	1 = 6" x
T3	16	A = 4" x
T3	16	B = 4" x
T3	2	D = 5" x
PLEXIGLAS	16	C = 5" x 4 1/4" x

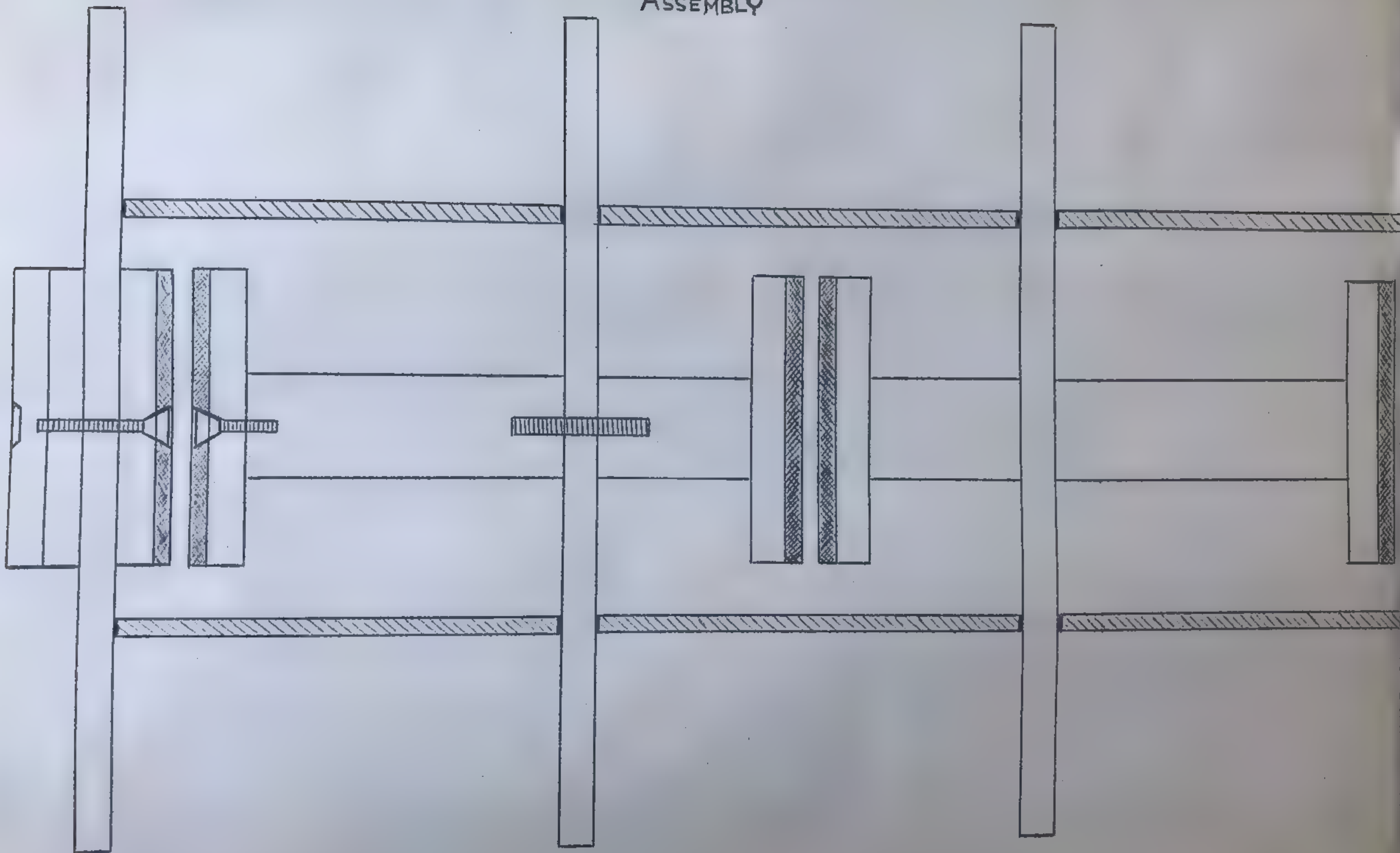
a = 9/16
b = 1/8
c = 1/8
d = 3/16
e = 1 1/2



ACTUAL SIZE

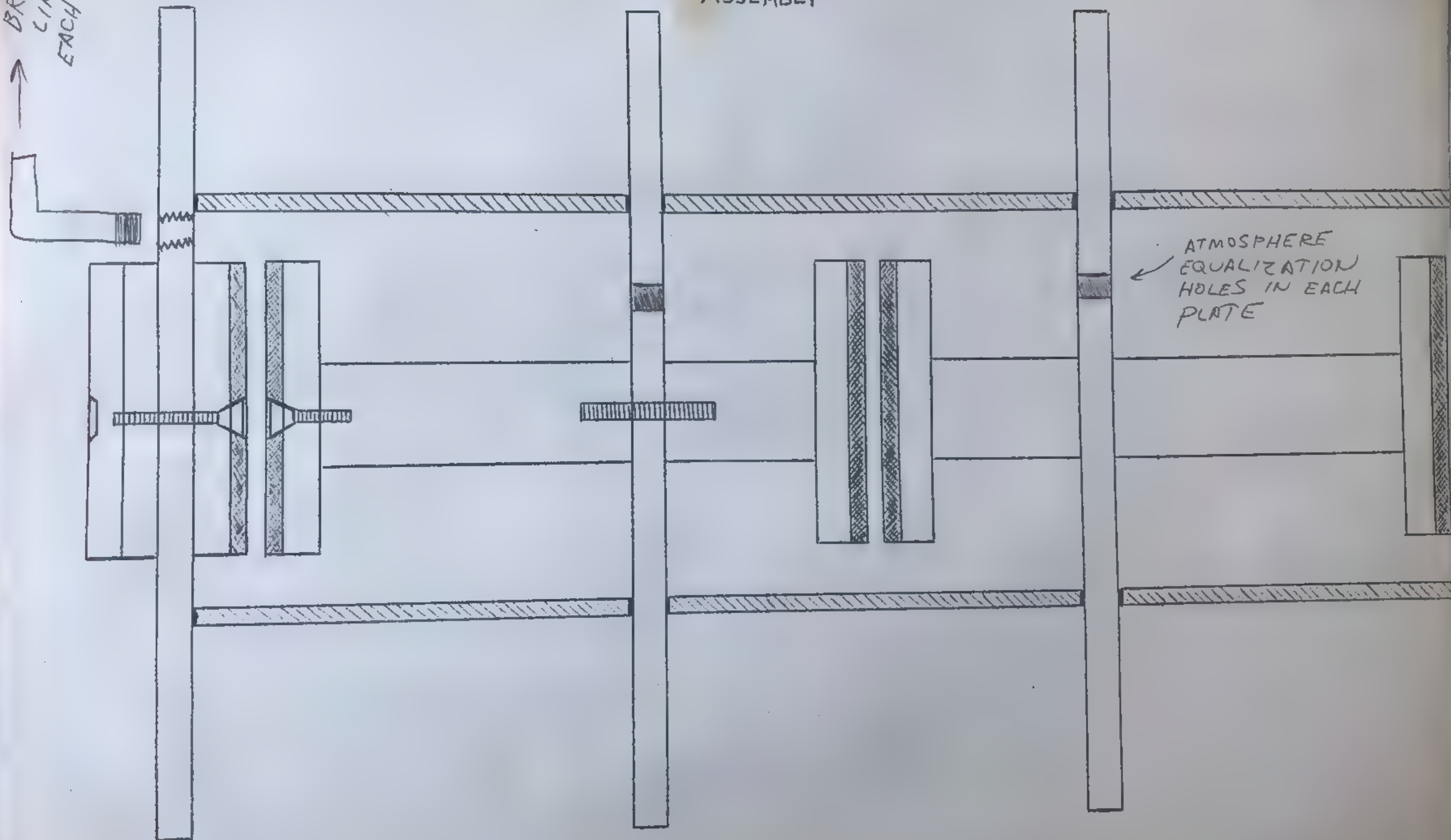


10 Kw QUENCHED GAP INTERIOR
ASSEMBLY



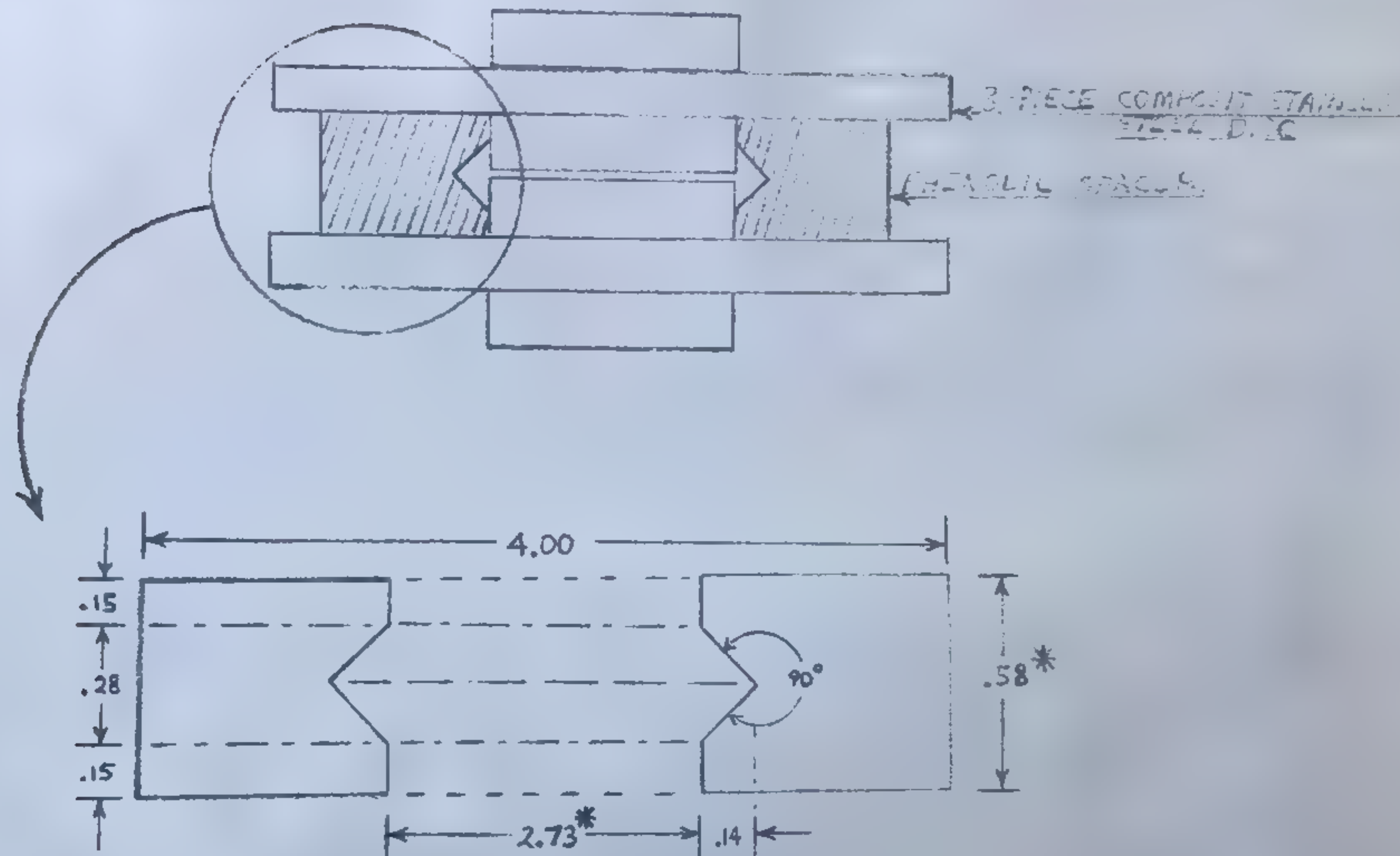
10 Kw QUENCHED GAP INTERIOR
ASSEMBLY

BREATHING
LINE IN
EACH END PLATE



ATMOSPHERE
EQUALIZATION
HOLES IN EACH
PLATE

CROSS-SECTION VIEW: TWO DISCS WITH ONE SPACER



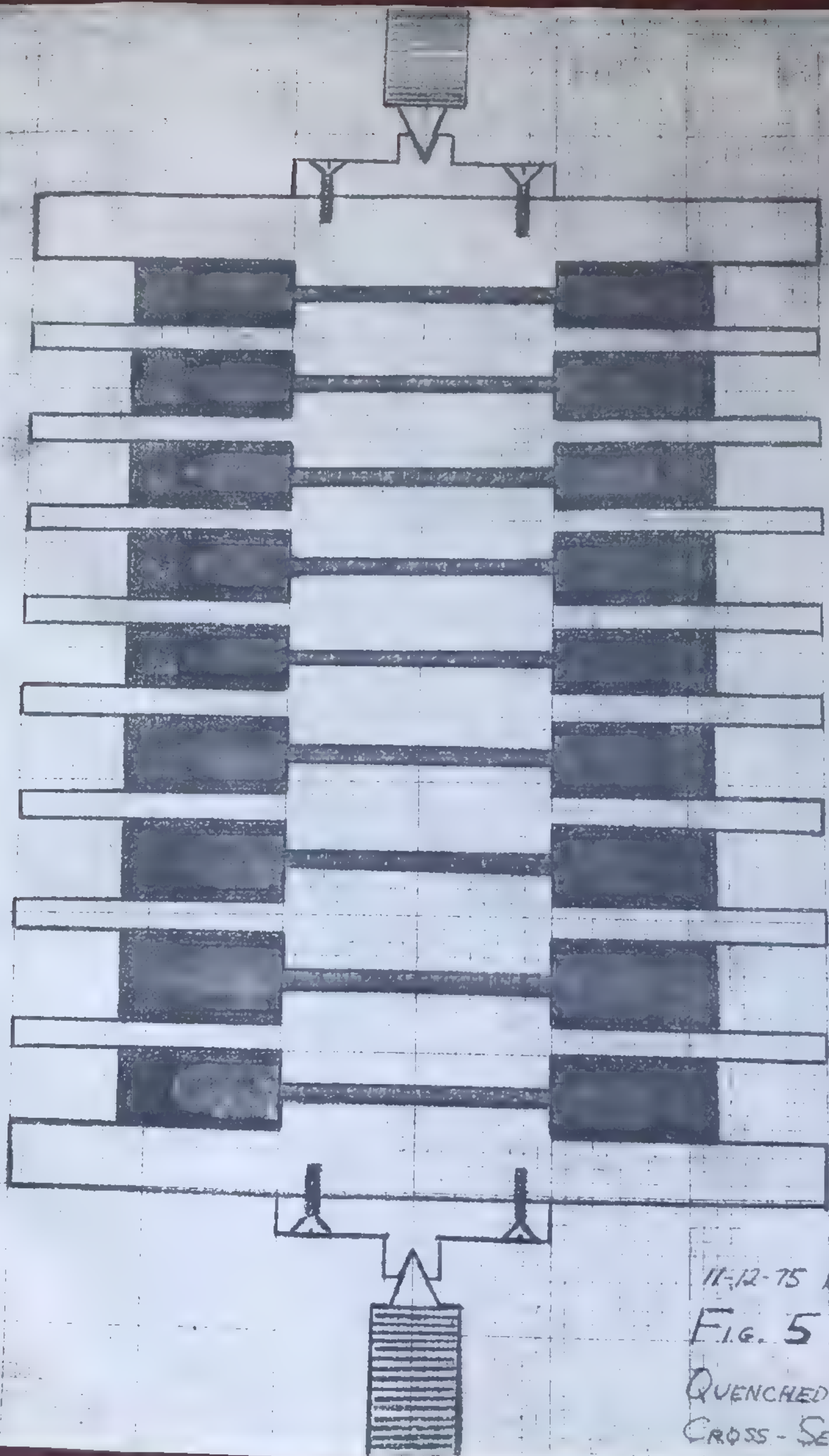
ITEM: PHENOLIC SPACER 12-28-76

QUANTITY: 10 PIECES FINISHED

WORK TOLERANCE: $\pm .0005^*$; $\pm .01$ ALL OTHERS

DATE REQUIRED: ASAP PHONE 466-0662/469-1173

DRAWN BY: WCH



11-12-75 Bill Wysock

FIG. 5

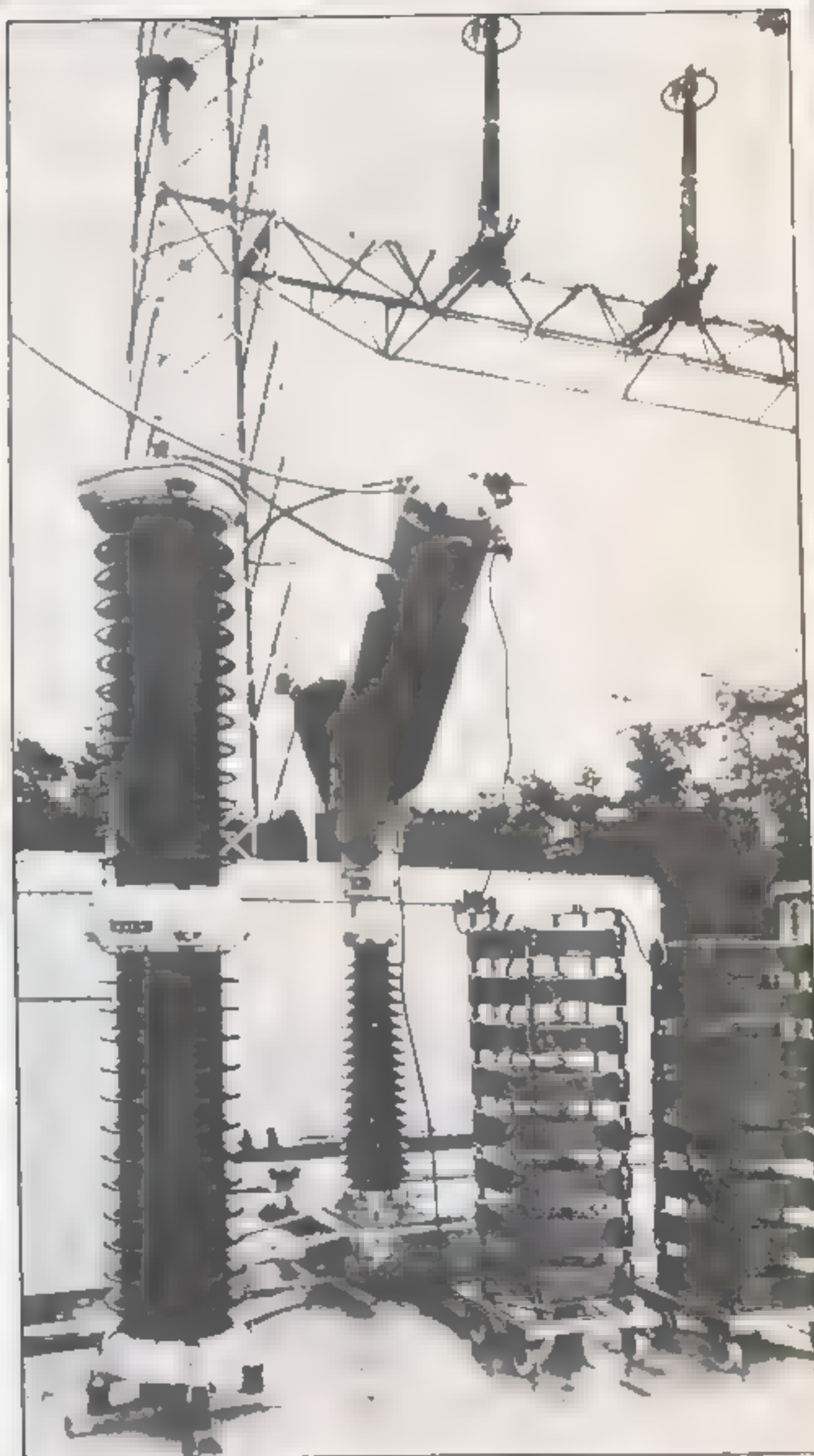
QUENCHED GAP
CROSS-SECTION

Design International



AERIAL SWITCHES designed for 750 kV and aerial-switch modules for 1.15-MV transmission lines are being tested at the research institute of the Uralelektrotiyazhmash production association in Sverdlovsk. Also in the superhigh-voltage laboratory, a new oil circuit breaker is being studied. The equipment is being developed as part of the 1976-1980 program for the development of the national economy of the U.S.S.R. Objectives of the program include an integrated power grid that links the power systems of Siberia and Central Asia with the European system, and new superpower transmission lines rated at 500, 750, and 1,150 kV.

—U.S.S.R.



CIRCUIT BREAKER for high-voltage dc transmission lines successfully interrupted currents of 500 to 2,500 A during recent tests. Designed for system voltages to 200 kV, it can handle higher voltages if individual breaker components are connected in series. For example, the experimental unit pictured is designed for two breaks. Two series-connected surge diverters (left) are hooked in parallel with two minimum-oil circuit breakers in series (center) and with two series-mounted commutation capacitors (right). The development project, supported by the Swedish, German, and Swiss team of AEG-Telefunken, ASEA, Siemens, and Brown Boveri, is being carried out at Brunswick Technical University

—Germany



FEB. 1974

INSULATORS for the proposed Moscow-Leningrad 750,000-V, high-tension line are now under test at the Leningrad Polytechnical Institute. The same facility is reportedly also testing equipment that will be used for lines of 1.2 million V(ac) and 1.5 million V(dc). Present tests are concentrating on the influence of high voltage power surges.

—U.S.S.R.

41

HIGH VOLTAGE test lab is being built in Novosibirsk by the Siberian Power Research Institute. It will be used to study the behavior of high-tension lines in severe climatic conditions. For example, designers have to contend with ice loads on cables and towers which are measured in tons. Outdoors, lines are tested on 165-ft towers using transformers capable of withstanding 1.5 million v. Indoors test equipment includes a 4.8-million volt "lightning" generator.

AUG. 1974

—U.S.S.R.

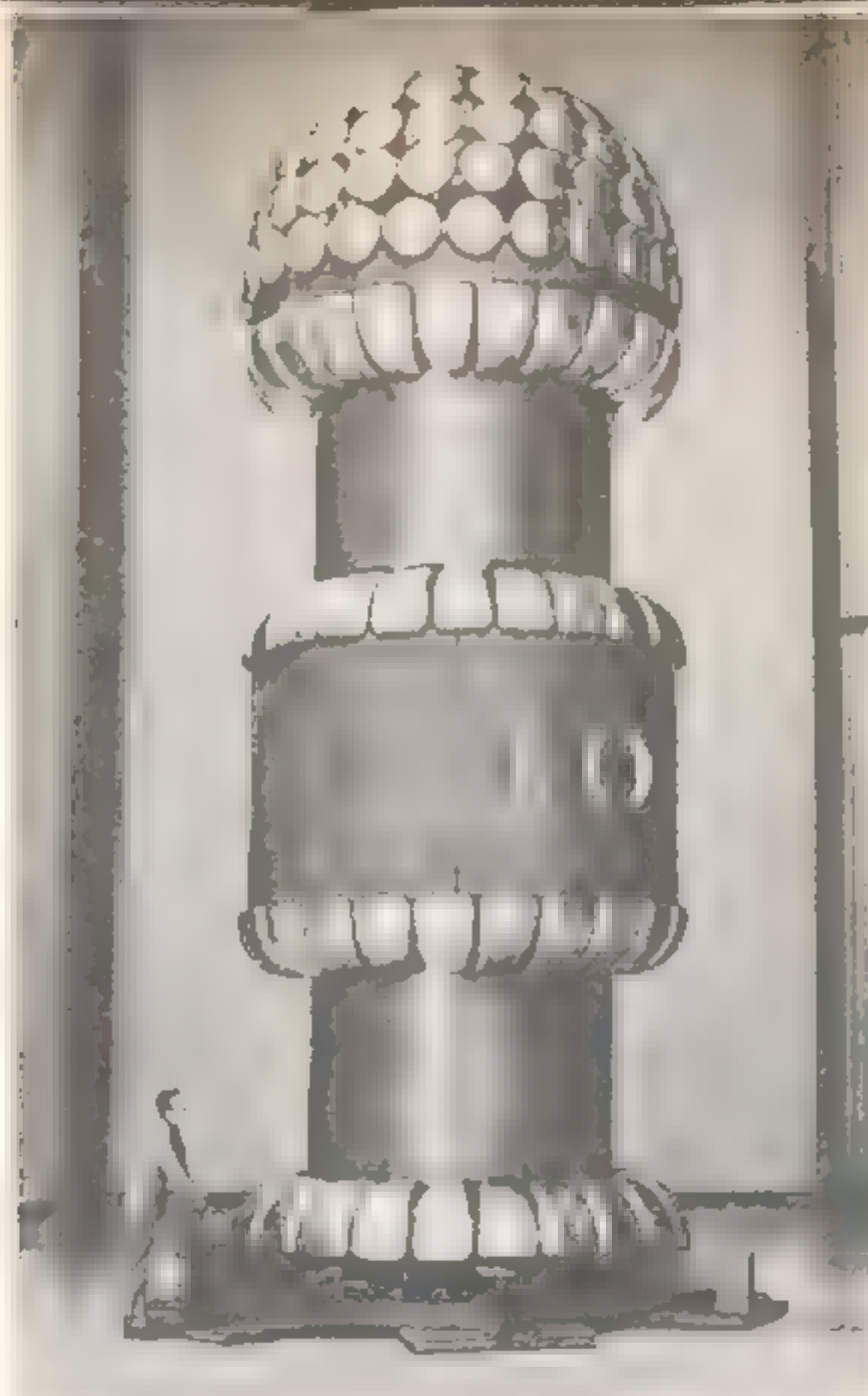




LARGEST IMPULSE VOLTAGE GENERATOR in the world can produce 5.6 MV. Built by E. Haefely & Co. Ltd., the machine will be used for research on future transmission networks of 1,200 and 1,500 kV by the Bonneville Power Administration, Portland, Oreg. A multiplying circuit supplies the output voltage. The capacitor stacks superimposed on the stages are charged in parallel at 200 kV, and are discharged in parallel by the controlled firing of the coupling spark-gaps.

—Switzerland

MACHINE DESIGN



TEST TRANSFORMER of a new design consists of two windings connected in series and mounted one on top of the other on a common core. It's available to research and development laboratories in indoor and outdoor models, rated up to 2,200 kV. The transformers, having heights of up to 18 m, can be provided with air castors for easy moving. The indoor unit pictured, which ASEA built for its own high-voltage laboratory, stands 10-m high and is rated at 1,200 kV, 1 A.

—Sweden



HIGH-VOLTAGE EXPERIMENTS at high altitudes are now being conducted at the Anzob station, located 3 km above sea level in the mountains of Tajikistan. Engineers are studying physical processes that may occur in power transmission lines at these heights. A 3-MV pulse generator, shown, is used to simulate lightning discharges and other phenomena, and to test insulation for high-voltage lines and substations. The Soviet's tenth five-year plan, covering 1976 to 1980, calls for a power increase of 67 to 70 GW for that period.

—U.S.S.R.

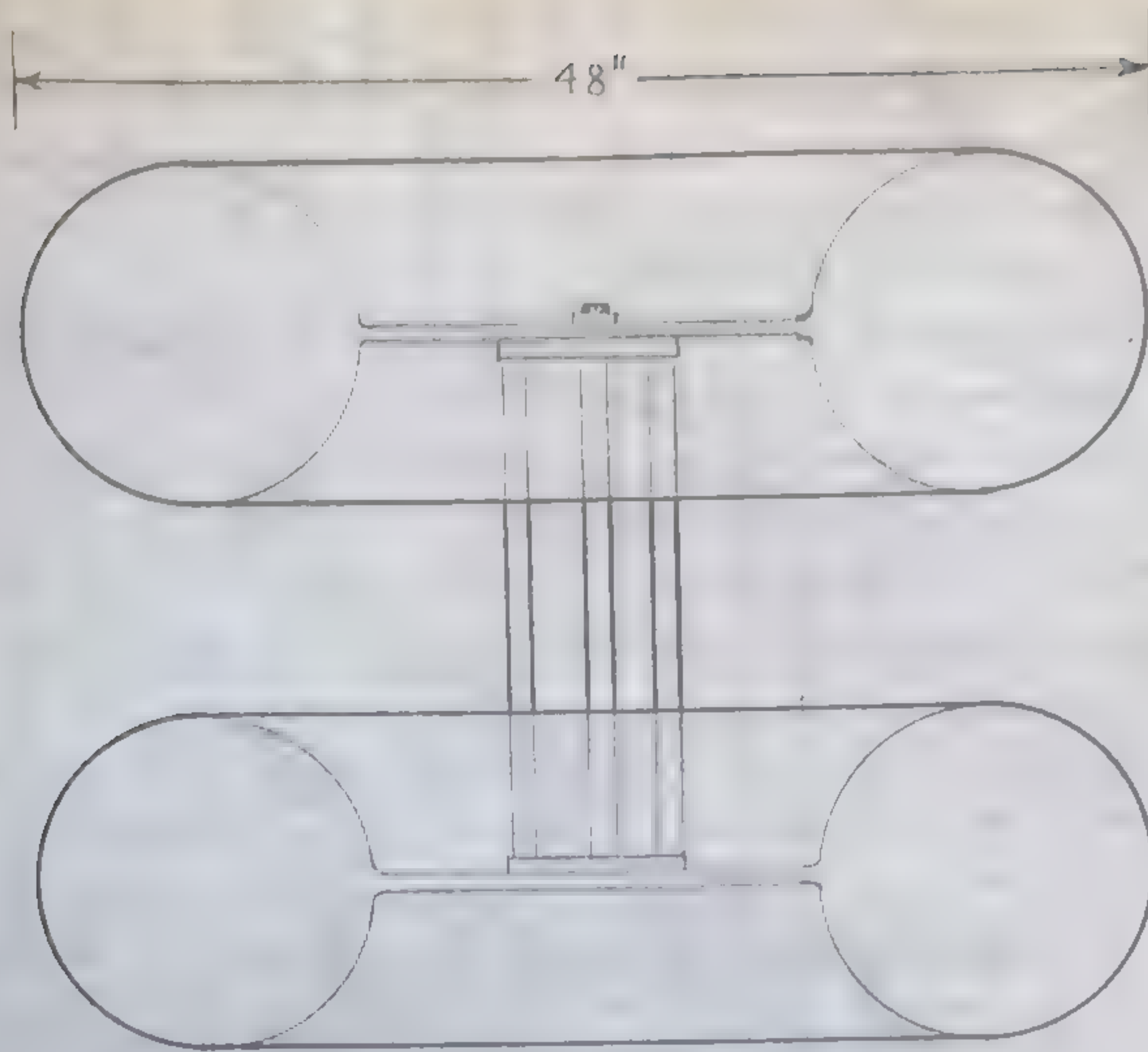
FEBRUARY 10, 1977

SUPERHIGH-TENSION LINES in the forests outside Moscow will soon supply a "research town" with the energy it requires. Prototypes of two grids—a 1,500-kV dc line and a 1,150-kV ac line—are up for testing. Plans call for the experimental ac line section to be 1.17 km long, and for all of its equipment to be experimental. Soviet engineers see this system as a test bed for ideas generated in their country.

—U.S.S.R.

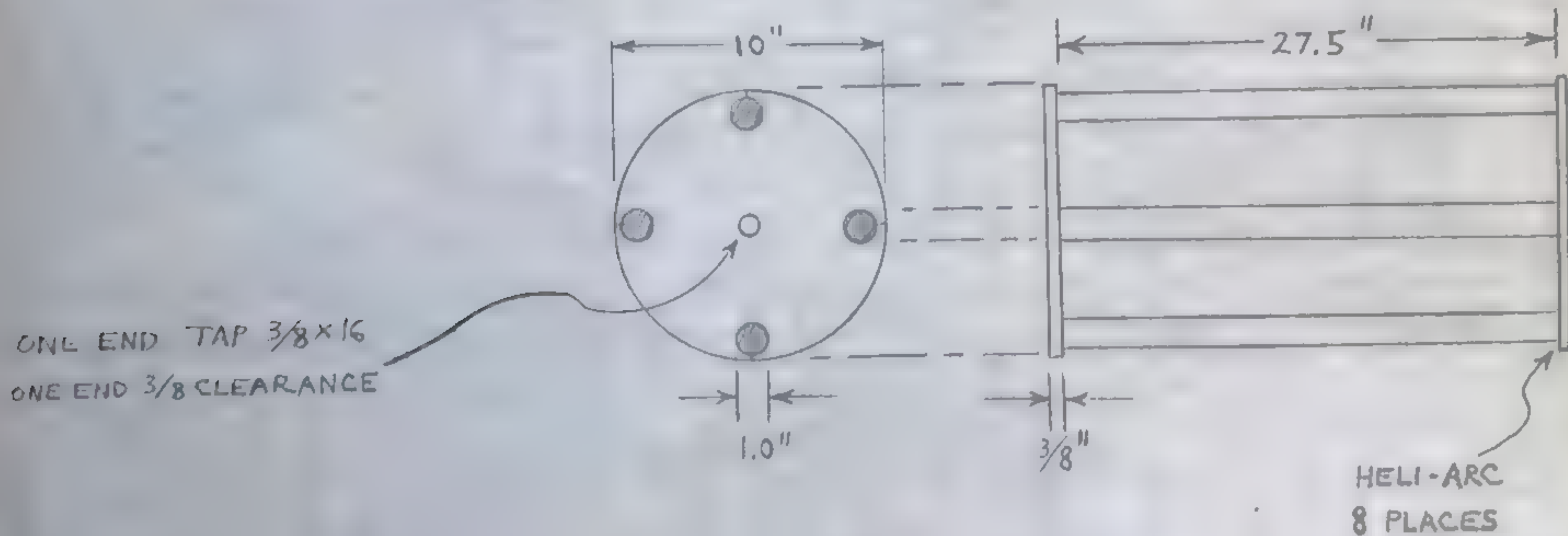


May 29, 1975



TOP CENTER
HOLE IN
SPACER ASS'Y
DRILLED & TAPPED
FOR $\frac{3}{8}$ " X 16

28"

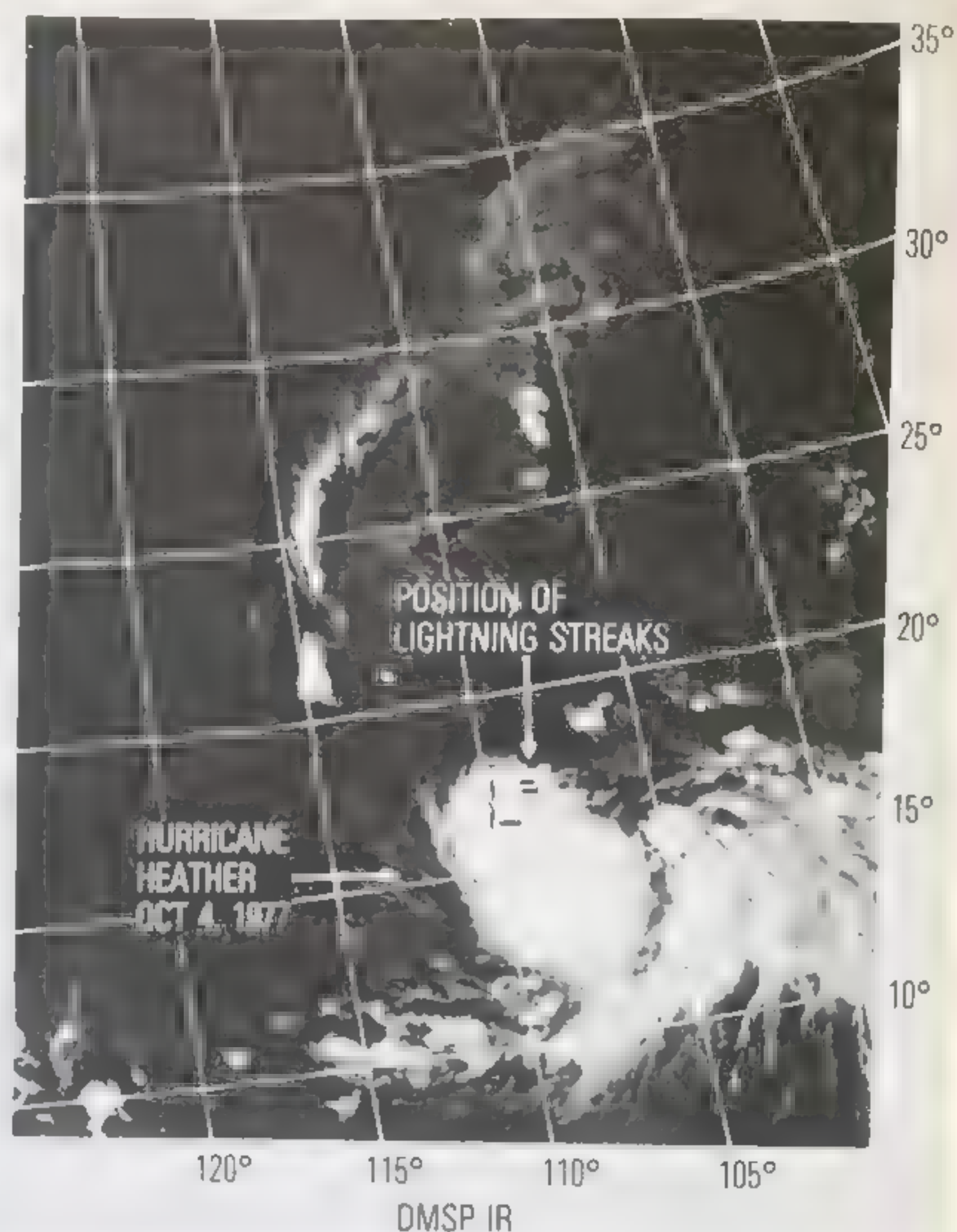
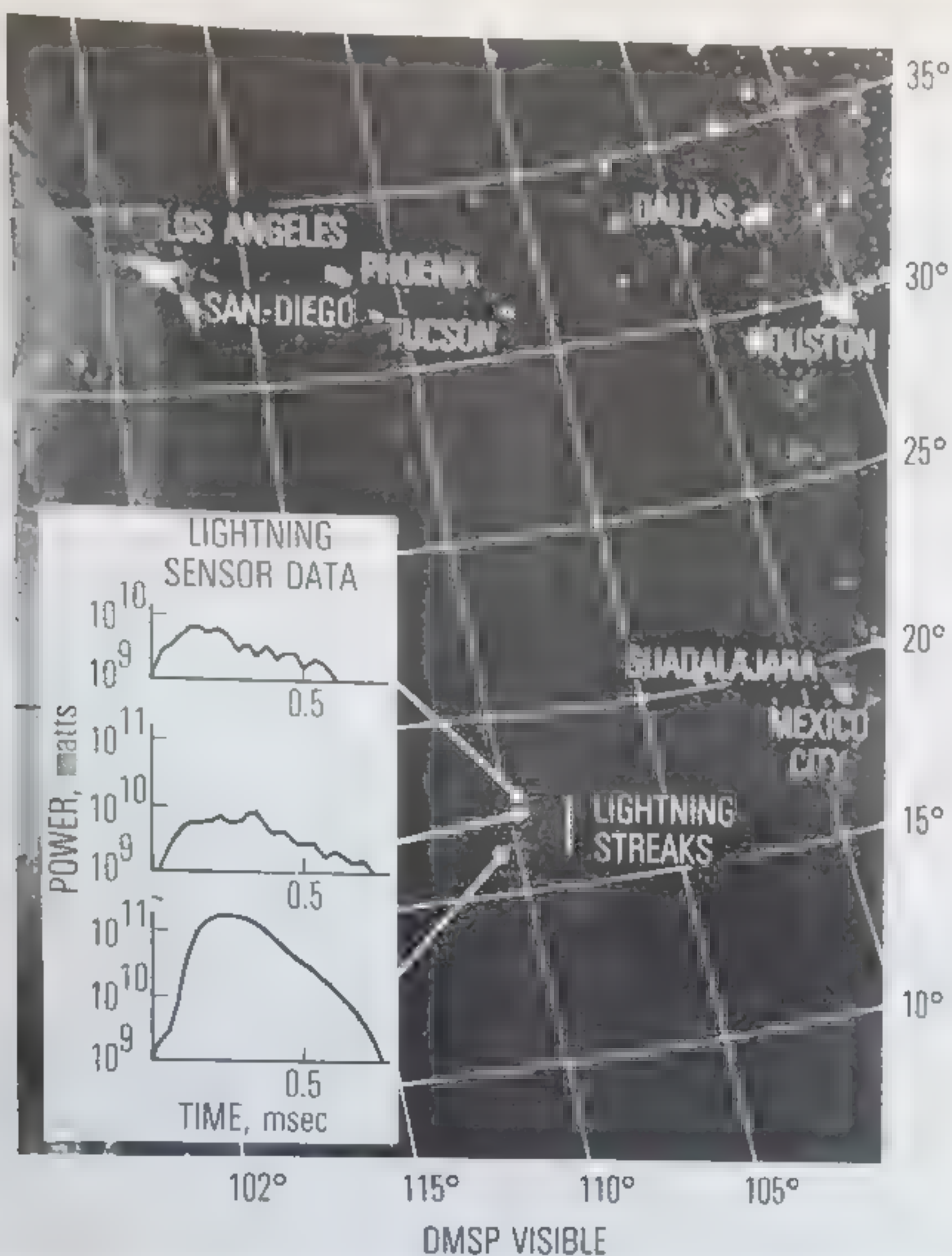


ONE END TAP $\frac{3}{8}$ X 16
ONE END $\frac{3}{8}$ CLEARANCE

HELI-ARC
8 PLACES

UNIVERSAL TOROID SPACER

FOR USE WITH HIPOTRONICS
TO - 20, TO - 30, TO - 48



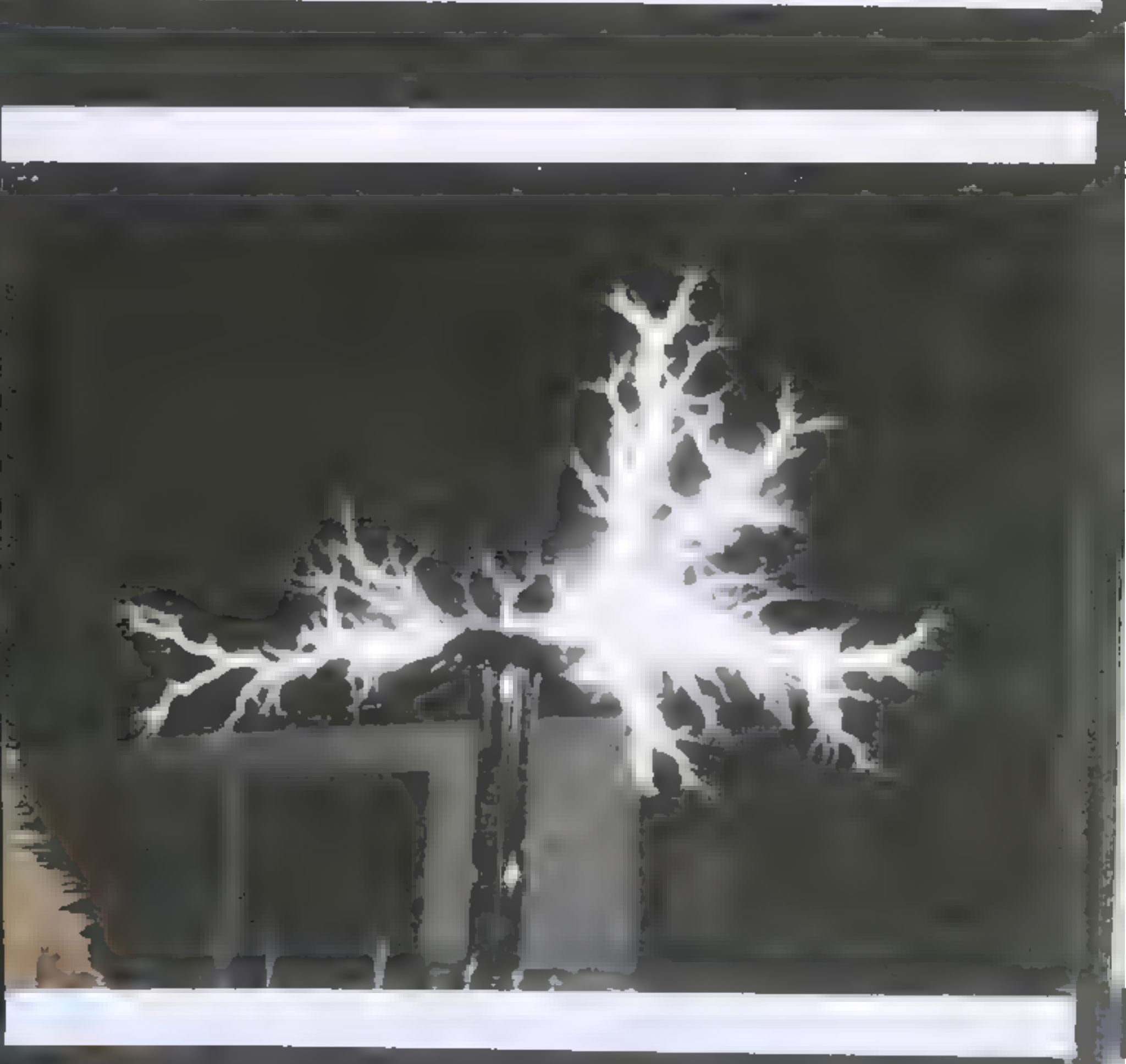
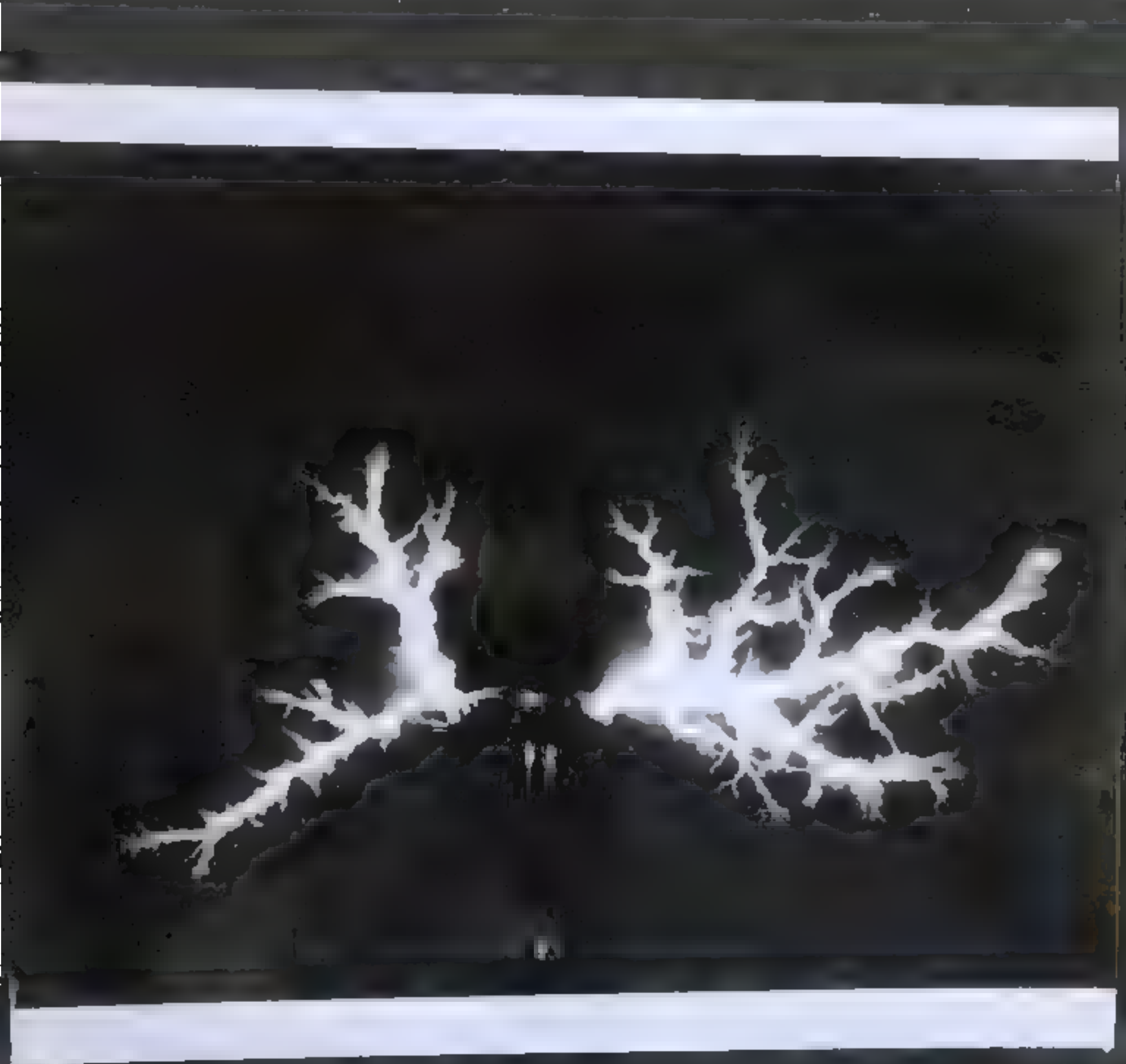
THESE PHOTOGRAPHS were part of a presentation given by Dr. Bruce Edgar of the Space Sciences Laboratory at the 12th Technical Conference on Hurricanes and Tropical Meteorology, April 24-27 in New Orleans. The photos were taken by a DMSP satellite as it observed lightning activity associated with tropical storm Heather off the West Coast of Baja California. The

lightning flashes were located by noting the position of light streaks appearing on the DMSP satellite visible cloud photo (left). The strongest activity was located just north of the hurricane's center, as pictured by the infrared cloud photo (right). Plots in the inset show the optical power-time profiles of lightning as measured by the DMSP lightning detector.

THE AEROSPACE CORPORATION
ORBITER

Volume 19, No. 10

May 9, 1979











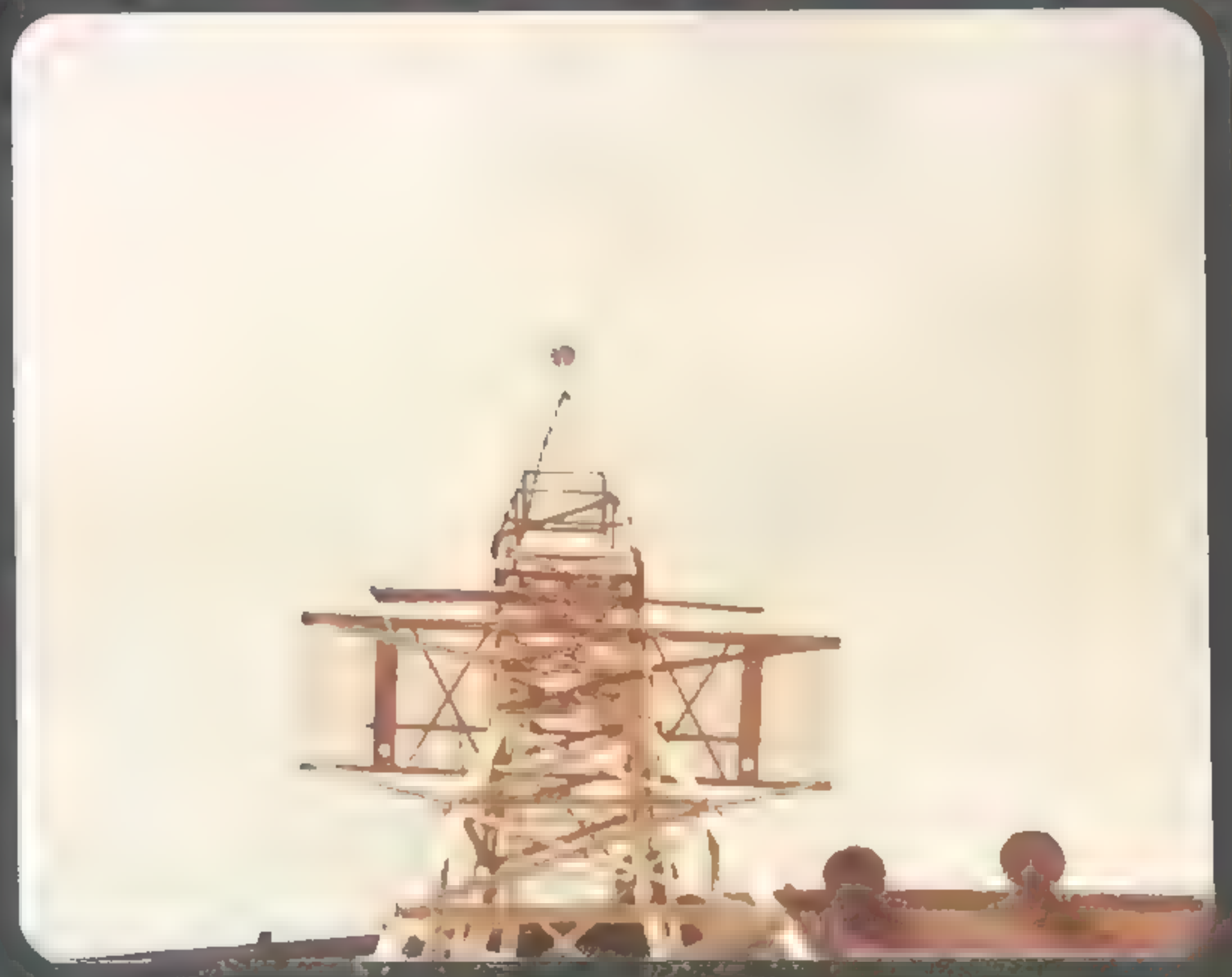


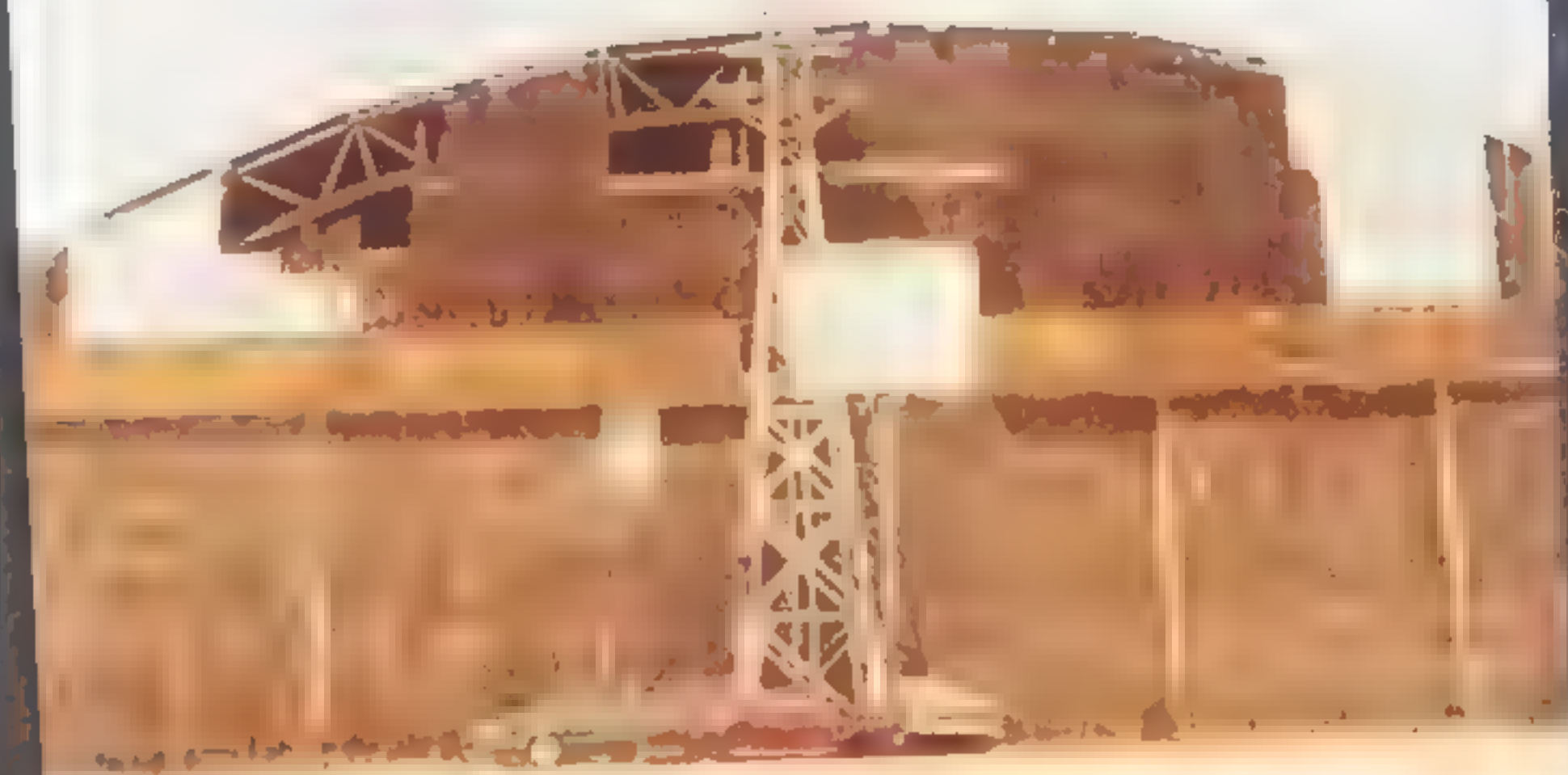








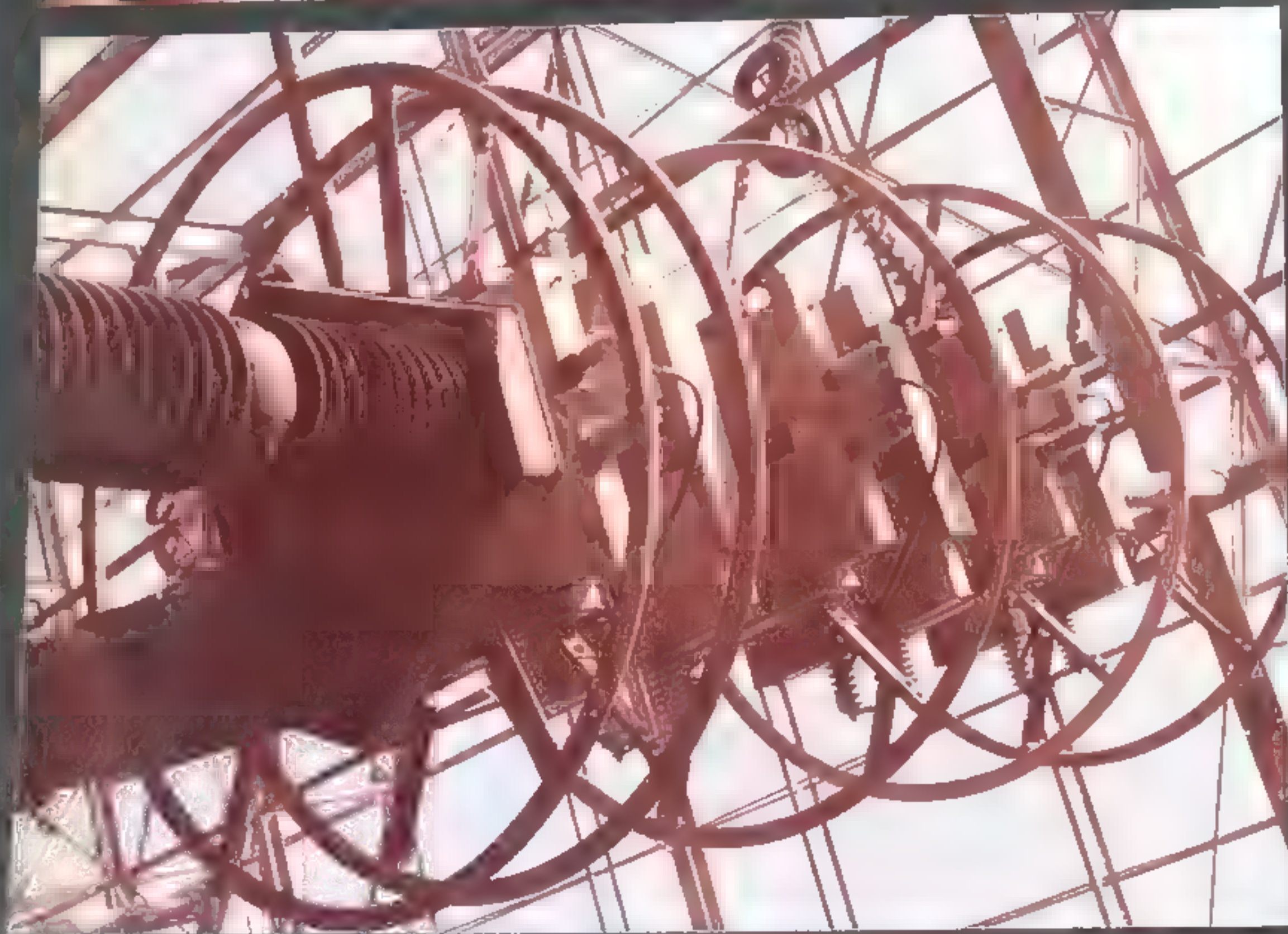
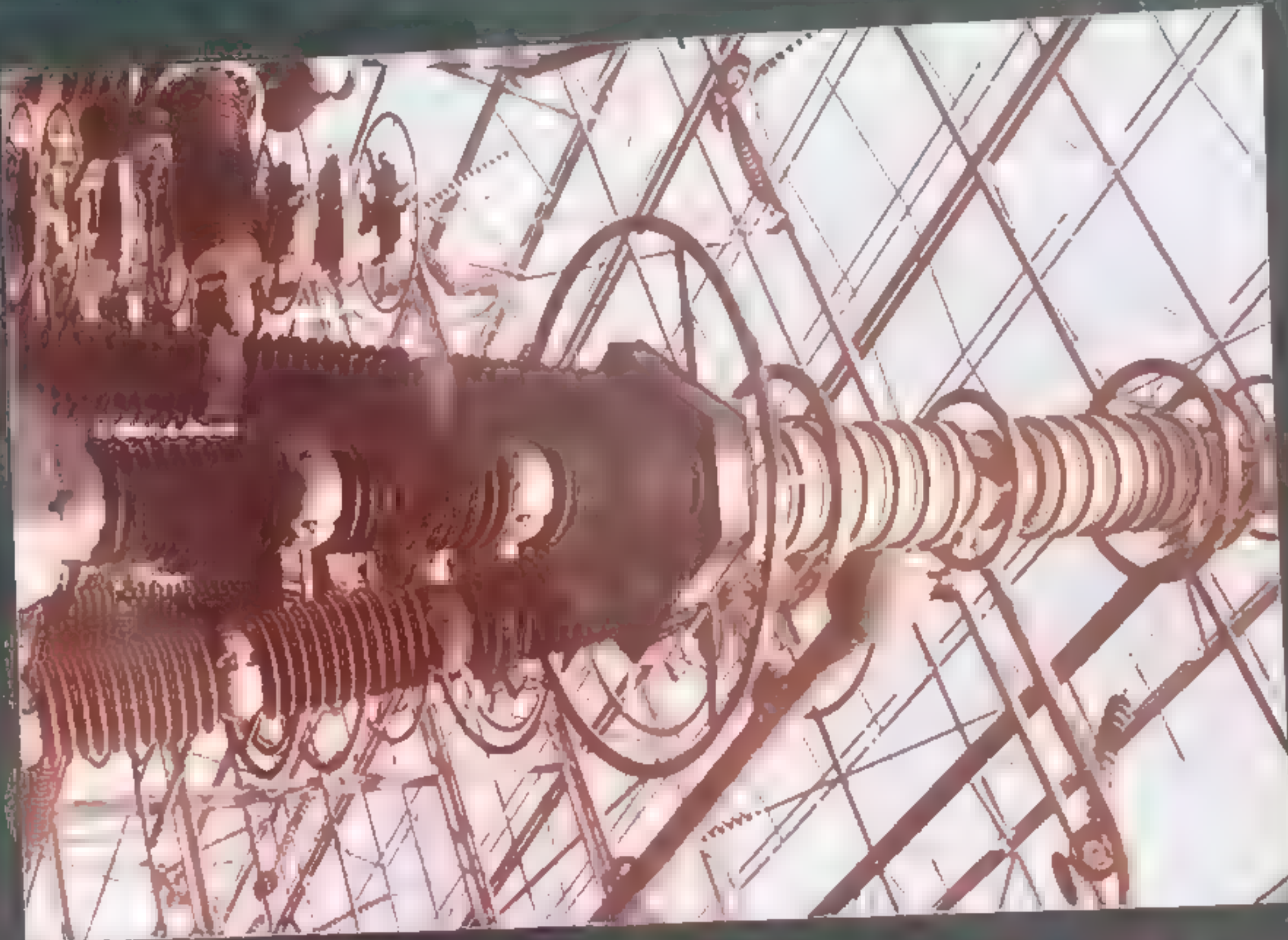
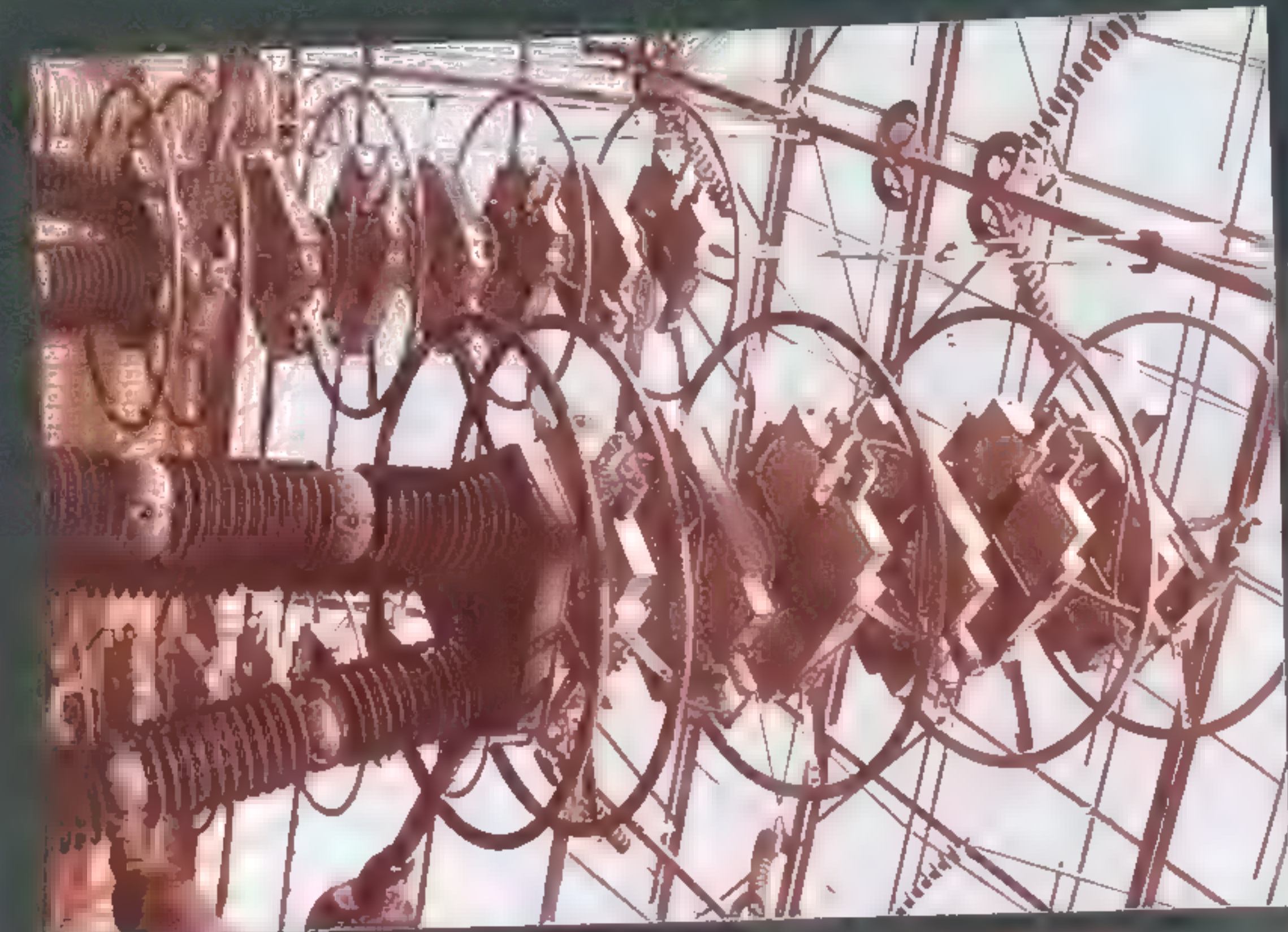


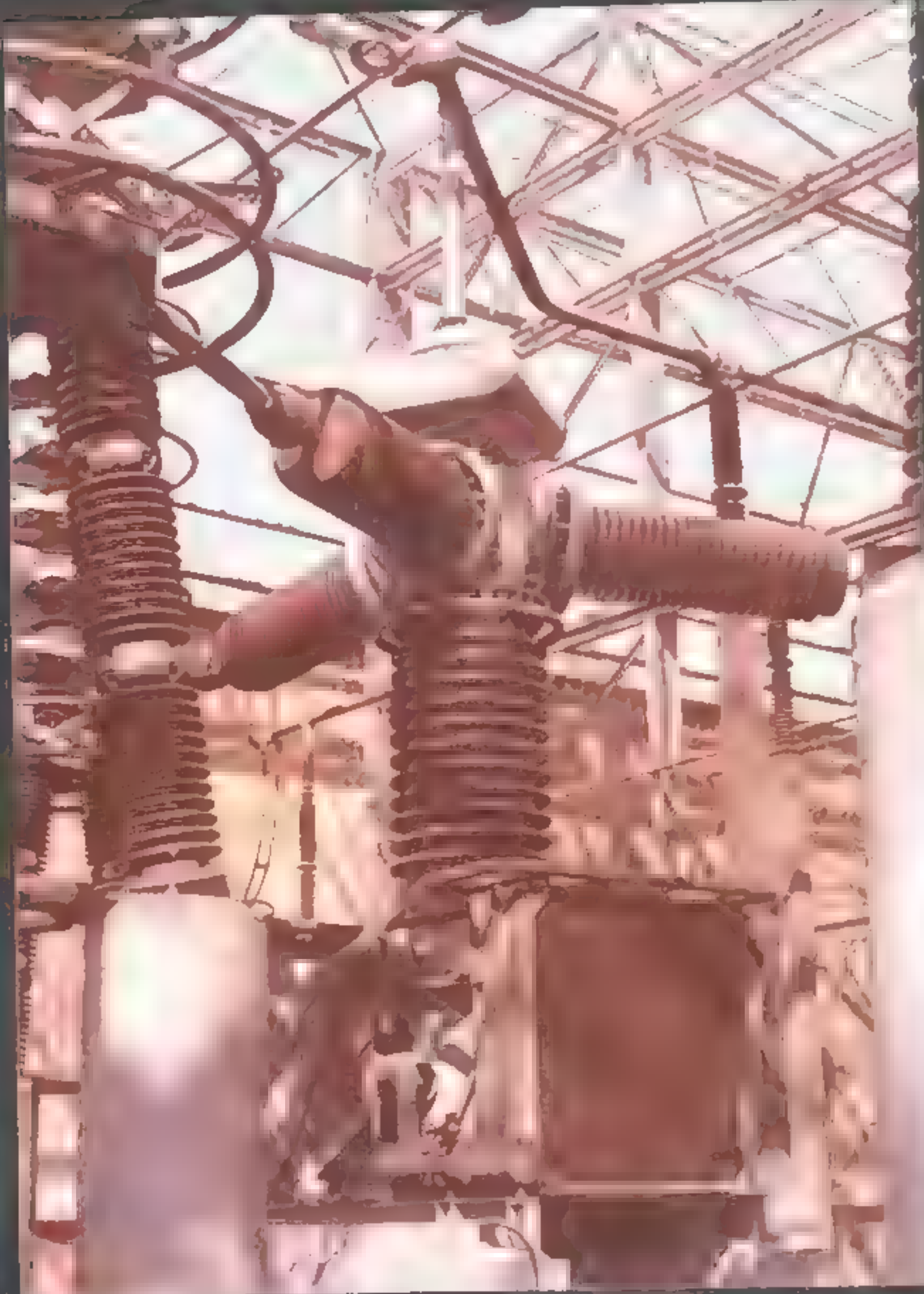


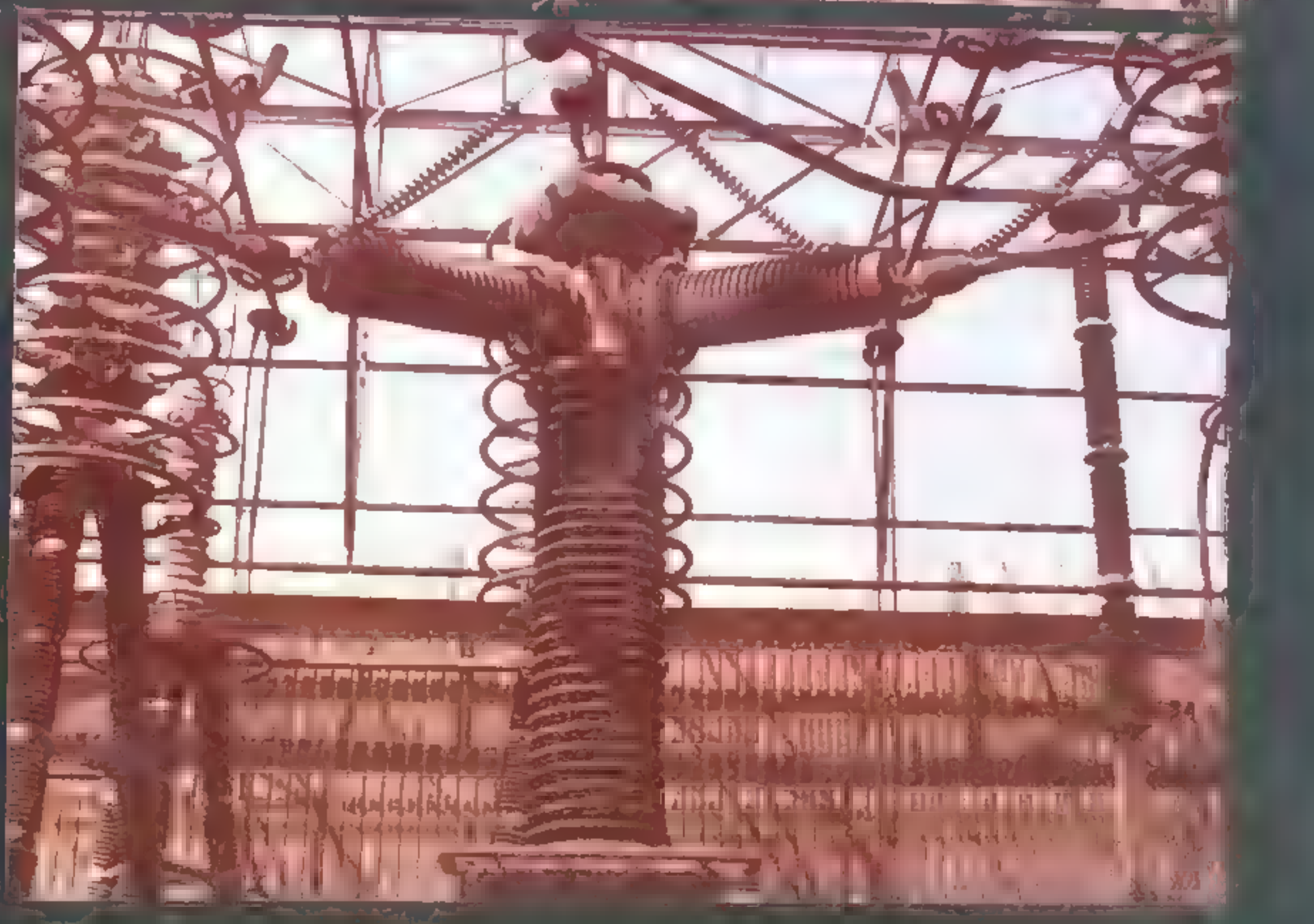
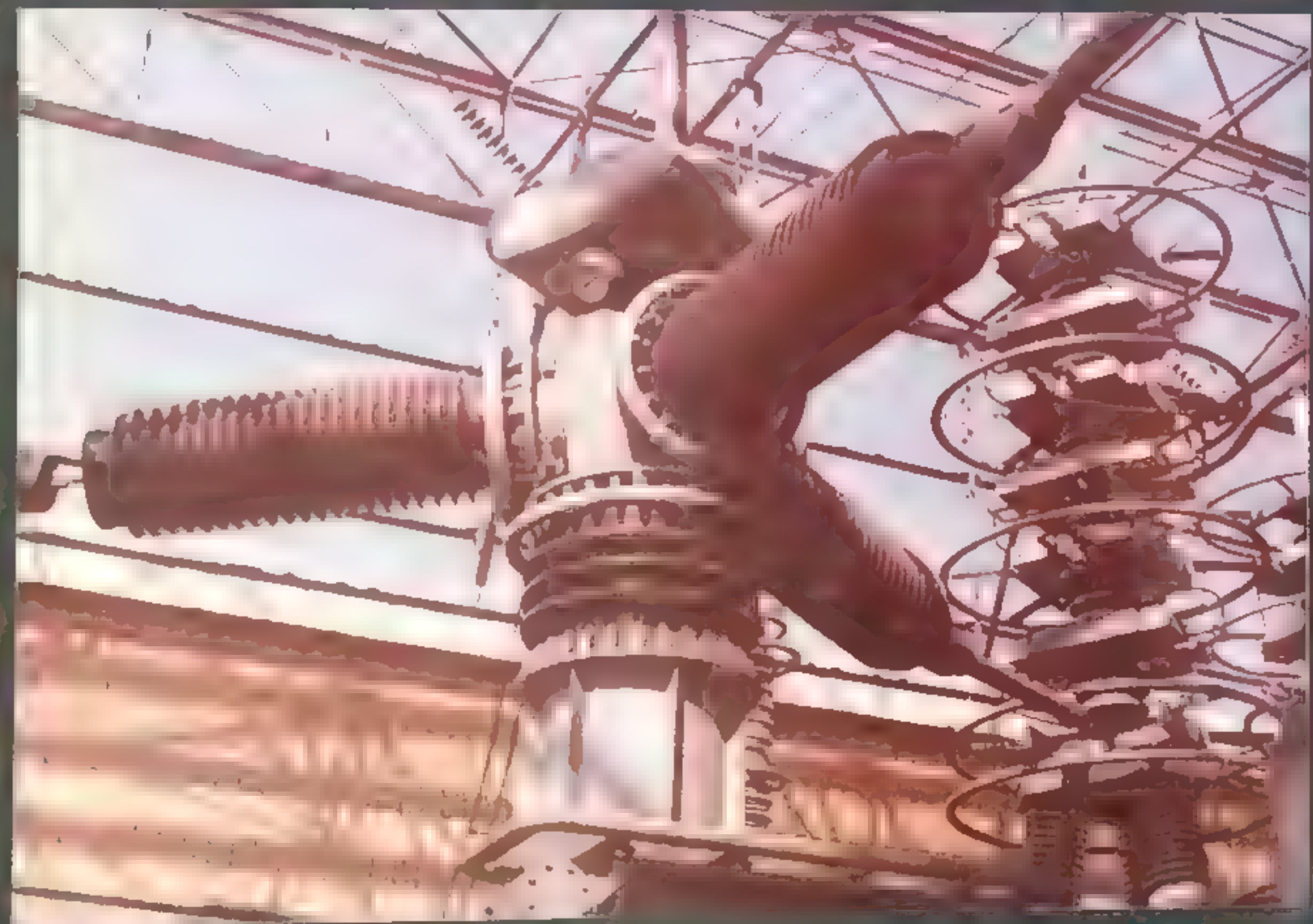
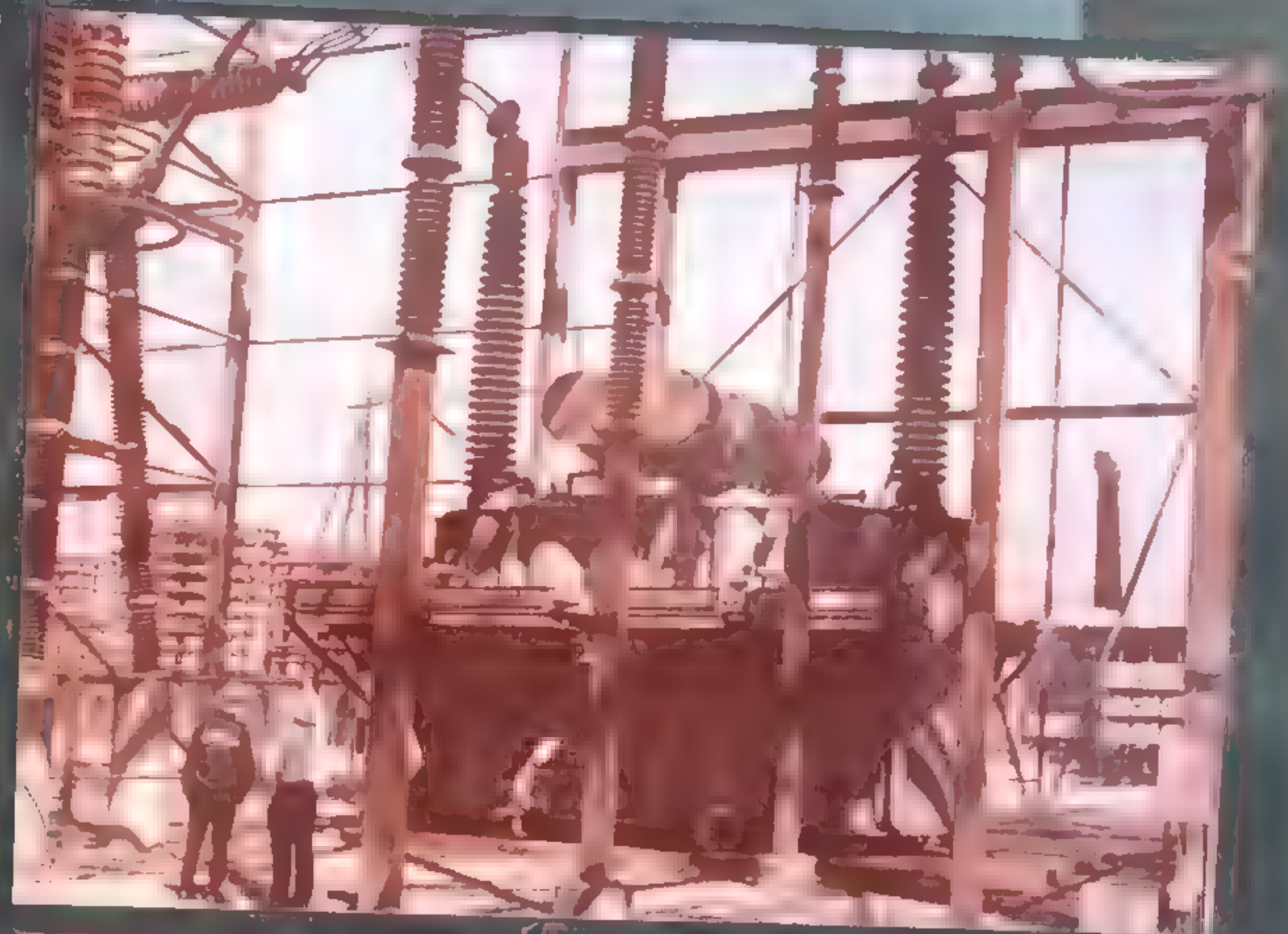
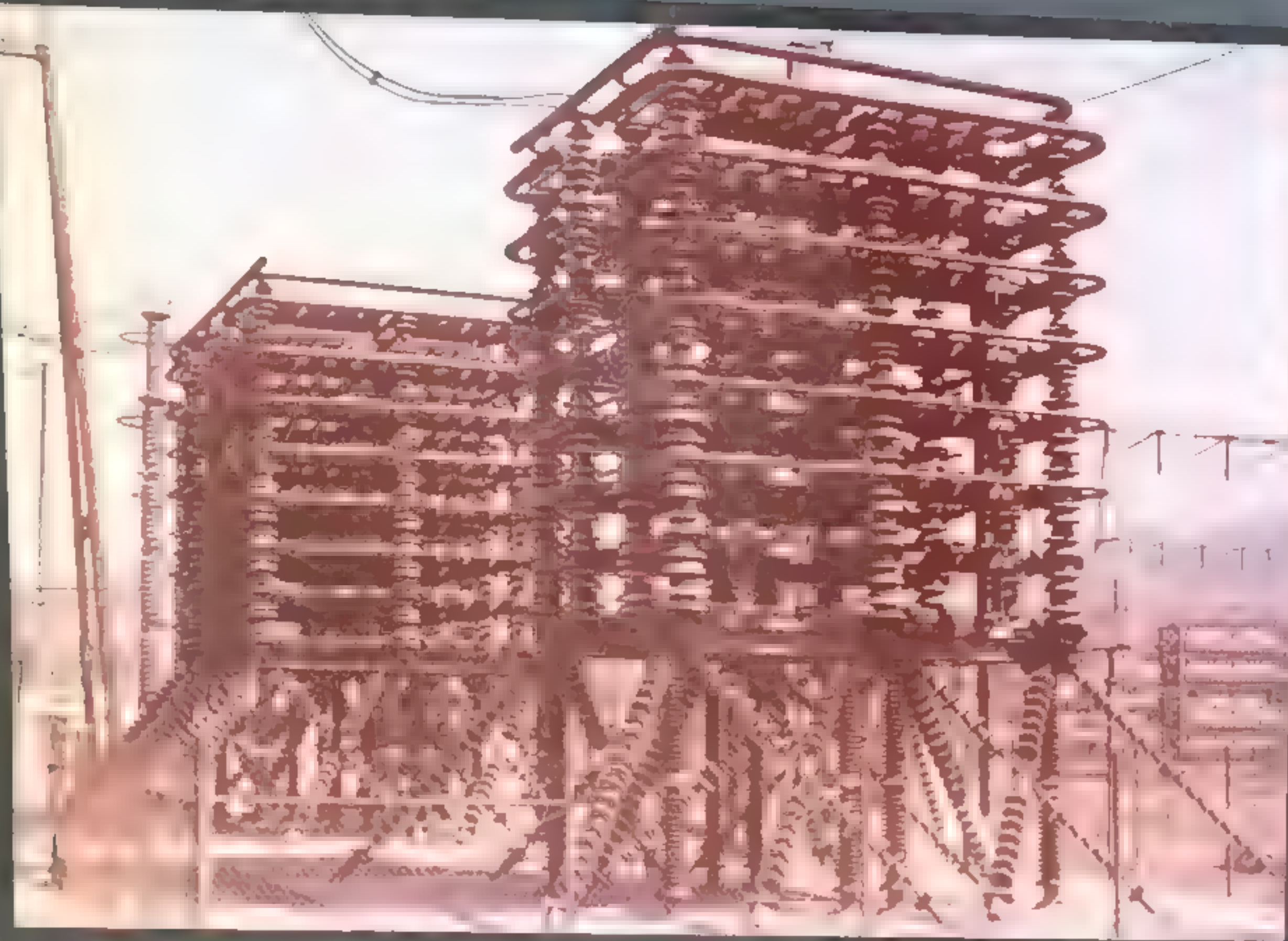


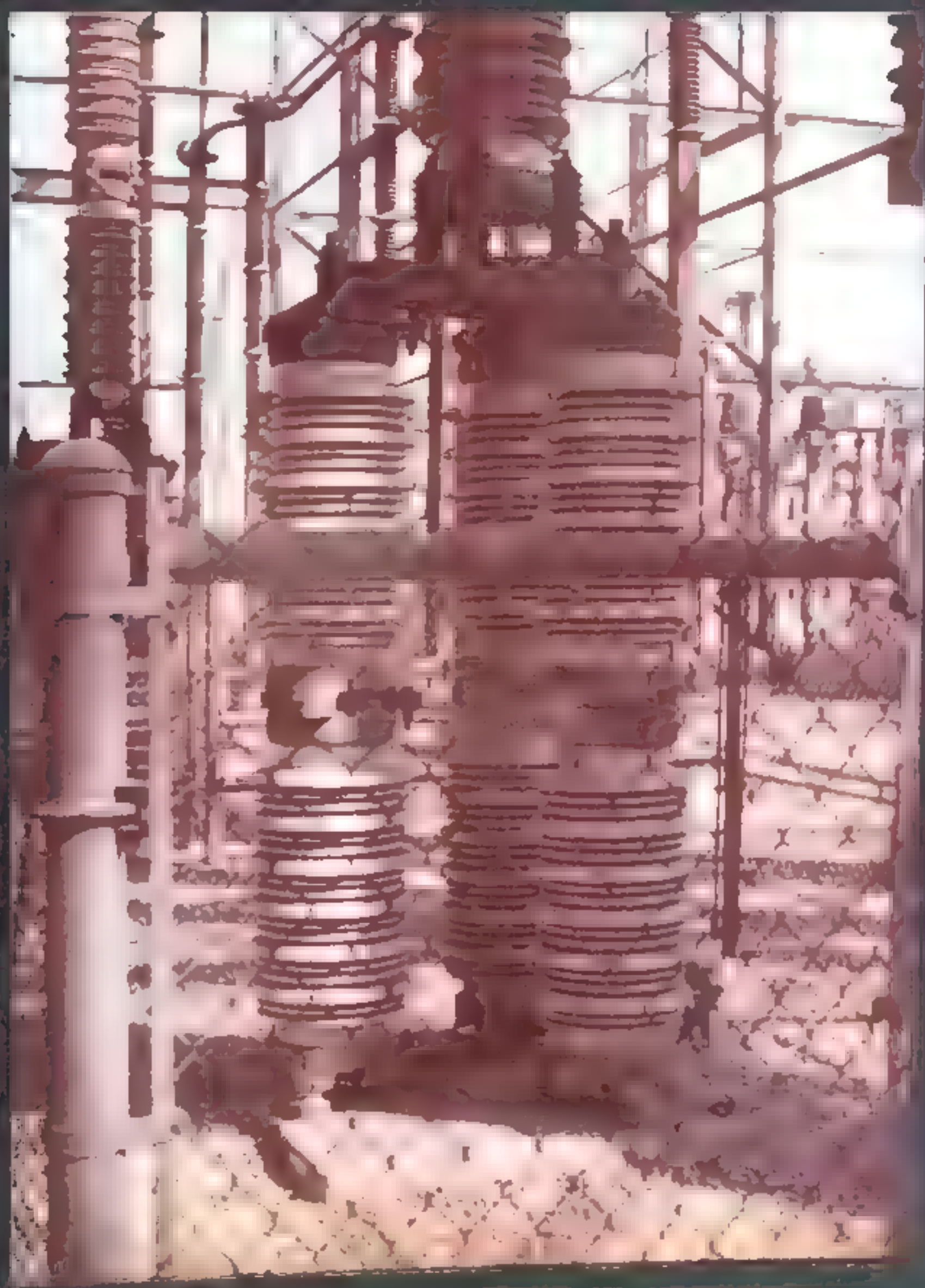
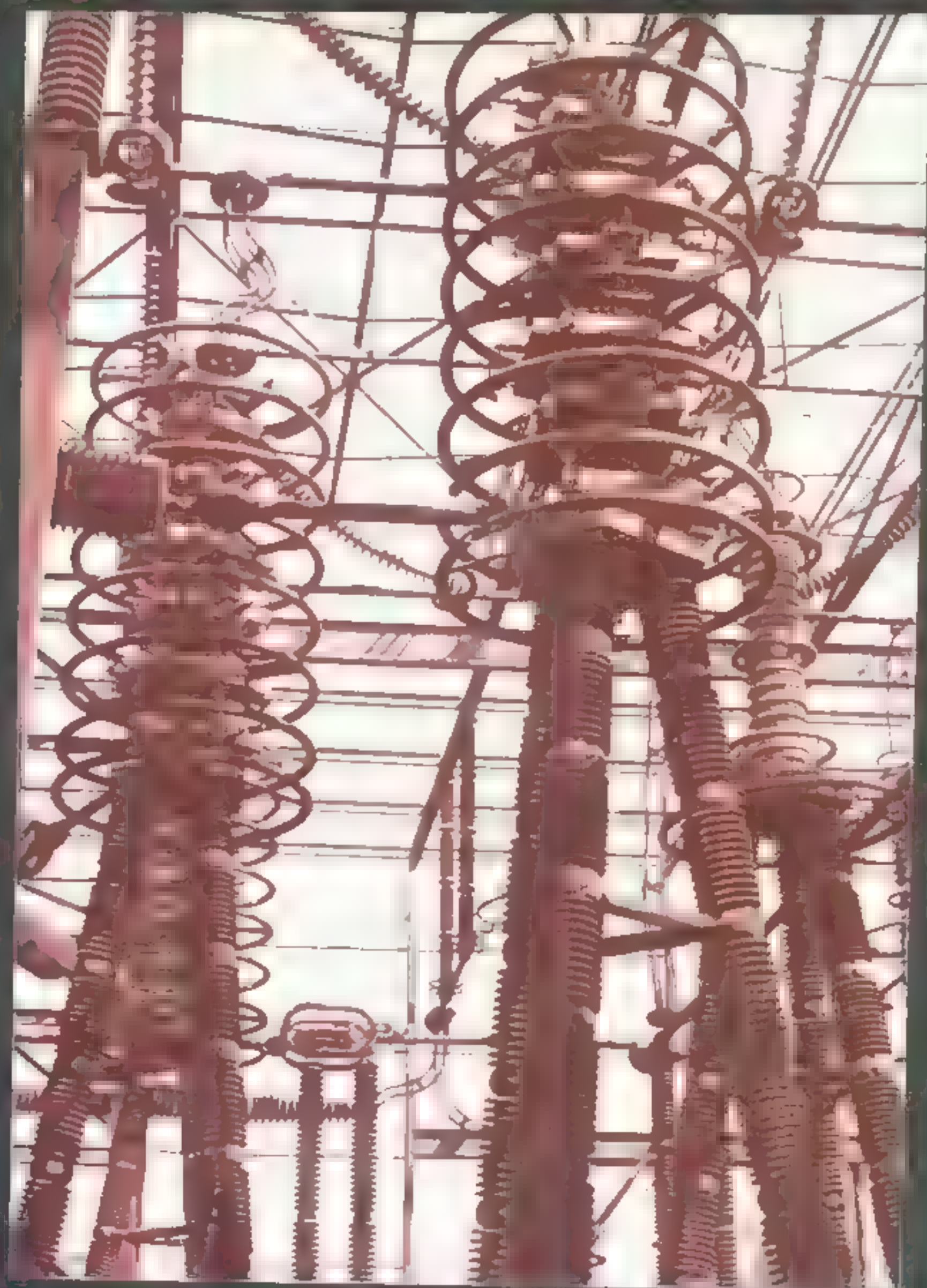


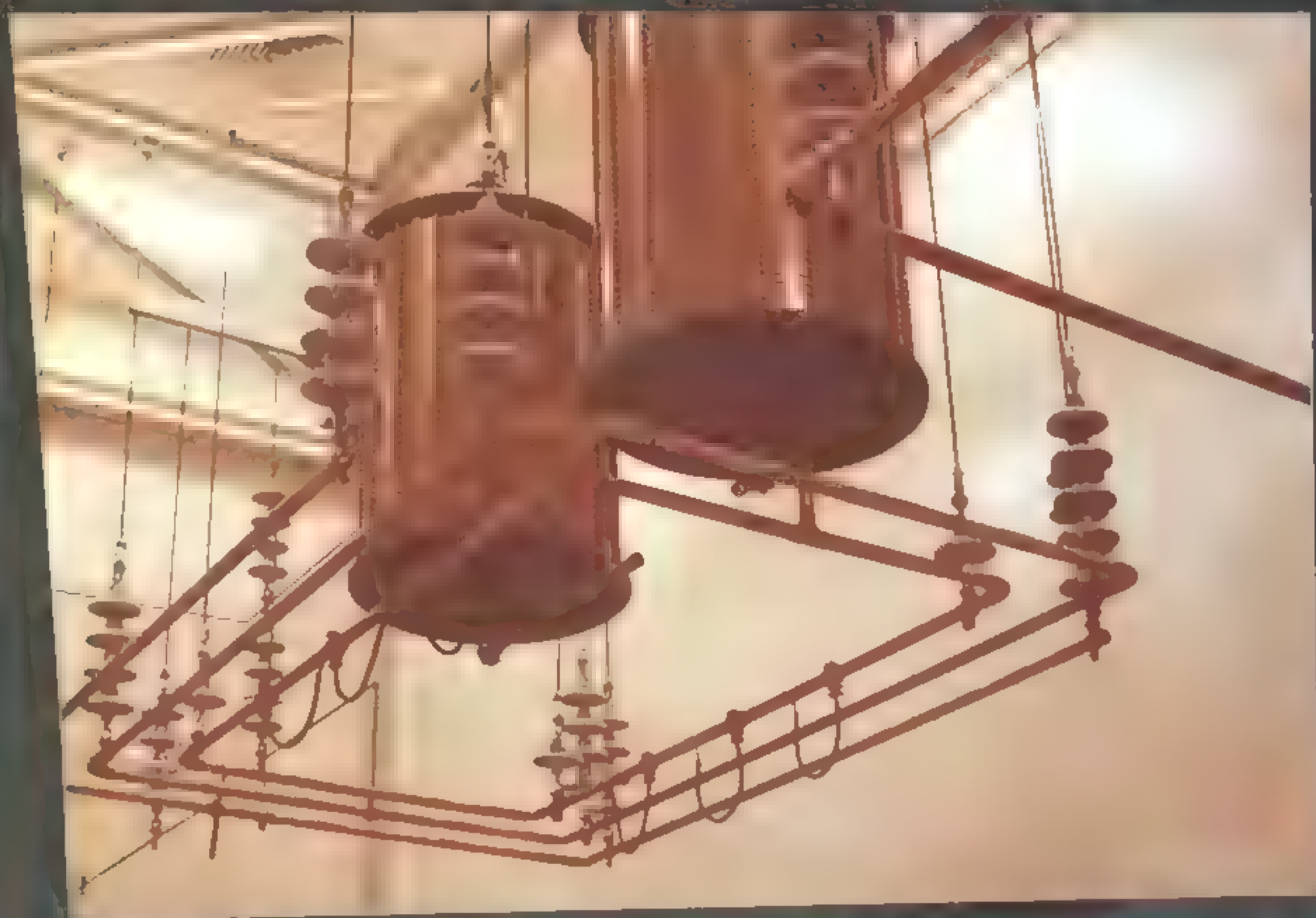


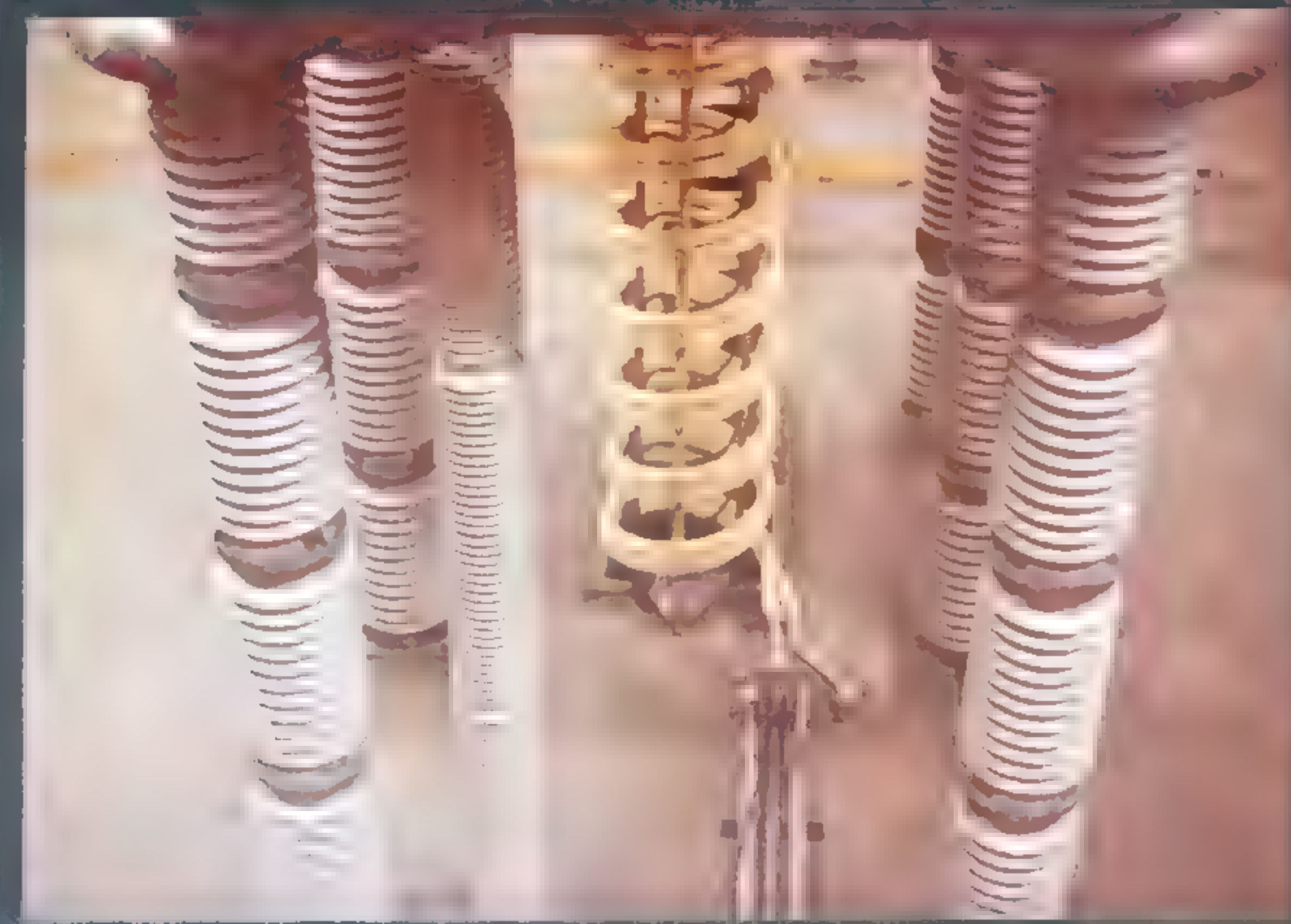


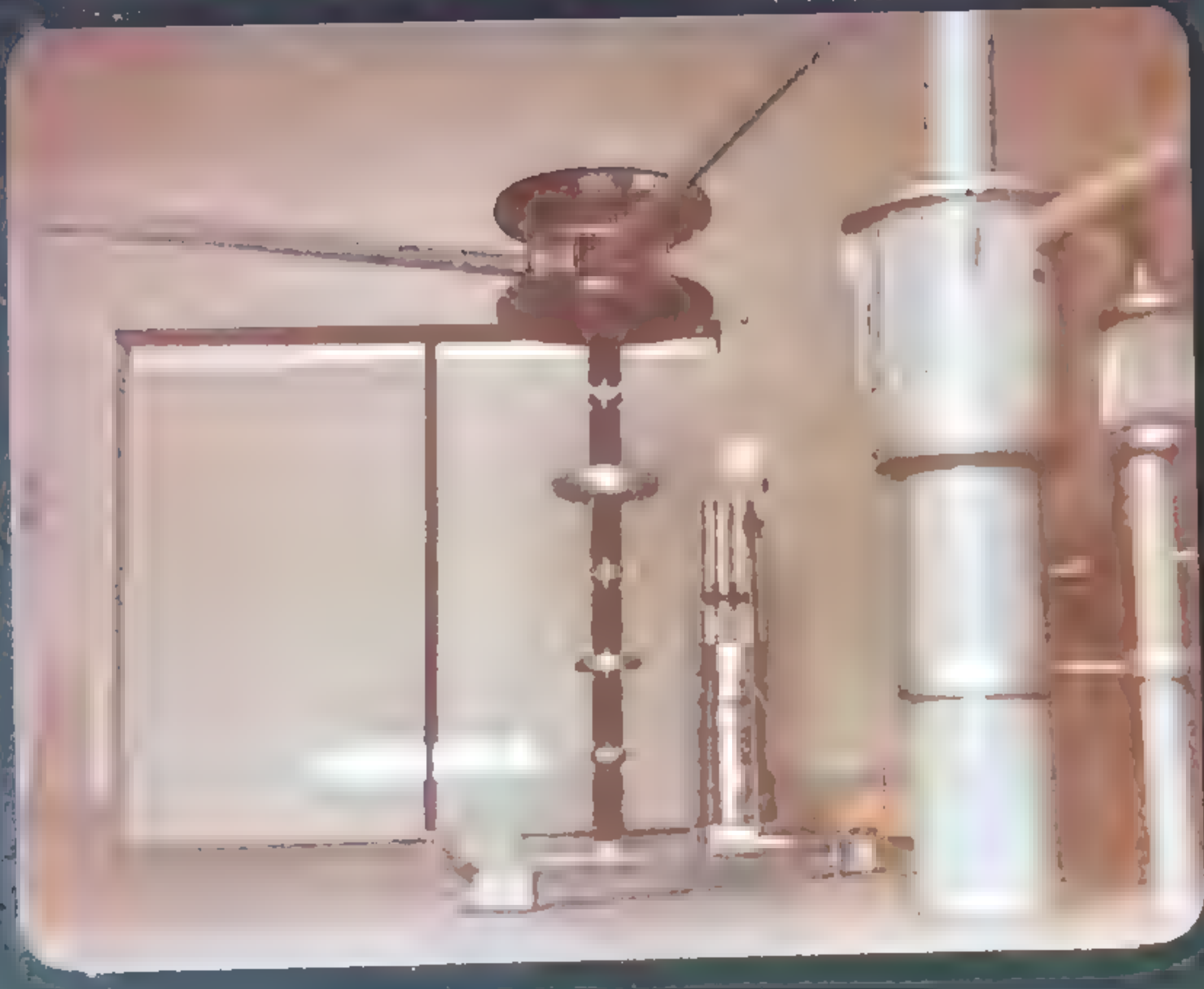


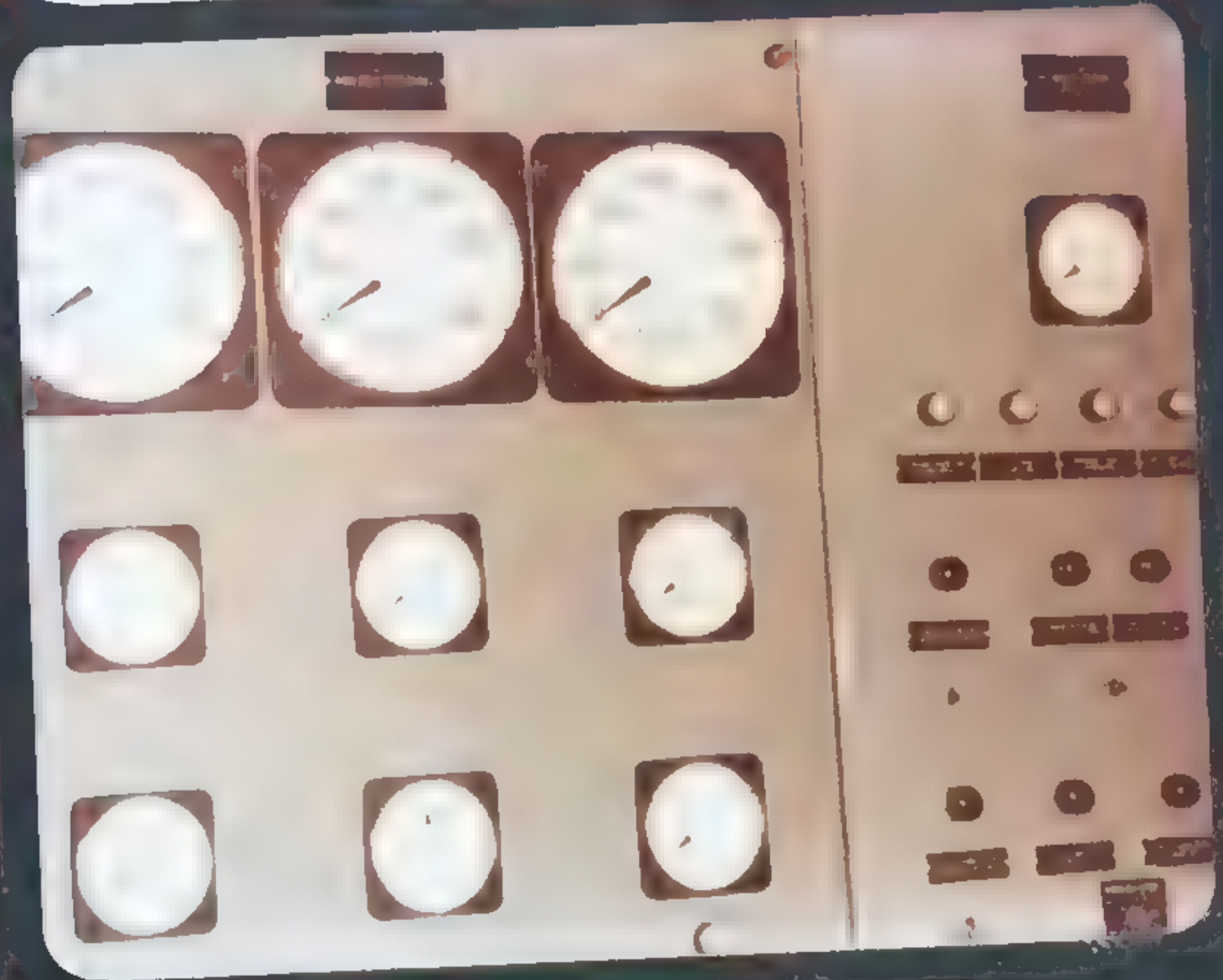
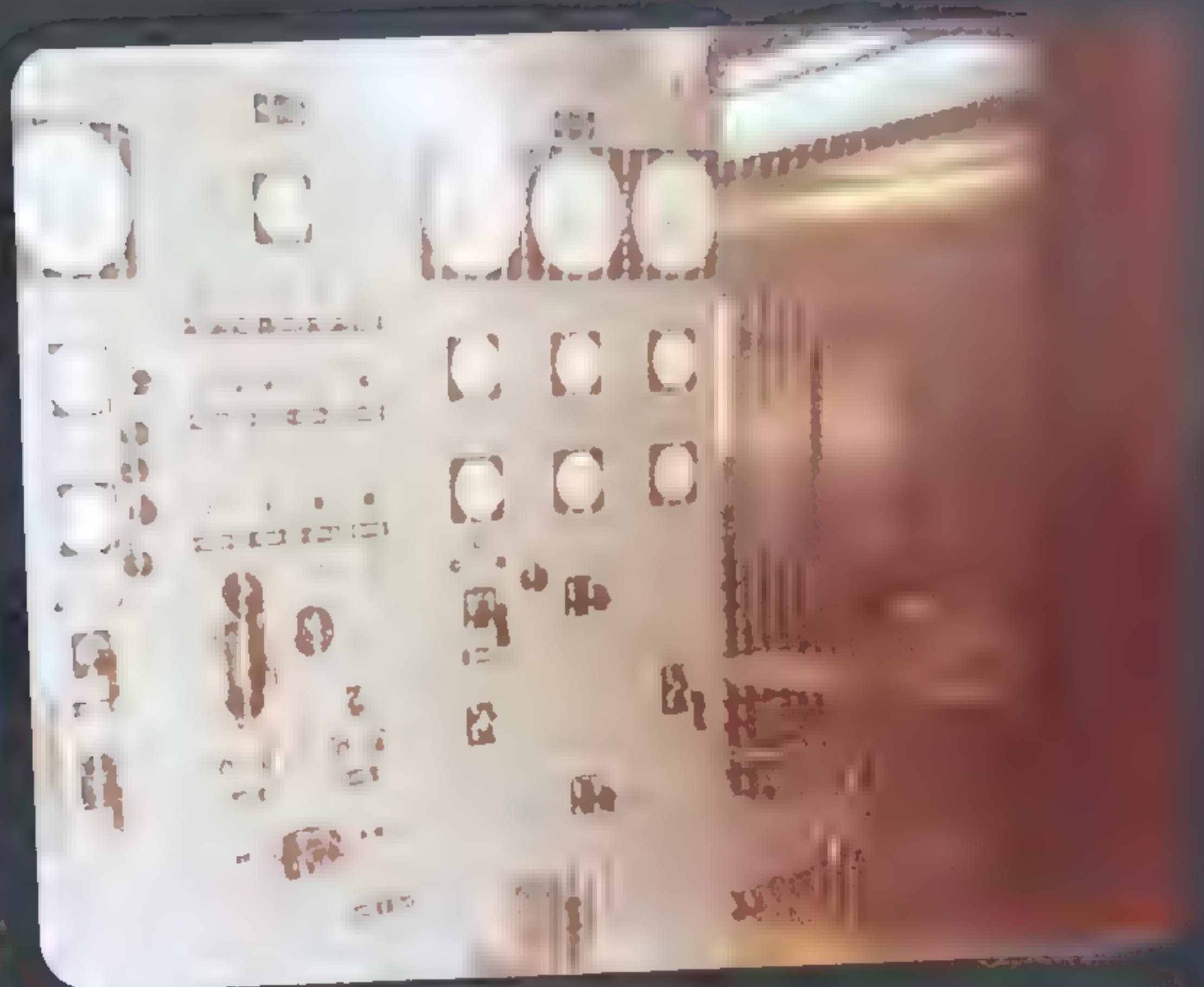
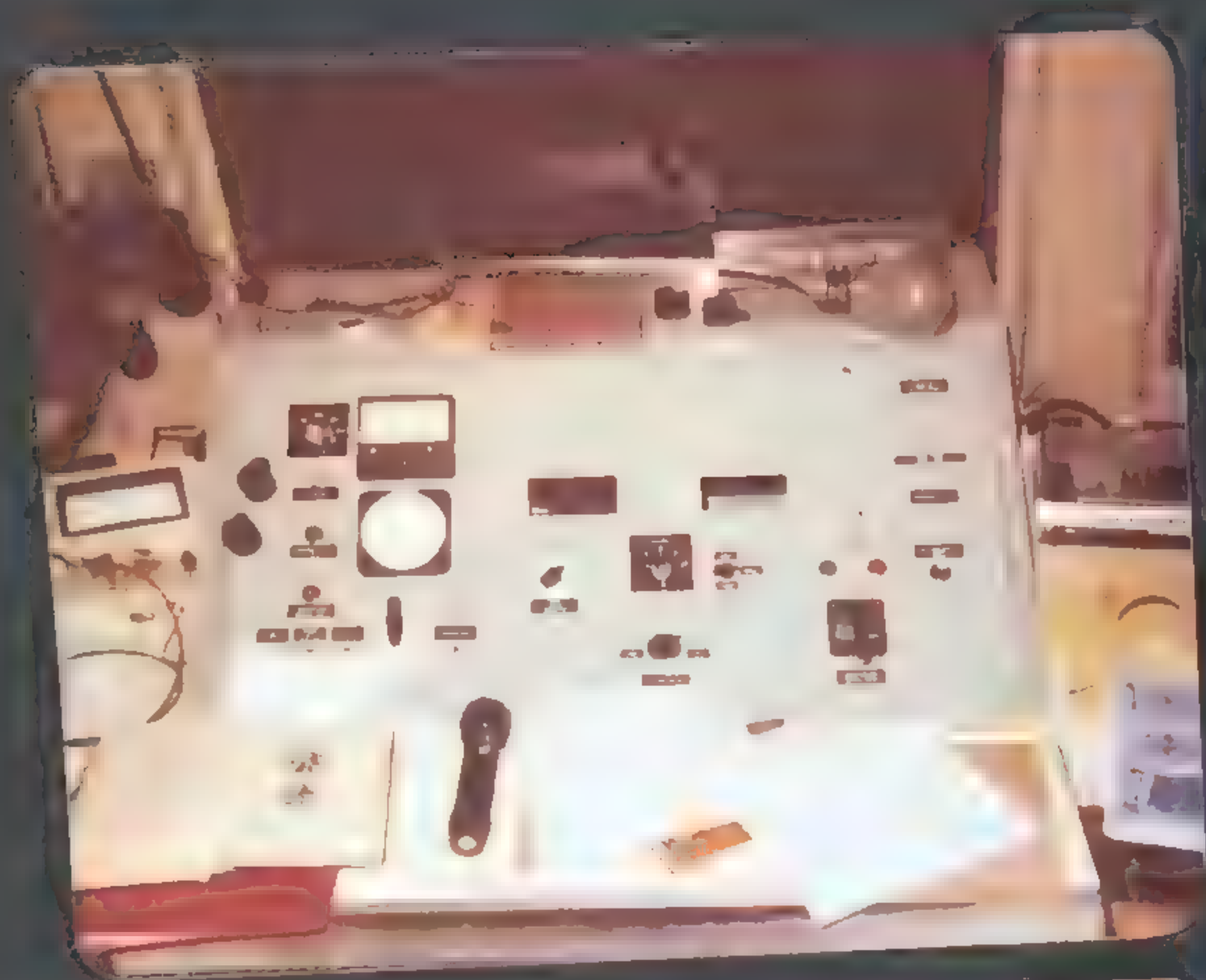




















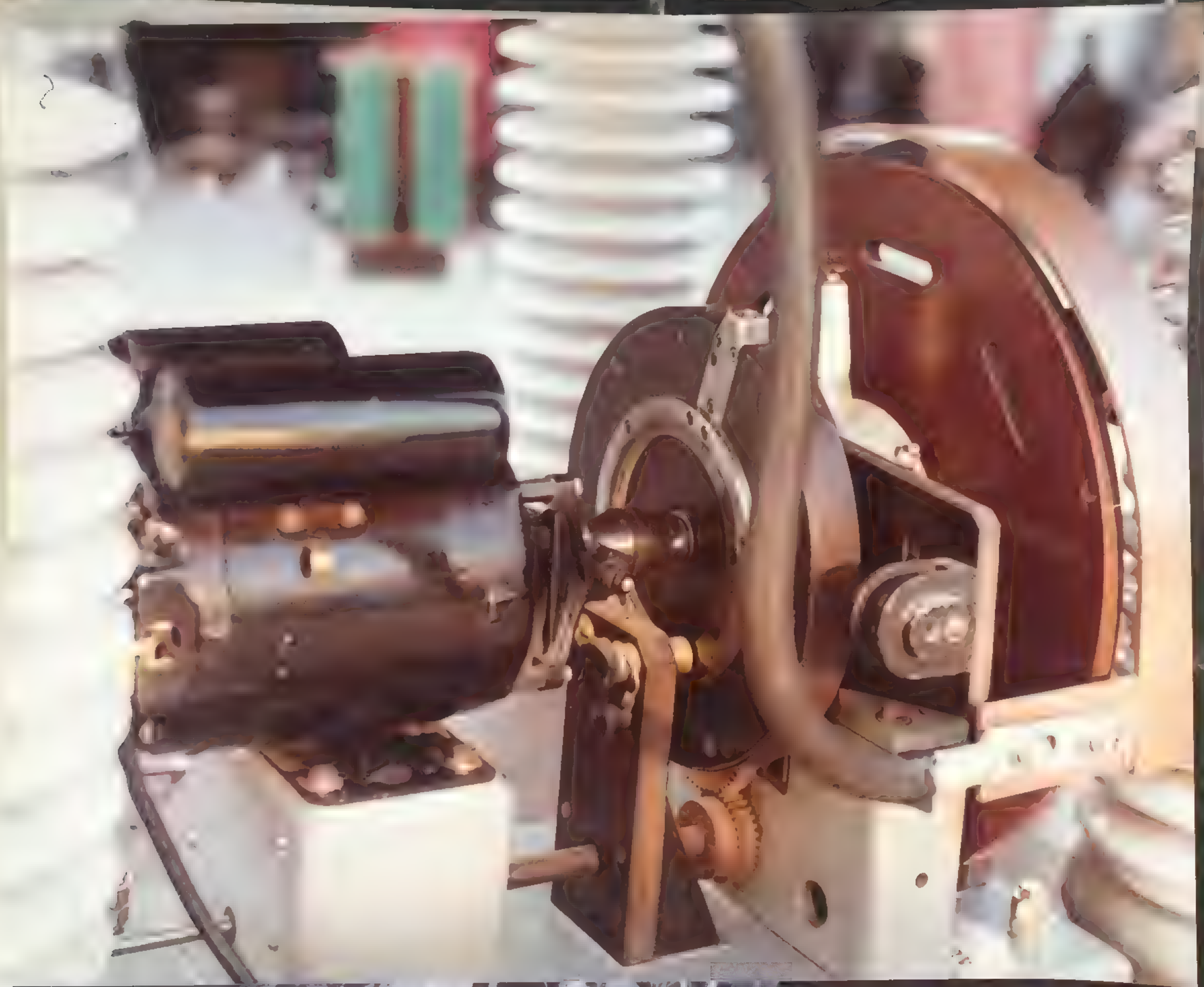




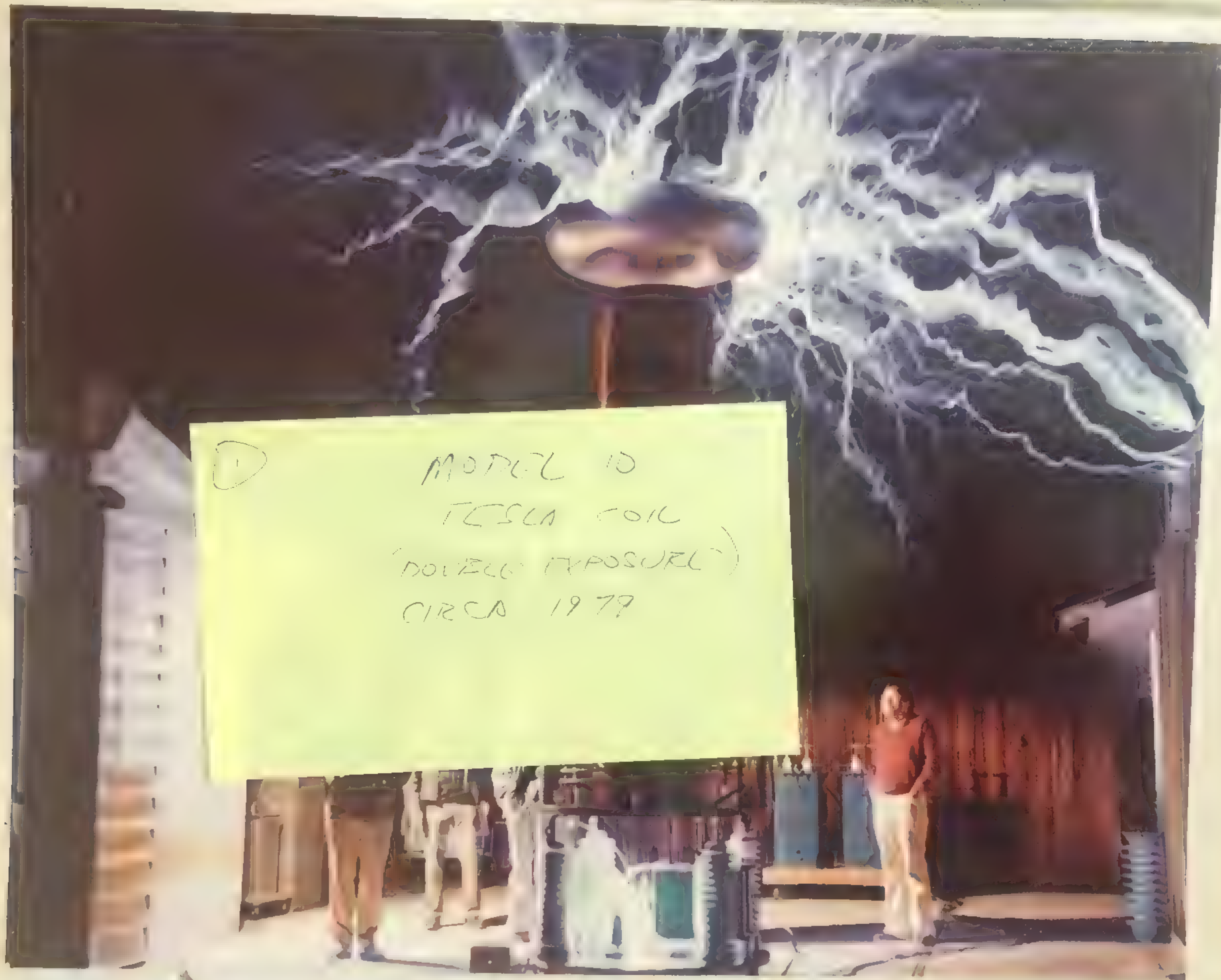
(3)

MODEL 10 TESLA COIL
WITH 4 FOOT DIAMETER
TOROID; CAPACITORS AND
ROTARY GAP AT BASE;
POWER SUPPLY TRANSFORMERS
AT RIGHT, CIRCA 1981





(4) MODEL 10 TESLA COIL
SALIENT-POLE, 1800 RPM
SYNCHRONOUS ROTARY
SPARK GAP; 40 KVA



①

MODEL 10
TESLA COIL
(DOVELE EXPOSURE)
CIRCA 1979





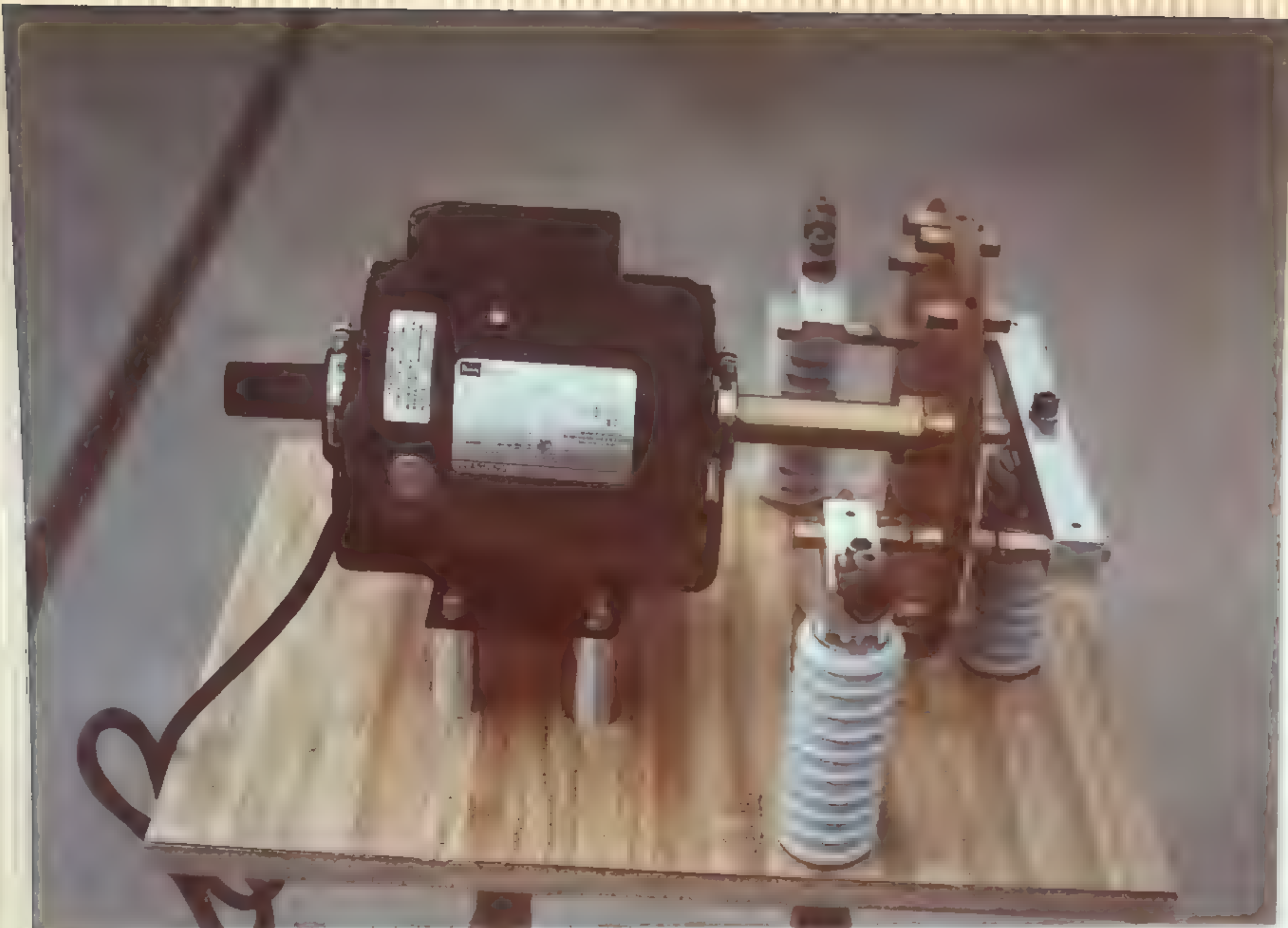
















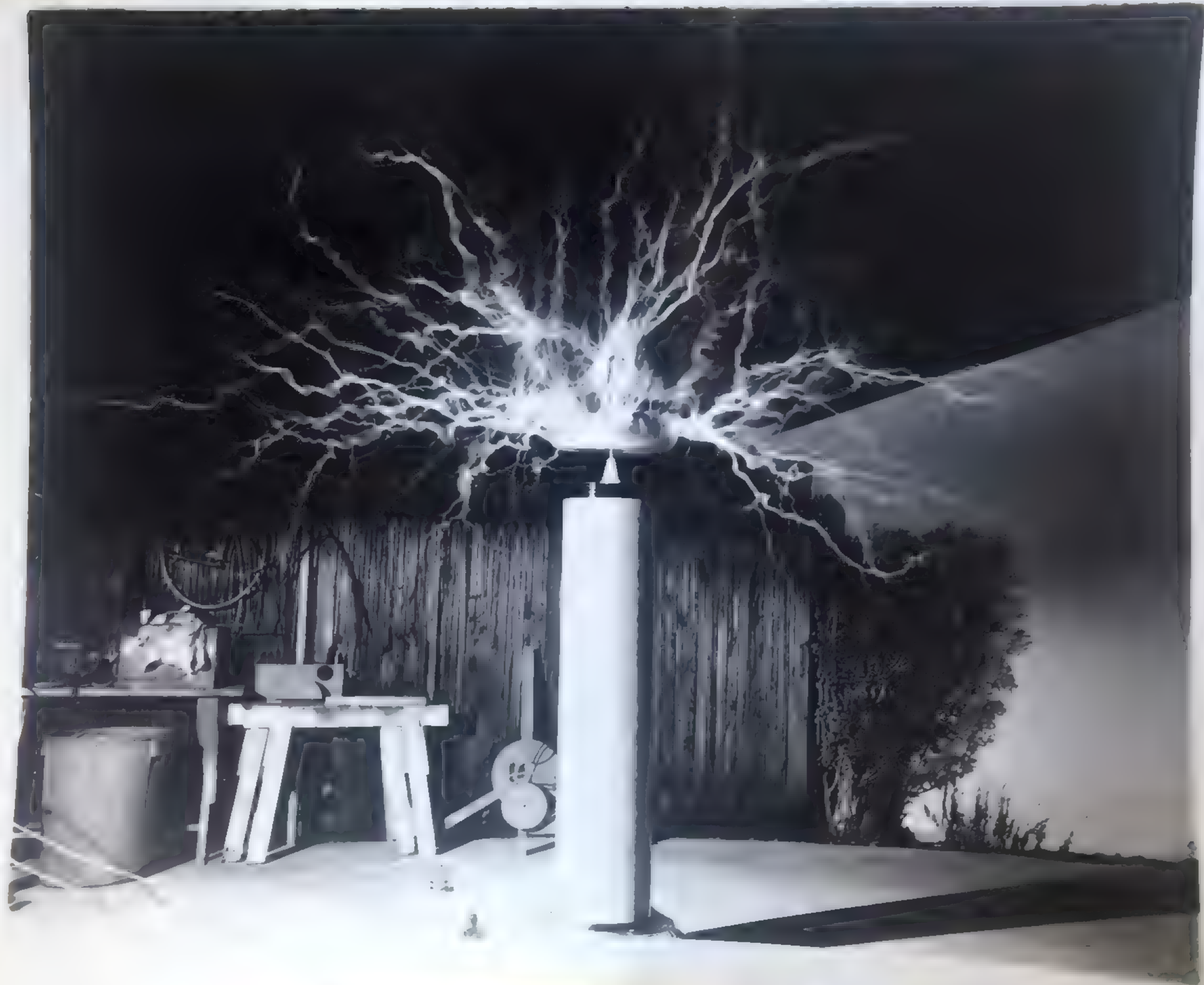






















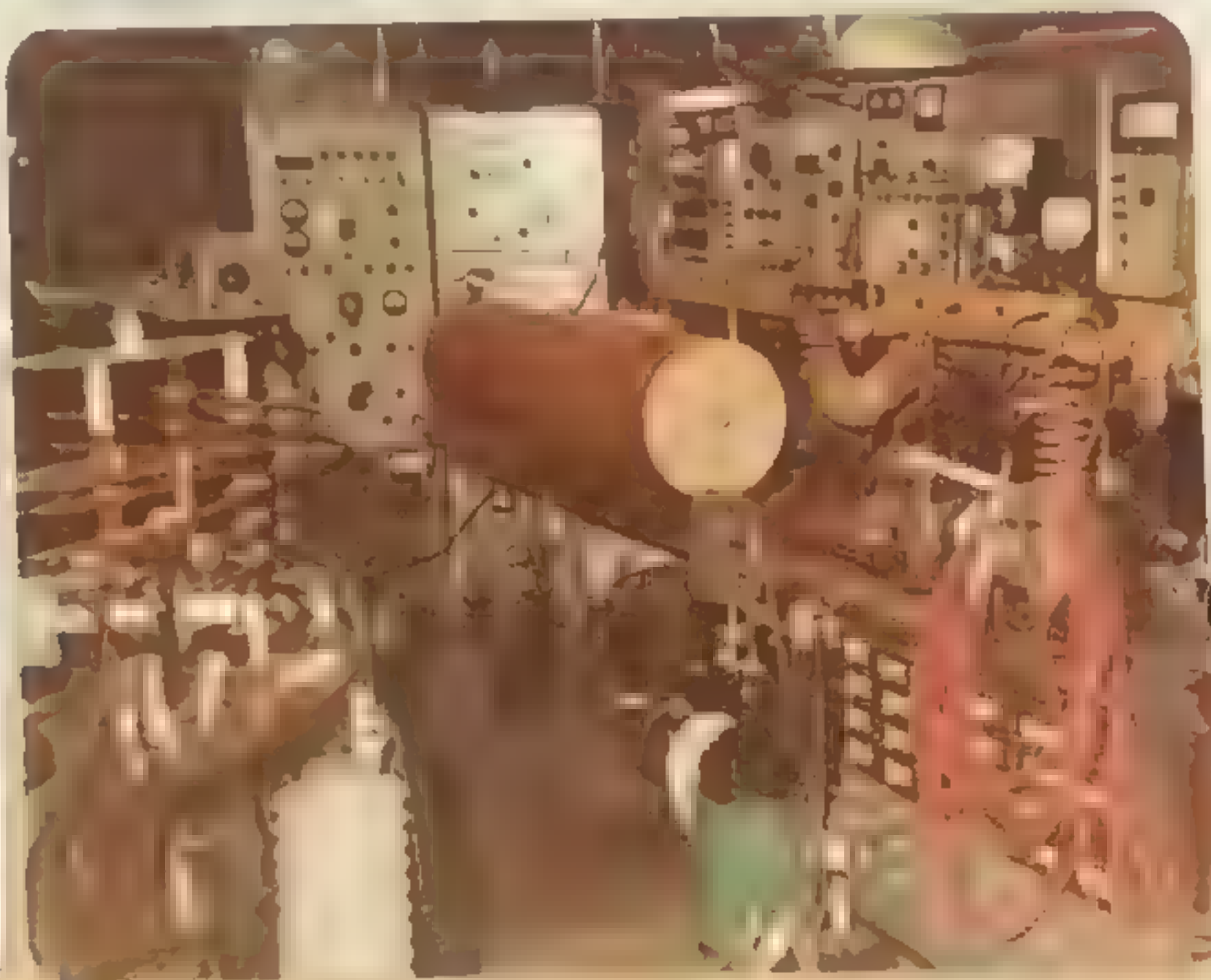
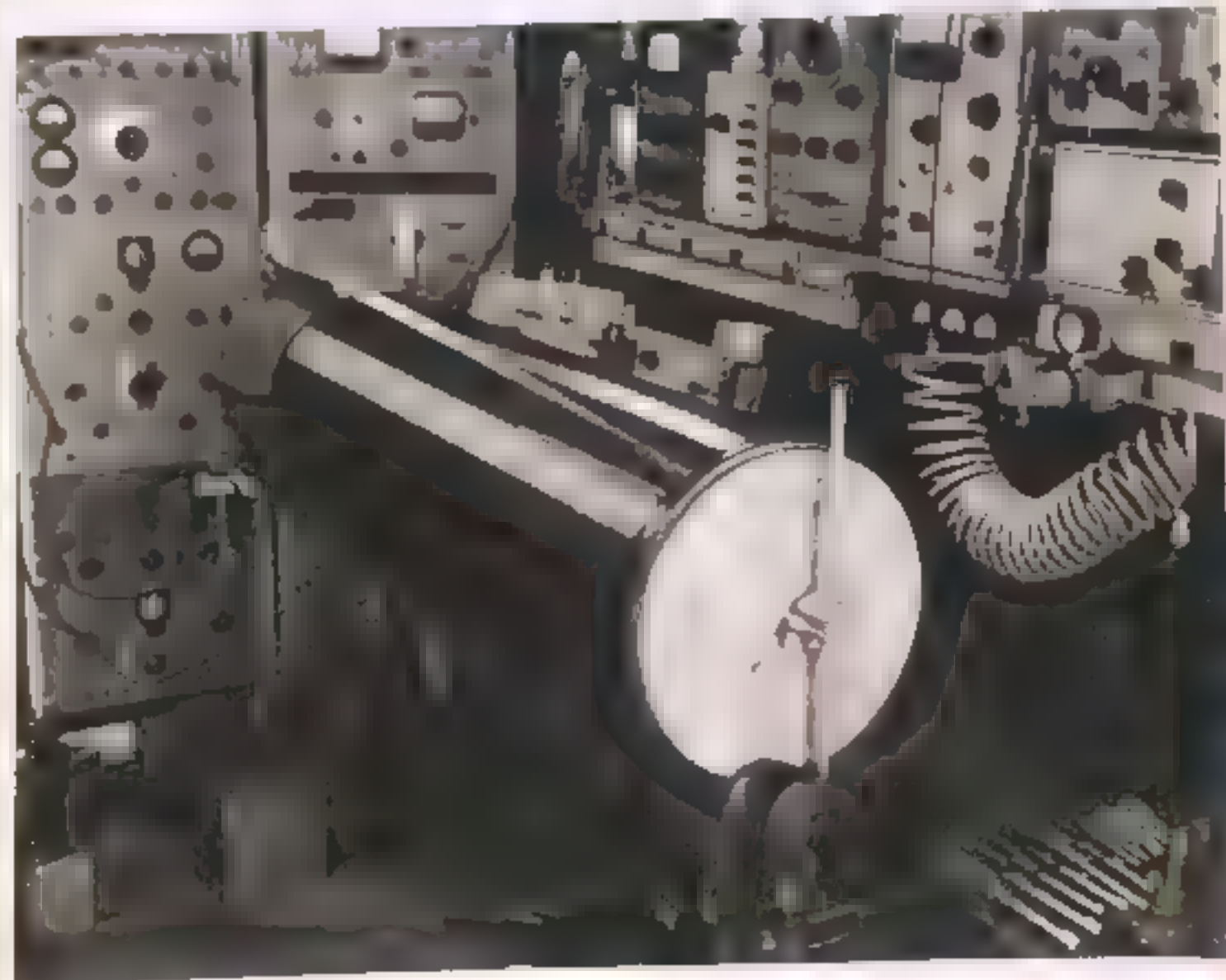
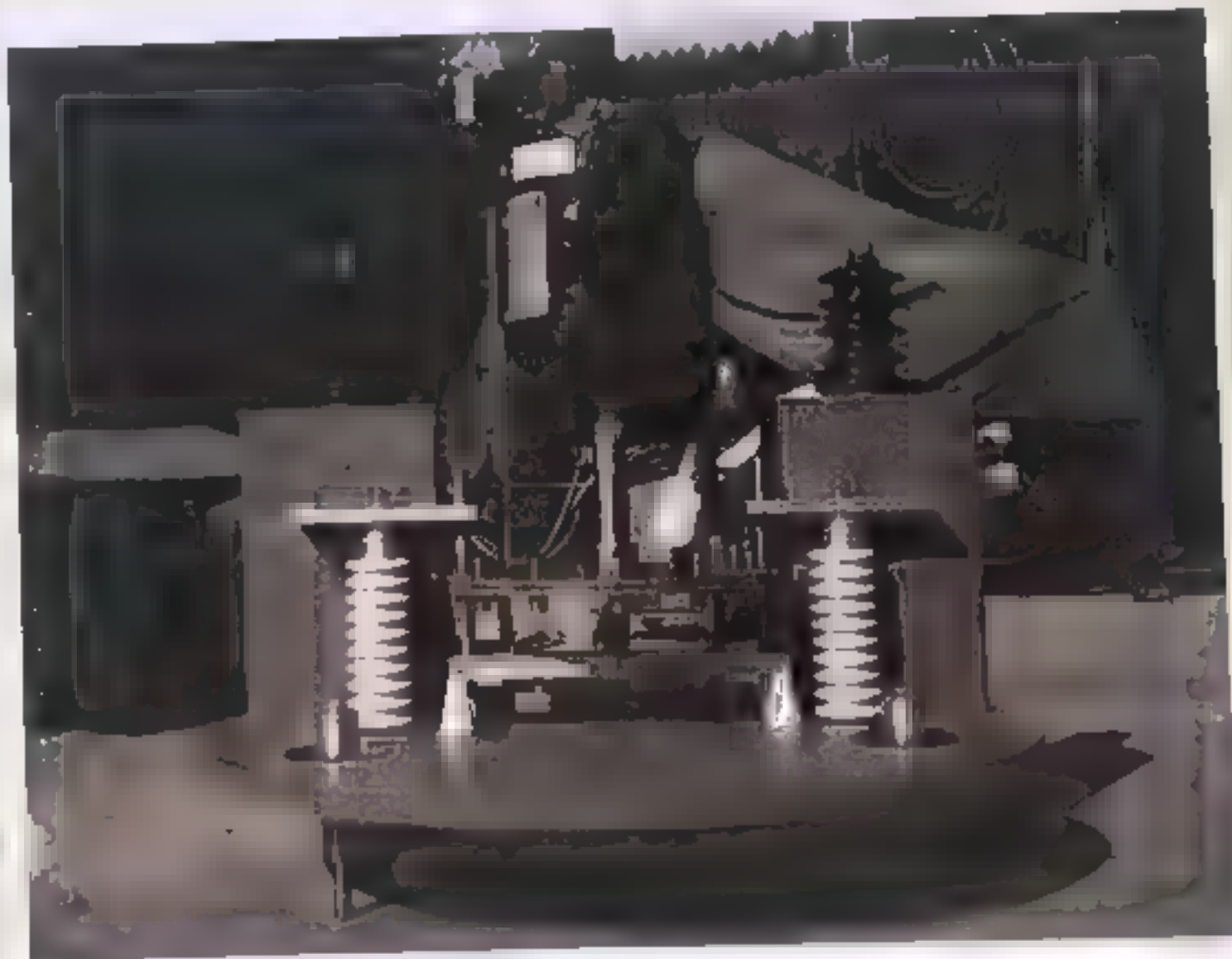
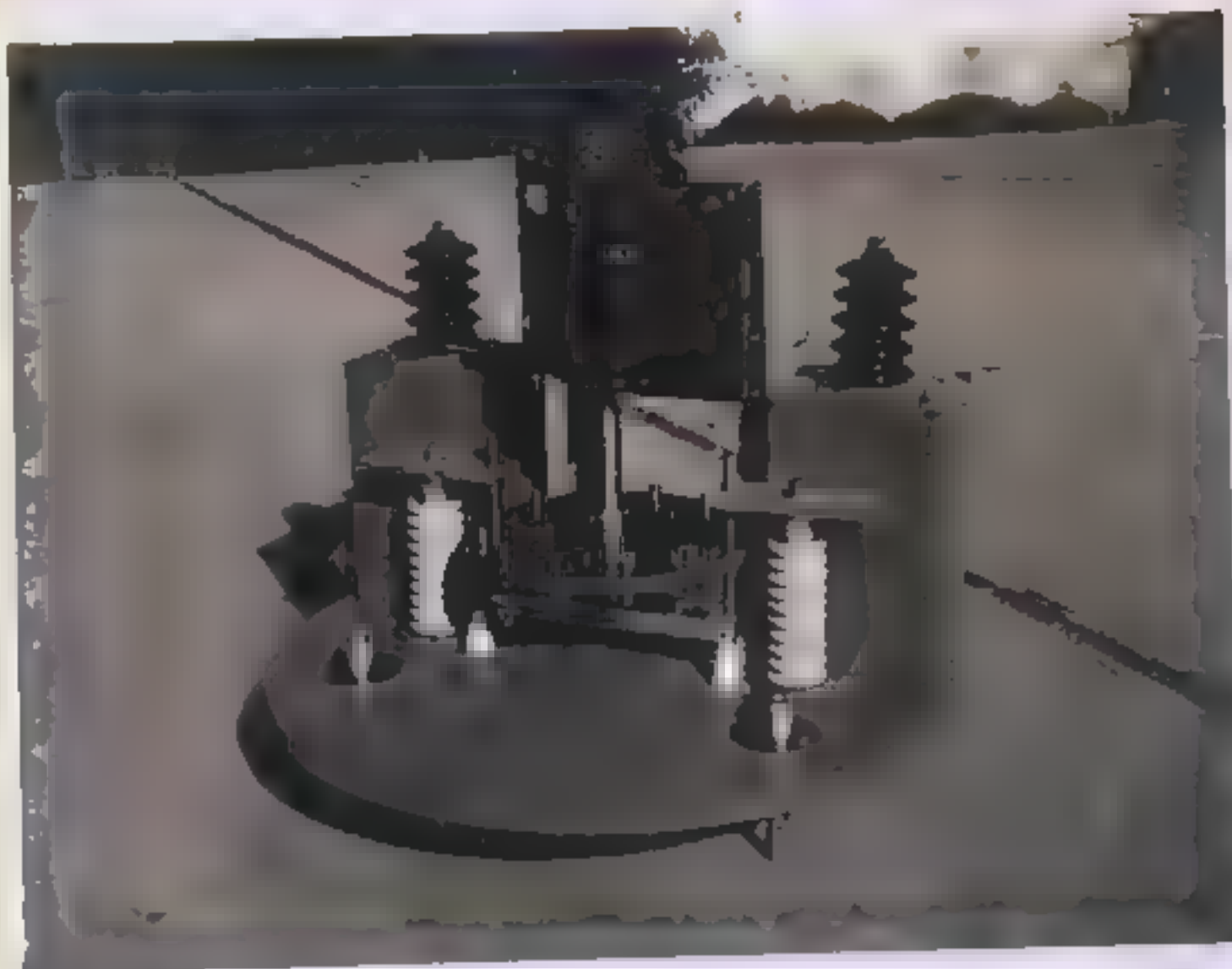








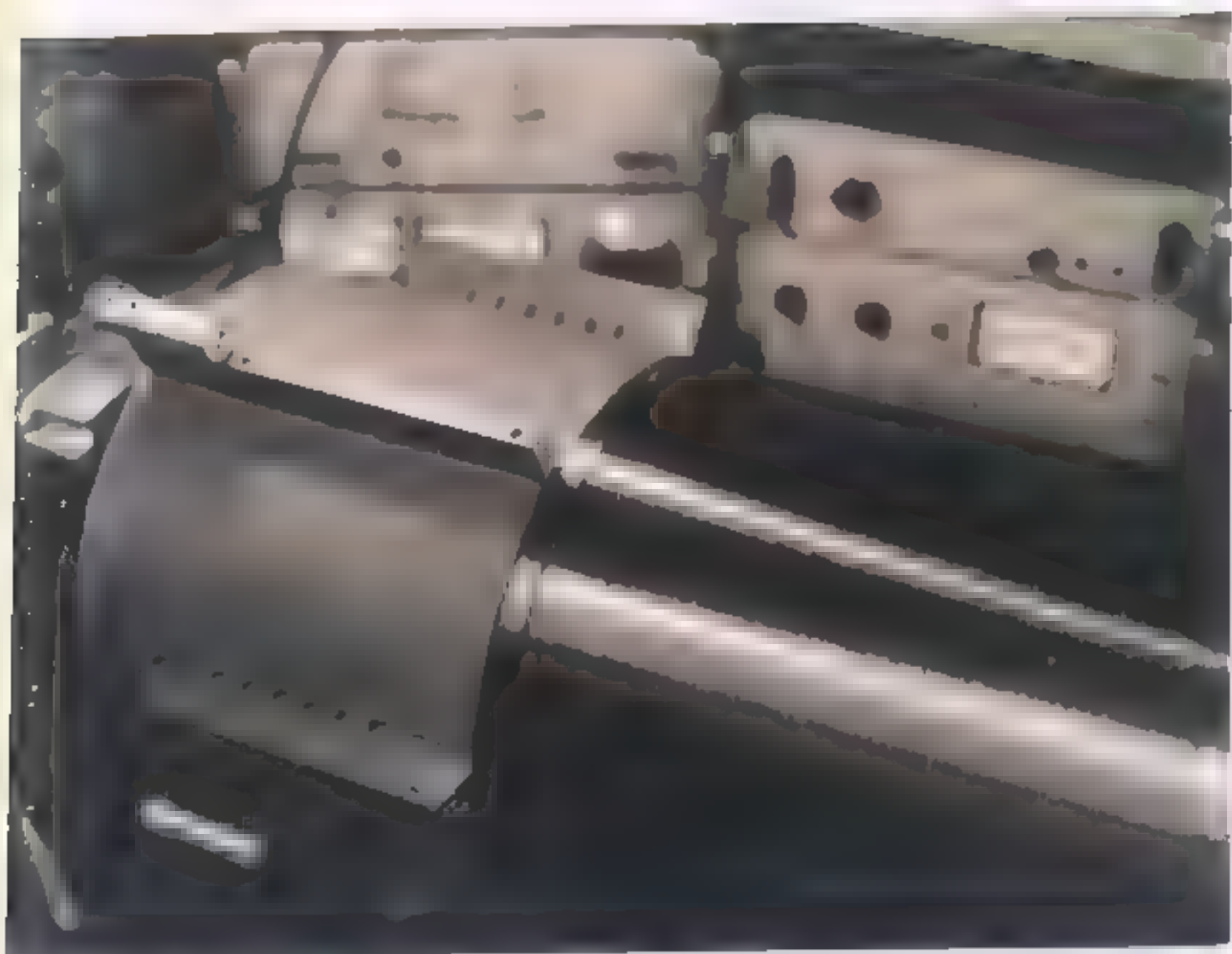




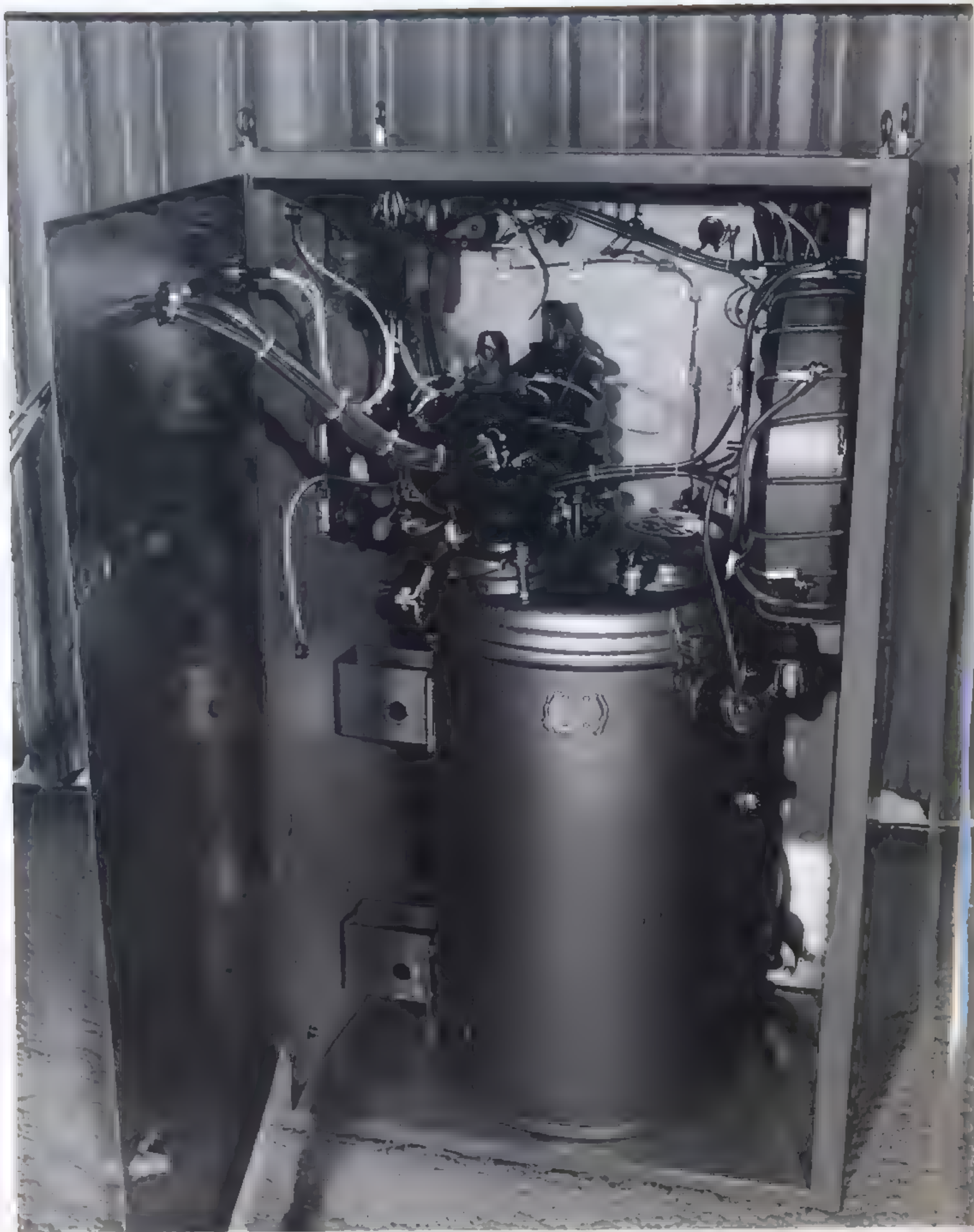








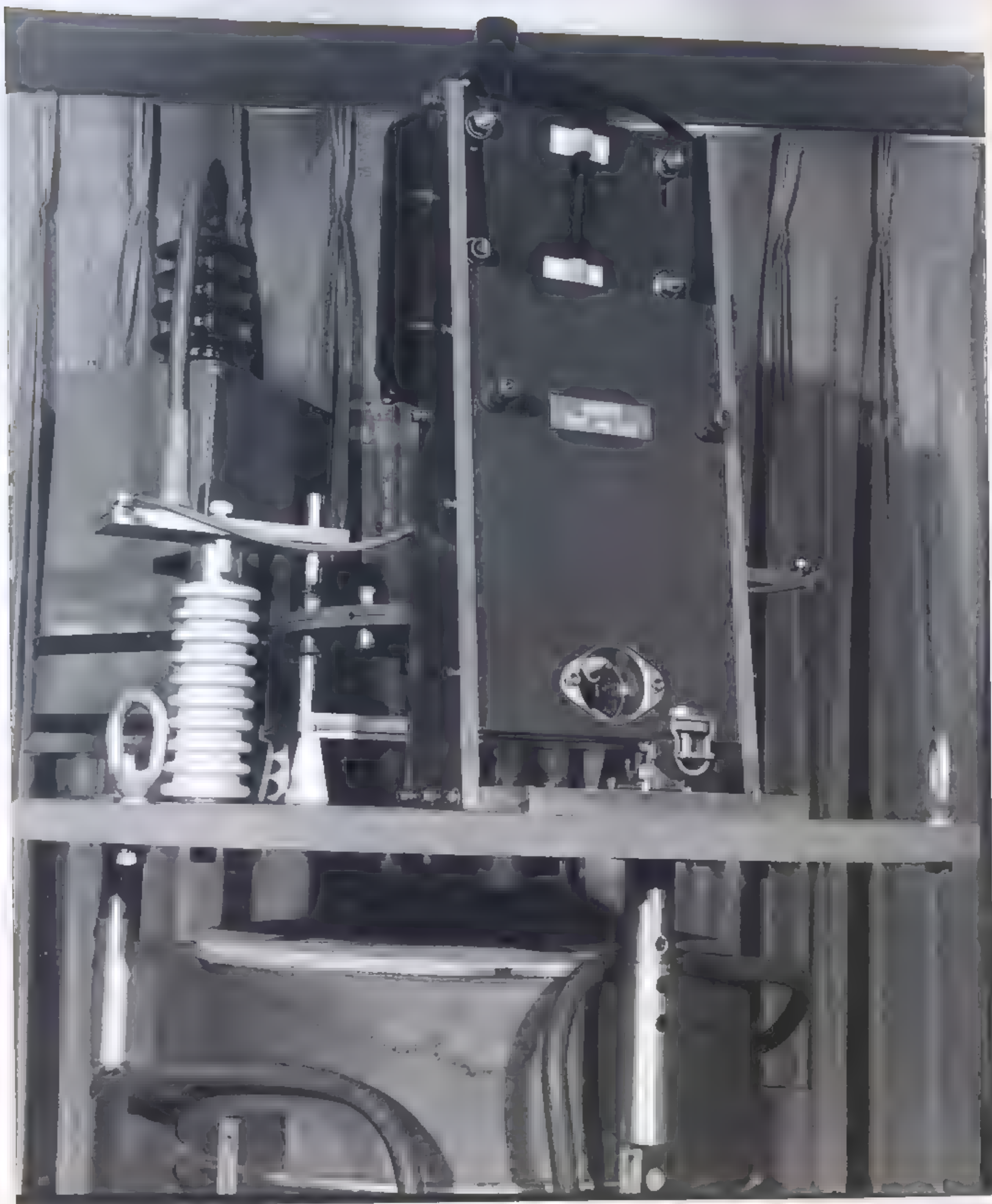










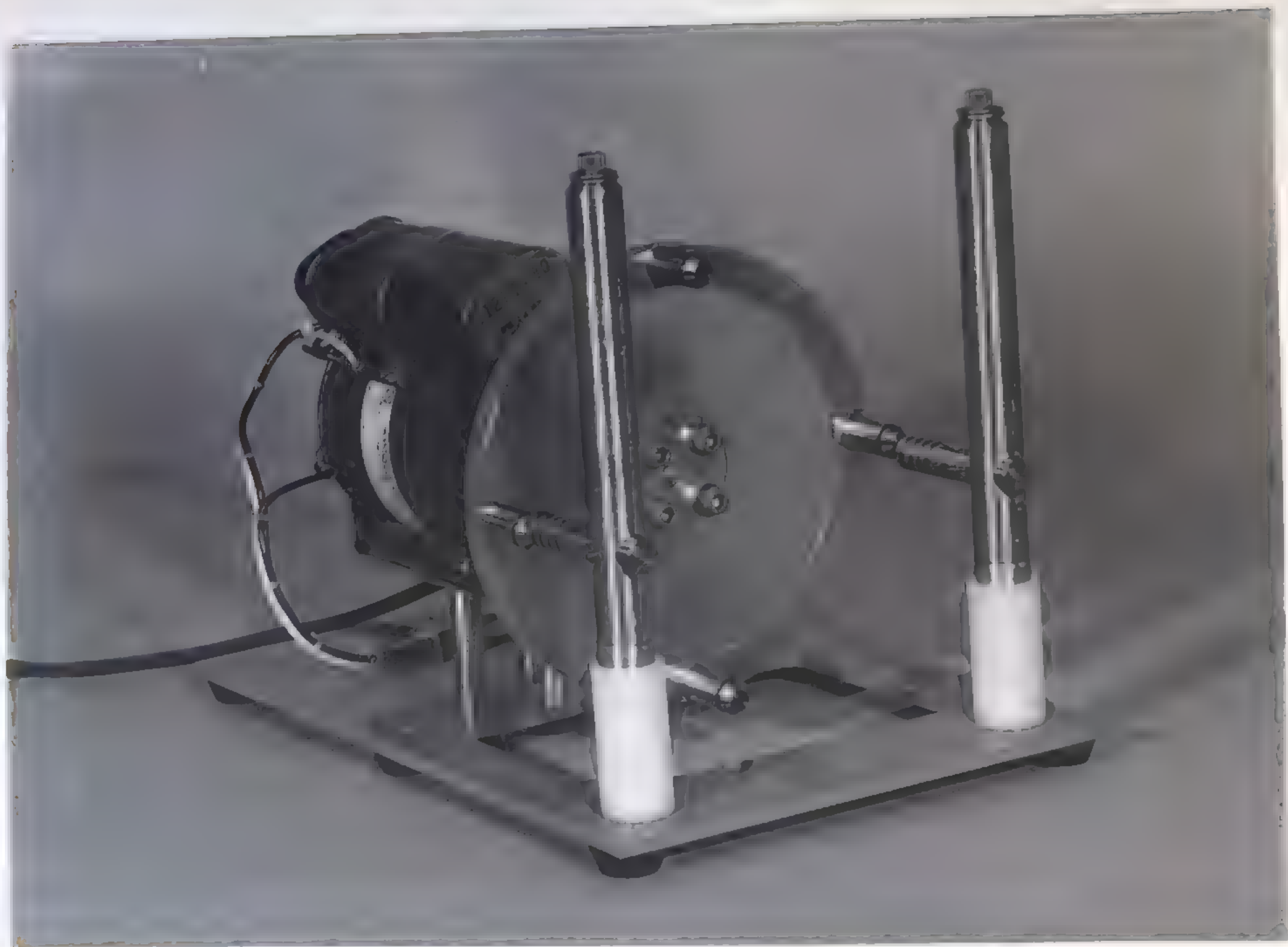






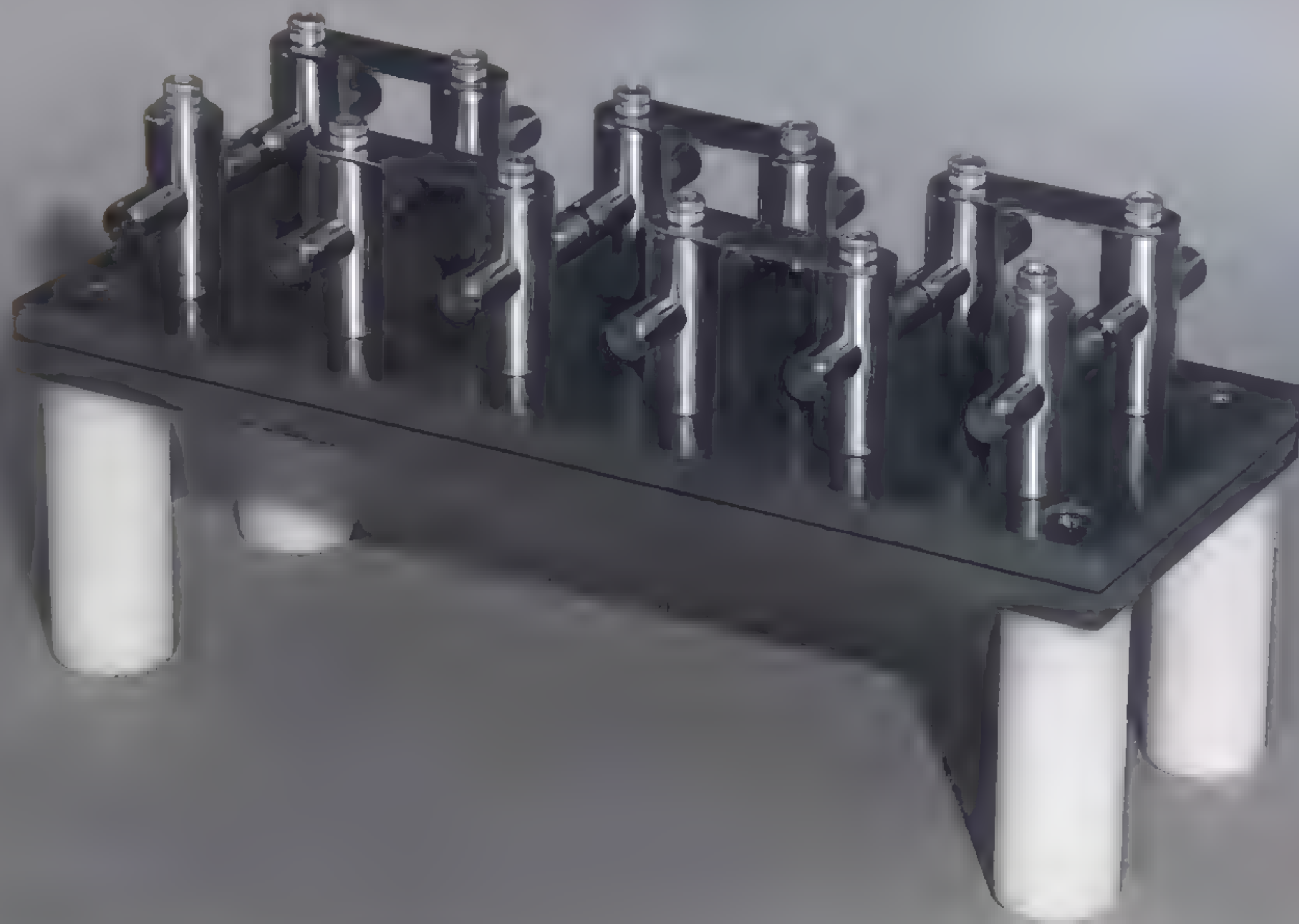






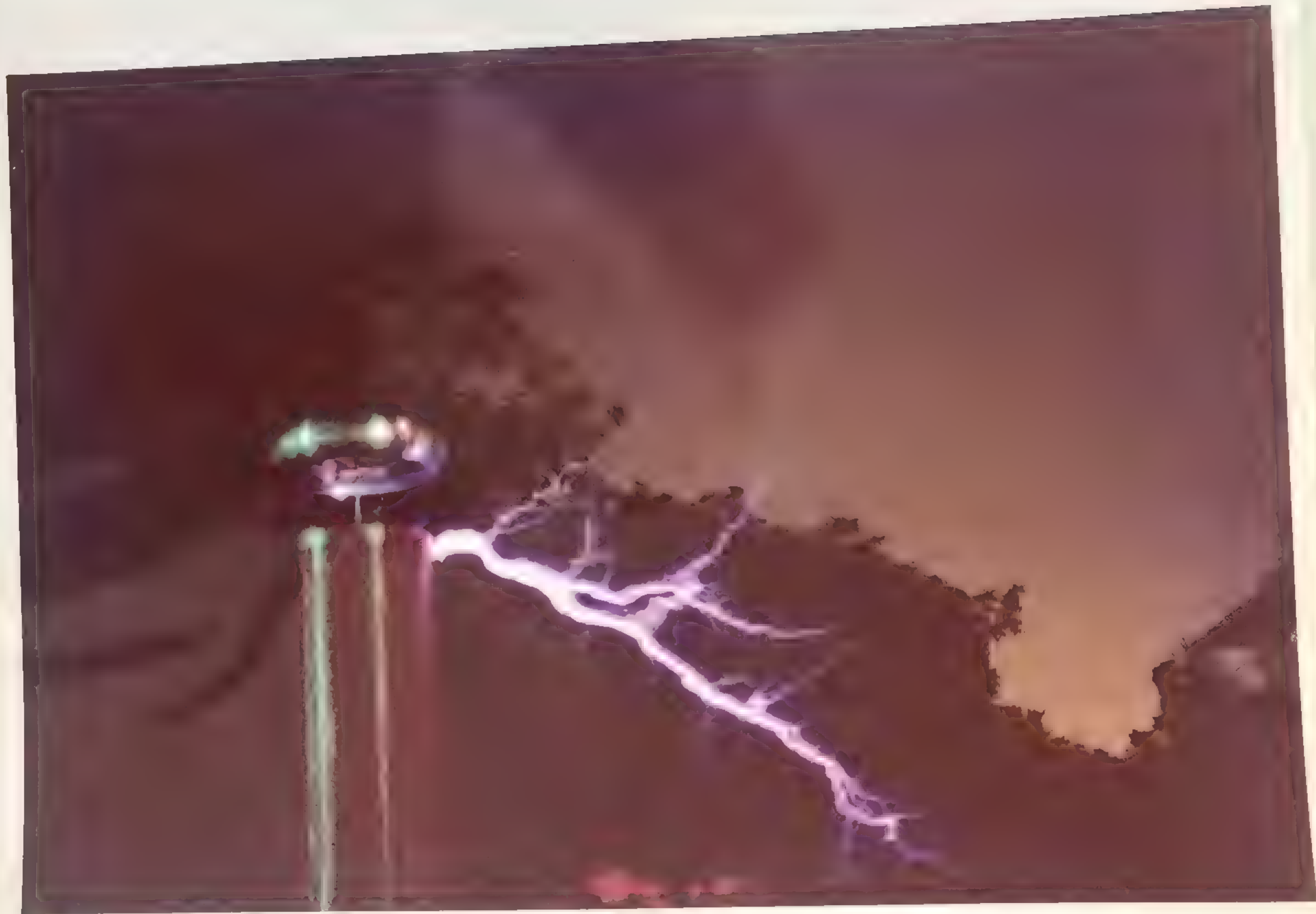




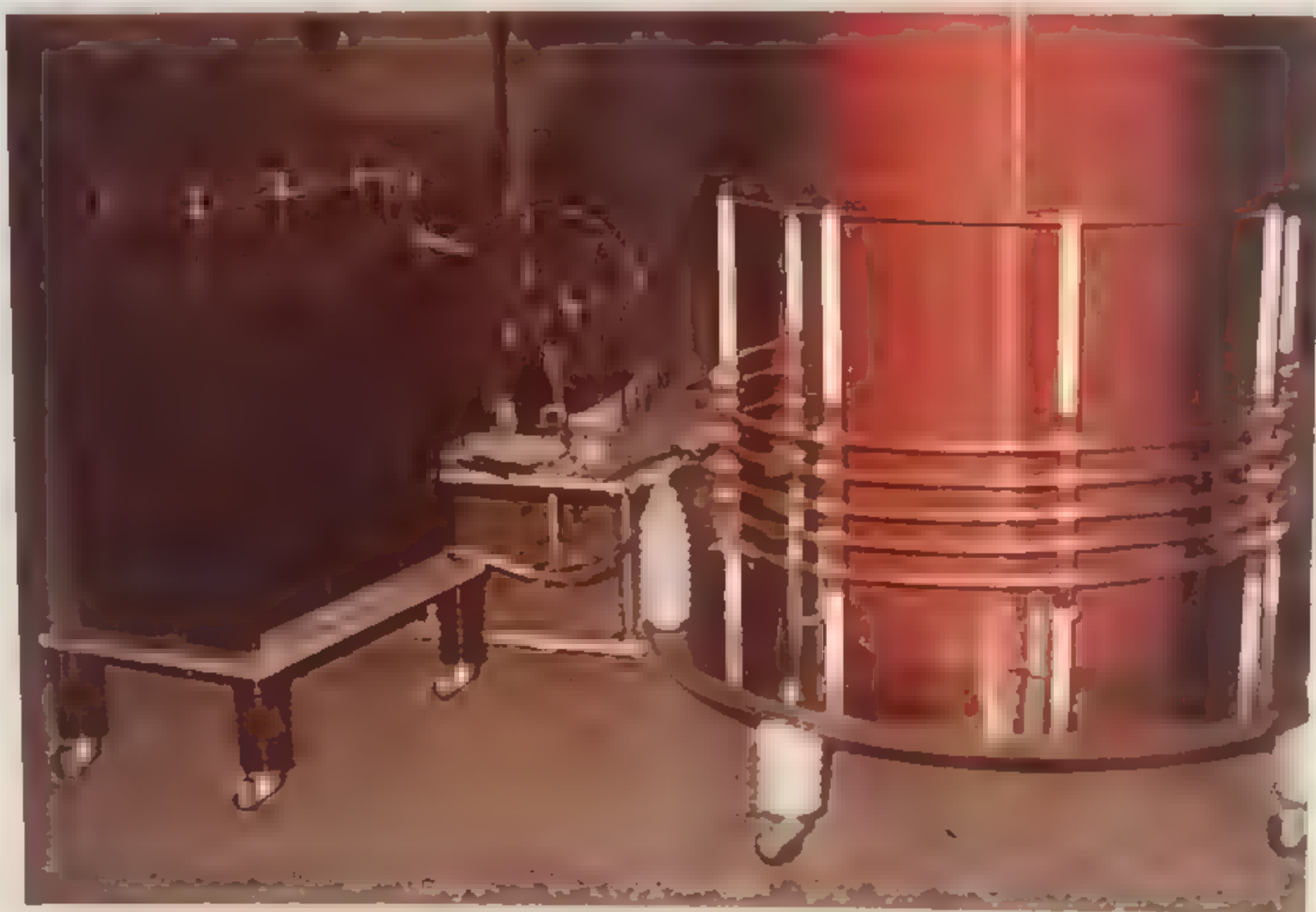




*In his laboratory at Colorado Springs Tesla produced extremely high voltages up to.
12000000 volts (at a frequency of several hundred thousand cycles per second)*









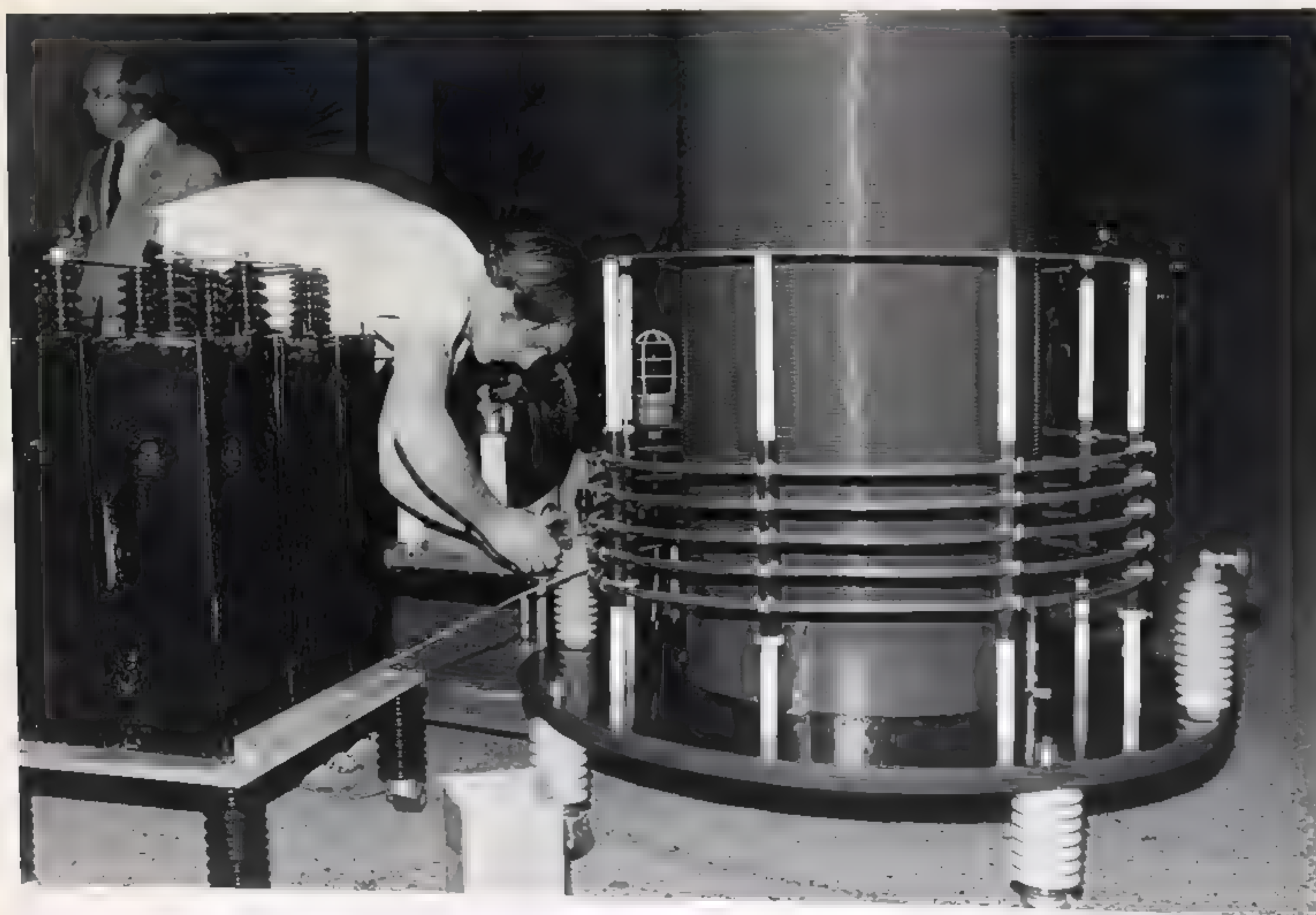


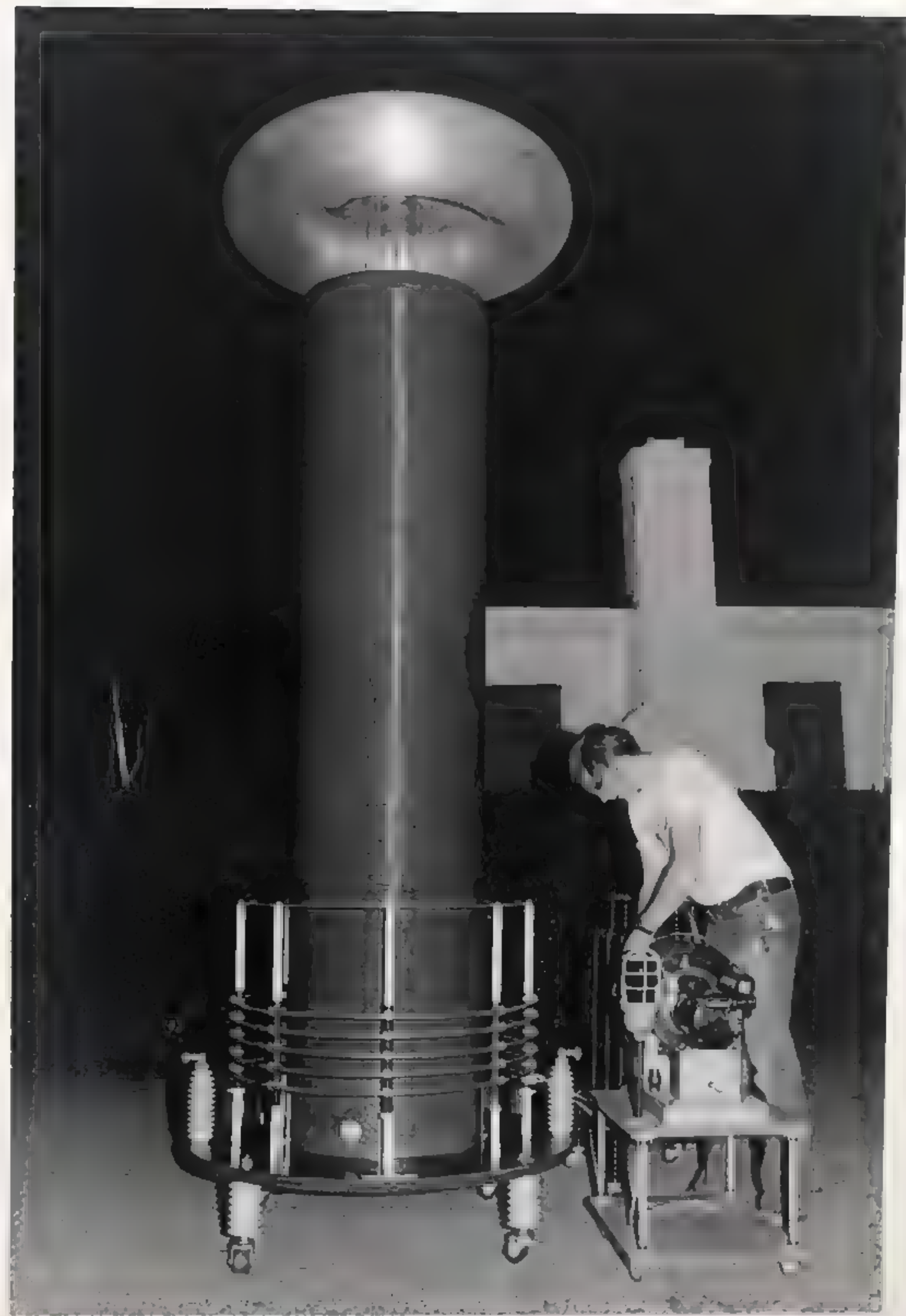




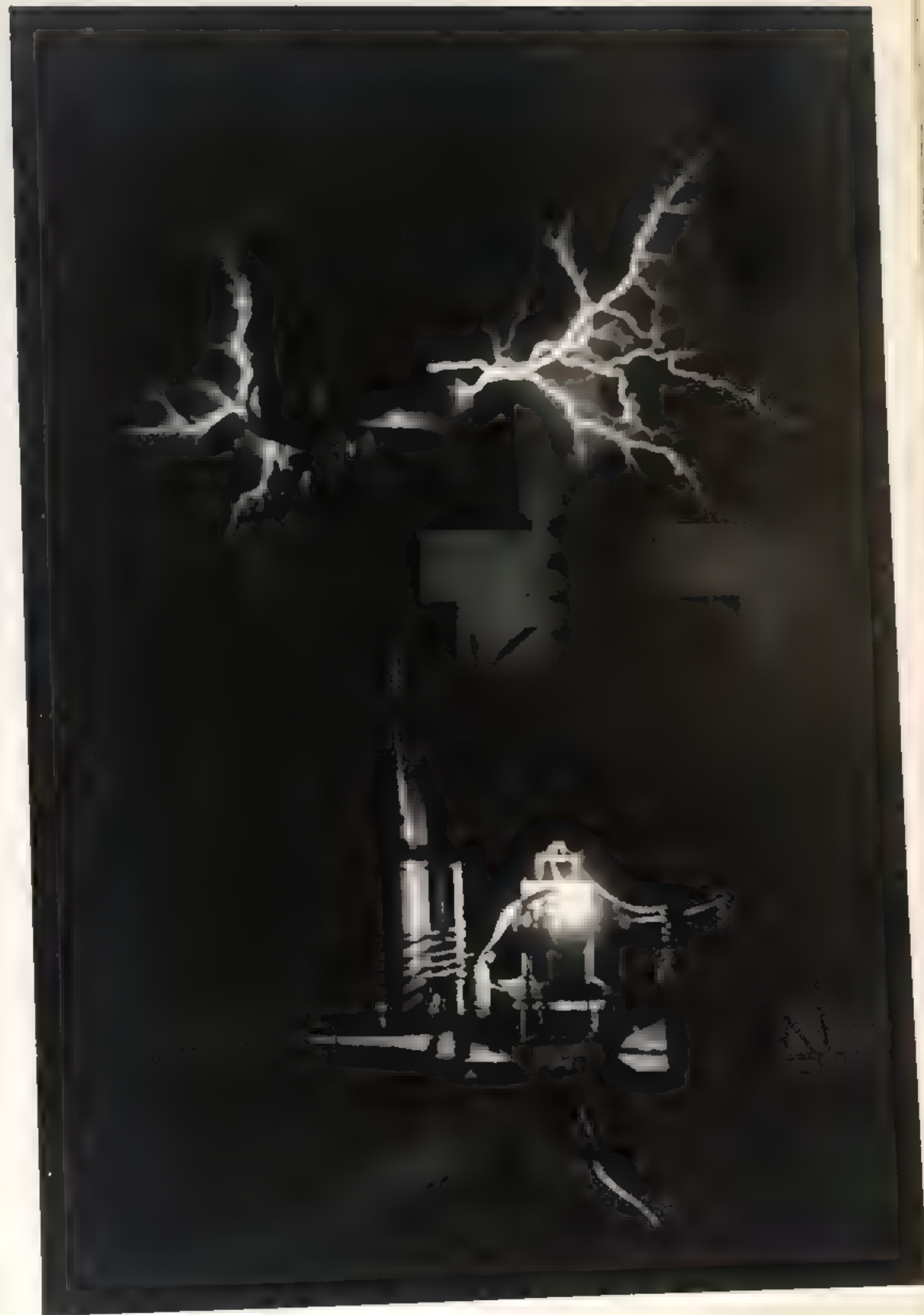


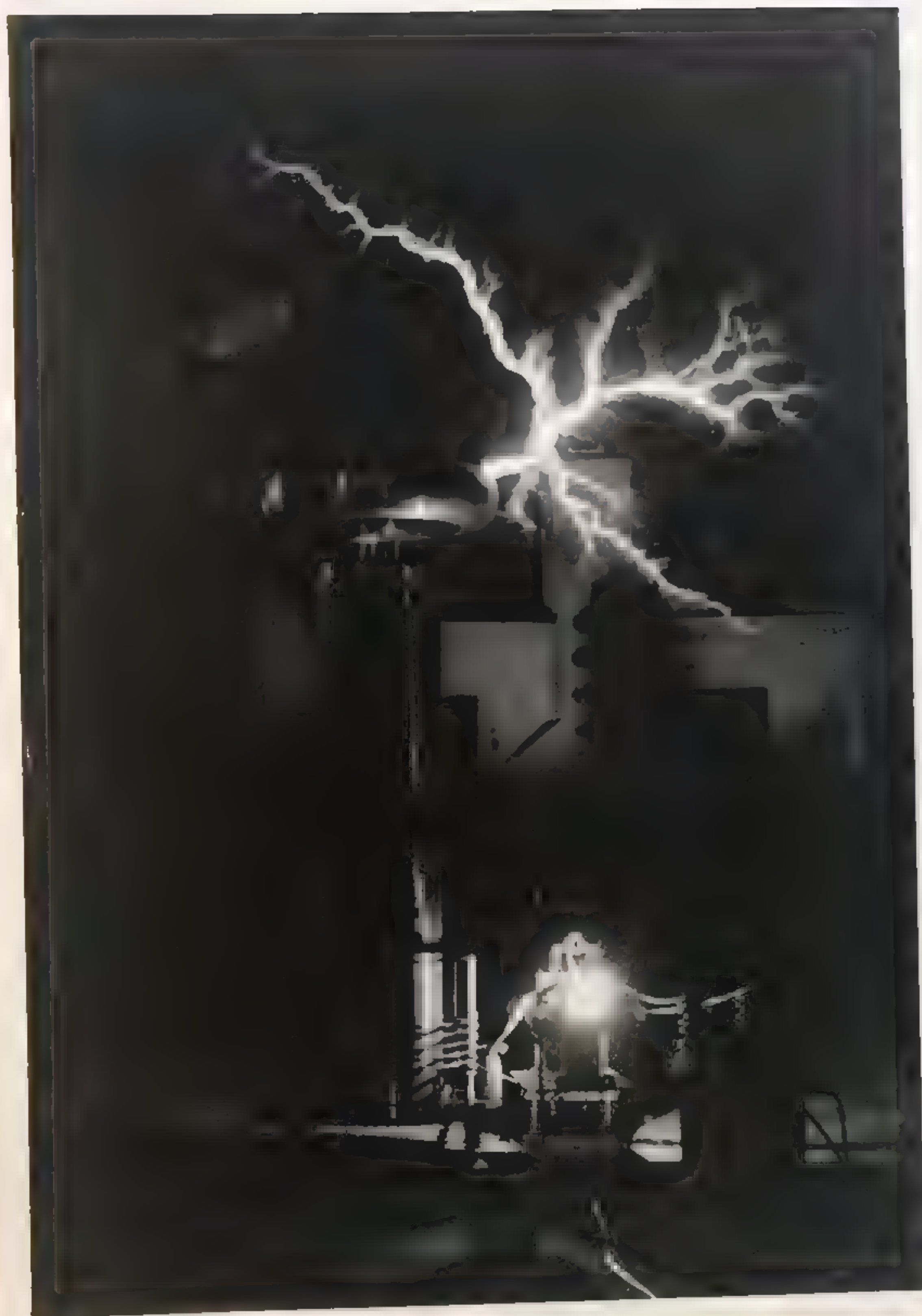


































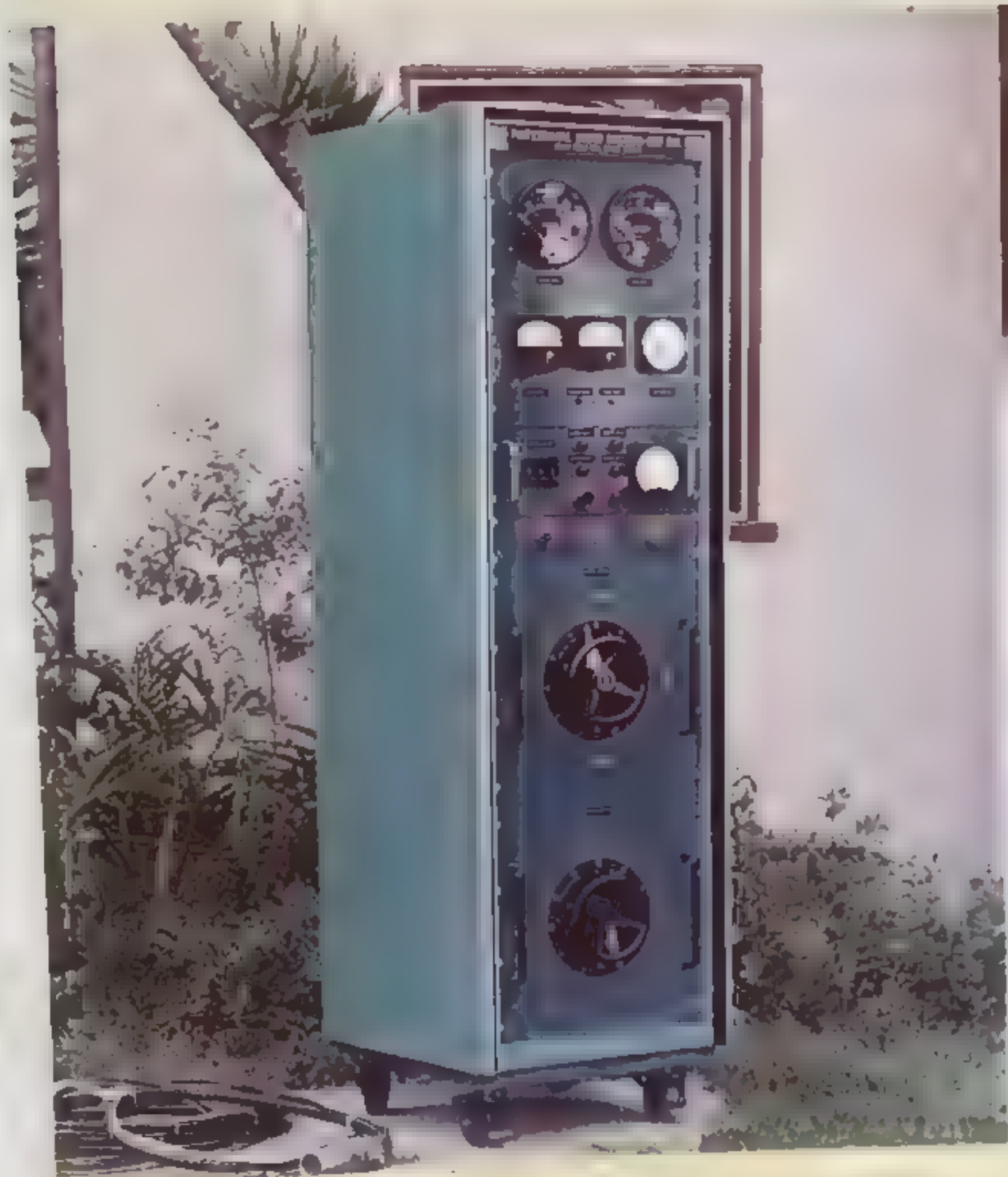


















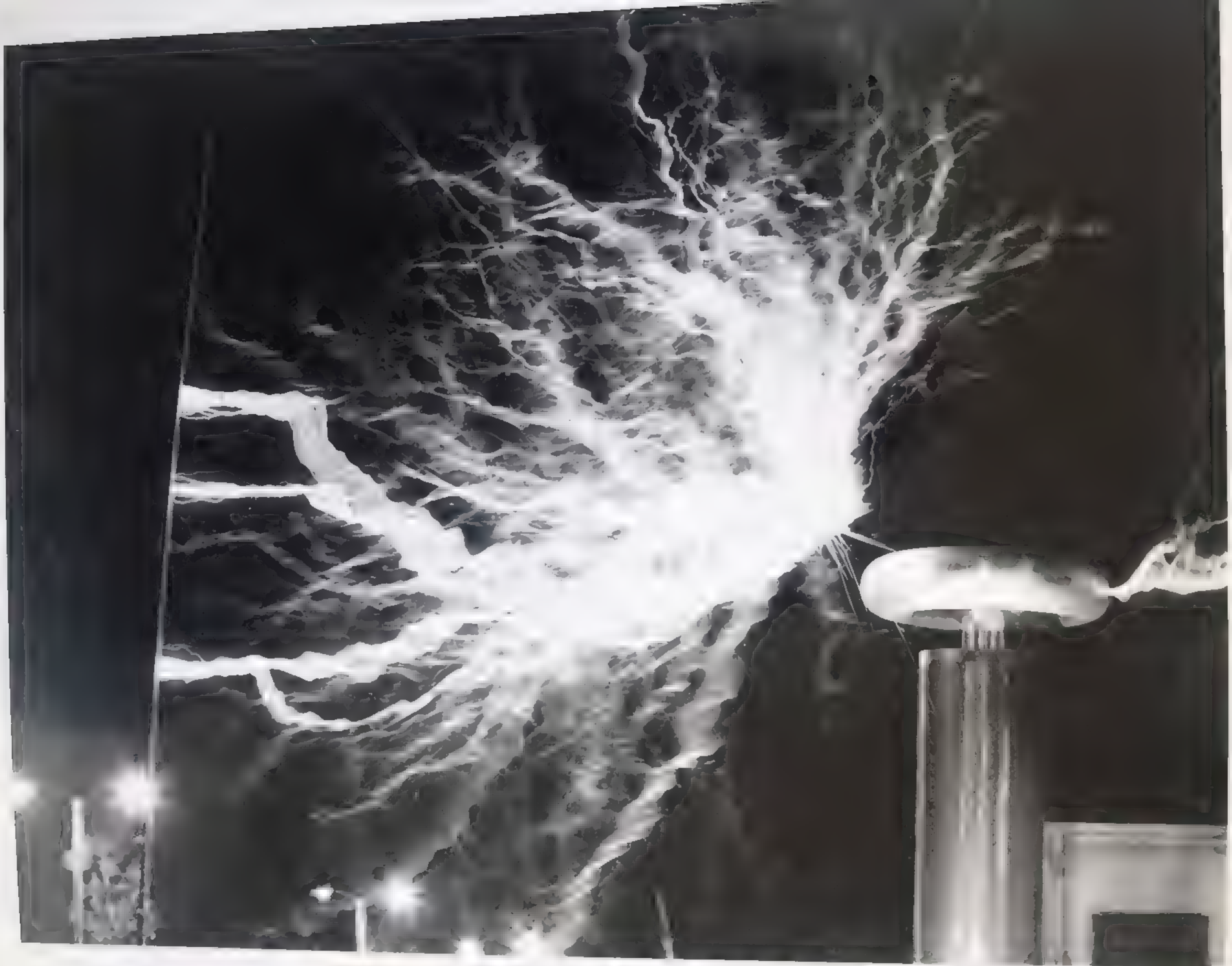


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PROFESSIONAL SOUND SYSTEMS
4914 BALDWIN AVENUE
TEMPLE CITY, CA 91780

ULTRA HIGH VOLTAGE DIVISION

WILLIAM C. WY SOCK



© 1975

PROFESSIONAL SOUND SYSTEMS
4914 BALDWIN AVENUE
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ULTRA HIGH VOLTAGE DIVISION

WILLIAM C. WYSOCK



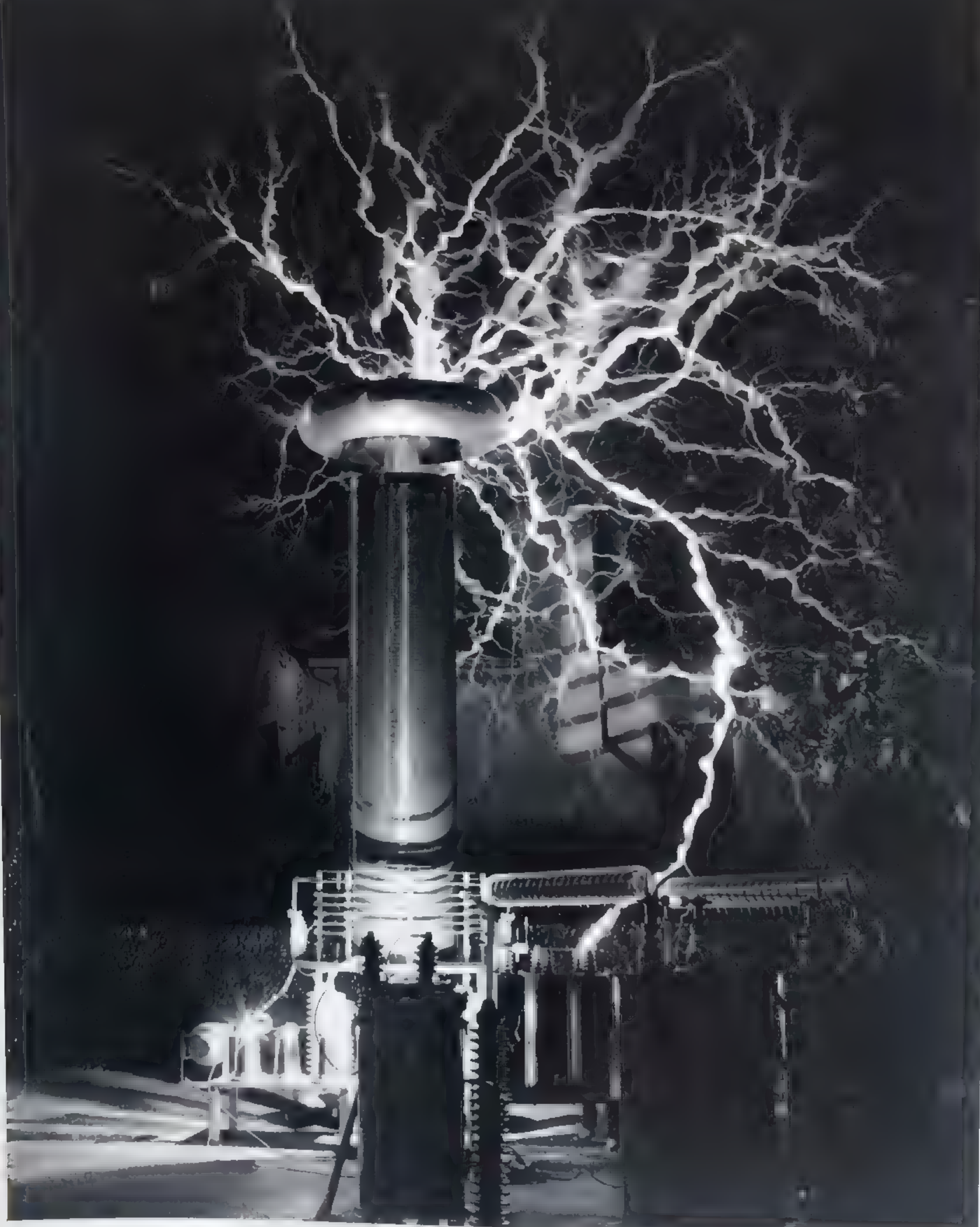
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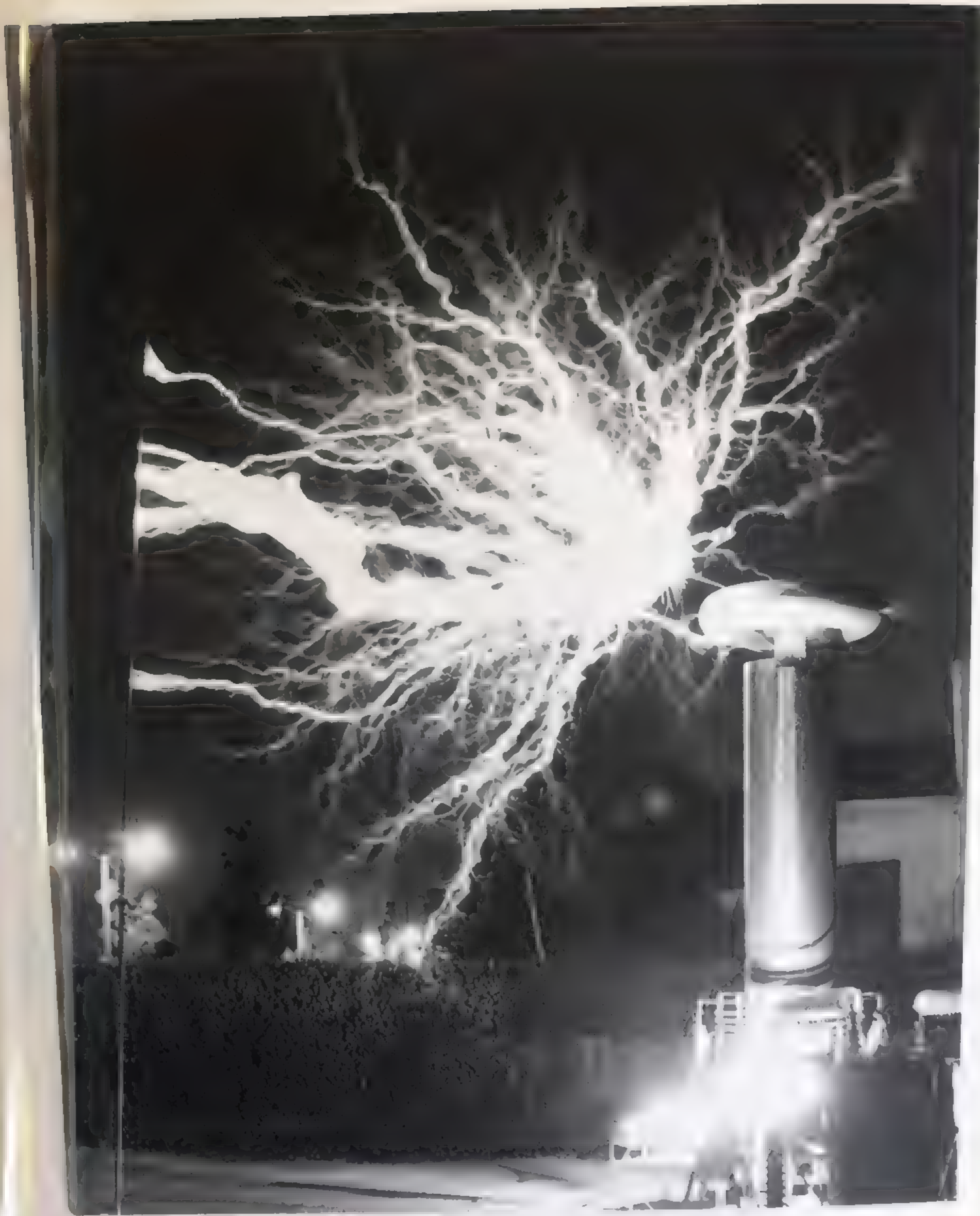
PROFESSIONAL SOUND SYSTEMS
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TEMPLE CITY, CA 91780

ULTRA HIGH VOLTAGE DIVISION

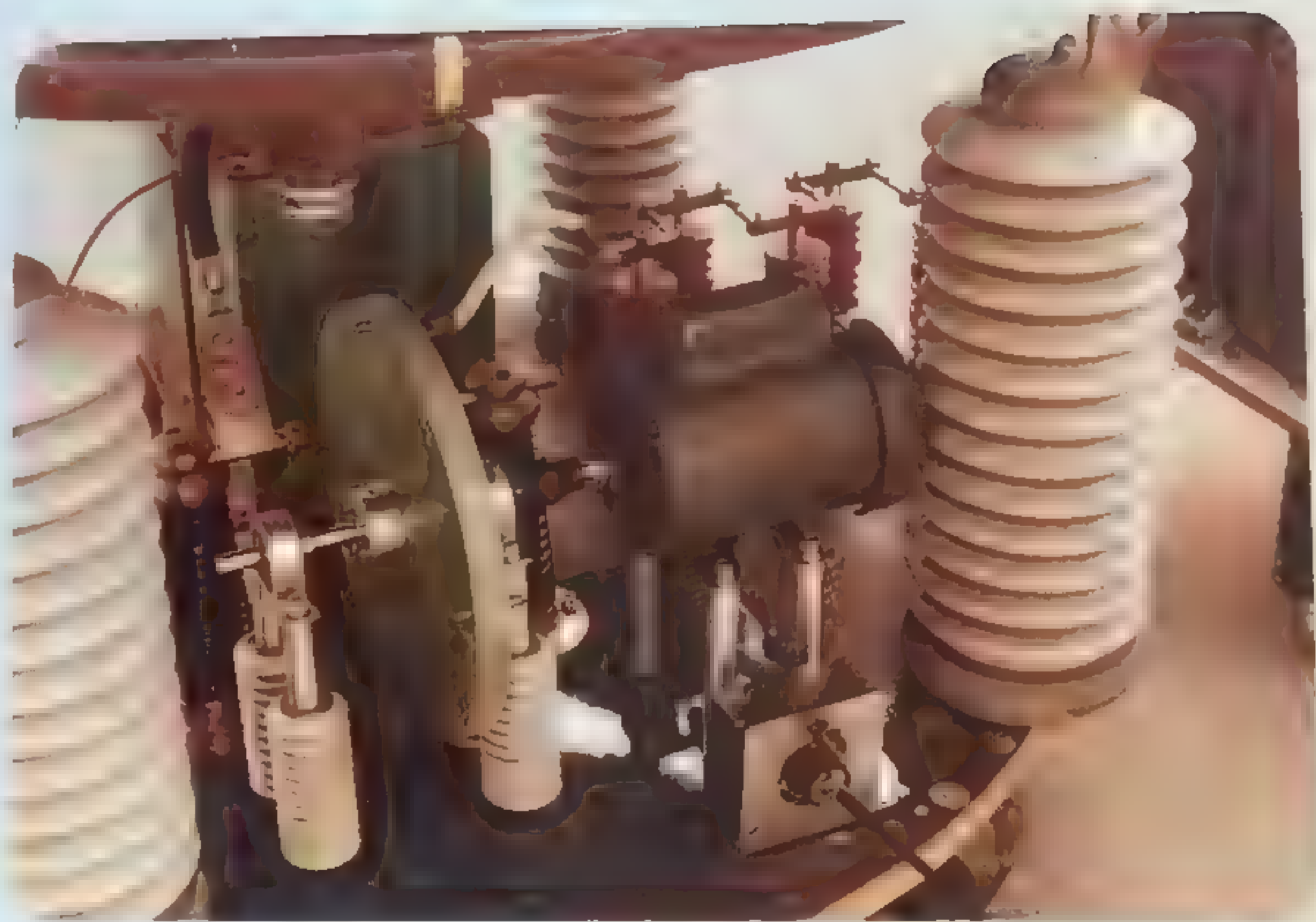
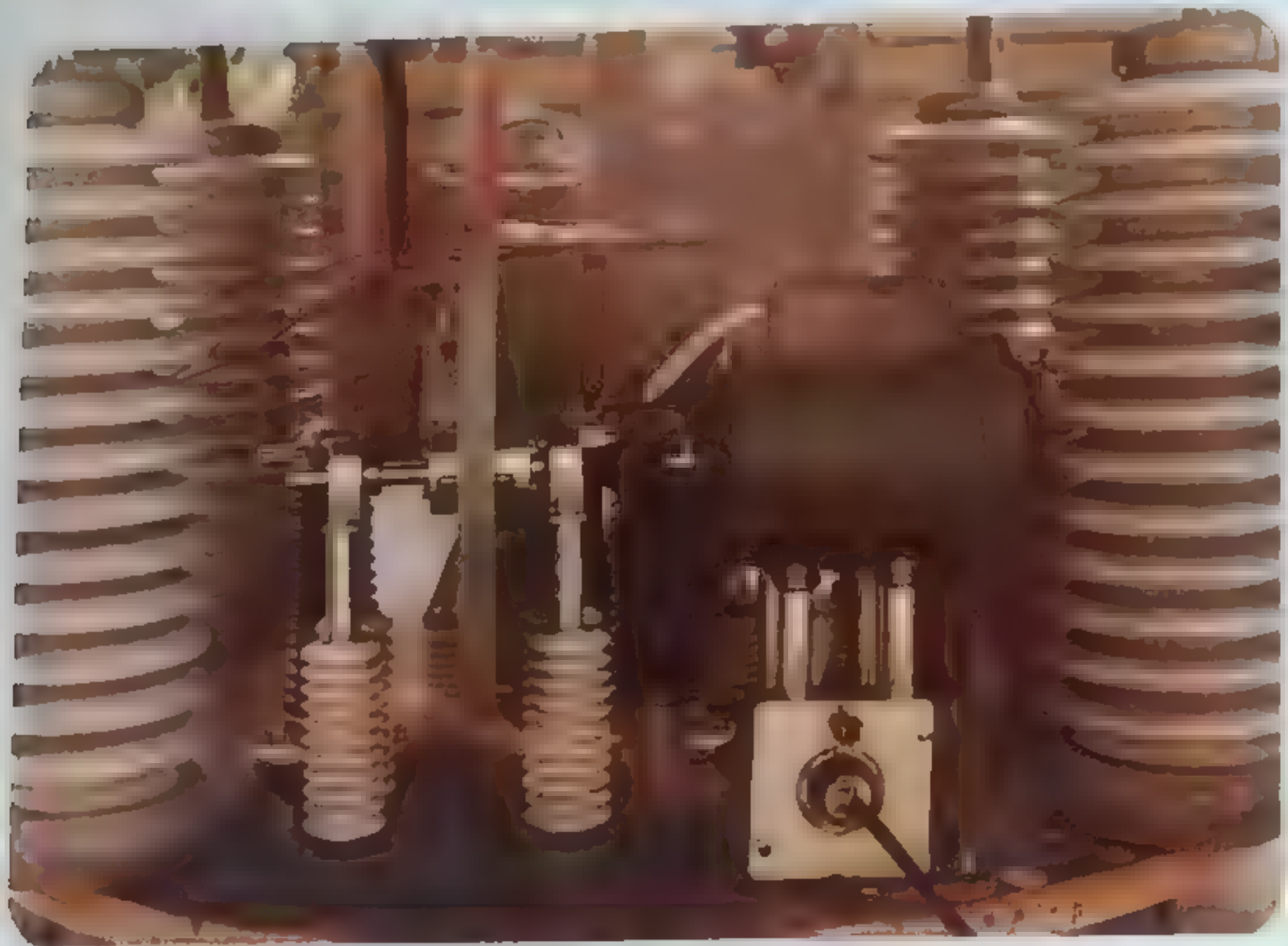
WILLIAM C. WYBICK















TESLA TECHNOLOGY RESEARCH







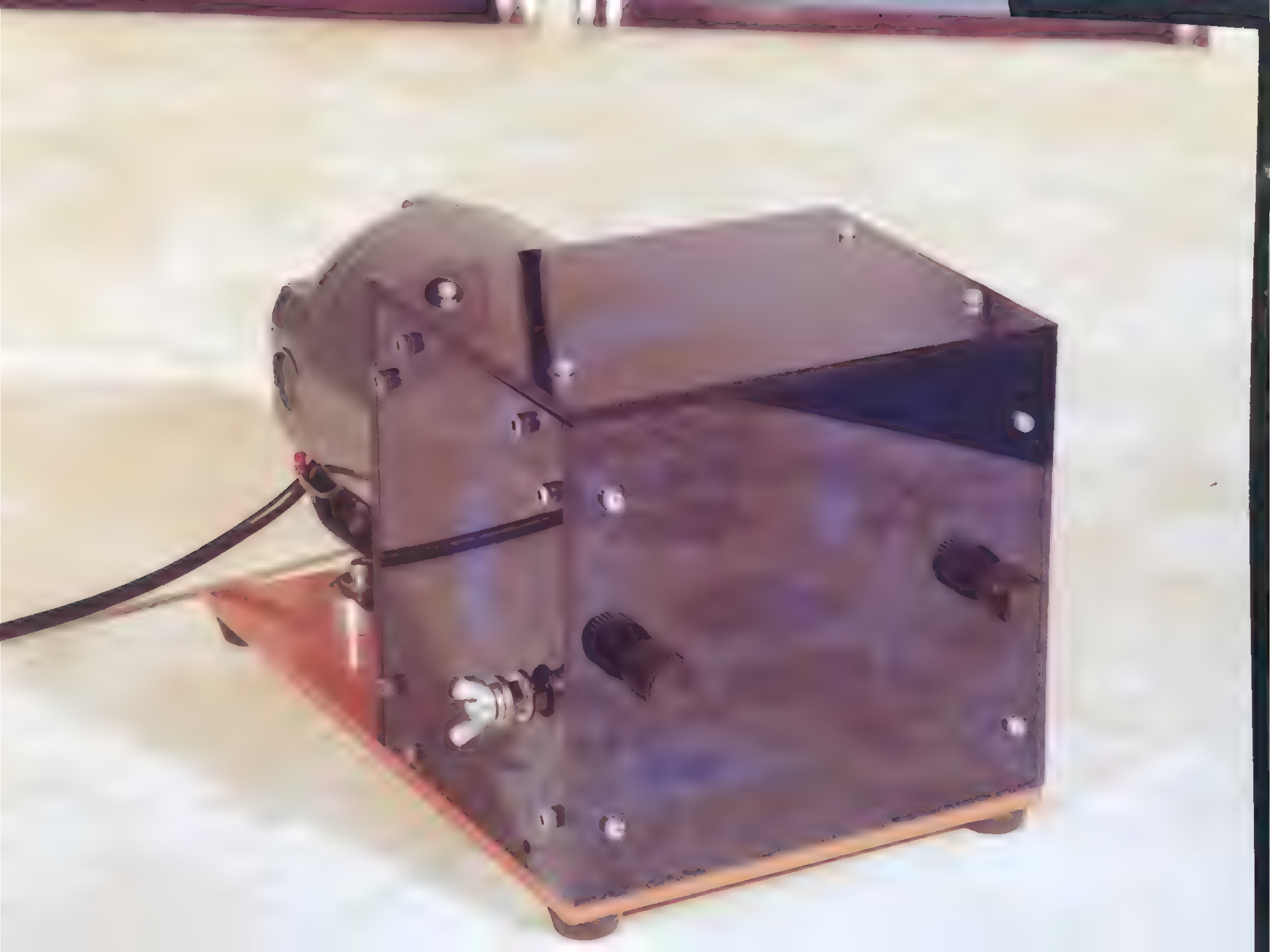




































Science Is
Where You
Find It

Richard

11" x 14" Color Enlargements
Panoramic Prints
Black & White
12 Exposures
24 Exposures
36 Exposures

Agfa
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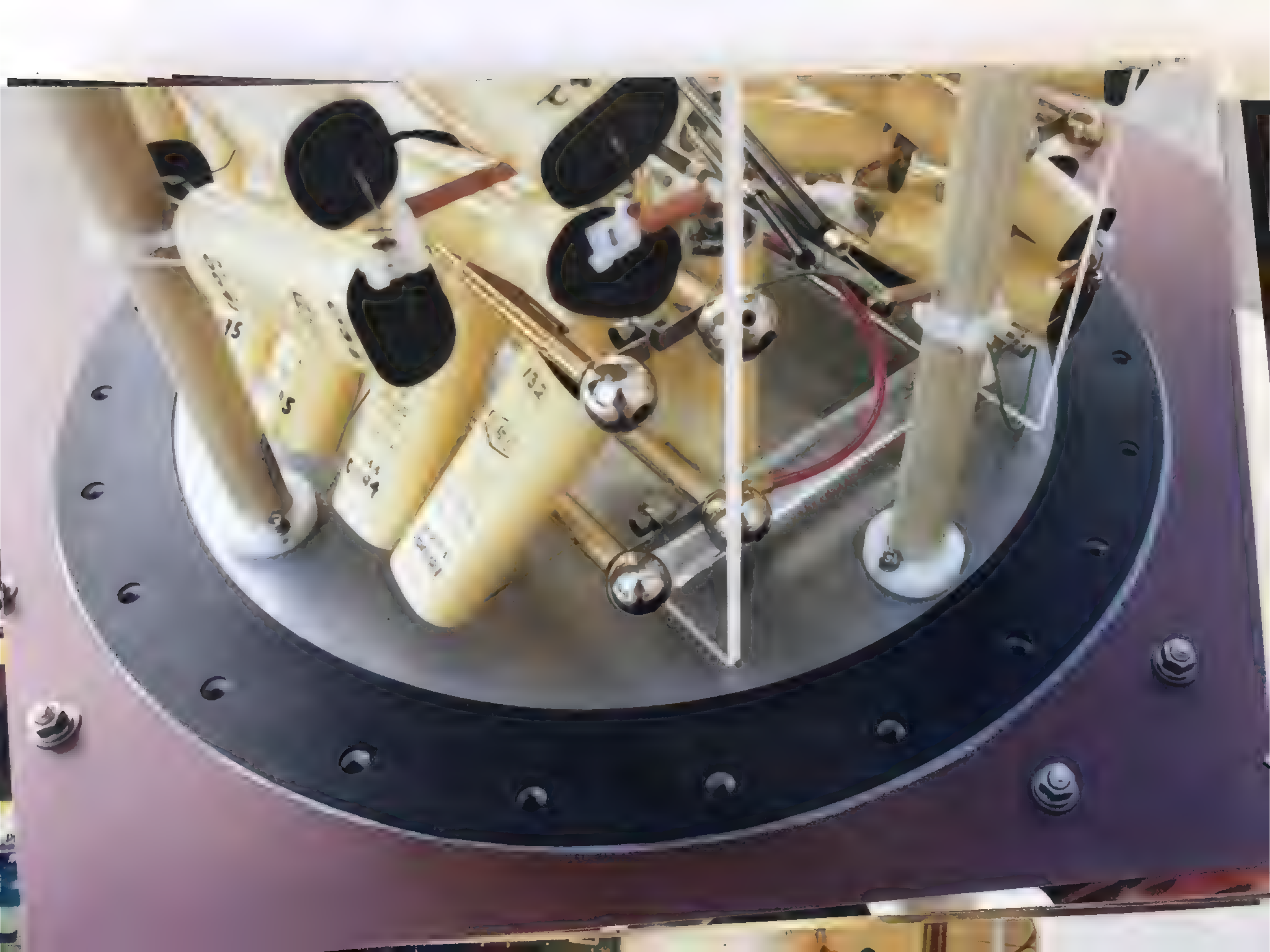




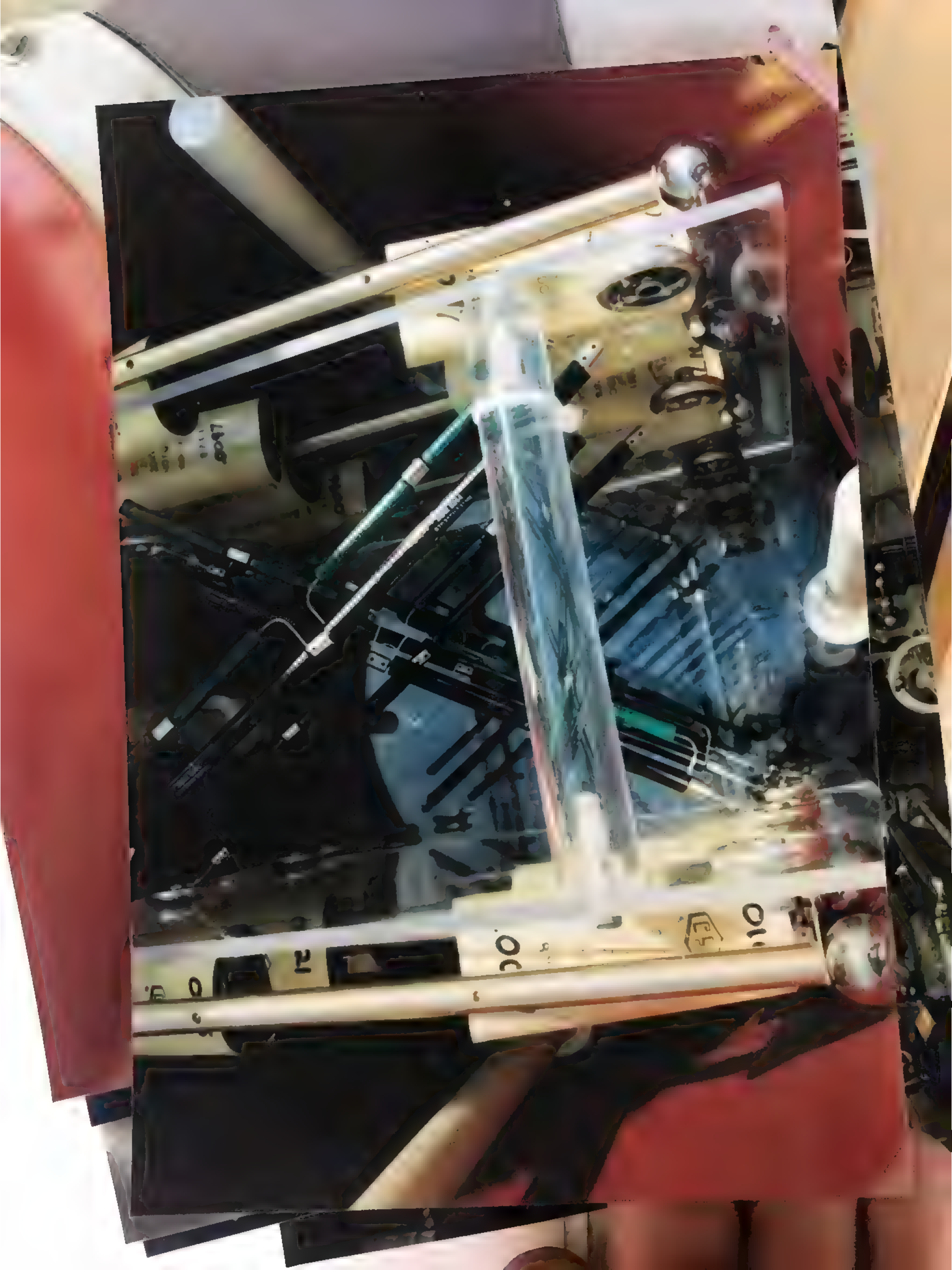


























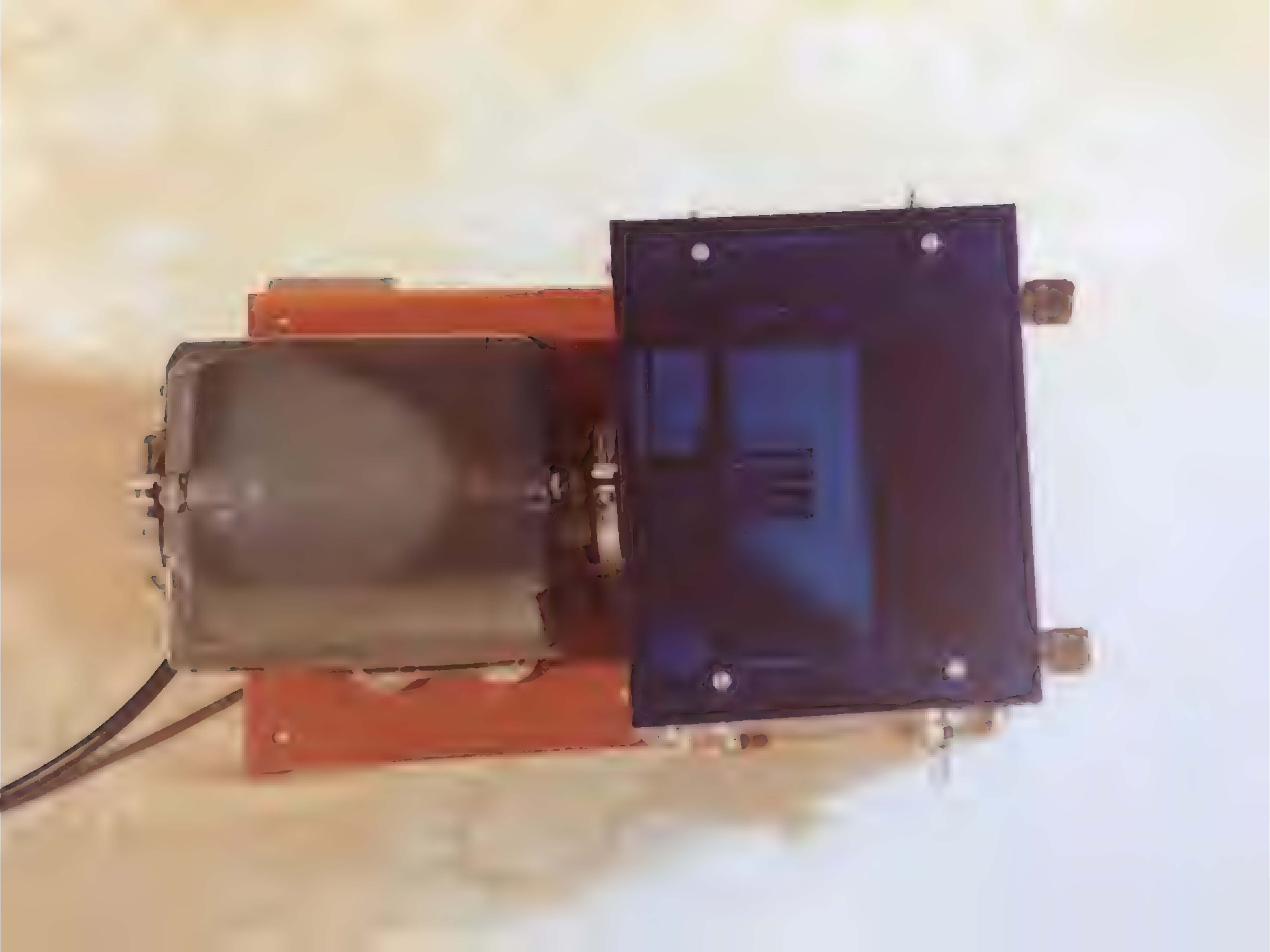








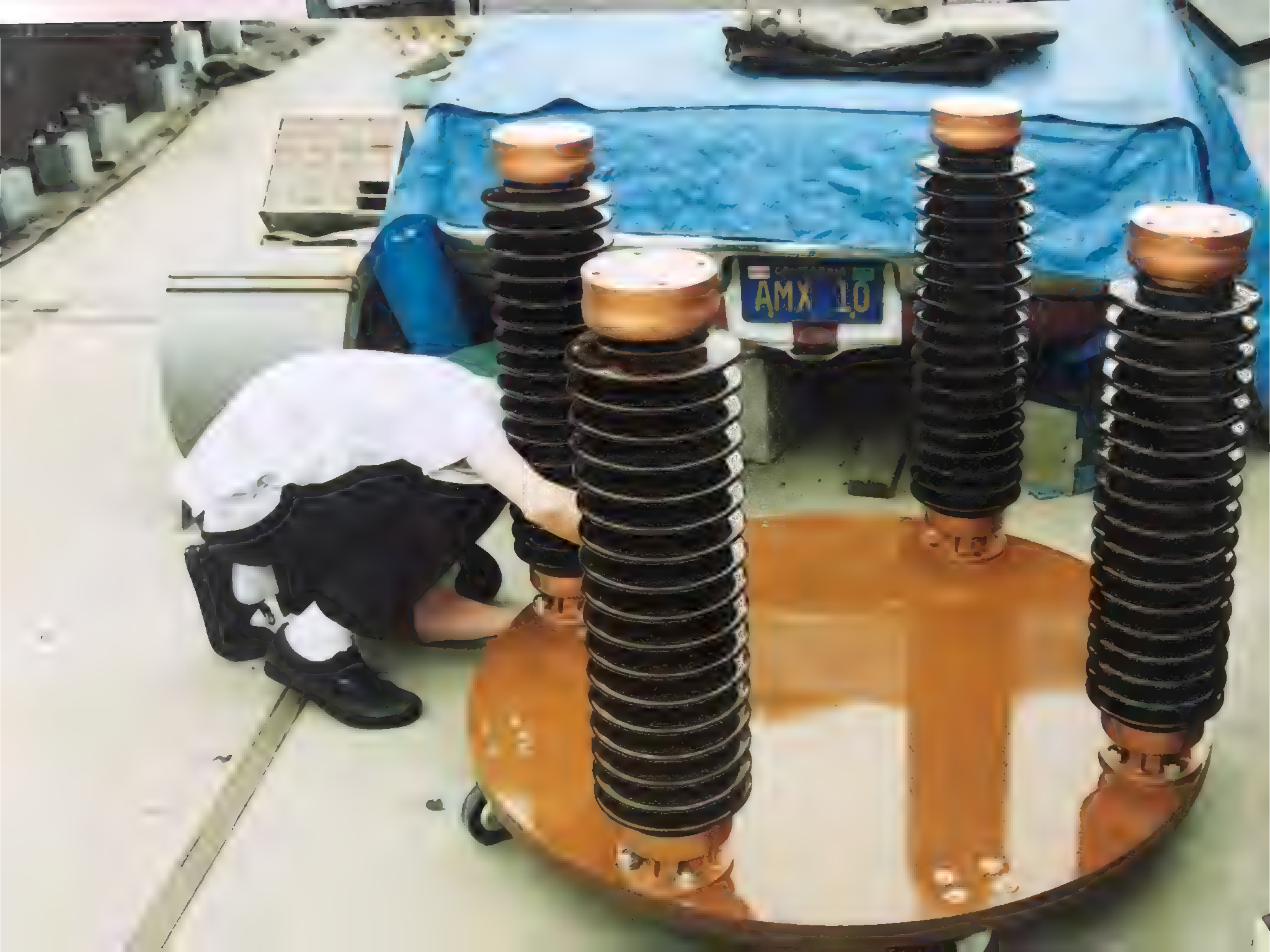






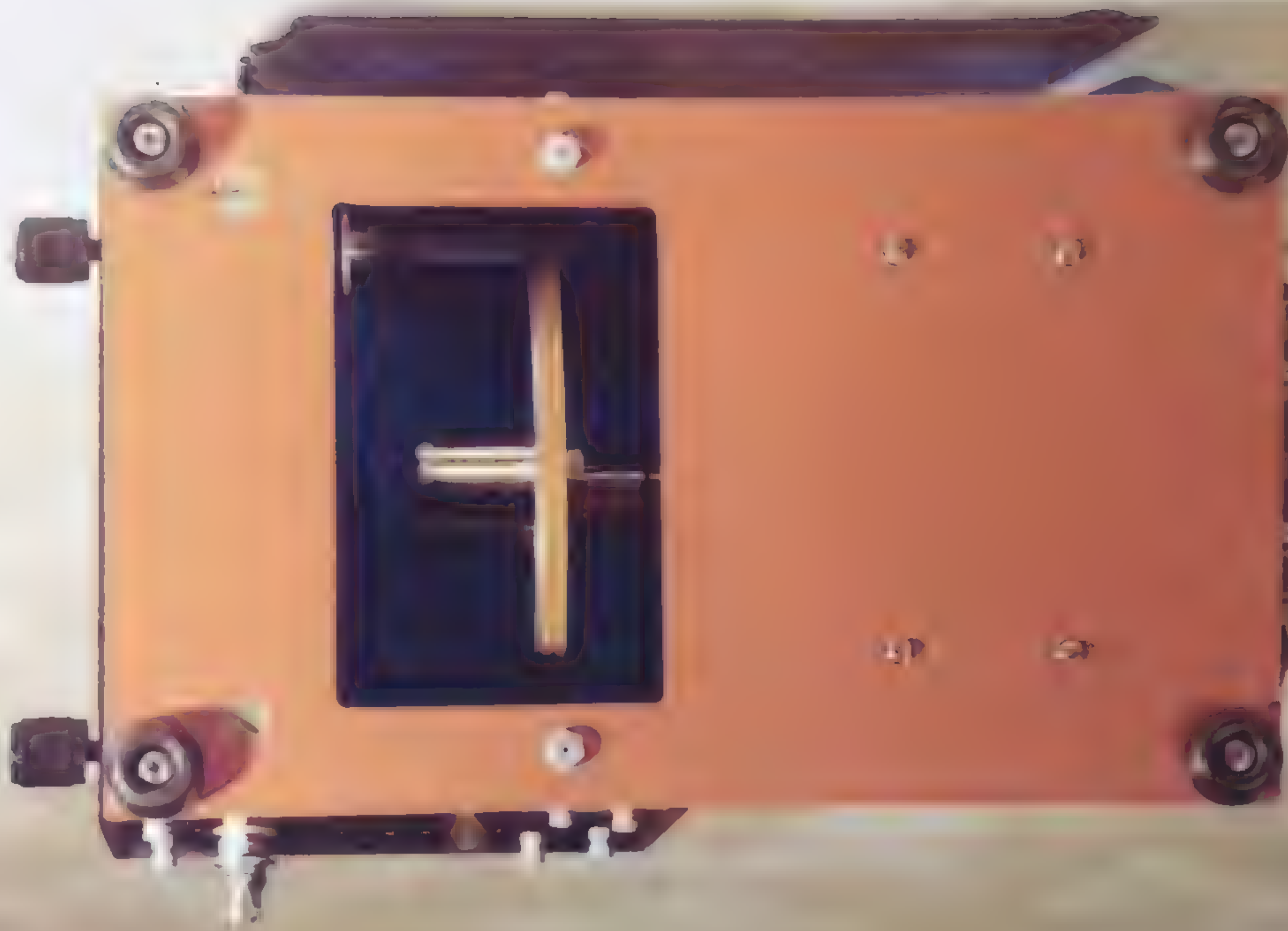


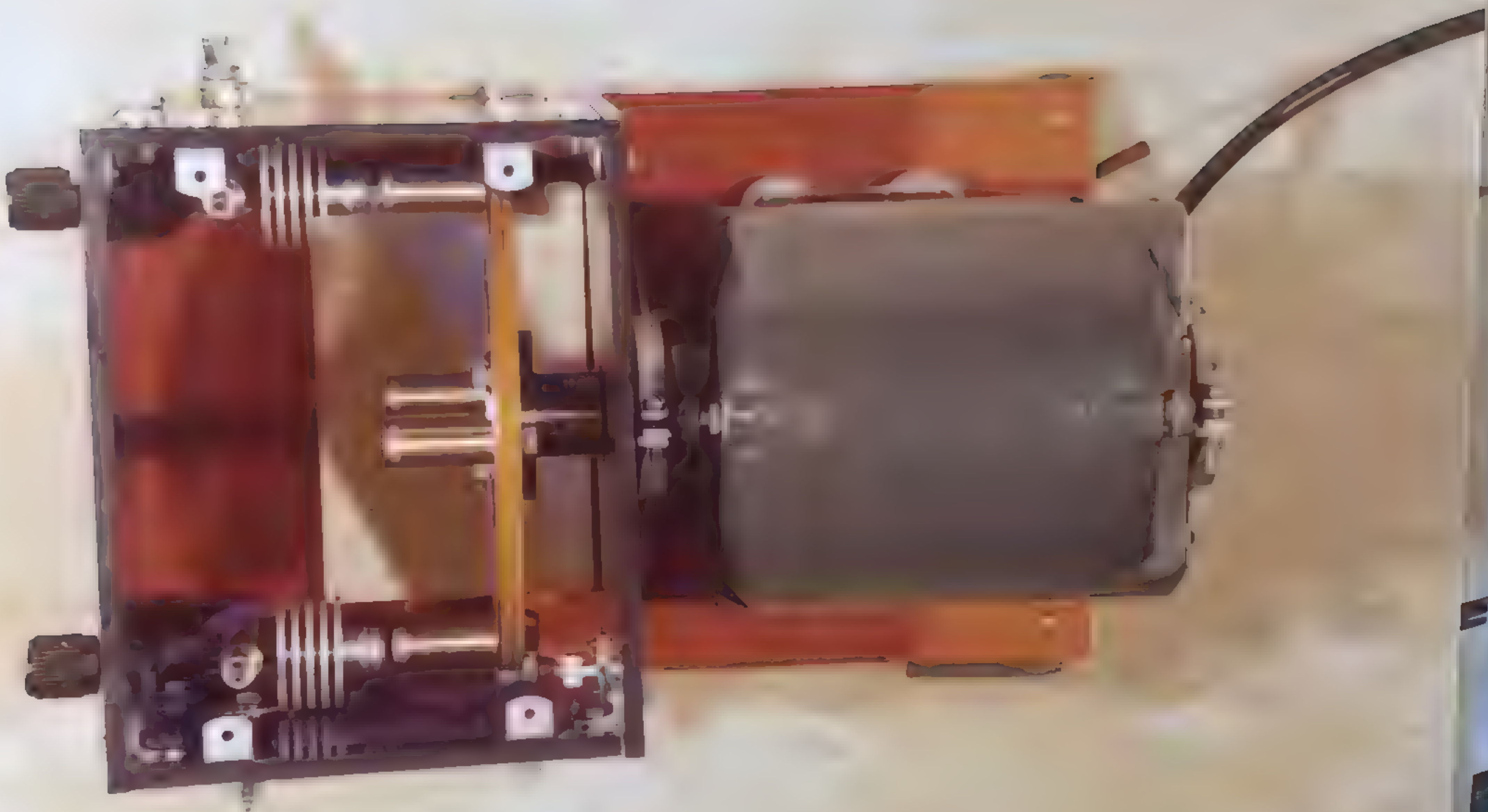








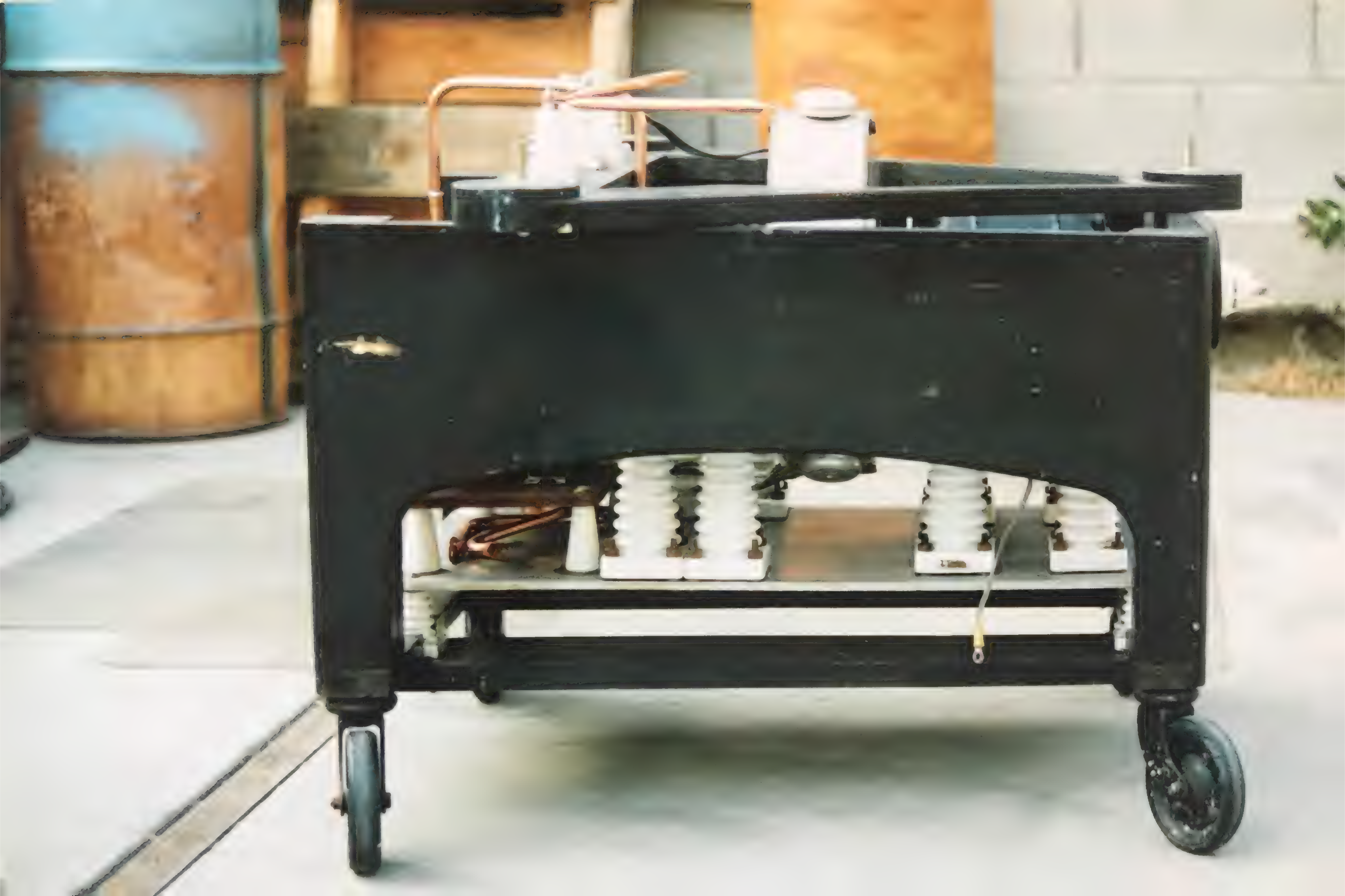


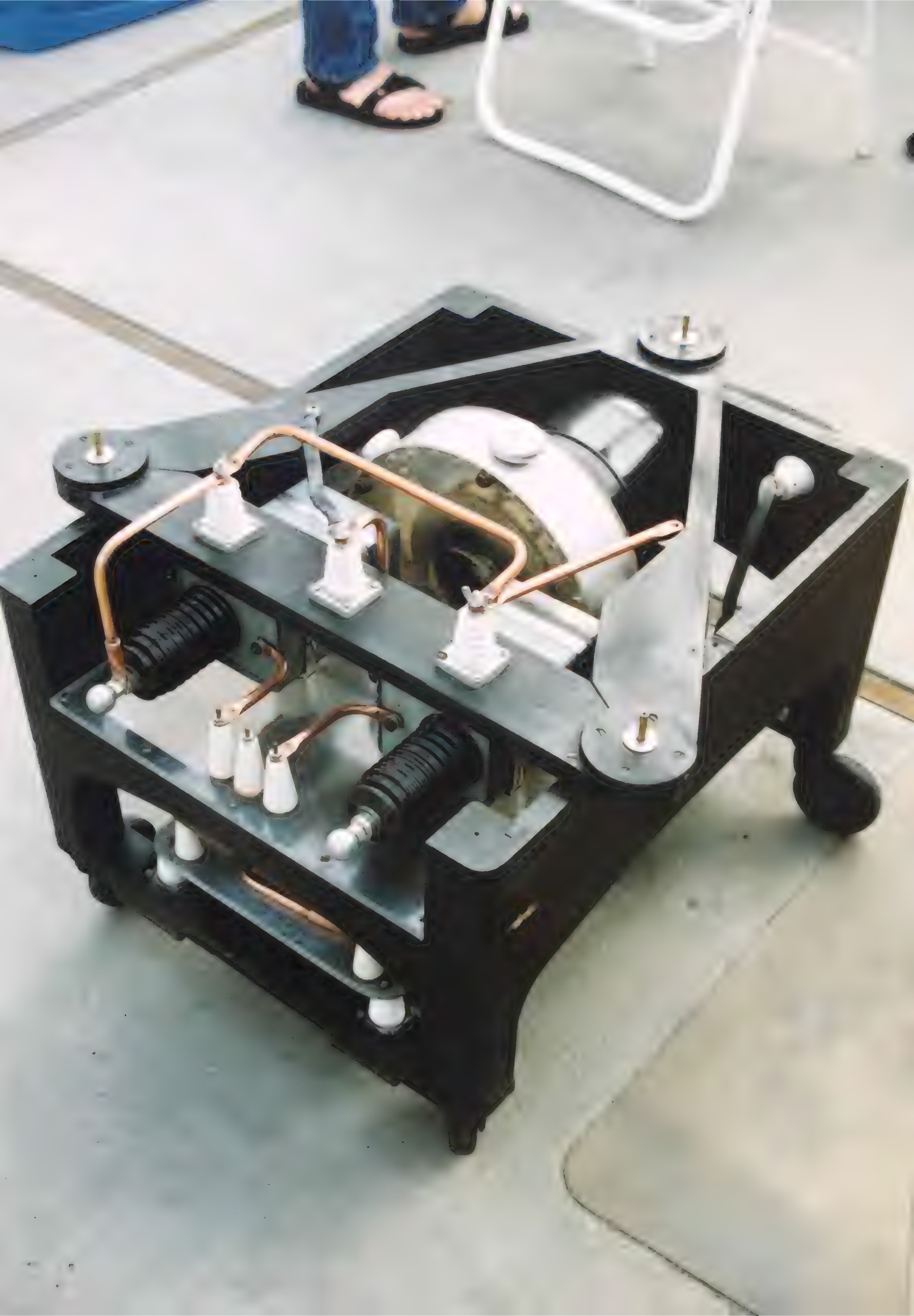






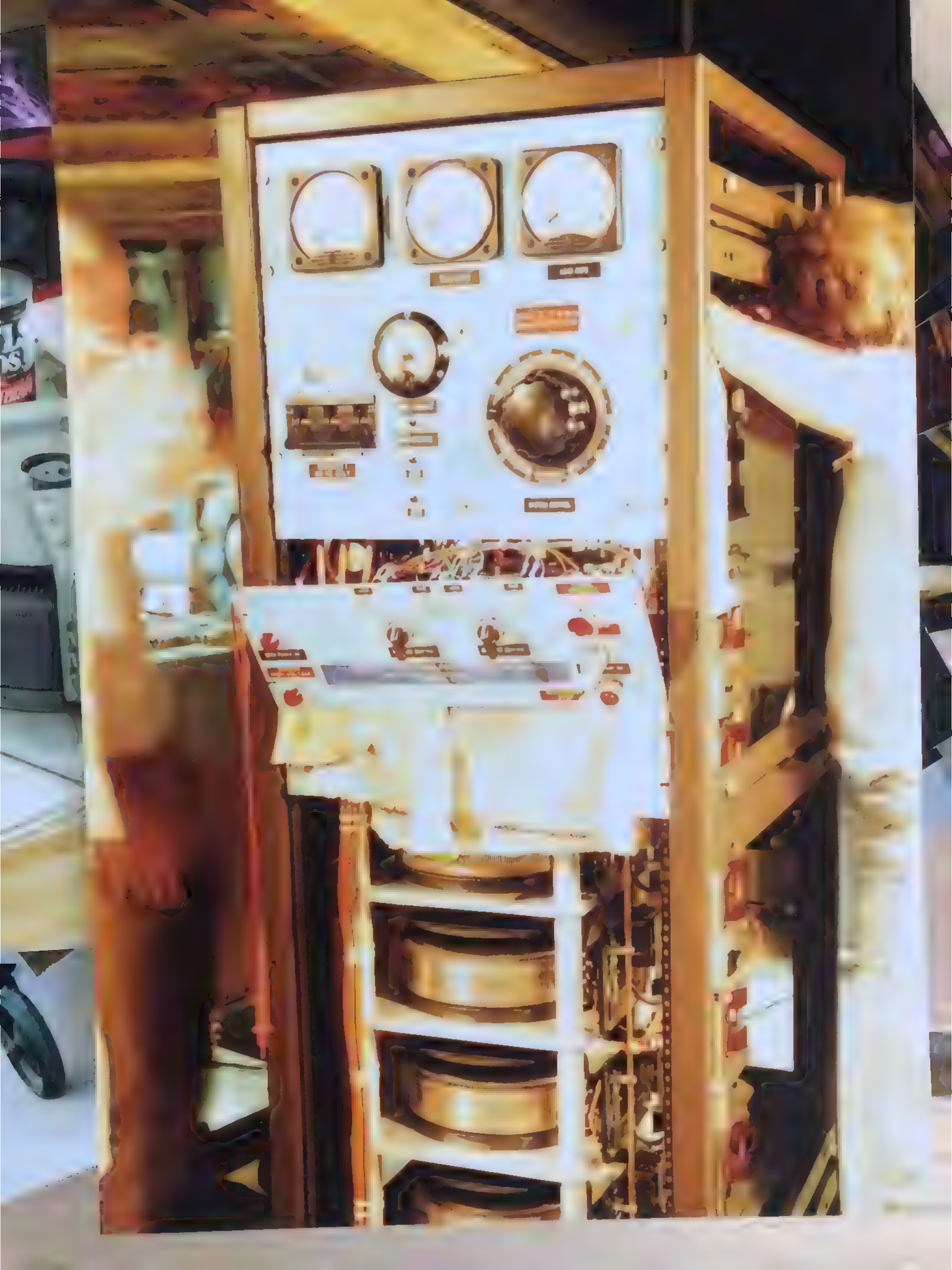


















































































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HARRY FISCHER
OF COUNSEL AT LAW

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Beverly Hills, CA 90212

Office 310-788-4790

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Fax 310-788-4770

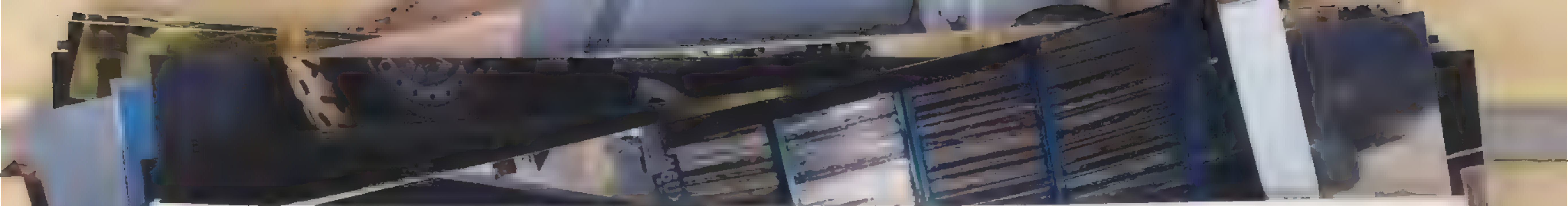
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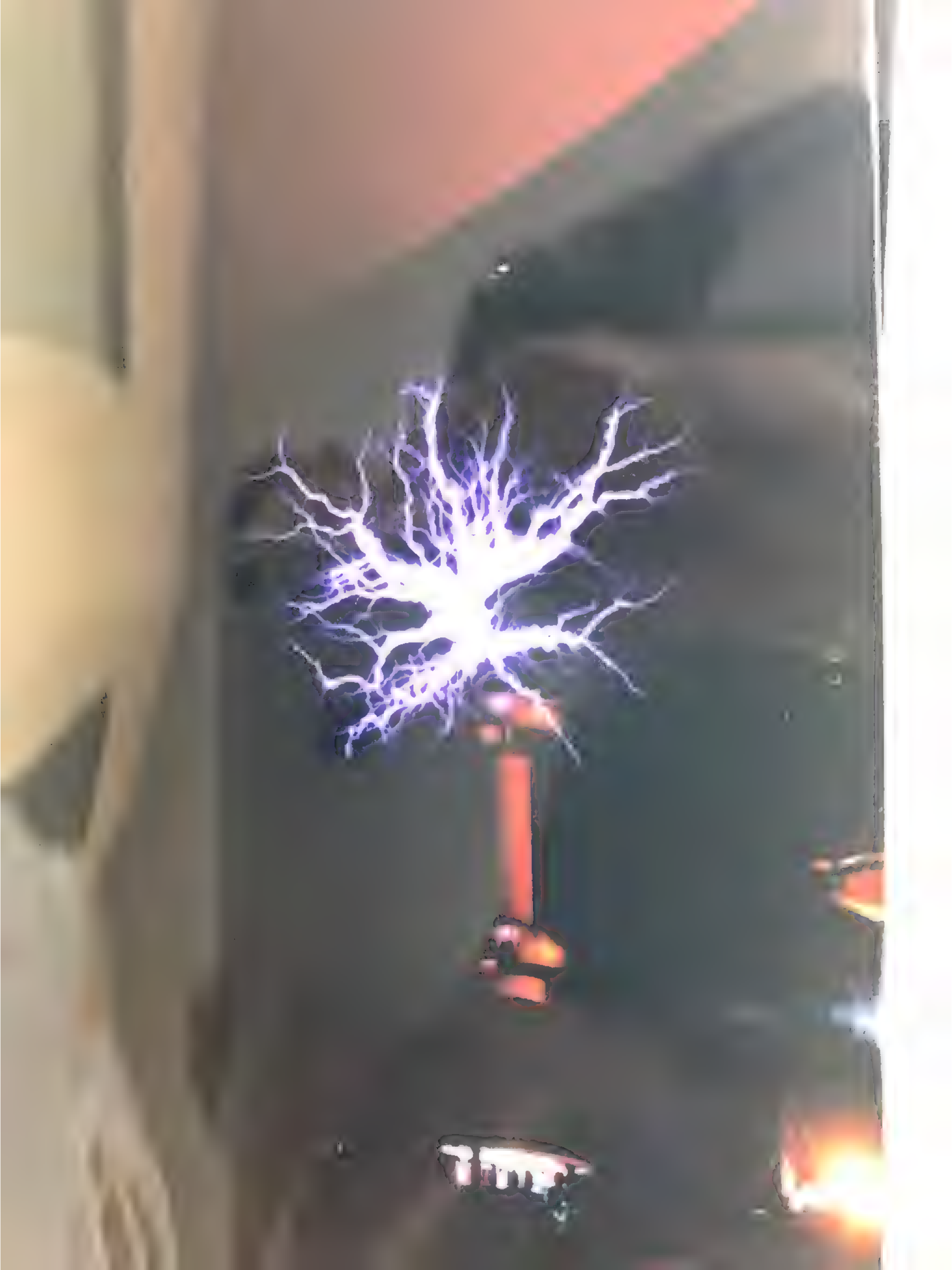
































BILL & WENNY

11-28-2001





































PORECLAM
INSULATORS

20" O.D. x 5"
ALUMINUM FOR
ELECTRODE

TESLA SECONDARY COIL

ON 1/2" MEDIUM 40 PVC

1" CABLE, 10"

1" CABLE, 10"

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1" CABLE, 10"

1" CABLE, 10"

FREE END OF CABLE HANGS TOWARDS GROUND
WHEN POLE ASS'Y
IS IN FAULTY POSITION.
GAP DISTANCE FROM END
OF CABLE TO FLOOR CUT
TO MEASURE 24" APPROX.
CABLE SHOWN WITH POLE IN
"STORED" VERTICAL POSITION.

#1 STRANDED CABLE.
(ONE ONLY FOR EACH OF 2
TRANSFORMER FEED-THRU
BUSHINGS.)

ALL COMPONENTS EITHER
GLASS (INSULATORS) OR
FIBERGLAS. NO METAL ALLOWED.
TYP. 2 PLS.

SEE DETAILS AT RIGHT.
(TYP. 3 PLS. AT REQ'D)

NON-CONDUCTIVE MAIN
SUPPORT "V" STRUNG
PHYLLISTRAN TYPE
CABLES.

CABLE UMBILICAL INCLUDES:
A. 1/2" O.D. AIR PRESSURE LINE
B. 3X12A.W.G. S.D. CABLE - ROTARY GAP POWER
C. 3X12A.W.G. S.D. CABLE - GROUND RETURN LINE (ALL 3 CONDUCTORS BUNDLED TOGETHER.)
D. 2X G.T.O. 15KV SINGLE CONDUCTORS

1/4" x 8" STEEL STRAP (WELDED EYE).
(MAIN HANGING SUPPORT. POSITION FOR
CENTER-OF-BALANCE ON COMPLETED
POLE ASS'Y WITH TANK & COIL IN
PLACE.)

FIBERGLAS POLE CONSTRUCTION
CROSS-SECTION

1" FIBERGLAS THREADED
ROD STOCK & SQUARE
NUTS AS REQ'D.
(TYP. 6 PLS.)

FIBERGLAS 5" x 5" x 1/2" TUBING

TRANSFORMER
TANK
CROSS-SECTION

FIBERGLAS
1 1/2" x 5" x 5"
(GRIND TO TANK
I.D. CONTOUR)
SHOULDER WASHER
PLATE

NOTE: DRAWING NOT TO SCALE:
FOR ASSEMBLY REFERENCE
ONLY.

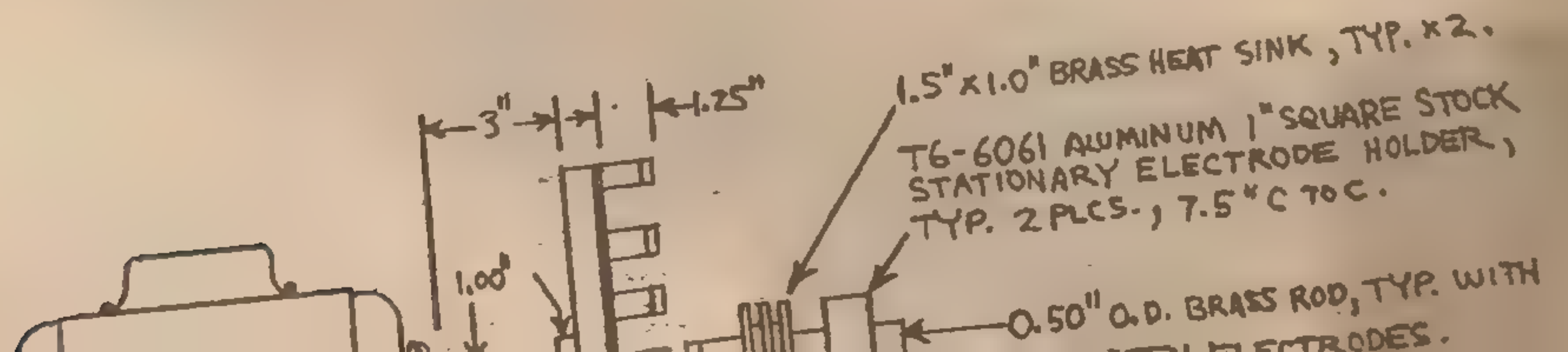
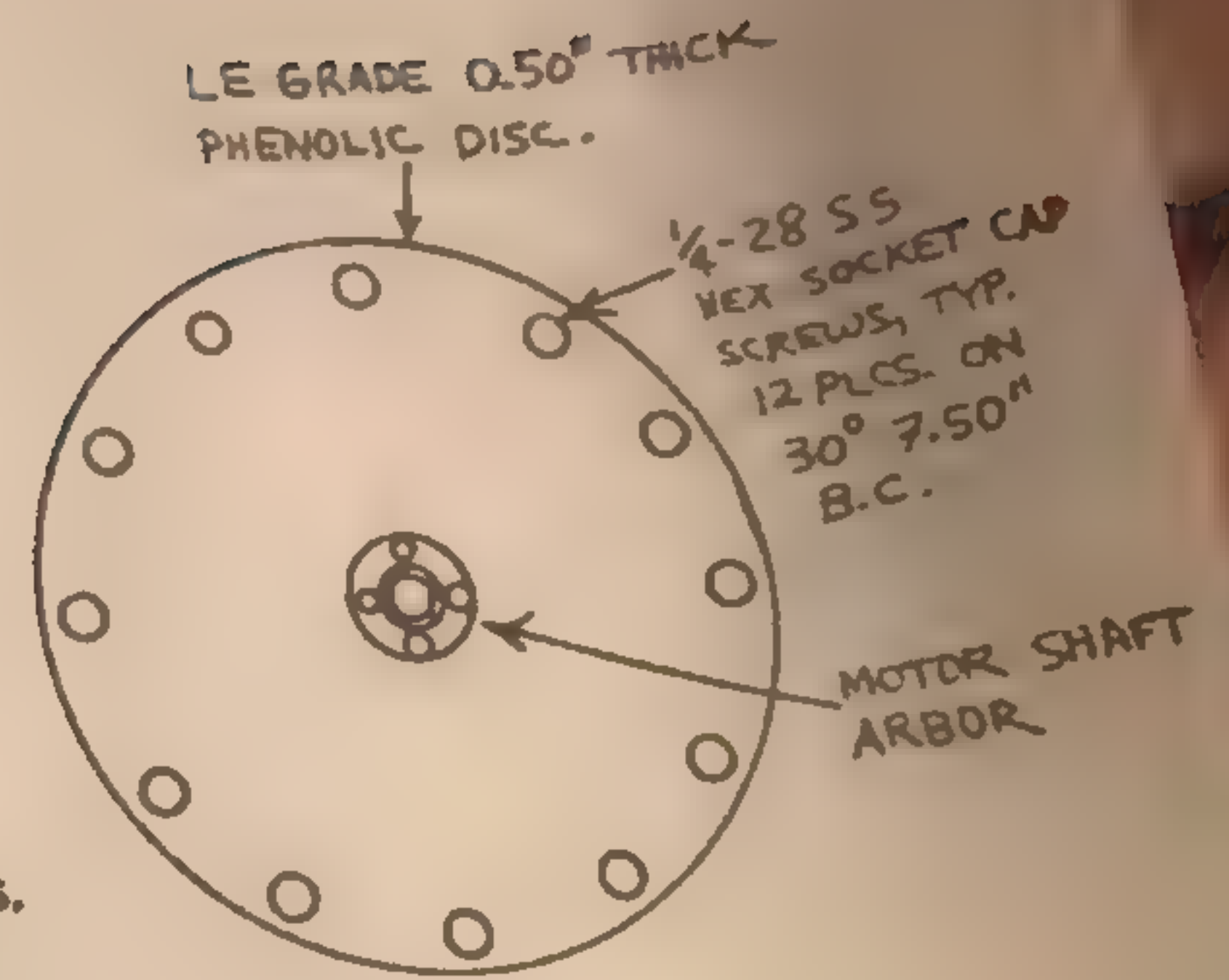
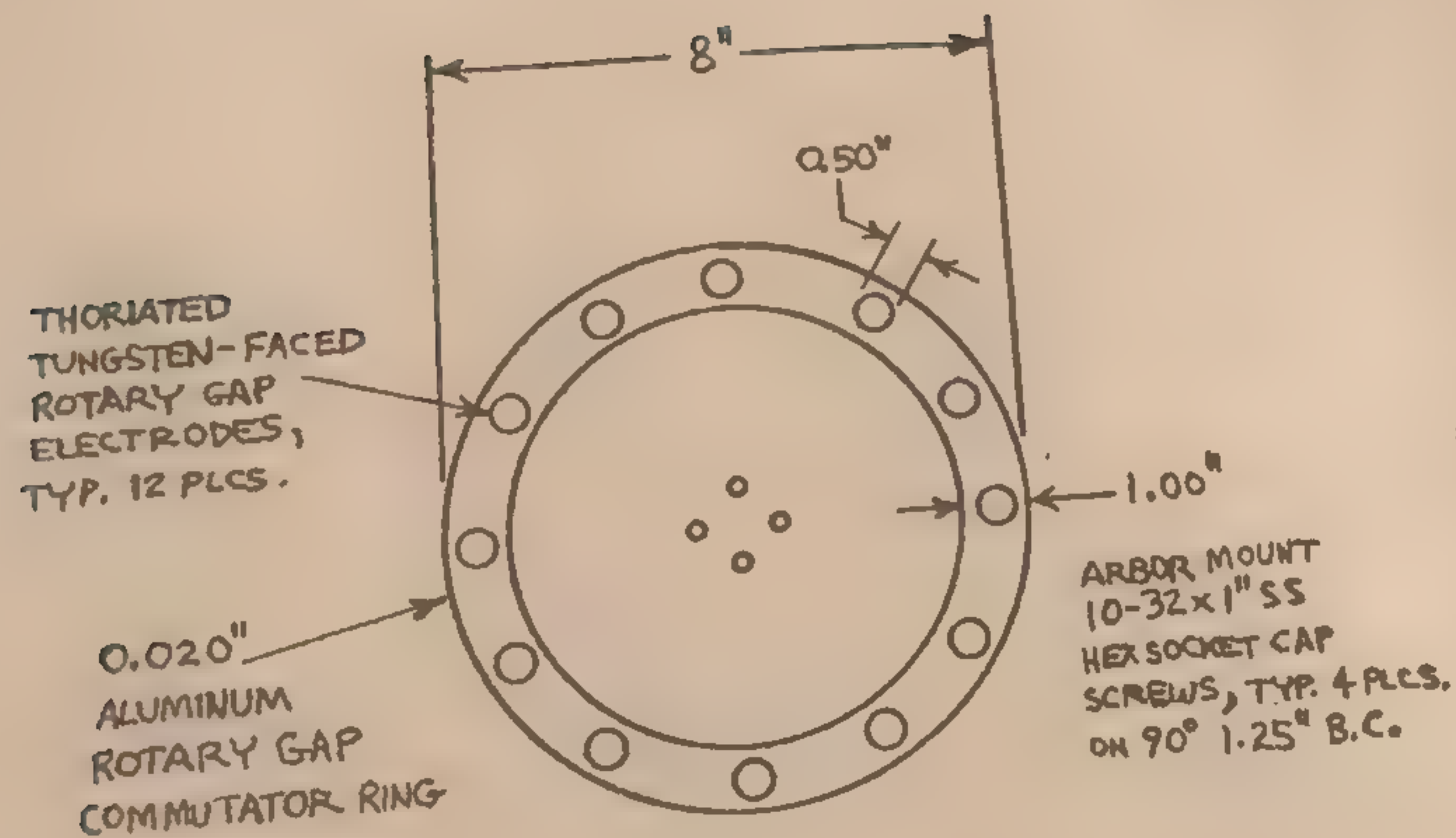
UNIVERSAL STUDIOS-FLORIDA
FALLING TELEPHONE POLE ASS'Y
POLE AND TRANSFORMER TANK ASSEMBLY

DRAWN: WCLW 1 NOV
SHEET ③ OF ③

TESLA
TECHNOLOGY RESEARCH
2527 Trudiane Ave.
Monrovia, CA 91016

TESLA
TECHNOLOGY RESEARCH
2527 Trudiane Ave.

TESLA
TECHNOLOGY RESEARCH
2521 TreeLant Ave
Menlo Park, CA 94026



51 / 35

3" LEXAN TUBE
CURVED KING

TESLA SECONDARY
COIL

TESLA PRIMARY
COIL

REMOVABLE
INSPECTION &
MAINTENANCE
COVER PLATE
FOR ROTARY GAP

ROTARY SPARK
GAP ASSY
(DRIVEN BY 1/2 H.P.
3450 RPM 1 Ø
120 V.A.C. MOTOR.)

3 COND BUSHHEAD CONNECTOR
FEED-THRU ON
#1 PORCELAIN
INSULATOR

NYLON SUPPORT
STAND OFF RODS,
TYP 4 PLCS.

1/2" AIR
TIGHT FEED THRU
INSULATOR TYP 2 PLCS.

1/2" AIR
TIGHT FEED THRU
INSULATOR TYP 2 PLCS.

2" LUCITE SUPPORT DISC

1/2" AIR
TIGHT FEED THRU
INSULATOR TYP 2 PLCS.

0.75" AIR
TIGHT FEED THRU
INSULATOR TYP 2 PLCS.

1/2" O.D.
STEEL PIPE
OR EQUIV. N.
BY OTHER MFG.
HARDWARE & NUTS
TYP 2 PLCS

NOTE!
THIS SIDE OF
POLE IS FACING
GROUND WHEN
POLE IS IN
COLLAPSED
POSITION.

1/2" LON OR POLYURETHANE
TANK, .375" WALL

1/4" FIBREGLASS BASE
SECURED TO 1/2" Ø OF
PLASTIC TANK

T-COIL GROUND
4 AWG TH

OSCILLATION CAPACITORS;
TYP 3 PLCS.

COAX LINES, RG-8U,
2 PLCS. ON NOS. 2,3
PORCELAIN INSULATORS
(CONNECTS H.V. TRANSFORMER
IN EQUIPMENT ROOM TO TESLA
COIL.)

CONNECT TO STEEL POLE

APPROX. SCALE, INCHES



ENVIRONMENTAL REQUIREMENTS

- 1.) POLE TOP SECTION AND TRANSFORMER TANK MUST REMAIN DRY AT ALL TIMES; I.E. NO CONDENSATION TO ACCUMULATE ON SURFACES, NO MOISTURE DRIP IN IMMEDIATE POLE AREA.
- 2.) DEPLOY DRY AIR BLAST OVER TOP OF POLE, & REQUIRED TO MAINTAIN DRY SURFACES.

ELECTRIC CABLE REQUIREMENTS

- 1.) 2 EA. RG-8U COAX, OR EQUIV. (FROM T-COIL TO H.V. PWR. SUPPLY IN EQUIPMENT ROOM.)
- 2.) 3 COND #10 A.W.G. SHIELDED CABLE WITH TYPE 50 NYMPHEN TACKET OR EQUIV.
- 3.) 1 COND. #4 A.W.G. TH TACKET GROUND WIRE (FROM T-COIL TANK TO METAL SECTION OF POWER POLE.)

FALLING POWER POLE

TESLA COIL INSIDE SIMULATED POWER TRANSFORMER CASE.

REF. NCA DWG. AB-SA-3312

SHEET 2 OF 2

DRAWN: W.C. WYSSOK 12-30-87

TESLA
RESEARCH
LABORATORY

3/8" COPPER TUBE
CORONA RING

TESLA SECONDARY
COIL

TESLA PRIMARY
COIL

REMOVABLE
INSULATION &
MAINTENANCE
COVER PLATE
FOR ROTARY GAP

ROTARY SPARK
GAP ASSY
(DRIVEN BY 1/2 H.P.
3450 RPM 1Ø
120 V.A.C. MOTOR.)

3 COND BUSHHEAD CONNECTOR
FEED-THRU ON
#1 PORCELAIN
INSULATOR

NYLON SUPPORT
STAND-OFF RODS,
TYP 4 PLCS.

COAX LINES, RG-8U,
2 PLCS. ON NOS. 2,3
PORCELAIN INSULATORS
(CONNECTS H.V. TRANSFORMER
IN EQUIPMENT ROOM TO TESLA
COIL.)

SHORT WIRE CORONA POINT
DISCHARGE ELECTRODE

HIGH VOLTAGE
PORCELAIN FEED-THRU
INSULATOR, TYP. 2 PLCS.

NYLON 1/8" IN. HEX
BOLTS, TYP. 2 PLCS.

1/2" LUCITE SUPPORT DISC
1/8" X 1/4" WALL
FIBERGLAS TUBING

NYLON OR POLYURETHANE
TANK, .375" WALL

1/4" FIBERBOARD BASE,
SECURED TO I.D. OF
PLASTIC TANK

T-COIL GROUND
4 AWG TH

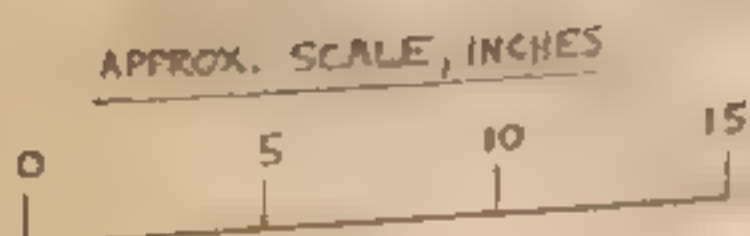
OSCILLATION CAPACITORS;
TYP 3 PLCS.

CONNECT TO STEEL POLE

0.75" W.D.
4.0" H.D.

3/4" O.D.
EPOXY FIBER
OR FIBERGLAS TUBING
W/ 1/8" X 1/4" WALL
WASHER & NUTS;
TYP 2 PLCS.

NOTE!
THIS SIDE OF
POLE IS FACING
GROUND WHEN
POLE IS IN
COLLAPSED
POSITION.



ENVIRONMENTAL REQUIREMENTS

- 1.) POLE TOP SECTION AND TRANSFORMER TANK MUST REMAIN DRY AT ALL TIMES; I.E. NO CONDENSATION TO ACCUMULATE ON SURFACES, NO MIST OR SPRAY IN IMMEDIATE POLE AREA.
- 2.) DEPLOY DRY AIR BLAST OVER TOP OF POLE, IF REQUIRED TO MAINTAIN DRY SURFACES.

ELECTRIC CABLE REQUIREMENTS

- 1.) 2 EA. RG-8U COAX, OR EQUIV. (FROM T-COIL TO H.V. PWR. SUPPLY IN EQUIPMENT ROOM.)
- 2.) 3 COND. #10 A.W.G. SHIELDED CABLE WITH TYPE 50 JACKET OR EQUIV.
- 3.) 1 COND. #4 A.W.G. TH JACKET GROUND WIRE (FROM T-COIL TANK TO METAL SECTION OF POWER POLE.)

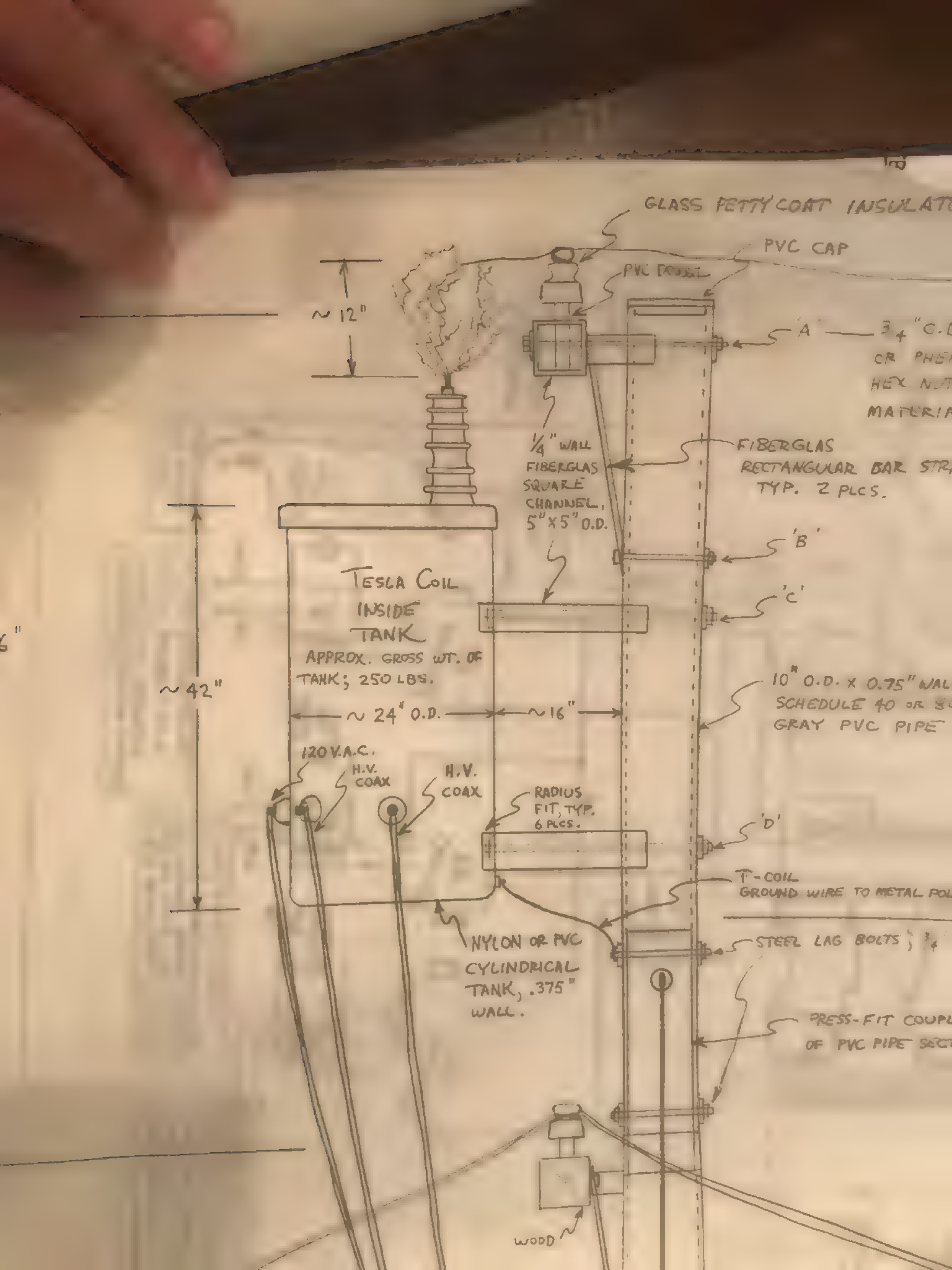
FALLING POWER POLE

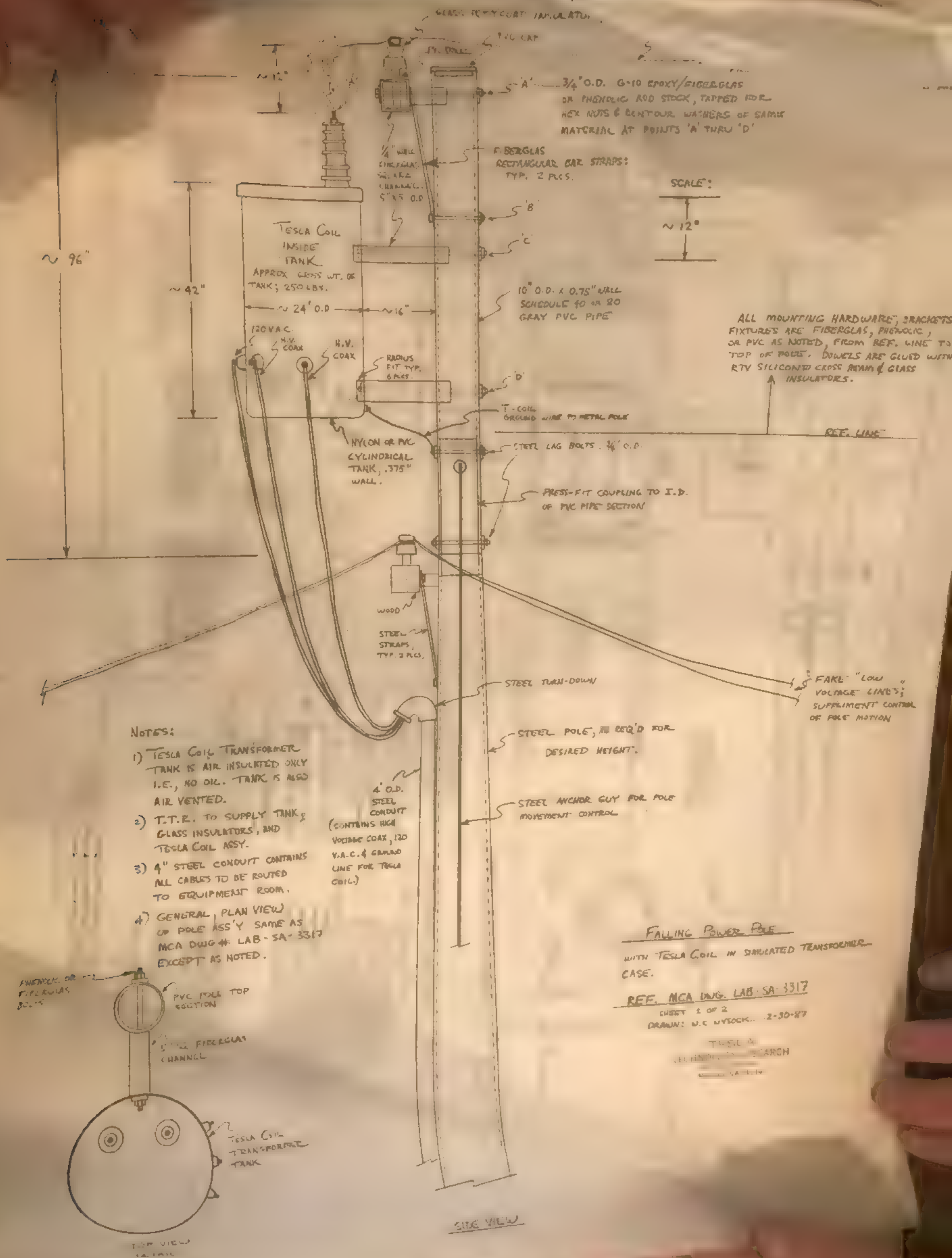
TESLA COIL INSIDE SIMULATED POWER
TRANSFORMER CASE.

REF. MCA DWG. LAB-SA-3317

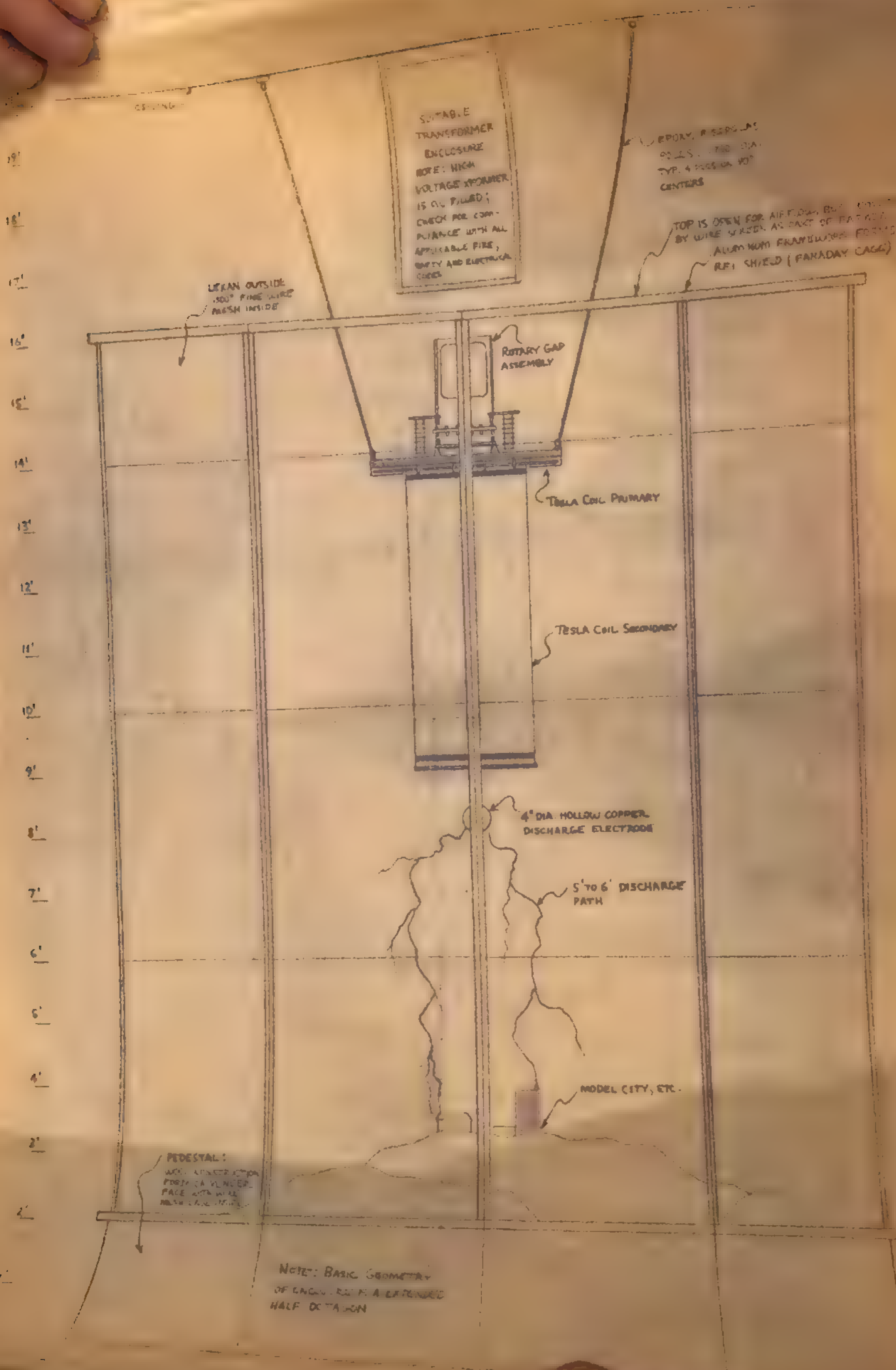
SHEET 2 OF 2
DRAWING DATE: 11/20/87

TESLA
SEARCH









SUITABLE
TRANSFORMER
ENCLOSURE
NOTE: HIGH
VOLTAGE TRANSFORMER
IS OIL FILLED;
CHECK FOR COM-
PLIANCE WITH ALL
APPLICABLE FIRE,
SAFETY AND ELECTRICAL
CODES

EPOXY RESIN
POLES, 1/2" DIA.
TYP. 4 INCHES APART
CENTERS

TOP IS OPEN FOR AIR FLOW, BUT MUST BE LINED WITH
BY WIRE MESH, AS PART OF FARADAY CAGE
ALUMINUM FRAMEWORK FORMS PART OF
RF SHIELD (FARADAY CAGE)

UTERAN OUTSIDE
100" FINE WIRE
MESH INSIDE

ROTARY GAP
ASSEMBLY

TESLA COIL PRIMARY

TESLA COIL SECONDARY

4" DIA. HOLLOW COPPER
DISCHARGE ELECTRODE

5' TO 6' DISCHARGE
PATH

MODEL CITY, ETC.

PEDESTAL:
WOOD CONSTRUCTION
POSSIBLE VENEER
FACE WITH WIRE
MESH LANE ATTACH

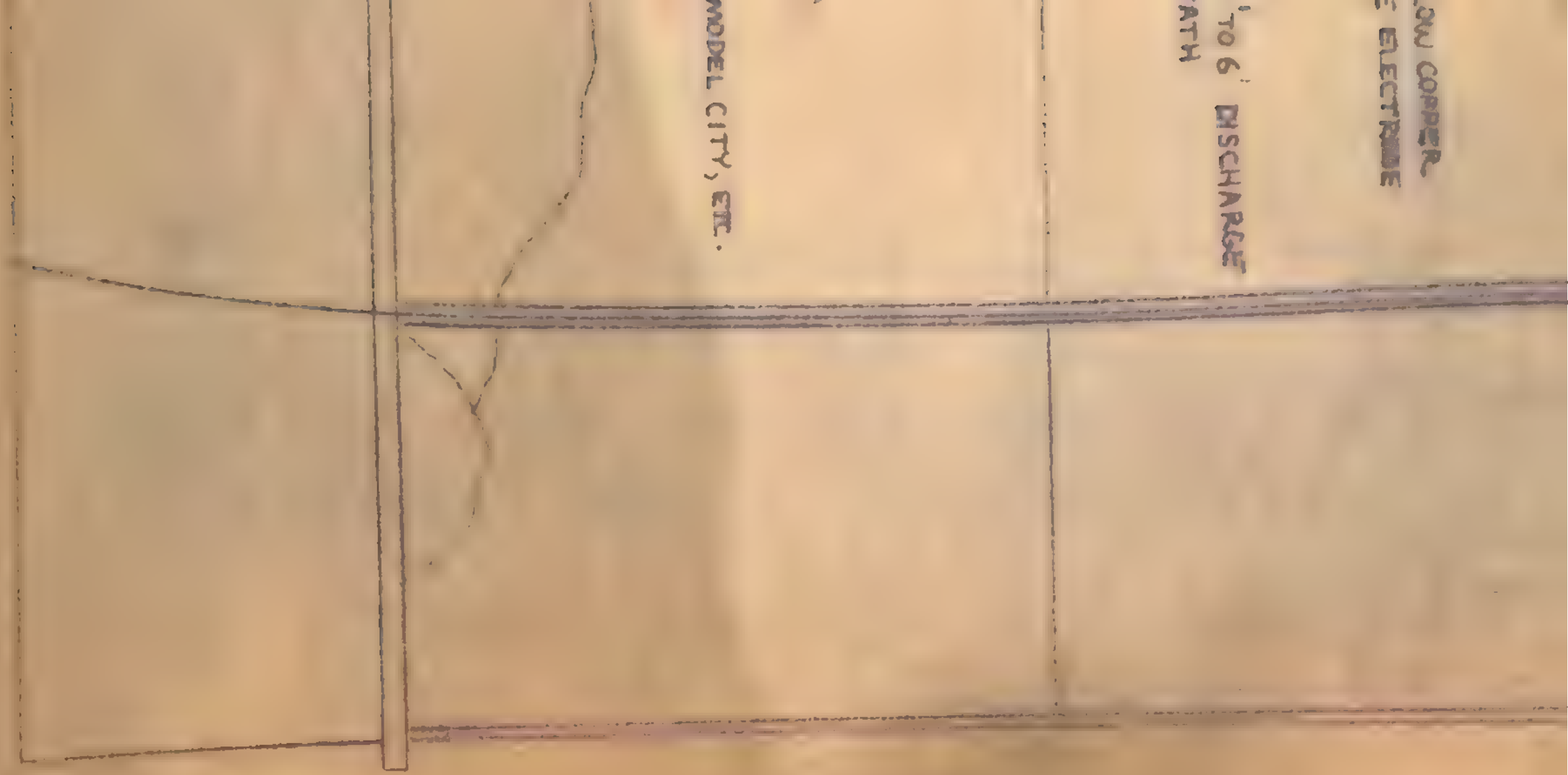
NOTE: BASIC GEOMETRY
OF ENCLOSURE IS EXTENDED
HALF SECTION

EXHIBITION SYSTEMS
FOR DISSEMINATION
OF SCIENCE FOR
TECHNICAL
EDUCATION

200 COPPER
ELECTRODE

TO 6 DISCHARGE
ATH

MODEL CITY, ETC.



PROFESSIONAL SOUND SYSTEMS
ULTRA HIGH VOLTAGE DIVISION

SUGGESTED ENCLOSURE SCHEME FOR
MODEL 7 TESSA CATHODE SYSTEM

MODEL 7 TESSA CATHODE SYSTEM

ENCLOSURE BY: M.C. JOY SAUER
10-21

Ceiling

SUITABLE
TRANSFORMER
ENCLOSURE
NOTE: HIGH
VOLTAGE XFORMER
IS OIL FILLED;
CHECK FOR COM-
PLIANCE WITH ALL
APPLICABLE FIRE,
SAFETY AND ELECTRICAL
CODES.

EPONY/PIBERGLAS
POLES, .750" DIA.
TYP. 4 PLCS ON 90°
CENTERS

TOP IS OPEN FOR AIR FLOW
BY WIRE SCREENS AS PART OF
ALUMINUM FRAMEWORK
RFI SHIELD (PARTIAL)

LEXAN OUTSIDE
.500" FINE WIRE
MESH INSIDE

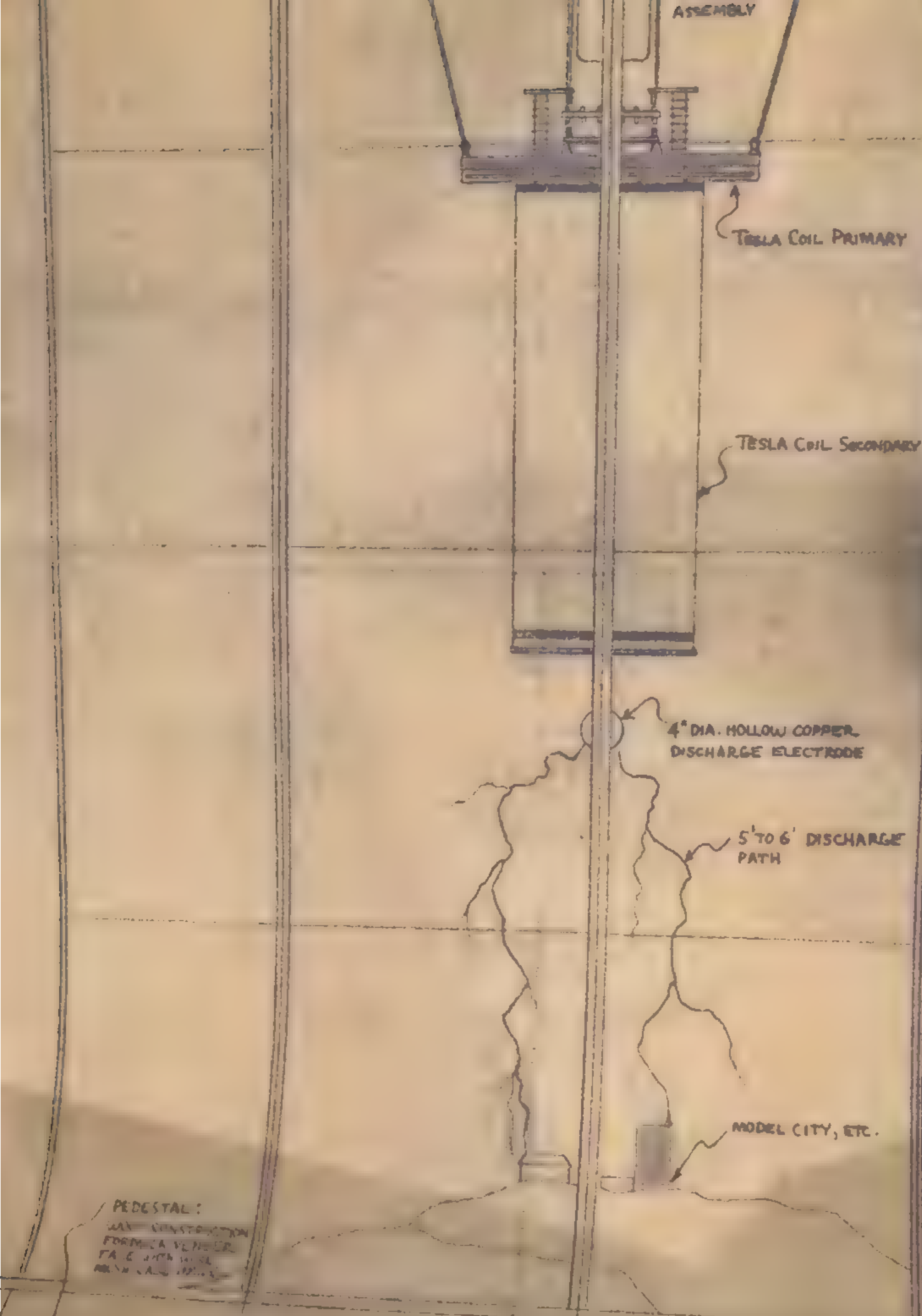
ROTARY GAP
ASSEMBLY

TESLA COIL PRIMARY

TESLA COIL SECONDARY

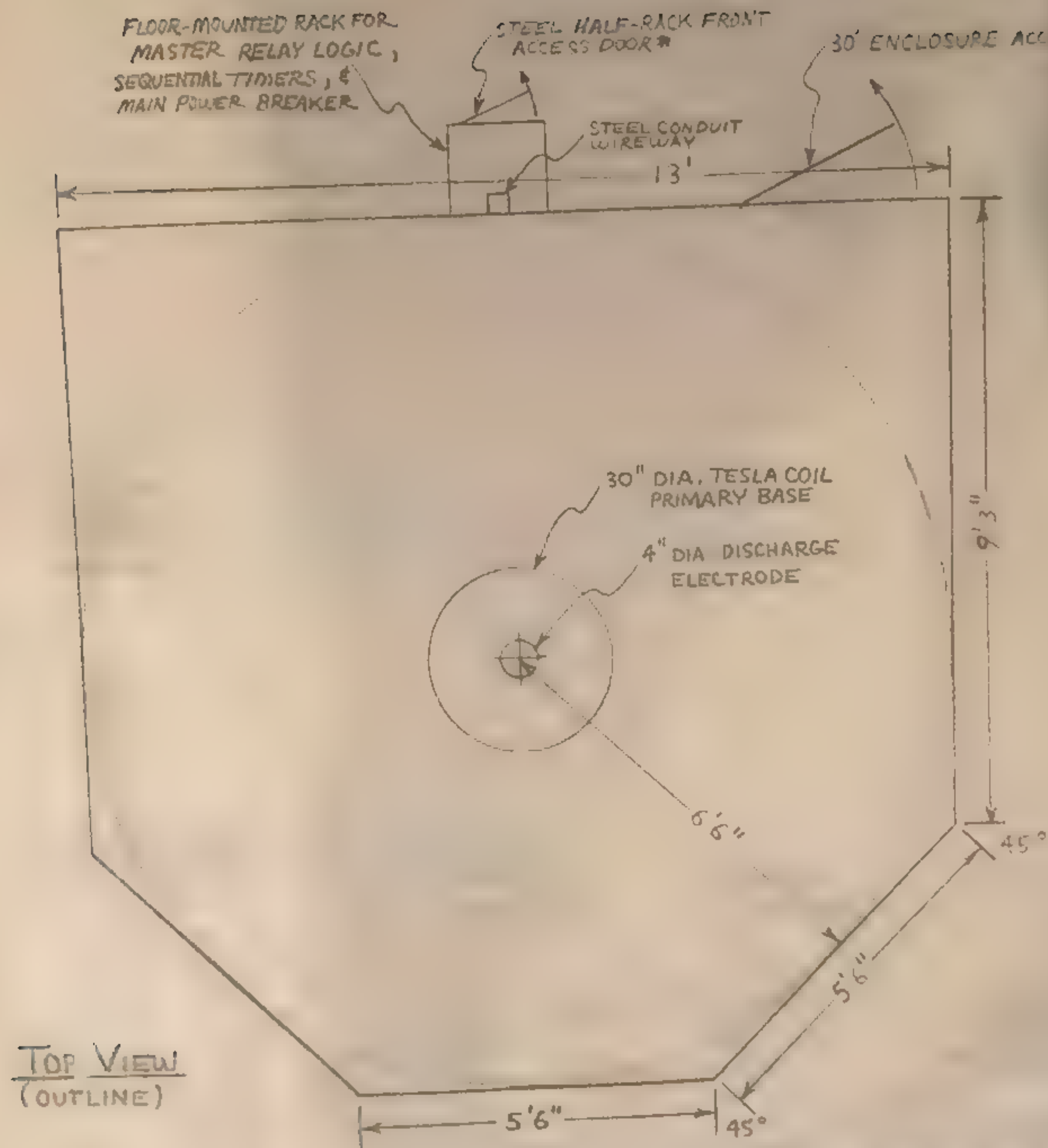
4" DIA. HOLLOW COPPER
DISCHARGE ELECTRODE

5' TO 6' DISCHARGE
PATH



NOTE: BASIC GEOMETRY
OF ENCL. RD. K A EXTENDED
HALF OCTAGON

TELETYPE SYSTEMS
DIVISION
TELETYPE SCHEME FOR

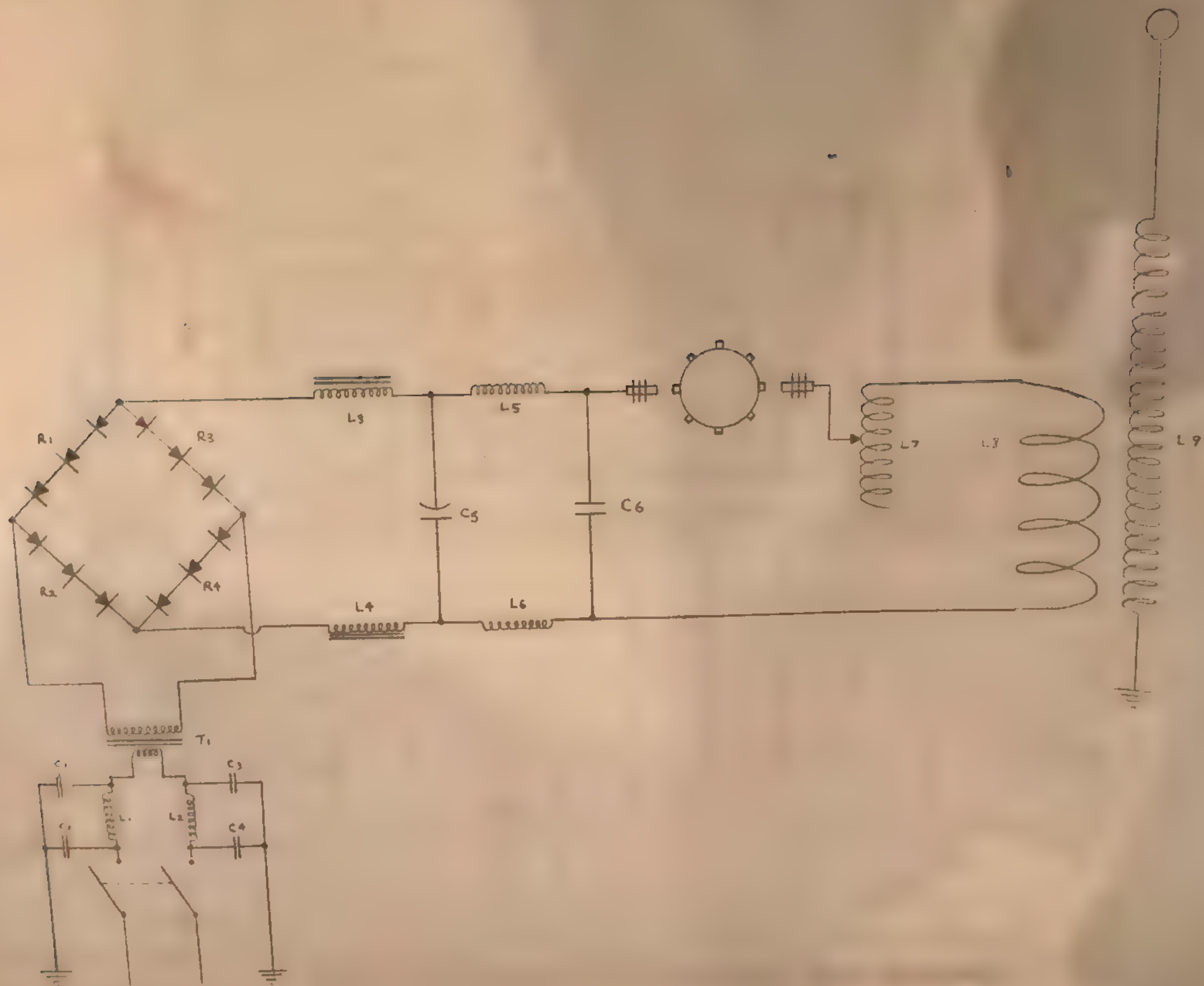


* NOTE: ALL ACCESS DOORS TO BE EQUIPPED WITH LOCK SWITCHING (ALL EQ IS TO BE 100% DISAB ALL DOORS TO HAVE 2 KEY LOCKS: MUSEUM SUPERVISOR TO HOLD TECHNICAL SUPPORT TO HOLD SECOND KEY.

SCALE: 1" SQ. = 24" SQ.

PROFESSIONAL SOUND SYSTEMS - ULTRA HIGH VOLTAGE DIVISION
 MODEL 9 TESLA COIL SYSTEM DISPLAY ENCLOSURE
 FOR
 HILLSBOROUGH COUNTY MUSEUM OF SCIENCE & INDUSTRY

DRAWN: W.C. WYSOCKI
 3-10-81



PREVIEW

PROGRAM

LINE IN

NOTE:
LINE OUT
CONNECTS
TO ALBEC
MASTER
8237

ALTEC 8714
VU RANGE

MONITOR GAIN

UTC A-24

UTC A-24

SCOPE OUTPUT

PHASE
REVERSE

STEREO-MONO

UTC LS-91

UTC LS-

BOARD INPUT

UTC LS-91

MONO BAL. B

MONO BAL. A

51"

192"

