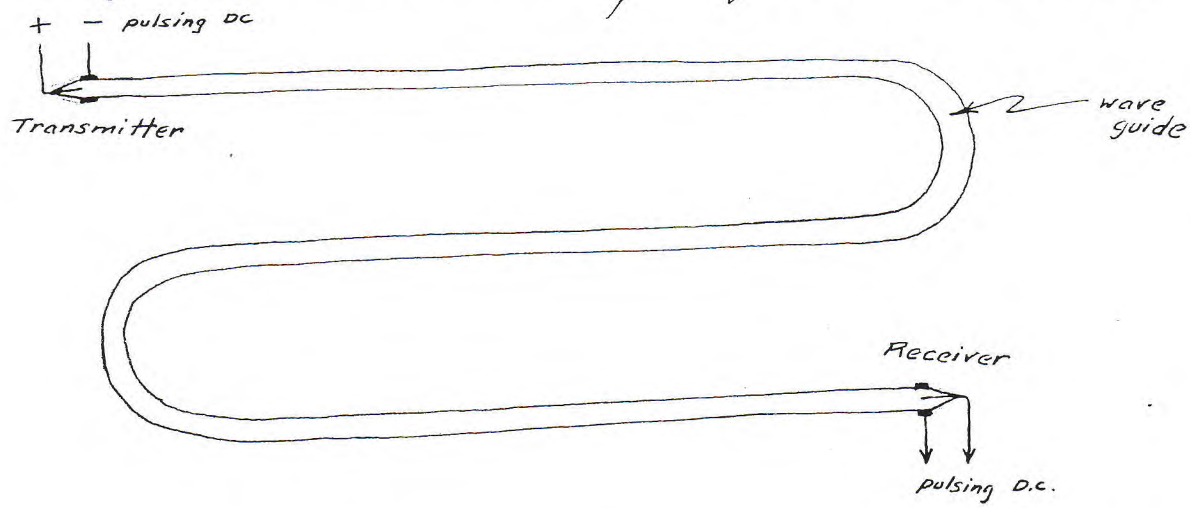
T. T. Brown

Vega Aircraft Corp.
Burbonk, Calif.

NOTES

Wave guide transmission of "splash" radiation.



1. Radiant dielectrics are installed at the ends of a wave guide (tubing). 2. If the dielectrics are of the proper type for low-loss transmission, the internal radiation may be transmitted and received, using a <u>solid dielectric wave guide</u> instead of metallic tubing. The system bears a striking resemblance to an elementary nerve structure, where the nerve fibre is a dielectric wave guide. If such a relation does actually exist, it is possible that radiations of from 10 mm to .1 mm wavelength may have interesting effects on the nervous system, and that certain mitogenetic radiations may be identified as lying in this frequency region. Pulsing discharges are possibly transmitted along the nerve fibre to create equivalent electrical pulses at the receiving end. Thus a nerve fibre is visualized as a wave guide (dielectric fibre) capable of transmitting u h f "splash" radiations, and not a kind of organic electrical conductor for the low frequency nerve or muscle-activating pulses. Reference: "Researches of the Johnson Foundation".

Dec. 28, 1942

Quoting from P. 391 - Lindenblad: Transmitters for Frequencies Above 300 mc. "Radio at Ultra High Frequencies, R.C.A. Institute Technical Press.

"The electric field from the electron, which at a distance covers the electrode fairly uniformly and causes a current of no definite origin to flow thru the electrode, as the electron moves, becomes more concentrated as the electron nears the electrode. The current origin in the electrode becomes more and more defined into a spot under the electron where it becomes very concentrated. The direction of this current is toward the spot if the electron is in an approaching state and away from the spot if the electron is in a receding state. --- This phenomenon is naturally extremely rapid in that such concentrations do not become noteworthy until the electron is fairly near the electrode. It takes place during a very small fraction of the total transit time of the electron. Its period is therefore greatly in excess of that represented by the transit time and represents real ultra-high frequencies. These "surface oscillations" are independent of the frequency at which the device operates and depend only upon the number and velocity of the electrons.

Carrying the discussion a little further it becomes increasingly difficult to see where to draw the line between these "spot impulses" and heat quanta. It depends largely upon the size of the area under consideration if the period belongs to the radio-frequency region or the heat region. If the electron is headed for a landing on the electrode the spot becomes smaller and smaller until we reach the molecular and atomic structure of the electrode where the remaining kinetic energy is interchanged.

If the electron does not approach the electrode quite so close, like for instance when an electron passes thru a grid structure the frequency produced, while high, is definitely one far below that of heat."

current triggered by the field on the grid.

Radar Receiver

This radiating system may be used as a receiver as well. Radiant energy will cause the extremities of the dielectric to become differently charged. Audio amplifiers must then be used to bring this signal up to the desired level to operate the "scopes". No radio frequency circuit is employed, except that in the antenna-rectifier system.

Another receiving system might utilize the variation in the cathode to plate current. Fig. 2.

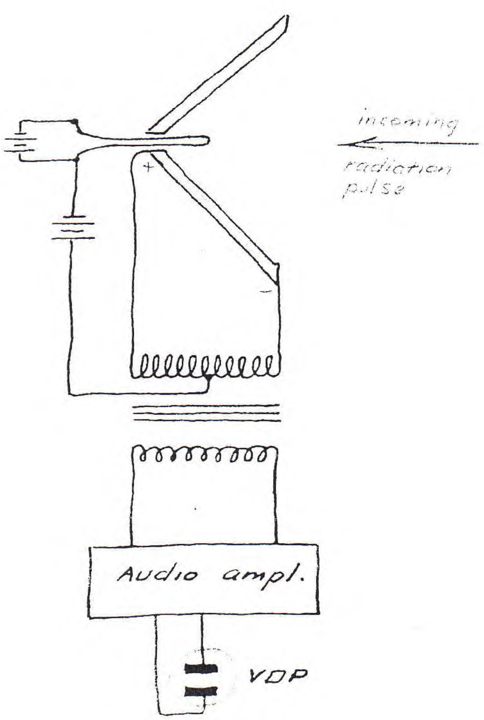


Fig. 1

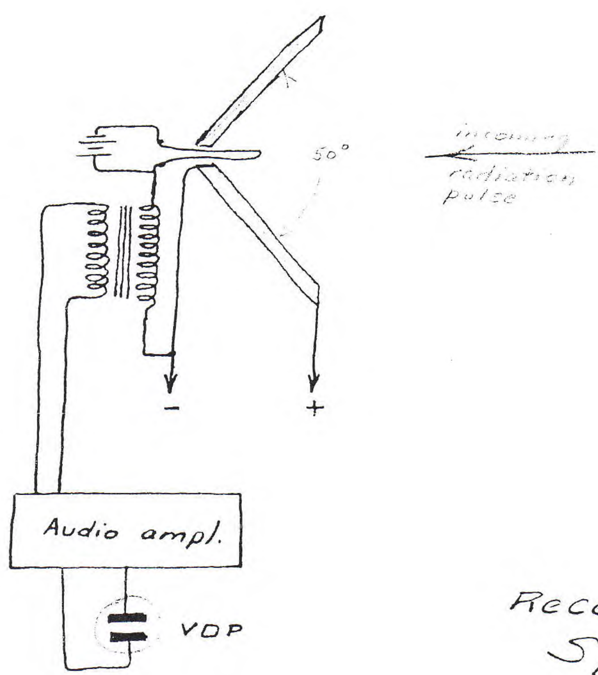
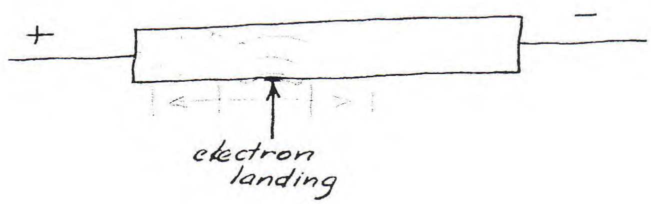


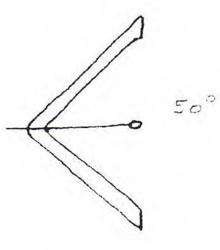
Fig. 2.

Receiving Systems

The arrangement of dielectric shown in Fig 1 of P. 62 differs radically from that described earlier in these notes. It is the thought that the transients caused by the landing of electrons on the dielectric are transmitted principally along the surface where the electrons land. Internal waves induced in the dielectric are perfectly reflected by the opposite surface. These internal waves do not reach the outside, because of the great difference in impedence.



Therefore, radiation is present in the space between the walls of the dielectric cone occupied by the ionizing wire or cathode. These radiations leave the cone at the "open" end and are beamed by the 50° optimum angle.



No radiation is present on or from the back of the cone. The applies only to "splash" radiation. Relaxation frequencies are undoubtedly present on the back side, but of less magnitude than in front.

Dec. 11, 1942

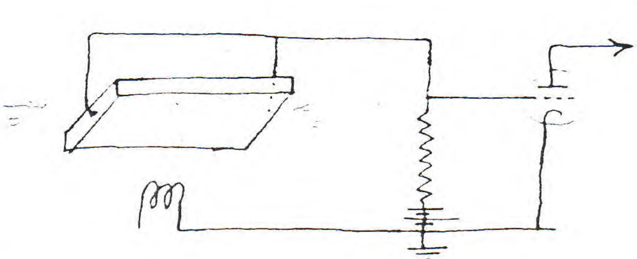
Type A is reversible. For this purpose it is made symmetrical. When the slider on the high voltage potentiometer is moved toward the negative end, the force (or radiation) is increased regardless of the position of direction-reversing switch S. The direction of radiation is always toward the positive electrode; the direction of reactive forces always toward the negative.

Type B is not reversible. The slider controls the force, as in Type A.

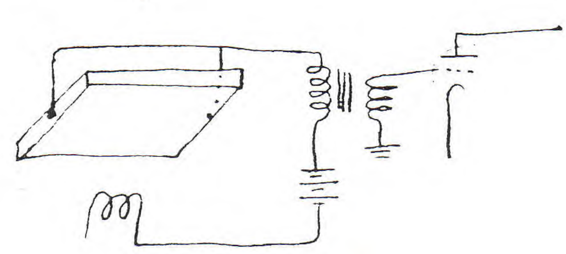
Type A may also be used as a bi-lateral transmitter, See P. 28-29. For this application, both ends of the semi-conducting dielectric are made positive with respect to the cathode.

Bi-lateral Transmitter

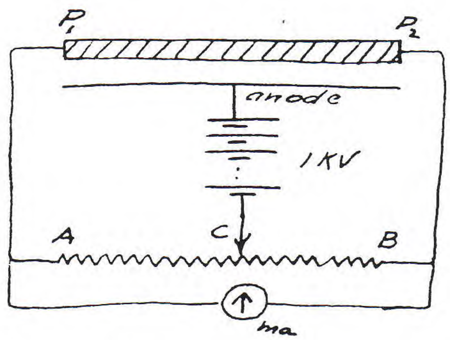
As a bilateral receiver, the following circuit is indicated: Pulsating radiation only.



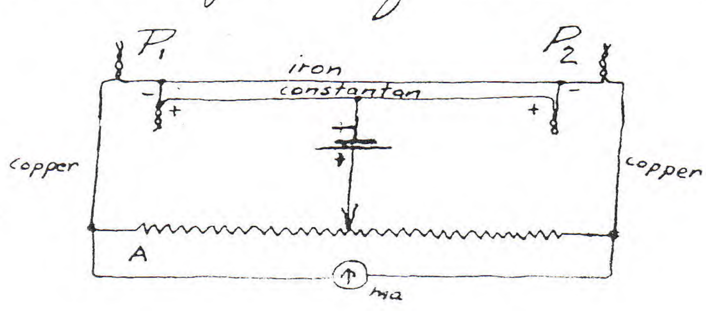
or



substantially what happens in the case of dissimilar metal junctions of a thermocouple.

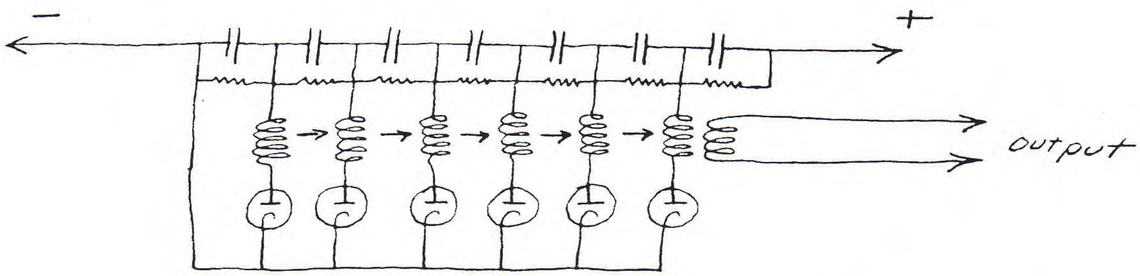


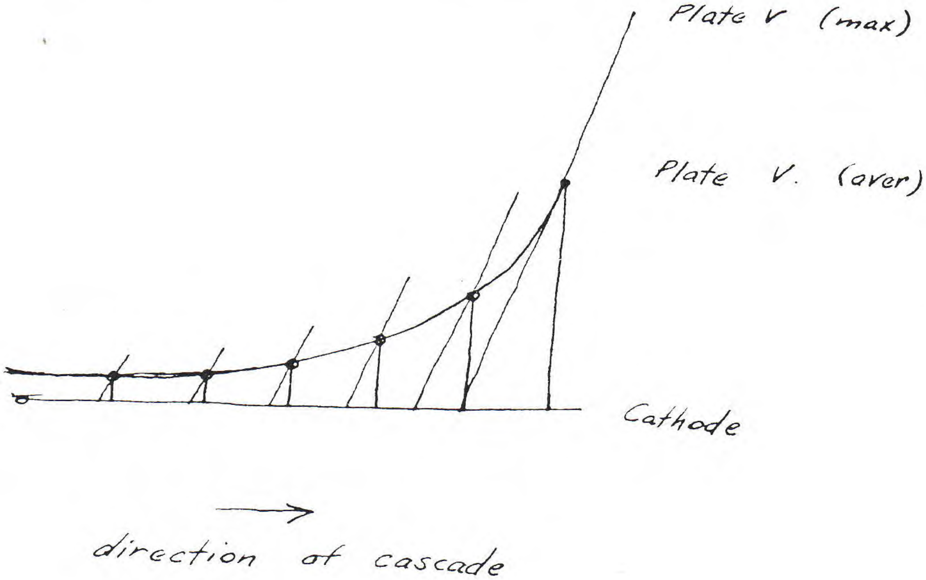
Dielectric rod P_1P_2 is arranged in close proximity to an anode plate as indicated. So long as the dipole oscillation (temperature) of region P_1 equals that of P_2 the nul position of the potentiometer slider is centered between A and B, at C. If, however, the dipole oscillation, either through direct radiation or by actual temperature, of P_1 exceeds that of P_2, the nul will move toward A. If the oscillation of region P_2 exceeds that of P_1, the nul will move toward B. When the potentiometer is centered, the potential difference between A and B is a function of the heat (temperature) or radiation differential. The thermocouple equivalent circuit is:



Dec. 15, 1942

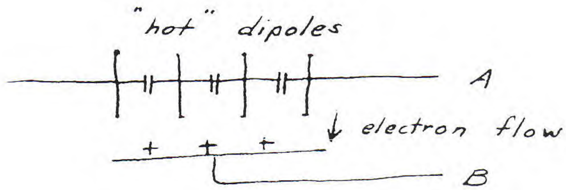
It would seem that the principles herein set forth may be applicable also to a multi-stage low frequency oscillation, where the wave is developed in amplitude by "cascading". At each stage, additional energy is applied:





Thermoelectric equilibrium:

Certain thermoelectric effects are predicted which appear to parallel well-known photo-electric effects. As described in P. 23-25, incoming radiation causes dipole oscillation. If the dielectric containing the oscillating dipoles is placed in a transverse electric field, electrons are pulled out, current flows and dipole oscillation is "resisted." The oscillation is damped and heat is absorbed. If the heat "supply" radiation is discontinued, the dielectric "cools" until oscillation ceases. In this way, the action might be considered "endothermic". Heat energy is converted into electric current.



"Hot" dipoles evolve electrons until A becomes sufficiently positive, with respect to B, to prevent evolution. The positive charge on A, then, is a function of its temperature. If a conductor of low resistivity connects A with B, a current flows. If losses are present, the dipole oscillation is "removed". This is

Dec. 10

It is noticed that, in the apparatus described on P. 33, heating of the anode results from continuous operation. After the unit has become "warmed up", it will therefore operate on AC, since the direction of the applied potential makes very little, if any, difference in the resultant forces. In this case, the filament heating may be discontinued without loss of efficiency.

Table of wavelengths.

1 micron = 10^{-6} meters.

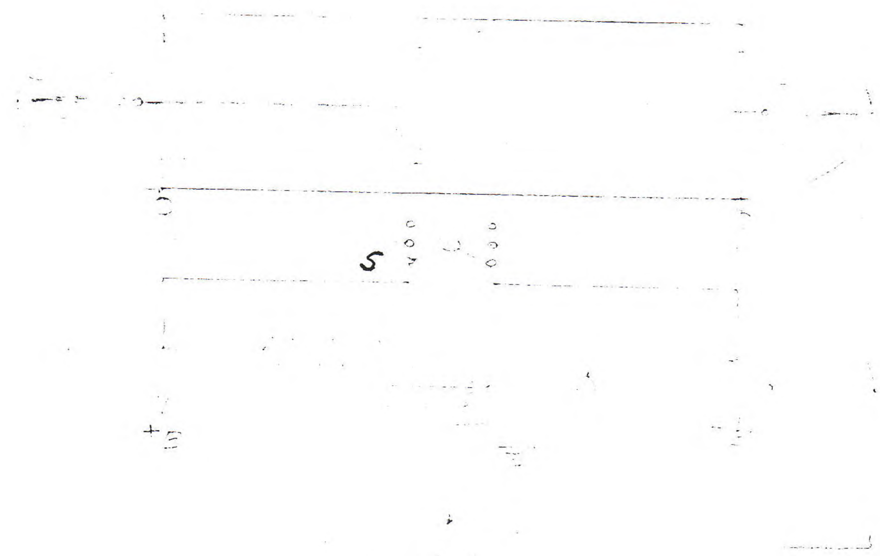
	100,000	microns	=	10 cm	(radar)
"sub" heat radiation	10,000	"	=	1 cm	(sidereal)
	1,000	"	=	1 mm	(radio-heat border)
	100	"	=	.1 mm	(heat)
	10	"	=	.01 mm	(heat)
	1	"	=	.001 mm	(heat-light border,
	.8	"	=	.0008 mm	(red)
	.4	"	=	.0004 mm	(violet)

1 angström = 10^{-10} meters

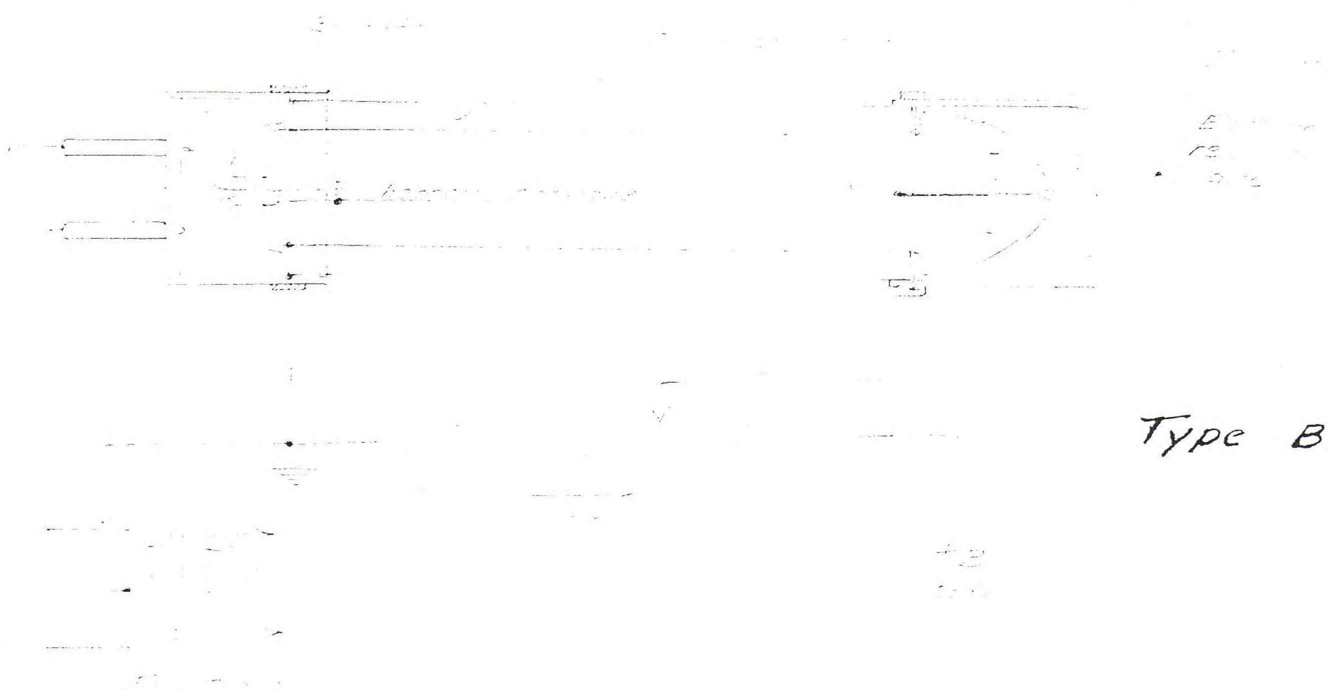
8000.	angströms	—	red
4000.	"	—	violet
1.	"	—	medium X rays.

Dec. 10, 1942

Several types of small experimental tubes are suggested — as follows:



Type A.



Type B.

Dec. 10, 1942

Suggestions as to suitable "semi-dielectric" materials are those which offer:

1. Heat resisting qualities. Capable of operating at temperatures from 600 to 1200°F (dark red heat).

2. Dielectric strength, averaging 25 KV/inch.

3. Proper conductivity to achieve results indicated in P. 33. Conductivity to increase rapidly as temperature rises above 1200° F.

4 Mechanical strength at high temperatures.

5. Capable of maintaining high vacuum within cylinder at high temperatures. (Low permeability).

6. Minimum coefficient of expansion.

Materials to be considered are:

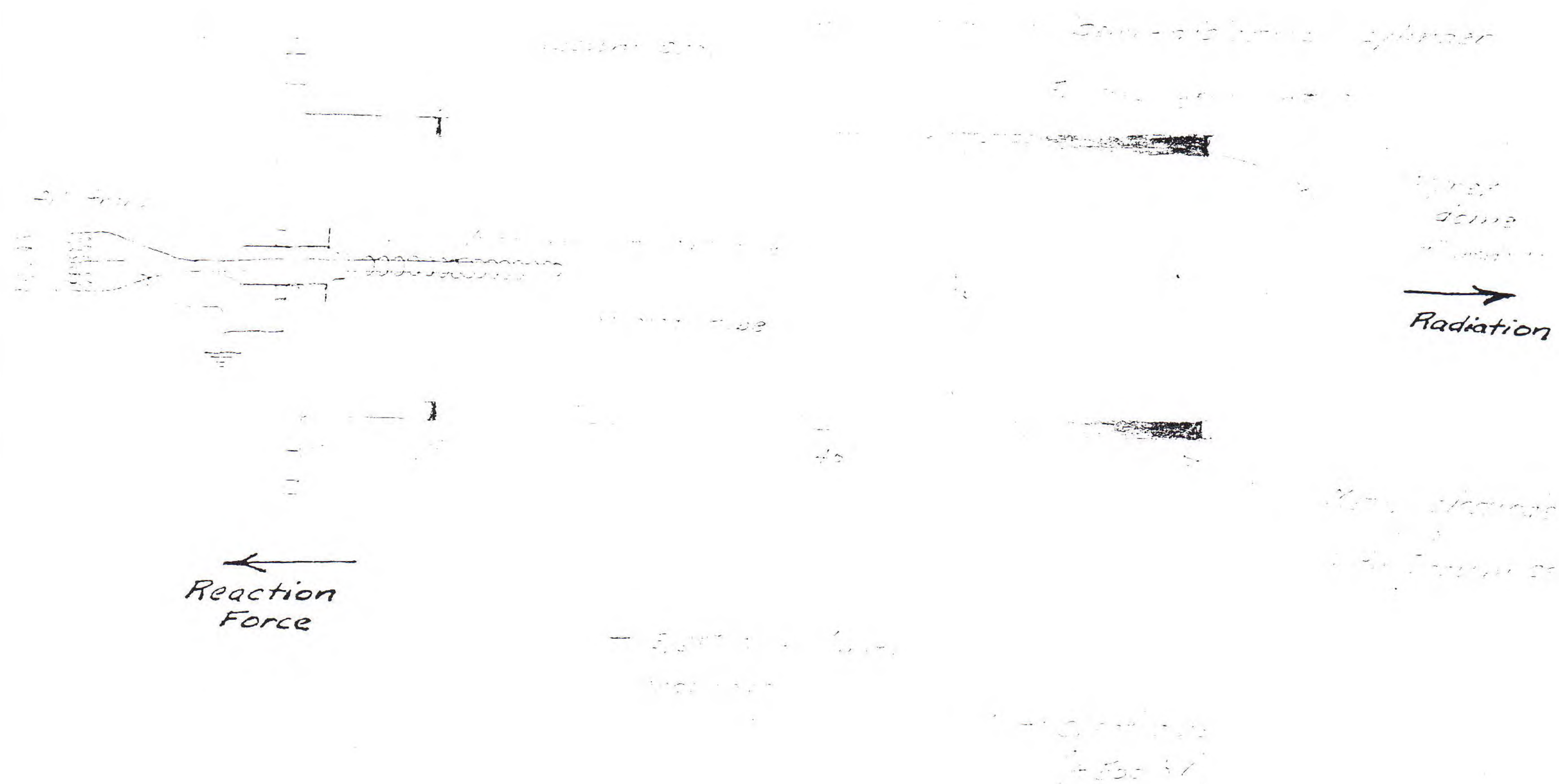
1. High grade refractory porcelains. With various conducting agents, thorium oxide, graphite, etc.

2. Boro-silicate-quartz glass with metallic ions, carbon or oxides.

Dec. 10, 1942

High-Powered Radiator —

Progressing, for a moment, to a theoretical radiator of the future, certain special features of design are indicated:

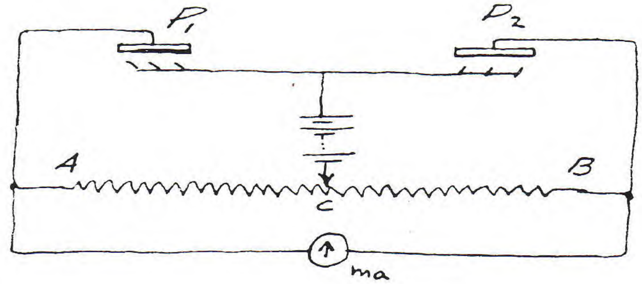


The heat resisting "semi-dielectric" cylinder will run "hot". Its conductivity under such conditions should be capable of being "doubled" by the cathode-to-plate current. Total current at 500 KV should be approx. 100 m.a., with full power maximum at about 1000 m.a. Dielectric must withstand exceedingly high voltage gradient near the positive electrode.

Witnesses: B. F. Jenkins 12-10-42

T. T. Brown

The photo-electric equivalent circuit is:

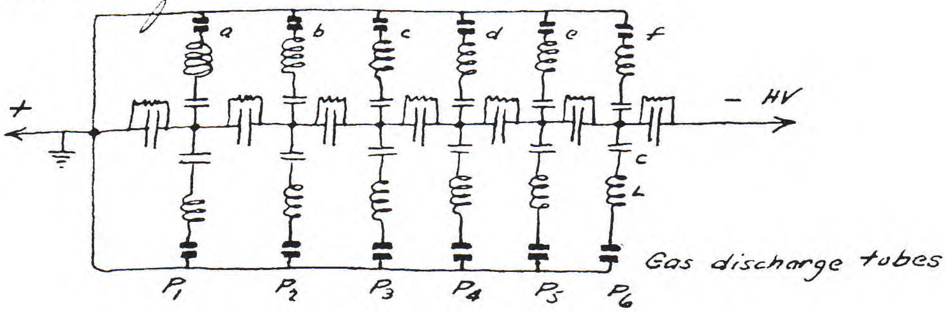


If radiation (light) on photocell P_1 exceeds that on P_2, the null moves toward A, and visa versa.

Returning to "sub" heat radiations discussed thruout this theory, the wavelength of the order of <u>1000 microns</u> appears reasonable. The band may spread from 10,000 microns to 100 microns conceivably. The "radiation-to electricity" effects must be substantially the same as with infra-red and light. These effects are observable in the behavior of certain dielectrics in electric fields.

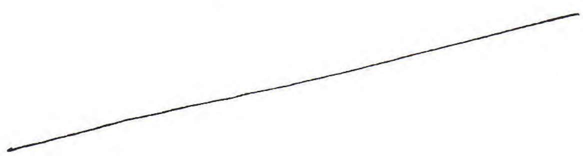
The type of dielectric selected seems to depend on the wavelength utilized. Longer waves require larger inductance and capacitance per unit volume of dielectric. Furthermore, the more dense dielectrics offer greater natural absorption. Electrical resistance likewise causes absorption.

The choice of dielectric depends on several factors. Let us examine closely the action of the radiating system and how it is affected by these factors.



Radiating System

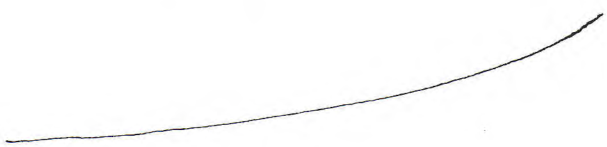
Fig 1



- voltage distribution

Condition with no current flowing at discharge tubes

Fig. 2



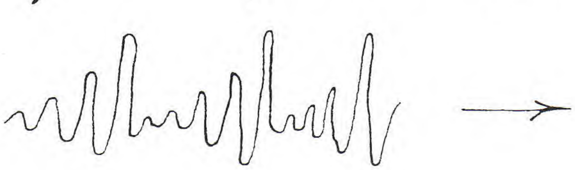
- voltage distribution (aver.)

Condition with all tubes "firing".

Fig. 3.

As a starting point, let us assume P_3 "fires" due to high potential difference of its electrodes. The resistance of the tube momentarily drops to a low value and the potential of that end of the dipole suddenly changes toward the positive. If the dipole is $\lambda/2$ the potential at c changes toward the negative by an equal amount. But this is far beyond the critical potential and c fires as a result. This is reflected again at P_3 but due to the exceedingly high frequency, P_3 has not yet recovered sufficiently to fire again, and the dipole oscillates freely and with such damping as results from radiation. When the tube has recovered, it will fire again on one of the upswings — followed immediately by the opposite tube.

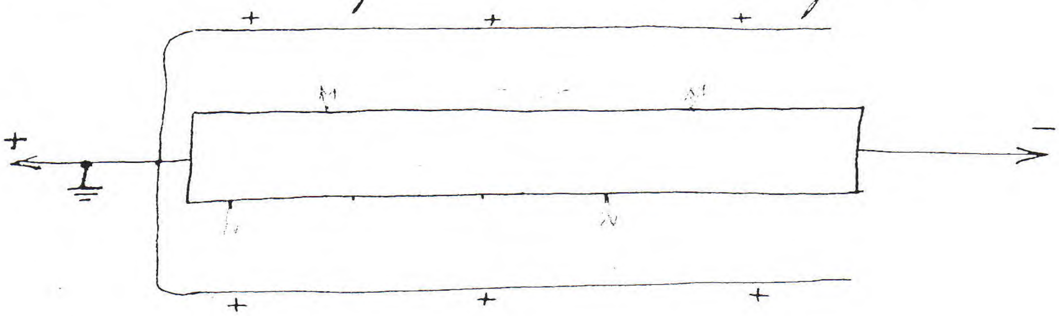
Returning to the initial firing of P_3 and the resultant "tilting" of the dipole, a wave is produced which travels outward and induces a opposite current in neighboring dipoles. Due to the fact that the potential of P_4 is higher than P_2, it fires first and with a greater expenditure of energy. For the same reason P_5 fires and then P_6. The wave travels toward the region of higher energy (higher voltage). As the wave front travels along, it leaves a region of recovered tubes behind it, so that a second wave front is initiated which follows the first — both moving toward the region of higher energy. Then a third, fourth and so on — each steep "front" followed by a procession of damped waves.



Dec. 18, 1942

All tubes will oscillate if the potential of the "lowest" one is beyond the firing potential. Pulses will be followed by a damped train of oscillations of the natural period of the dipole. The entire undulating effect travels toward the region of higher voltage. The period of the initial pulses depends upon the recovery time of the tubes.

The effect has a mechanical analogy in the multi-cycle engine, where explosions of the fuel occur only at certain multiples of revolution of the crankshaft.



Phase velocity is approximately the velocity of light.

The factors affecting the frequency of pulses are:

1. Condition of the surrounding space as it effects ion or electron movement. Low relaxation time.
2. Voltage applied.
3. Character of emitting surface.
4. Dielectric resistivity.
5. Dielectric absorption.

Dec. 18, 1942

Factors affecting frequency of natural dipoles.
1. Mode of oscillation of the dipoles.
2. Dimensions of the dipole. (length)
3. The LC product.

Factors affecting the dipole currents, inter-dipole magnetic relations. (recoil forces)
1. The LC product.
2. Voltage applied.

It is apparent that all the factors are inter-related and it is difficult to separate them.

For maximum radiation and its attendant recoil, the factors may be summarized as follows:

1. Maximum exposed dipole area for radiation into the "outer" system.
2. Sufficient conductivity to maintain high pulsing currents & frequency.
3. Highest possible working voltage.
4. Proper gas (ion) content and pressure for optimum currents and recovery time.
5. Highest dielectric constant
6. Highest dielectric absorption.

It may be seen, therefore, that pulses will travel successively down the line of dipoles toward the high voltage end. Discharge at the dipole ends travels similarly. The phase velocity may be somewhat less than the velocity of light.

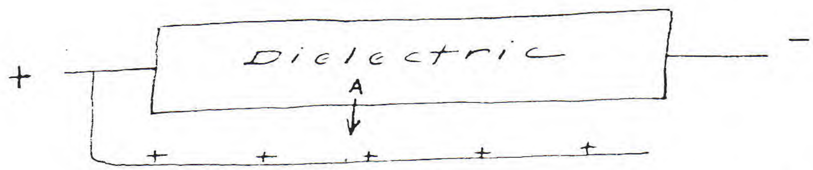
The time between pulses or discharges depends on:

1. Period of recovery of positive space charge or negative space charge. "Clean-up" time.
2. Reappearance of absorbed charge in the longitudinal dielectrics.
3. Voltage at which the system is operated.
4. Dielectric resistivity, which is a measure of power required.

The reappearance of absorbed charge in the longitudinal dielectrics is mainly responsible for the tilting of the gradient toward the low voltage end, causing the discharge to reappear successively at the low end after it had progressed the length of the dipole system and disappeared.

In effect, the following is a summary of the action which takes place:

Dec. 19, 1942



A glow discharge takes place at some point A on the dielectric. It quickly extinguishes itself due to the current flowing to the spot thru one arm of the dipole (width of dielectric). This arm is an inductance. A magnetic wave travels toward both ends of the dielectric and encompasses other dipoles on both sides in quick succession. The dipole to the right (toward the high voltage end) absorbs energy parasitically, as does the one on the left, and a voltage is induced which is additive to that already present. However, the dipole on the right is already at a higher voltage than the one on the left, therefore its high negative end "fires" before that of the dipole on the left. When it fires, the current is quickly reversed and reaches a maximum during the "build-up" of the magnetic wave which triggered the action. Mutual net forces are present which trys to move the dipoles to the left. In quick succession, approaching the speed of light (magnetic phase velocity), other dipoles to the right are "fired" and their forces of mechanical recoil developed. The glow discharge area quickly runs off the high voltage end of the dielectric and disappears.

Following behind the glow discharge area is a dark area where ultra-high frequency waves are surging back and forth across the $\lambda/2$ width of the dielectric. These surges likewise interact in and between dipoles of that area to contribute to the recoil forces, since they are started by and are in phase with the initial travelling pulse.

At some point in the rear of the dark area sufficient absorbed charge of the dielectric becomes present in additive relation that another pulse is initiated. If the ultra-high frequency surges have, by that time, not been damped out by radiation losses, the negative swing will trigger the pulse and a new steep wave front initiated. This will be marked by a glow discharge area which will travel rapidly to the right end and disappear as before.

Naturally, the greatest radiation and recoil forces will result when pulses are close together and the following train of oscillations synchronized and maintained in continuous high amplitude.

This requires ~~a~~ correspondingly greater current because of more frequent pulsing. This current is maintained by the high voltage through the dielectric resistance.

To add electrical inertia to the oscillating dipoles the L and C of the dielectric is as high as possible. Therefore, a material of highest specific inductive capacity is employed.

Dec. 19, 1942

The dimensions of the dielectric are important. The simplest radiator is a dielectric $\lambda/2$ width so that surge reflections are obtained on the inner faces. The thickness of the dipole affects the current, within certain limitations. It must be remembered that the speed of the surges will not be the speed of light, but something less. The amount less depending directly upon the specific inductive capacity of the dielectric.

In other words, the dipoles should be ~~longer~~ shorter, the higher the dielectric constant, to maintain a certain wavelength. But, it is indicated that the added electrical inertia is a decided advantage, both to maintain continuously higher currents in the dipoles but to derive greater energy of oscillation (and very much less damping).

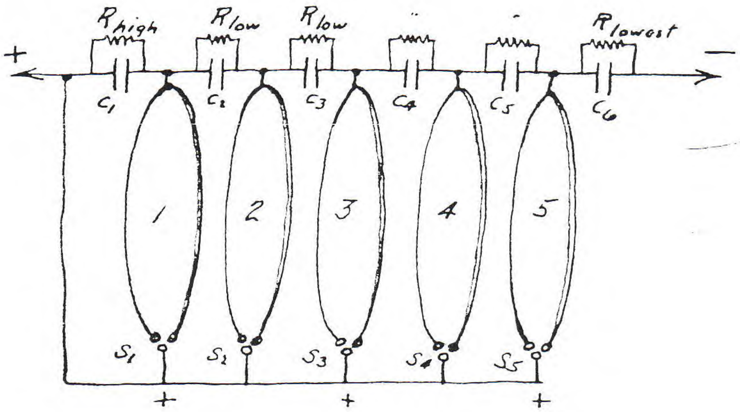
Naturally, the initial energy of the pulse, to set the dipoles oscillating, will be correspondingly greater. It may turn out that metal sheets will be the "ultimate" material for the dipoles, whereas a dielectric of high absorption and low resistivity the "ultimate" for the longitudinal condensing spacers.

Another dipole shape is the disc. In this case, the center is one pole and the periphery the other. Oscillations would cause circularly polarized waves. See P. 14.

Another form of dipole is the ring, where the inner surface of the ring constitutes one pole and the outer surface the other pole. This form was suggested in P. 16, 32, 33 and 36. It has the advantage of internal excitation, leaving the outer surface unobstructed for radiation.

The Hertzian Loop Design.

Pursuing ideas advanced (P. 49) as to the "ultimate" materials for both lateral and longitudinal dielectrics, the following type of construction appears to warrant consideration. Essentially, it is a series of Hertzian Loops with condensers between them at the nodes:



Let us assume that a spark jumps initially at S_3, from one leg or pole of the loop to the positive end of the HV feed. For this purpose, a 3-pole spark gap may be employed.

A heavy current flows momentarily upward thru the leg of the loop. An expanding magnetic field envelopes the adjacent loops, and equal emfs are induced in the loops on both sides. Since loop No. 4 is already at a higher potential than No. 2, its gap will "fire" first. Due to the fact ~~that~~ the magnetic field from No. 3 is still increasing when current flows in No 4, recoil forces are exerted on No 4 in the direction of No 3. (Conductors carrying currents in the same direction)

No. 5 fires as a result of the triggering inductive emf of No. 4 (plus residual induction from No. 3.)

When their associated condensers have been discharged, Nos 3, 4 and 5 become inactive successively. But No. 1 then initiates the fire which passes in succession to No. 2, 3, 4 and 5, and then repeats. Recovery comes about by the re-appearance of absorbed charges in the condensers. For this reason a material of high-dielectric absorption should be chosen. In order to discharge relatively high currents at frequent intervals the condensers must be of low resistance or else a separate resistance should be shunted across each one except C_1. This condenser should have high absorption and high resistance

Perhaps a better arrangement would be to use separate resistors, with those of higher value toward the left (referring to the diagram) — and those of lower value progressively to the right. This would bring about a more uniform voltage distribution when all units are firing.

In the foregoing description the travel of the initial pulse from the low voltage end to the high voltage end was indicated. The radiation (to the right) and the recoil (to the left) was predicted. However, it must be remembered that the initial pulse is followed by a train of u h f waves or oscillations in each loops and that appreciable u h f currents are flowing in adjacent loops. It is believed that the phasing of these currents bears the same relation from one loop to another as the initial pulse. Consequently, recoil forces are developed so long as oscillations persist. The damping is caused by the losses due to radiation, and energy must be periodically applied by the pulses to keep the loops oscillating. It is believed that the oscillation of metallic loops will persist longer (with less damping) for a given radiation resistance than that of dielectric loops — due to greater electrical inertia. See P. 49

Dec. 21, 1942

The 3-pole spark gaps shown in the diagram of P. 50 may be replaced by a 3-pole gas discharge tube or two 2-pole tubes. A tube of minimum recovery time is desirable — to increase pulse frequency. Perhaps a full wave rectifier tube, either gaseous or high vacuum can be used to advantage. In this case, the filament would have to be negative and the polarity of the system, as shown on P. 50, would be reversed.

All of the systems shown so far have been "self pulsing". The pulse period has been dependent on circuit conditions; such as, dielectric absorption, capacitance, clean-up time, transit time, potential applied, etc. The total net radiation of u.h.f. and the recoil forces are dependent only upon the proper phase relationship of successive loops and the maintenance of oscillations at maximum amplitude against damping due to radiation resistance. (See P. 43)

To maintain oscillations at maximum amplitude, high energy pulses must be applied as rapidly or frequently as possible. Increasing longitudinal capacitance increases the energy of the pulses (current flow) but likewise increases the pulse period when self pulsing or relaxation circuits are employed.

To obviate this, "controlled" pulsing is indicated.

Dec. 21, 1942

Controlled Pulsing

Any standard oscillating circuit may be utilized to initiate and control the pulse of the first Hertzian loop. Naturally, the power required increases with the frequency. Also, the recoil forces are proportional to the pulse ~~period~~ freq. at low pulse frequencies. At high pulse frequencies proportionality disappears and the force becomes some lesser direct function of the pulse frequency. In this respect the pulsing of the system becomes a means of control both for the net radiation and for the recoil force as well.

It may be seen, then, that the system of Hertzian loops form essentially a relaying system which is also a power or radiation amplifier. Power is consumed in reinforcing and directing the radiation. The No. 1 loop is the control loop and all others merely reinforce the radiation of No. 1 as it travels along — triggering each one in succession. The energy comes from the D.C. high voltage source, and the gain is dependent upon the voltage gradient between successive loops. Since the potential of each loop drops "almost to zero" in the passage of each pulse, it is apparent that a considerable amount of power is consumed at ~~the~~ high voltage when pulsing at high frequency.

Dec. 22, 1942

To limit the firing time in such a way as to prevent loss of efficiency, a condenser of lower capacity than the longitudinal condensers may be placed in the circuit between the loop node and the potential divider.

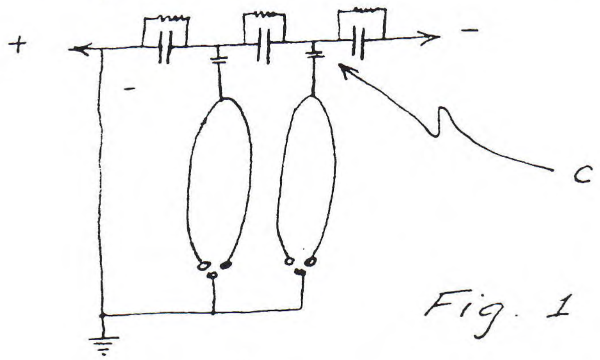
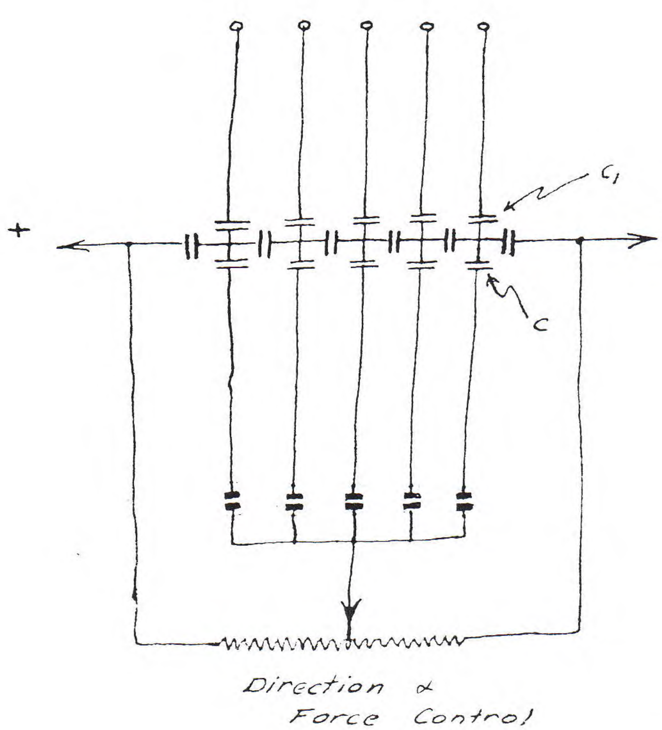


Fig. 1

This will assist in understanding the last paragraph of P. 54.

Gas discharge tubes may be employed in place of spark gaps, with resulting gain in efficiency.



Glow-discharge Tubes. Shown with dipoles instead of Hertzian loops.

(with discharge-time limiters)

C_1 used for balance.

Fig. 2.

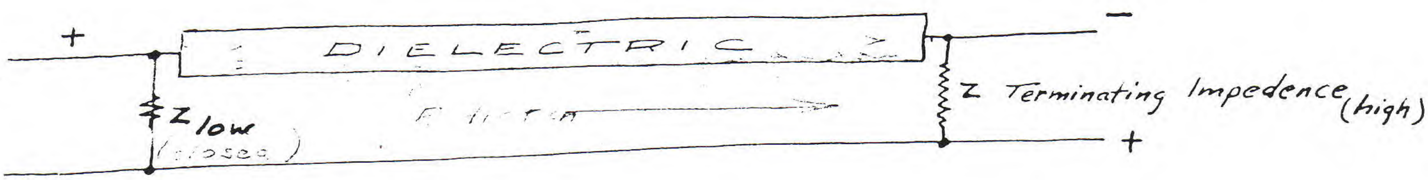
It will be observed that the discharge-time limiters shown in Fig. 2. will increase the LC product and consequently reduce the frequency of the u.h.f. This is not so with the arrangement shown in Fig. 1.

Extent and Direction of Radiation controlled by Impedence of Transmission Line.

In practically all of the foregoing explanation, the radiation was supposed to have arisen from the action of a wave train travelling toward the high voltage end of the dipole system. In this respect the action would be similar to that of the end-firing Beverage antenna. It is noted, however, that the Beverage antenna must have a terminating impedence which differs "slightly" from the characteristic impedance in order to cancel or absorb the backward reflections, thus creating uni-directional action.

The possibility that this may also be the case with the self-exited dipole system is quite important. It is desirable to give the matter consideration at this point. For this purpose, the dipole system and its associated "reactor" plate or field is thought of as a parallel transmission line.

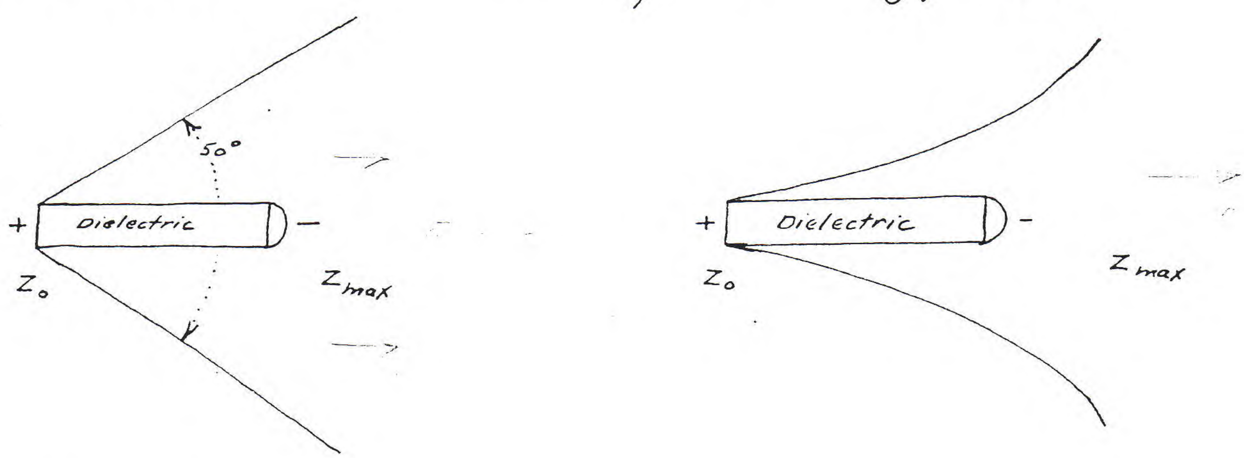
Dec. 23, 1942



Any disturbance in the electric field along the surface of the dielectric, such as that caused by the emission or arrival of charges, will travel as transients in <u>both</u> directions. They will be reflected at Z_{low} and not from Z_{high}. The net result is radiation off the "open" end only. Radiations of a comparatively broad band of frequencies will be generated and radiated. Since the "generator" operates because of the many rapid and aperiodic changes in the field between the dielectric surface and the adjacent conductor of the transmission line, the "effect" is that of electric noise with a flat and broad coverage of u.h.f. frequencies. All the energy of this "noise" will be radiated uni-directionally, as shown. Due to the frequency distribution, the total amount of energy so radiated can be considerable, and depends only upon the electric fields and current available.

The principal source of loss appears to come about thru the surface resistance of the dielectric and the adjacent conductor, and to a lesser extent because of internal resistance.

If the foregoing "impedence hypothesis" is correct, certain changes in design are indicated which might improve the results. As least, they would serve as a test of the hypothesis.



Conical horn Exponential horn

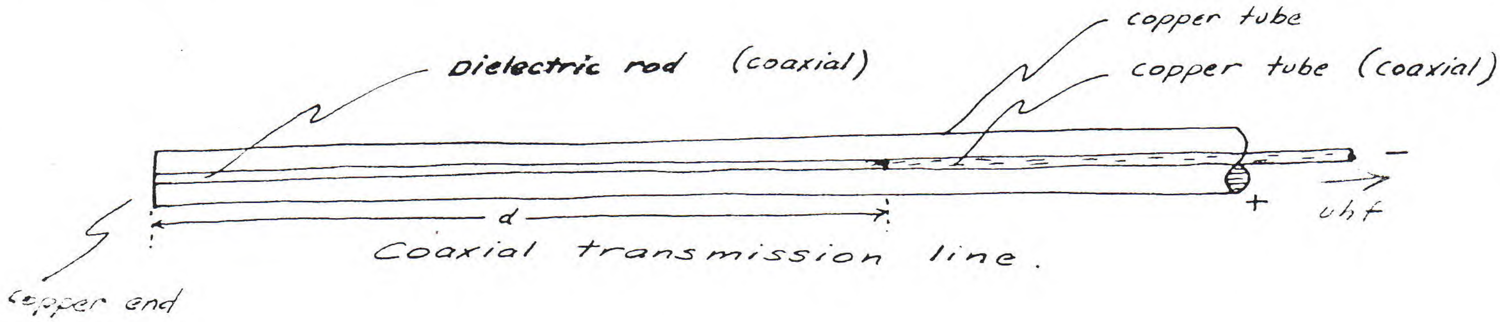
The inner face of the horn should be smooth, polished if possible, and of highest elec. surface conductivity.

The dielectric should be smooth and of max. (?) surface conductivity at u.h.f. Sufficient direct current (or volume) conductivity should be provided to replace and redistribute lost or displaced charges.

It is reasonable that a "field" of positive ions around ionizing wires could replace the horn, tho it is difficult to reconcile such action with the required low surface conductivity of the horn. It is possible that the u.h.f is conducted by the field in the same fashion as it is conducted along the surface of a conductor.

Since heavy and large ions (+) are desired, some special ionizing means should be provided.

Dec. 23, 1942

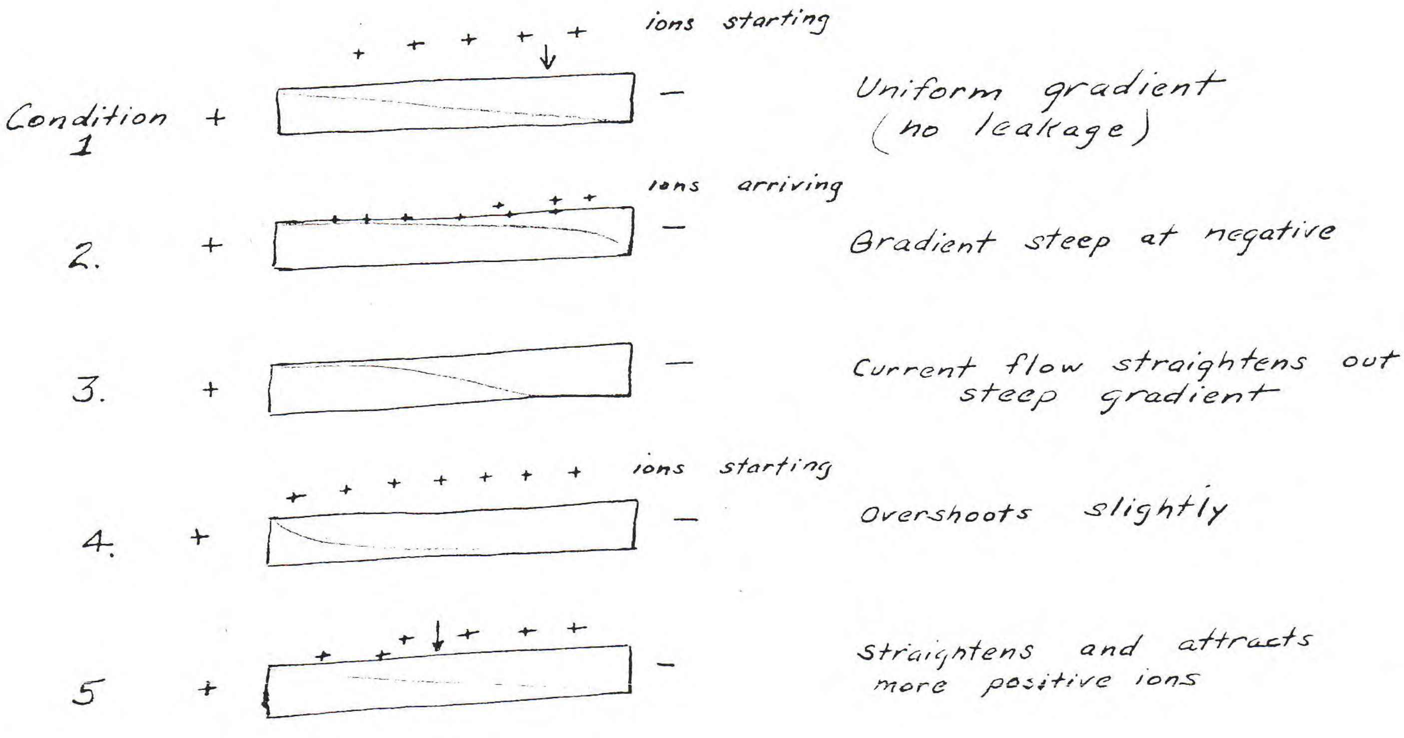


Ions escaping from or impinging on the dielectric rod cause a momentary shift in electric gradient. This results in the formation of an electric wave. As this wave travels along (both ways) on the surface of the rod (and in the surrounding space to the wall of the cable) it affects the arrival of other ions, producing a train of waves of various frequencies. Those waves travelling toward the closed end are perfectly reflected. Those waves travelling toward the open end continue in that direction and are picked up by the copper tube and transmitted along the coaxial cable as shown.

This radiation must form an exceedingly broad band of frequencies — noise frequencies — and consequently could represent great amount of radiant energy. It is probably similar, and closely related, to thermal noise in common radio circuits.

Relaxation Surges

Certain undulatory movements of the electric gradient undoubtedly are present, especially when the ionization envelope is not stable. This relaxation effect surges back and forth longitudinally in a long dielectric under strain. Transit time of ion clouds is principally responsible.



The frequency (fundamental) of such relaxation surges is an inverse function of the length of the dielectric and a direct function of the voltage.

Surges of this nature may, conceivable, produce an additional radiation from the unclosed end of the transmission line. P. 58.

Dec. 23, 1942

Such a relaxation oscillation causes the field in the dielectric to be progressively distorted, first in one direction - then in another. The result is equivalent to a potential reversal at points near the center of the dielectric.

Resistance of dielectrics at ultra high freq.

Certain dielectrics possess lower resistance at high frequency than at low freq. or d.c.

A rigorous theoretical formula is:

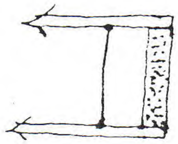
$$r = R_0 \left[1 + \left(\frac{1}{12} \frac{2\pi F S \mu}{R_0 10^9} \right)^2 - \left(\frac{1}{180} \frac{2\pi F S \mu}{R_0 10^9} \right)^4 + \cdots \right.$$

where r = ac resistance (uhf)
R_0 = dc "
S = length (cm)
μ = permeability
F = freq. in c/sec.

Ref: A new method for measurement of ultra-high frequency impedance.
Seeley & Barden
License Laboratory, R.C.A.

Example:

Carbon resistor 5300 Ω D.C
4100 Ω 50 meg.
3600 Ω 100 meg.



middle band pass filter.

#18 wire — high res. at high freq.
low " at low freq.

Carbon resistor — low res. at high freq.
high res. at low freq.

It is understandable, therefore, that the dielectric material which is considered in this application (P. 56. etc) should have low u.h.f resistivity. Transients are conducted by the system without much loss. They are reflected by the closed end of the "transmission line" and are radiated at the other end, similar to the end-fire of the Beverage antenna.

It is possible that suitable dielectric materials would include carbon resistors, lead monoxide-paraffin, slate, marble, leaded bakelite, porcelain-graphite, porcelain-thorium oxide, boro-silicate-quartz glass with metallic oxides or carbon. See P. 34.

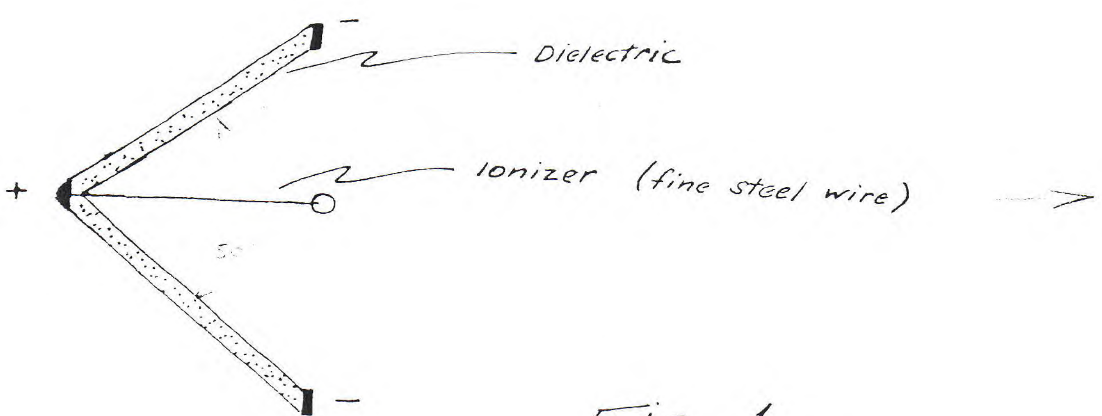


Fig 1.

The advantages of the design shown in Fig. 1 are as follows:

1. Conical reflector for maximum lobe, approx 50°.
2. Desirable (linear) direct current gradient.

Dec. 24, 1942

3. Centralized positively charged ionizer. Highest gradient near the ionizer rather than the dielectric.

4. Proper spacing and arrangement of parts for high voltage.

5. Activated surface on inside of cone — for maximum directed radiation.

Hot cathode emitter.

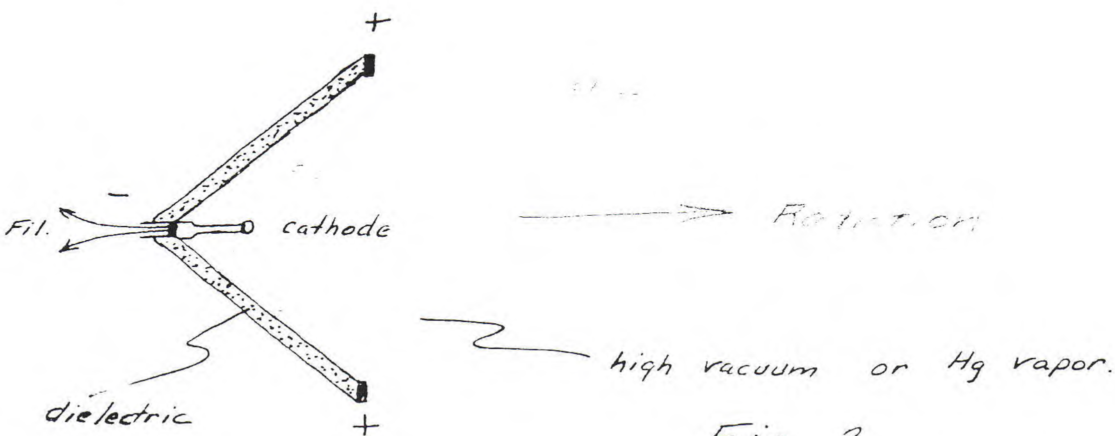


Fig. 2.

Advantages:

1. Higher current – greater radiation.
2. Probably a higher frequency, particularly when the tube is evacuated and a high voltage is used.

Witnesses as to date.

F. de Lathe 12/24/42

Victor J. Roosin 12/24/42

T. T. Brown

To develop the hot cathode emitter outlined on P. 63, the following refinements are indicated:

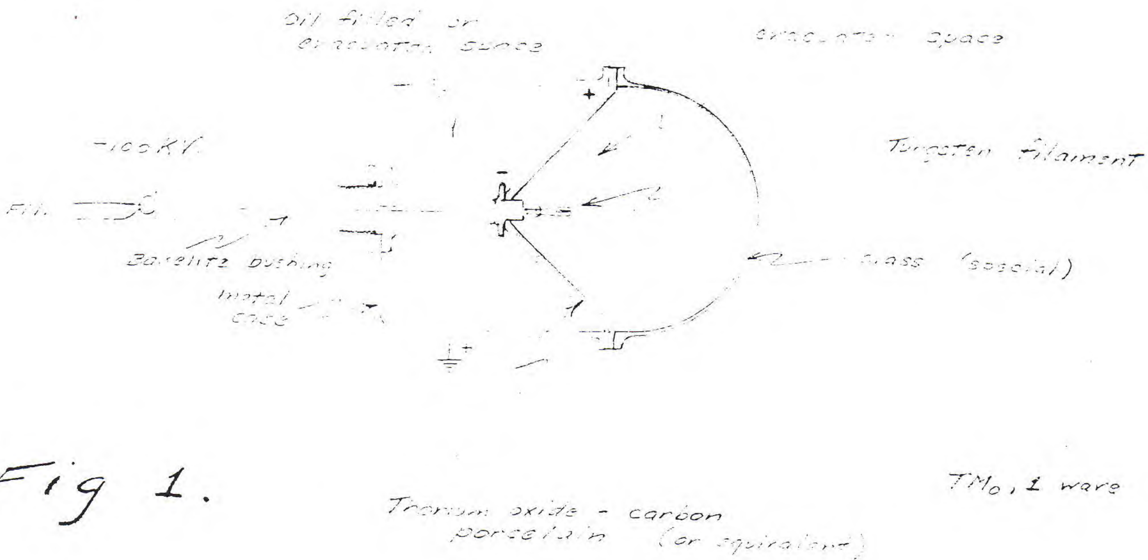


Fig 1.

The initial electrostatic condition of the dielectric in Fig. 1. is such that the steepest gradient exists near the negative electrode. As soon as electrons begin to arrive in this region the steep gradient shifts progressively toward the positive pole. The electron flow follows the gradient. Soon a situation exists where the electron flow substantially short circuits the dielectric current and the electrostatic condition quickly returns to the initial state where the steep gradient is near the negative. Thus the cycle is repeated. The gradient and its associated potentials and currents surge back and forth. These relaxation surges were described on P. 60. The frequency is an inverse function of the distance travelled, i.e, the length of the dielectric.

and a direct function of the applied voltage. This is the fundamental or lowest frequency. If the sides of the dielectric cone measure 10 cm. and the proper voltage is applied, 20 cm. radiation is produced. It is concentric and radially polarized,⊛ and the cone acts as a horn and impedence-matching wave guide. At the same time a whole series of harmonics and "noise" radiations of exceedingly high frequency are produced by the "splashes" of groups of electrons landing on the dielectric.* Due to the low AC resistance of the dielectric at these frequencies (P.61 (probably of the order of 1 cm. to .1 mm. wavelength) these waves travel almost without loss in both directions along the surface of the dielectric. Those waves travelling toward the apex of the cone are reflected (P. 56-59) and, together with those already travelling in the other direction, leave the cone at the base as radiant energy. The angle of the cone determines the sharpness of the directed beam. Following information (empirical) already at hand regarding the performance of wave guide horns, 50° appears to be the optimum.

Cooling of the dielectric may be necessary. This can be accomplished by a oil-filled space backing the cone. Cooling fins can be arranged on the outside of the case.

On the other hand, it may be found desirable to permit the dielectric to "run hot" for several

* See P. 68. ⊛ TM_0, 1 wave.

reasons:

1. Conductivity of this type of dielectric increases with temperature.
2. This would permit a natural balancing action between the dielectric conduction current and the electronic current from the hot cathode.
3. Thus, if a resistor is placed in series with the HV feed, the temperature would balance at any voltage value.
4. Hot dielectrics may give rise to additional dipole activity and an additional spread of ultra high frequencies. — In a sense, re-radiation of the heat energy in the form of quasi-heat radiation. (See also P. 39)

High-energy pulsing for radar purposes.

Energy stored in a high voltage condenser may be applied to the dielectric of the quasi-heat radiator. The duration of this pulse is determined by the capacity of the condenser, current consumed and the design of the pulsing circuit. It should be of the order of 3 μ sec. and as square a wave as possible.

Another method of pulsing, of somewhat less power however, is the use of a grid around the filament of the quasi-heat radiator. In this type of system, the potential on the dielectric would be maintained and the "plate"

Test of the Principle. Nº 4.

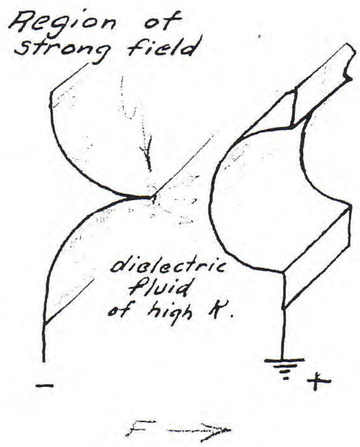


Fig. 25 (a)

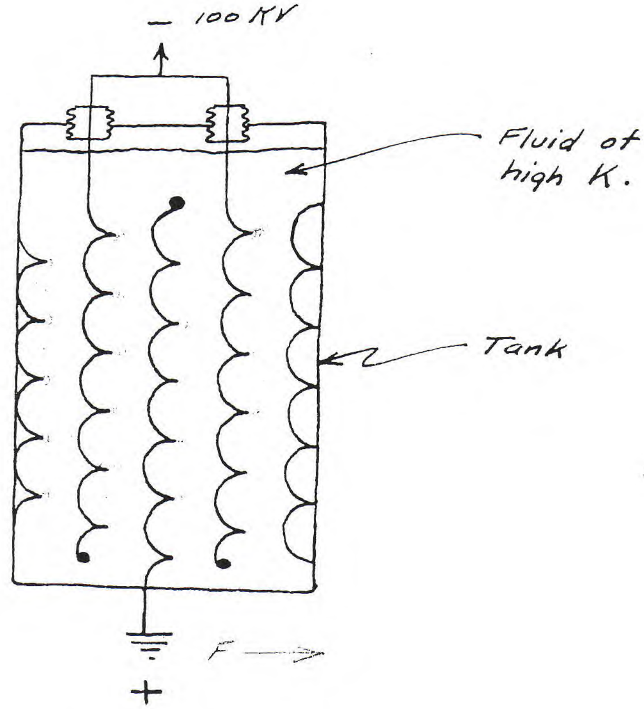


Fig. 25 (b).

Utilizing the strong electrostatic field of a point, the non-linear gradient to a spherical surface, within a dielectric fluid of high K, offers favorable conditions for the generation of the electro-gravitational force. The outstanding advantage is that a rupture of the dielectric, due to excessive gradient, is self-repairing. The space immediately adjacent to the point possesses the greatest "space potential" and the fluid is present thruout the gradient. Forces are produced in the indicated direction, not merely forces due to point discharge but to electro-gravitational gradients. Fig. 25 (b) shows a fully-enclosed system. The forces are developed in the fluid and transmitted to the walls of the tank.

Tests of the Principle. No 5.

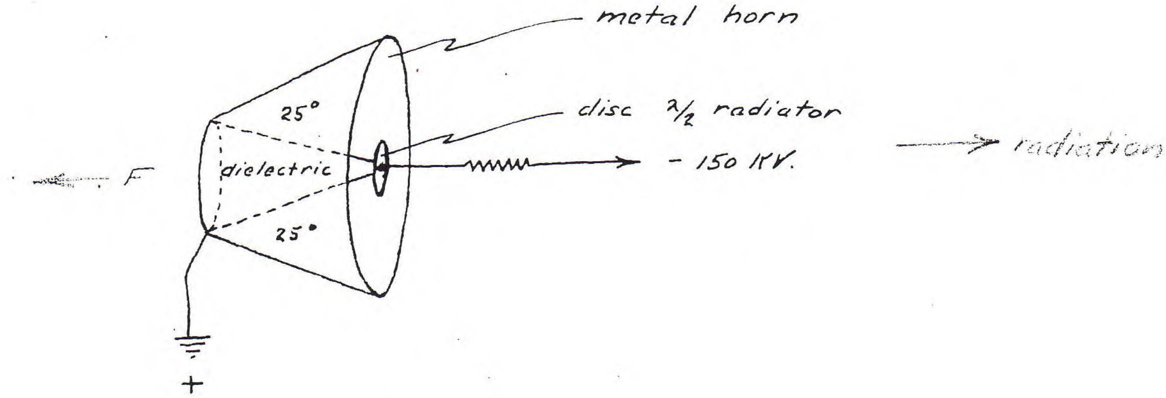


Fig. 26.

This is a dynamical system, parallel to that discussed in Par. 2 of P. S23, and is similar in many respects to that shown on P. 75. It features a λ/2 disc radiator at the high negative terminal. The radiation is impeded by increasing values of K as it travels along the dielectric, but leaves unimpeded outward from the horn as indicated. The electrogravitational force is in the same direction as the radiation pressure.

It may be found desirable to provide a means for heating the λ/2 disc radiator in order to increase electron emission.

Test of the Principle. No 6.

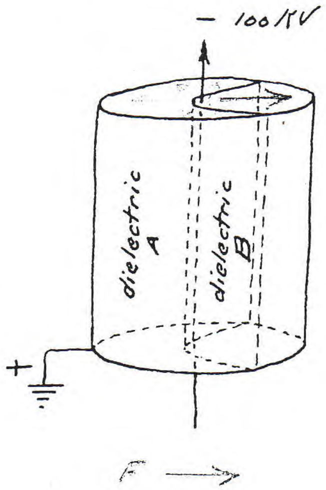


Fig. 27

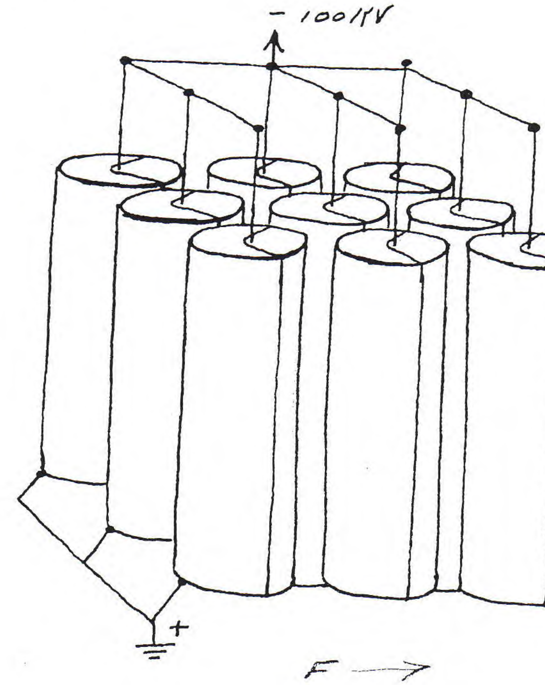


Fig. 28.

This is a "potential" system (as differentiated from a "dynamical" system). It employs a wire electrode (negative) at high potential, concentrically arranged in a cylinder which constitutes the positive electrode (grounded). A small sector of dielectric material B has greater K and mass than dielectric ~~segment~~ sector A. Since space energy is greatly increased by the steep electric gradient around the wire, gravitational forces are outward from the negative electrode. A mass (and K) differential exists, however, which causes the resultant F in the direction as indicated.

Fig. 28 shows the parallel connection of a multiplicity of "cells".

The Electro-gravitational equilibrium.

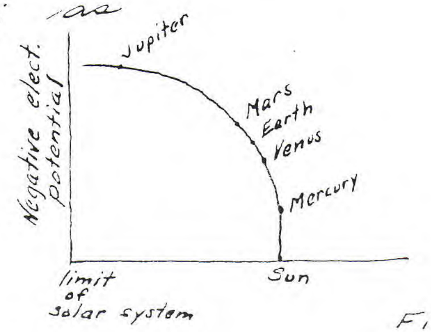
In summarizing, it is indicated that electrons, being essentially areas of high space energy cannot exist as entities where space energy is already maximum. In other words, in theoretical mass-free space (extra-galactic), electrons do not possess the gradient which makes their existence possible. See P. S6 & S7. Positrons, on the other hand, can exist due to the great contrast in potential, the gradient in space energy being reversed.

So it can be interpreted that pure space energy is essentially equivalent to electricity and that extra-galactic space is negatively charged. Any gravitational field will possess an electric field, the direction of which is from negative to positive. In this way, gravitational or space potential is inversely related to electrical potential. A freely insulated body assumes an electric charge which is related to the gravitational potential of the space in which it exists.

As an example, in the solar system the electric potential of the planets is of negative sign and that of the sun is positive. The more distant planets are the more negative.

In a sense, one may imagine the gravitational potential as inversely related to electric potential. If the sun is considered the seat of the gravitational disturbance in the solar system, the value of P or E at the center of the sun is the minimum for the system. Consequently, the positive charge is maximum for this region. It has been estimated, as a matter of fact, that the potential of the sun is of the order of a billion volts positive*, with respect to the earth. Other investigators*, have indicated the potential of the Earth at 400 KV negative with respect to the higher ionized layers. By the same token one may predict the electric potential of Venus to be positive with respect to the Earth and that of Mars negative. Both, however are negative with respect to the sun or positive with respect to Jupiter or Saturn.

It is probable that the potential difference between the sun and its planets increases more slowly as the distance from the sun increases; as



Electrical Potential of the Planets due to Gravitational Field of the Sun.

Fig. 29.

* [illegible]

By the same reasoning, the potential of the moon is negative with respect to the earth, due to its inclusion in the dominating field (gravitational) of the earth.

Perhaps then, this causes the side of the earth directed toward the moon to become positively charged by induction. This may explain the positive swing of the Philadelphia instrument as the moon crosses the meridian.

If the sun is highly positive, the side of the earth toward the sun will acquire an induced negative charge. This also appears to be borne out in the results of the Philadelphia observations.

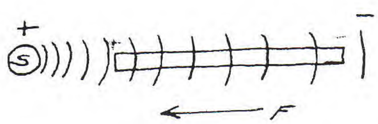


Fig 30.

When a system of masses comprising a dielectric, exists in a gravitational field, the end toward the "attracting" mass will become positively charged with respect to the other end. Likewise, a steeper gradient will be present at the positive end. A gravitator force F is nesent which depends upon the gradient differential. If the dielectric accelerates in response to this force the gradient differential disappears as the ~~velocity~~ acceleration approaches that of ~~light~~ g.

The disappearance of the induced gradient differential is due to the appearance of an opposing gradient differential due to acceleration. This is the equivalence of the gravitational field and the acceleration "field".

A freely falling body therefore has no gradient differential. It does, however, have an increasing potential differential (elec.) which increases as the velocity increases. P. 519.

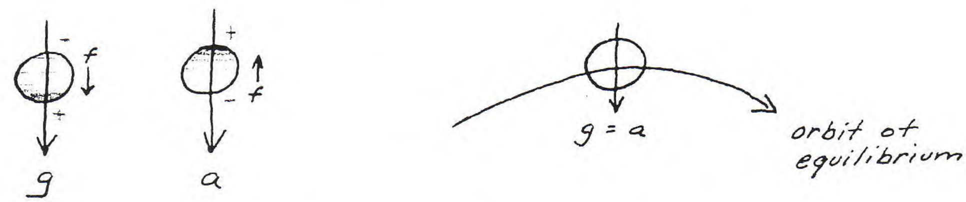
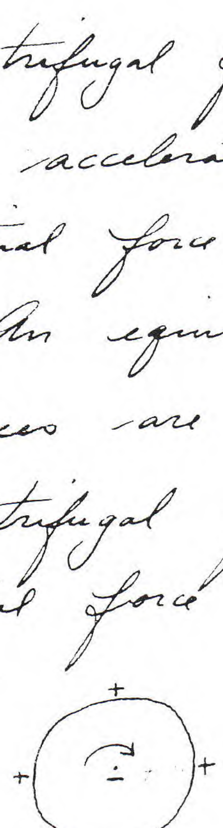


Fig. 31.

Centrifugal force is the electrogravitational force due to acceleration. It is equivalent to a gravitational force and is indistinguishable from it. An equilibrium orbit is one in which both forces are equal and opposite.

Centrifugal force not opposed by an equal gravitational force should produce gradient differentials.



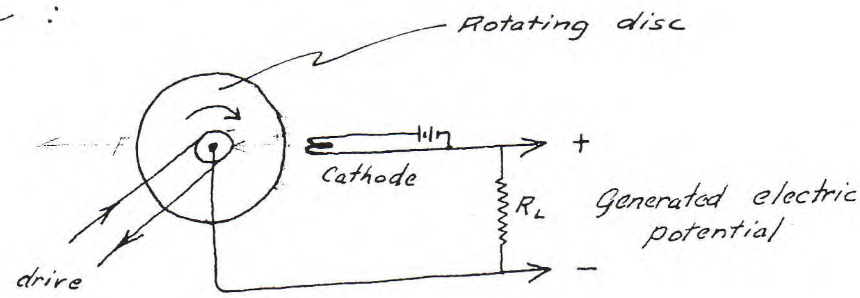
Electric field + gradient differential due to rotation.

Spinning Disc.

Fig. 32.

Centrifugal (electrogravitational) generator.

Based on the foregoing, it appears that a generator can be constructed along the following lines:



High speed disc rotated in vacuum.

Fig. 33.

When the metallic discs (and in certain cases, dielectric materials) are rotated at high speed, the periphery becomes positively charged and the axis of rotation negative. If a cathode (heated) is placed nearby electrons are drawn out and attached to the disc. As a result a current flows and a potential difference generated across a load as indicated.

When current flows, the steep gradient is (to a slight extent) shifted from the periphery (see P.S30) to the axle, thereby neutralizing some force (centrifugal) at that region. The force indicated by the F (in green) is due to the resultant imbalance. The magnitude of this force is directly proportional to the current which is flowing in the system. If this current is increased by an external battery the force is further increased.

The effect of rotation is equivalent to the "throwing outward" of the heavier charges which are positive. The "anti-gravitational" electrons are thus displaced to the center. The high gradient is likewise thrown outward as if the electric field itself possessed inertia. Since rotation is equivalent to effects of gravitation, the "g" of the centrifugal "field" is productive of electrical gradient:

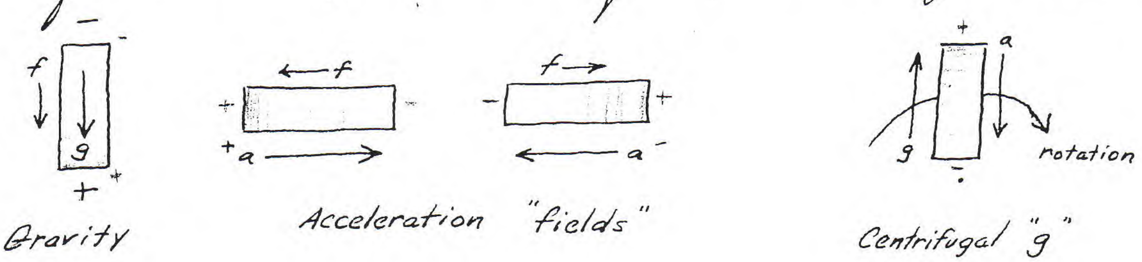


Fig. 34.

It is desirable to call attention to the necessity for the emitting cathode of Fig. 33 to be extended over a considerable arc of the disc in order that the gradient may not be steep at the region where electrons strike the disc. For successful operation the induced gradient must be steep at the apex, in the direction of the cathode.

It is possible also that dielectric discs, made for example from high tensile strength Bakelite, may produce results even with no appreciable current flowing. In this way, the system may be considered "potential" (P. S-26). Strong gradients would be "maintained" against leakage only.

Feb. 22, 1943

Tests of the Principle. No 7.

In order to increase gradient differentials and at the same time reduce the space and voltage requirements, the following structure is suggested:

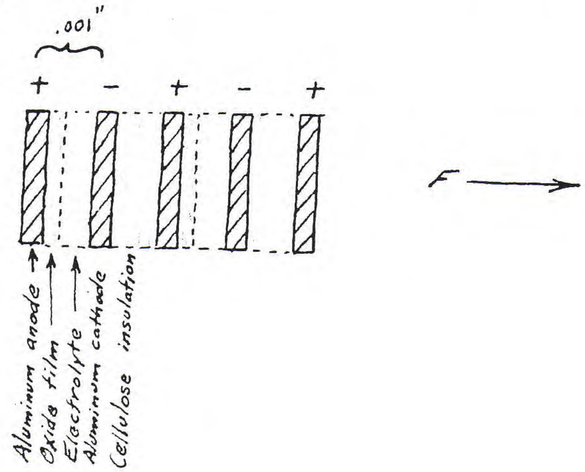
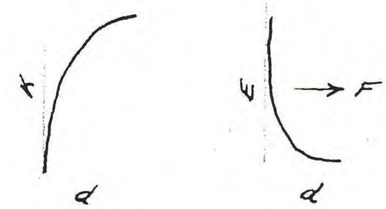


Fig. 35



Distribution of K and E across oxide film.

Fig. 36.

Due to the change of K with d, across the oxide film, the electric gradient is greatest near the anode and falls off to a negligible value at the surface of the electrolyte which forms the virtual cathode. Electrogravitational force is in the direction away from the steep gradient (as indicated).

What little gradient differential exists in the cellulose insulation is in the region immediately adjacent to (and caused by) the cathode. The electrogravitational force is therefore in the same direction as that in the oxide film.

The system would utilize comparatively low voltages (500 V maximum) but the gradient differentials might reach exceedingly high values.

Tests of the Principle. No 8.

On the basis of an effect due to gradient in K, see P. S-20, the following structure is suggested:

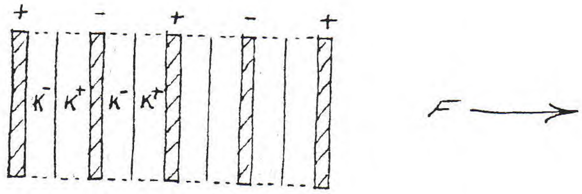


Fig. 37.

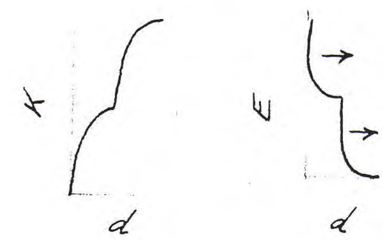


Fig. 38.

Due to the high value of K in one dielectric section and the low value in the adjacent section, the voltage gradient is greatest near the left boundary of the "red" section and falls to a minimum at the right boundary of the "green" section. Electrogravitational force is as indicated. Direction of the force is not changed by reversal of polarity in adjacent units.

The above effect, as well as that set forth on P. S-33, has not been tested. Success of the method is predicated on the assumption that the gradient differential alone, and not the combination of E & K gradient, determines the force.

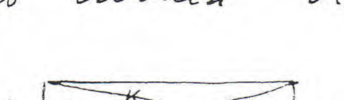
This latter possibility is worthy of consideration and therefore will be discussed in succeeding pages.

Feb. 23, 1943

Electric gradient differential versus "space potential" gradient differential.

There is an important difference between the two. For instance, where the value of K is physically constant thruout the dielectric, forces result directly from an electric gradient differential. If K varies, the electric gradient varies inversely. The distribution of electric charge (Q) remains the same however. Actually, it would appear that the charge Q per unit volume in space determines the "potential" of space. Therefore, what may actually be desired to produce an electrogravitational force is a gradient differential in "space potential" or the "quantity" of charge in space. By this reasoning, test No 8, (and probably No 7 also) might be expected to fail.

If a dielectric block has a physical gradient in K, the electric field will be found to arrange itself so that there will be an inverse gradient in E, this being so in order that the quantity of charge Q might be evenly distributed. It would be expected therefore that no gradient in Q exists and no electrogravitational forces would be present.



(no force)

Fig. 39.

If, however, a condition should be set up where a gradient differential exists in Q, electrogravitational forces are present which attempt to "correct" the condition. The correction is in the form of applied velocity, or in the first stages, acceleration.

At rest — Condition 1

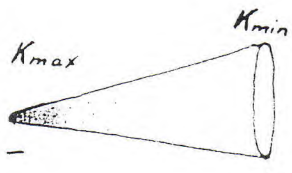
Accelerating → — Condition 2

Fig. 40.

Maximum force may be developed by a system possessing both a gradient in K and a gradient in E, thus a maximum gradient differential in Q.

The gradient in E can be obtained by the wedge shape, (P. S-22) and the force is always in the direction away from the high gradient when the system is near the potential of the Earth. In other words, it is toward the large end of the dielectric.

If, at the same time, the wedge would have a non-linear gradient in K, such that the greatest change in gradient is near the small end, the force would be still further increased. Thus:



F →

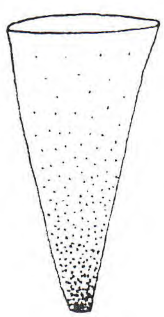
Increase of force with K gradient-differential

Fig.

A gradient in K tends to straighten the gradient of potential (electric) in the case shown in Fig. 41. A very steep gradient in K would even reverse the electric gradient differential. It is conceivable that this would operate to a practical advantage. For instance, where the electric gradient near the cathode is so steep that breakdown would normally result, a high value of K in this region would so shift the field as to reduce the electric strain. Thus the electric field might be made uniform, with a strictly linear gradient, and yet the required gradient differential in space potential would be maintained, and an electrogravitational force would still be present.

Thus, it is possible, and apparently quite advantageous, to have the electric gradient uniform in a wedge dielectric section. Such a construction would prevent excessively high electric fields from forming across the region of restricted cross-section.

Experimental cones of graduated K.



Mould filled with mixture of PbO and paraffin.

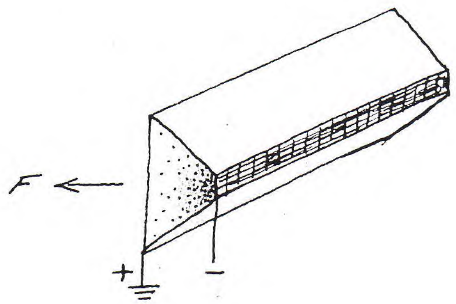
PbO allowed to settle as cooling progresses

To be connected as shown in Fig. 41.

Fig. 42.

Tests of the Principle. No 9.

Cones of graduated K as described on P. S-37 can also be formed into arrays. The dielectric wedges described on P. S-22 can also have graduated K, and then formed into arrays. The results apparently will be more satisfactory.



Wedge of dielectric with graduated K.

Fig. 43.

Due to the equilibrium between the gradient of K and the gradient of E, it appears that the principal advantages of a gradient in K are:

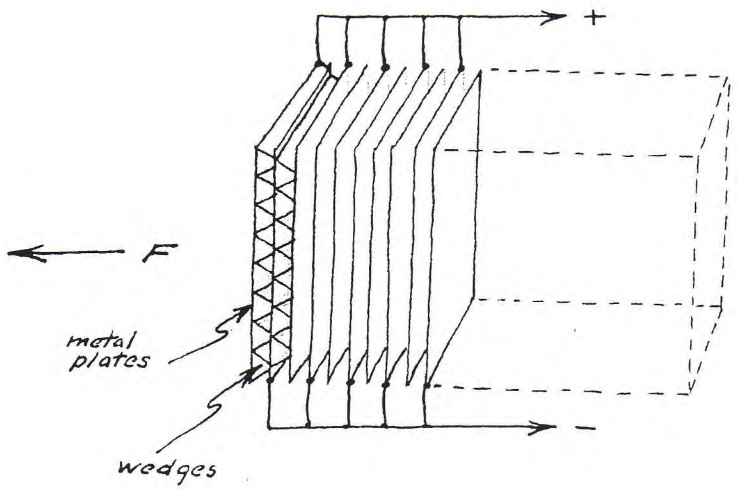
(1) to prevent excessive fields in the region of restricted cross-section.

(2) to permit a greater force due to the presence of regions of high Q.

A multiple array of graded wedges is a development of that shown in Fig. 43. Even without a gradient in K, such an array, when operated at low voltage, appears to have considerable promise.

Test of the principle. No 10.

Pursuant to the development indicated in Test No 9, the following type of construction appears worthy of consideration.



Parallel Array of Graded Wedges

For a unit to operate on 5 KV, the spacing between successive electrodes could be of the order of 1/4". Dielectric wedges could be made of PbO with a binder, so prepared as to give a K gradient. Tests of dielectric material of naturally high K, such as slate or marble, & without a K gradient, could be made for the purpose of determining the actual practical value of a K gradient. In general it appears that the force will be a direct function of the dielectric K, and independent of the K gradient. The only effect of the K gradient being to redistribute the electric field so as to cause less strain and less possibility of progressive electric breakdown.

T. T. Brown

Witnessed as to date: Ralph H. Swift 3/3/43
William F. Mansham 3/3/43

Excitation potential – A.C. versus D.C.

Naturally, direct current, due to the sustained charge, – gives best results:

(1) Maximum continuous force.
(2) Minimum loss in the dielectric by hysteresis, etc.

However, alternating current excitation may be desirable in order to reduce the amount of exciter equipment and the total weight. It is to be borne in mind that the direction or sense of the electrogravitational force is not reversed by a reversal of the electric field. The force depends primarily upon the direction of differential in the electric gradient.

Transformers with kenetron rectifiers with suitable filters are required for DC excitation.

For AC excitation, a transformer may be used without additional equipment. For increased efficiency, the inductance of the transformer secondary should be matched to the capacitance of the dielectric system (gravitator) for the particular frequency used, thus creating a tuned circuit.

May 2, 1944

Brownian Movement.

The basic considerations set forth in Fig 8, P. S-11, indicate a continuous force or motion of a dipole, always toward the positive pole if there is any absorbing matter in the space between. It is conceivable that some force or motion might be present if no absorbing matter lies between, due to the pressure differential at the sides (in the alignment of) the dipole.

The suggestion appears reasonable that molecular motion is the result of this pressure differential. Movement of any single molecule would invariably be from its negative elements to its positive elements; the movement of all molecules would appear random.

If a means could be found to align or polarize all molecules in a given volume of matter, it is conceivable that motion of the volume, as a whole, would result.

Probably a considerable amount of polarization or alignment can be accomplished by an electrostatic field, or, momentarily by a varying magnetic field.

Another method of approach might be the mechanical. It is possible that supersonic waves might align molecules, much as sawdust is arranged in a Kundt's tube.

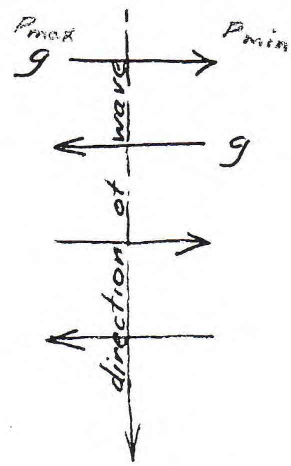
Certain forms of solid matter may be found more easily polarized and may even be partly polarized in natural form — for example, quartz crystal, other piezo-electric crystals, alnico or other magnetic material of high retentiveness.

Other lines of investigation might include the use of "electrets", electrically polarized bodies, such as certain waxes, which have hardened in an electric field.

Space Pressure equivalent to Gravitation.

On P. S-11, the space pressure effects of the electric dipole were illustrated. It was shown that the oscillating dipole radiated electromagnetic waves laterally. Space pressure first in one lateral direction, then in the other, travels as a wave. Whenever it strikes a conductor, its electrical effects become manifest. However, the alternating electric potentials actually exist in the space the wave traverses. The wave actually changes the electrical condition of "empty space" as it travels along. A conductor, existing in that space, merely picks up the changing potential of the ambient space.

Space pressure differential is indistinguishable from gravitation. Its direction from high pressure to low pressure is the direction of gravitational "force". One might say that to "look" at an approaching light (or other electromagnetic wave, one would "see" merely a gravitational field operating transversely to the direction of the wave, first to one side then to the other.



The light wave as transverse alternations of a gravitational field.

Fig. 45

The "passing by" of this alternating gravitational field induces an alternating current of electricity in any conductor arranged in the alignment of the field, at right angles to the direction of the wave.

If a sufficiently sensitive tuned reed could be placed in the path of the wave, it is possible it would be set in oscillation or vibration mechanically, in the lateral direction, by the transverse gravitational wave.

If the wave travels transversely from the radiating dipole, that is, to the side of the dipole, then by the same token, it must travel away from the ends of the dipole. However, it would not be transverse and would not be "picked up" by a transverse "device". Rather, it would be pulsating gravitation, with pulsing forces to and fro, in the direction of the alignment of the dipoles.

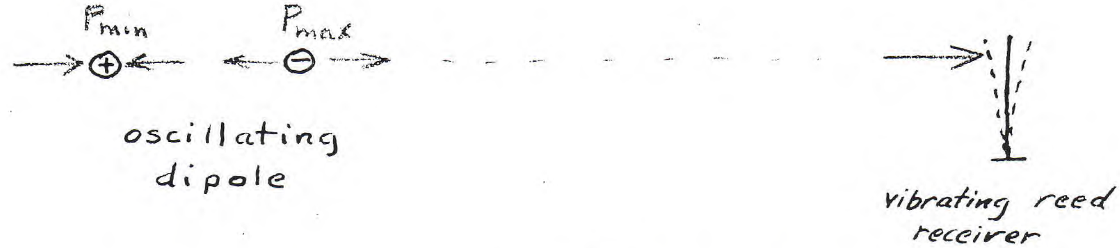


Fig. 46. Pulsing Gravitation.

Electric potentials of various gravitational potentials

Referring to Fig. 7, P. S-8, in extra-galactic space the pressure or potential is maximum. Also the electrical potential is maximum negative. In such space an electron (neg.) cannot exist as an entity, for the reason that the "differences" between the neg. electron and the space surrounding it "do not exist" where no gravitational fields are present, i.e. in extra-galactic space. The electron is "equivalent" to the space surrounding it. In fact, in the last analysis, the electron merely "melts into" and becomes indistinguishable from ~~that~~ space. One could say that this space is negative and "of the same composition" as the negative electron. Perhaps one could call such space a "completely negatively charged continuum".

As one approaches a material body the quality of space undergoes a change. The space pressure becomes less. The pressure difference causes a gravitational "field" toward the material body. Since the space occupied by said body has a lower pressure or potential, it also has a more positive electrical potential. See P. S-28. Consequently, the body itself shares this ambient electrical condition.

Conceivably, at the center of dense stars in the center of a galaxy, the space pressure is a minimum, approaching if not reaching, zero. Here, the absolute electric charge is maximum positive. A positron, as a separate entity, would not exist, for the reason that it would be of the same composition as the "space" surrounding it. Under such conditions of density (at the heart of dense stars) it is even probable that no "space" does exist, and that a positron, as a "hole" in space, cannot exist where there is no space. This then, would be the positive electrical continuum, more than likely just plain zero.

By such reasoning, only one "kind" of electricity actually exists — the negative. Electrons being "knots" of high "space pressure", while positrons are merely "inverse knots" or holes in space where the pressure approaches zero, "like the center of a cyclone".

The Gravitator.

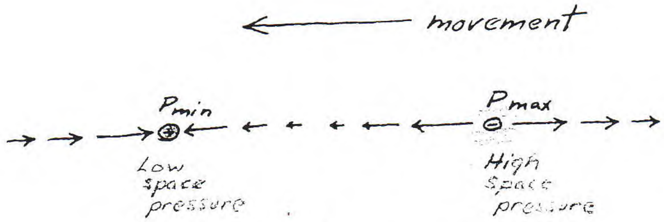
An electric dipole is a gravitator. It gravitates just as surely as a falling body. It possesses a force (from negative to positive) due to a dissymmetry of space pressure. The reaction to the force is in the opposite direction and is in the form of a gravitation field, "blowing backward from the rear". This field extends indefinitely "backward". It reacts against material bodies near and far. The integrated reaction forces, on all objects to the limits of the universe, equal the force of the gravitator in the "forward" direction. These reactive gravitational fields or space pressures (space potential differences) cause electrical potential differences which are exactly equal and opposite to the electrical potentials of the dipole.

In intra-galactic space a negative charge produces a gravitational vector away from the charge. This is due to the fact that space energy and pressure is greater than that normal for the region. A combination of a positive charge and a negative charge arranged as a dipole produces a unidirectional gravitational vector from the negative to the positive pole.

If the positive charge is borne by an electrode of large mass (high density) and the negative charge by one of low density, the unidirectional vector is increased. For example, polarized $Pb^{+}O^{-}$ along the line of motion.

Summarizing the above; a strong electric field affects the state of space energy. Regions of <u>high</u> space potential are to be found nearest the point negative charge and regions of <u>low</u> space potential nearest the point positive charge. The line of stress or force normally connects the two opposite charges. The quantity is a vector, depending upon the <u>rate of change of slope</u> of the electric field, directed away from the negative charge and toward the positive charge.

$$\vec{F} = \frac{m_1 m_2 (\overleftarrow{E}_1 - \overleftarrow{E}_2)}{d^2}$$



Space pressure in vicinity of elec. dipole

Fig. 8

Force depends upon the mass of the point electrodes and the mass of the region between the point. The exact function of mass is not clearly understood and an attempt will be made to develop the theory along these lines later.

In Fig. 8, true positive and negative charges are illustrated. They are what might be termed absolute charges. In practice, the potential of the Earth must be taken into account. The effects are significant.

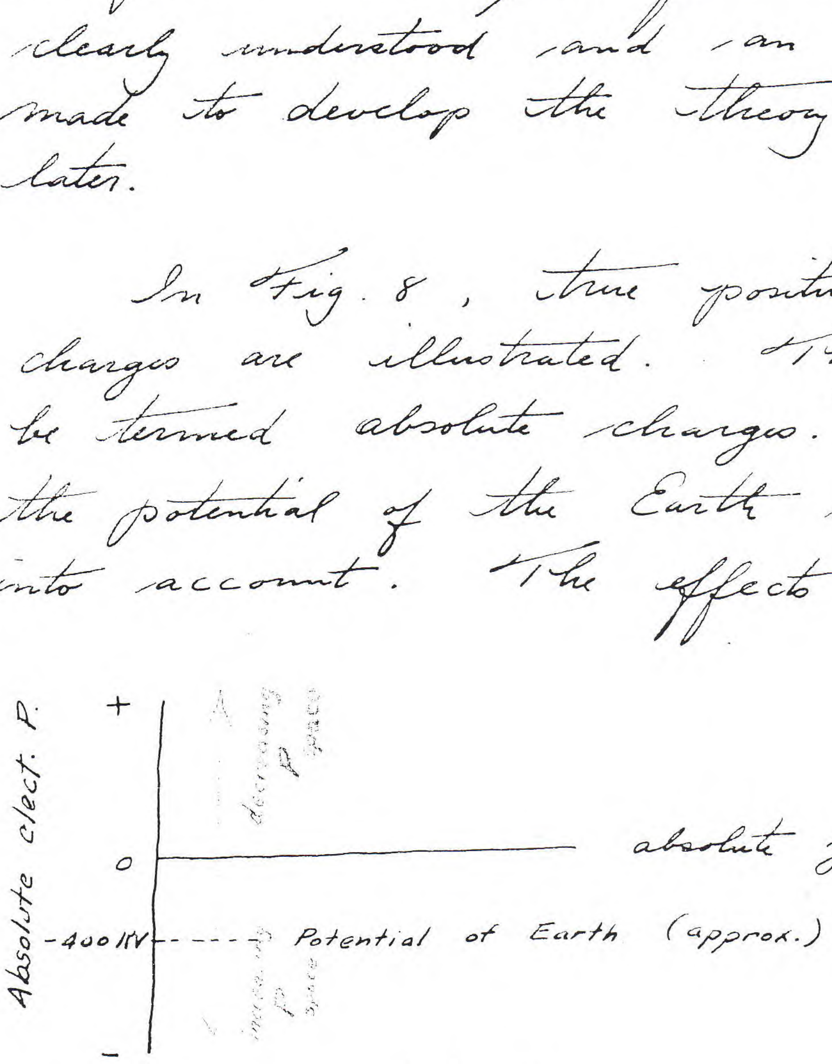
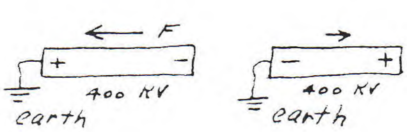


Fig. 9.

For example:



A non-linear electric gradient with steepest gradient near the negative will possess a greater space pressure differential and force than if polarity is reversed.