istical distributions including statistical mechanics and enjoy peaceful rest.

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September 21, 1946.

1. *Theories of Probability*, by Jagit Singh, p. 257. *Sankhya*, April 1946, **7**, Part 3.

A NOTE ON THREE NUMBERS IN A.P.

1. IN what follows A-G.P. stands for Arithmetico-Geometrical Progression, and I.R. for Indicator of Ratio of A-G.P., which means the common ratio of the component geometric series of A-G.P.

2. *Lemma.*—If a, b, c are in A.P., then a, $\frac{ab}{c}$, $\frac{a^2}{c}$ are also in A.P.

c, b, a are in A.P. (given).

Multiply each by the same number $\frac{a}{c}$ the result follows at once.

3. *Theorem.*—Any three numbers in A.P. are also A-G.P. having I.R. equal to the quotient obtained by dividing the third number by the first, provided neither the first nor the third number is zero.

Let the given numbers in A.P. be a, b, c, where $a \neq 0$ and $c \neq 0$.

These numbers can be written as

$$a,\ \frac{ab}{c}\left(\frac{c}{a}\right),\ \frac{a^2}{c}\left(\frac{c}{a}\right)^2, \tag{1}$$

which can be obtained by multiplying the corresponding terms of the following sets:

$$1,\ \frac{c}{a},\ \left(\frac{c}{a}\right)^2, \tag{2}$$

$$a,\ \frac{ab}{c},\ \frac{a^2}{c}\ . \tag{3}$$

Clearly (2) is a G.P., (3) is an A.P. (Lemma).

$\therefore$ (1) is an A-G.P. having $\frac{c}{a}$ as I.R.

Hence the theorem.

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FURTHER CONSEQUENCES OF THE "ACTIVATED LAYER" POSTULATE IN THE MECHANISM OF THE *LIGHT-EFFECT*

§1. THAT the *light-effect* Δi, a reversible and (sensibly) instantaneous current-change, on irradiation from extreme red[11] to X-rays,[11a] of chlorine and a number of other gases and vapours, is (so far) observed with semi- and full ozoniser discharges,[1,2] suggests that a dielectric surface is necessary for its occurrence. The ozonizer (Fig. 1a) is equivalent to a compound condenser, consisting of three serial capacities: C_1 and C_2 are associated with the inner and outer electrode walls respectively; the annular space filled with the gas represents the third, C_g. As illustrated by the generally low dielectric constants of gases, C_g is the smallest capacity; and is therefore, a chief determinant of i at a given potential V applied to the system.[4] The combined capacity

Fig. 1(a)

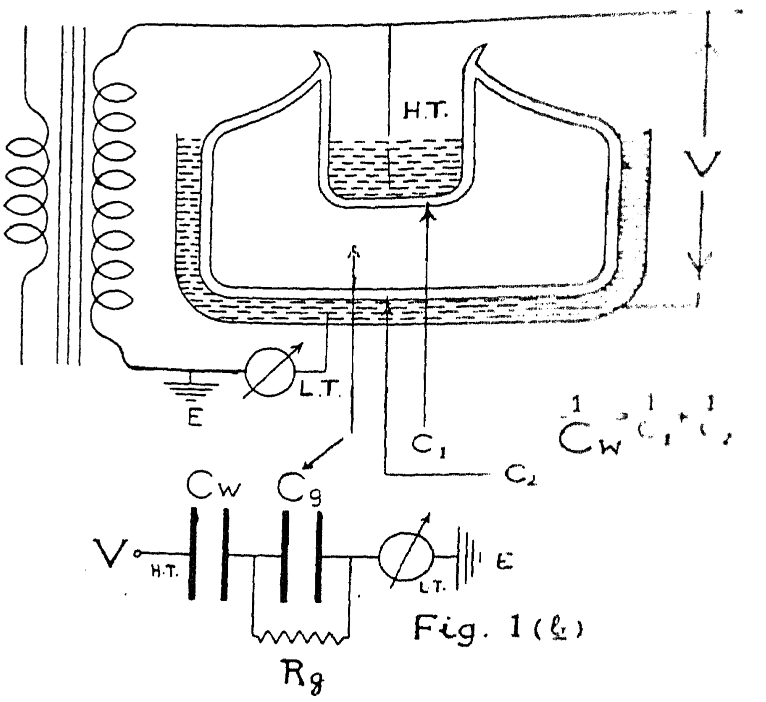

Fig. 1(b)

due to the inner and outer annular walls may be denoted by C_w, defined by $\frac{1}{C_w} = \frac{1}{C_1} + \frac{1}{C_2}$. At the '*threshold potential*' V_m,[3,4] the gas breaks down as a dielectric; the corresponding C_g may, therefore, be treated as a condenser shunted by an ohmic resistance, R_g; this represents the inverse of conductivity produced in the gas due to ionisation by collision under field due to V.

§2. The instantaneous i in the circuit may be denoted to a good approximation by,

$$i = \frac{V}{jL\Sigma f + \frac{1}{jC_w\Sigma f} + \frac{1}{\frac{1}{R_g} + jC_g\Sigma f}} \tag{i}$$

where Σf represents not only the frequency of the A.C. supply and its harmonics but also those produced under electrical discharge in the annular space due[6,7,8,2] to V. The *light-effect* Δi is observed at constant V; the corresponding circuital inductance L does not change sensibly. It follows, therefore, from (i) that the production of, *e.g.*, photo-diminution Δi implies an increase of R_g; that is, decrease of the ohmic or the conduction current; or/and. decrease of either or both the capacities C_w and C_g, due to the annular walls and the excited gas, respectively.[9] In a semi-ozoniser, the capacity C_1 is absent; it produces, however, a comparatively large $-\Delta i$ (as also $+\Delta i$ under appropriate conditions *vide infra* para 4). That a preponderatingly large photo-change, *e.g.*, increase of R_g might mask a possible variation of either or both C_w and C_g in a sense opposite to that contemplated in the above deduction, *viz.*, a decrease, requires further investigation.

Below V_m there is no ionisation current in the gas,[3,4] *i.e.*, R_g is infinite. The non-occurrence of the *light-effect* below[2,6,7,10] V_m despite intense irradiation in the ultra-violet[11] and even X-rays,[11a] suggests from (*i*) that the above capacities are not altered sensibly by a mere optical excitation of the gas. The term $\left(\frac{1}{R_g} + jC_g 2 f\right)$ is small at low V; and sensitive to change with a corresponding marked effect on $-\Delta i$. It follows, therefore, that relatively, $-\%\Delta i$ should be low (numerically) at large V, subject to the assumption that C_w is not affected sensibly; this deduction is in accord with the generality of the results in these Laboratories which show that $-\%\Delta i$ is a maximum near V_m and decreases thereafter.[1,2,11]

§3. A possible mechanism was developed previously for the decrease by light of $1/R_g$ the ionisation current, from a consideration of the corresponding behaviour of the (electrically) *excited* gas;[1,2,11,12] this has considerable electron affinity, *e.g.*, about 4·8 volts for normal Cl, and greater if *excited*.[11,2] An assumption was then made that a photo-electric emission from an activated electrode layer(s) in dynamical equilibrium with the gas phase is a primary reaction;[11,13] the conversion of these photo-electrons into slow moving negative ions due to the electron affinity of the excited medium should reduce *i*, as in the space charge effect.[12,13] That the numerical decrease of $-\%\Delta i$ in various gases is as $Cl_2 > Br_2 > I_2$, $HCl > O_2$ Air $> H_2 > N_2$, Ne; and the increase in the normally low $-\Delta i$ in air due to traces of impurities as $Cl_2 > Br_2 > I_2$, which is also the order for their electron affinity, receives a simple explanation. Franck and co-workers, especially Compton, have argued that '*excitation*' of even metallic and rare gas atoms increases appreciably their electron affinity. Anticipated from these considerations, appreciable $-\Delta i$ has actually been observed by the author in vapours of alkali metals (*e.g.*, over 30% in potassium vapour, near V_m; and by Prasad in these Laboratories in mercury vapour; $-\%\Delta i$ has been more than suspected in other similar systems which previously failed to show it due to limitations of the available detector. Being formed on a dielectric surface, this layer might contain ions of both signs (*vide infra* para 4); their electrostatic and inductive influence on the ions and molecules in the gas phase, modifies the annular capacity C_g distinctive of the normal gas.[12,13] A photo-electric emission from this electrode layer entails a capacitative change[12,13,9] in C_g (and, therefore, a phase-shift)[9,13,4] leading to the *light-effect* $-\Delta i$ from (i). This postulate of an electrode layer[12,13,4] is found useful in interpreting results for the '*zero order*' discharge reactions[14] and of a new type of a wide-spread '*periodic effect*'[1,4,14,15] under certain conditions of electrical discharge. (*a*) Prolonged 'aging' under the discharge; or/and surface 'impurities' should affect the 'work function' determining the behaviour of the electrode-layer;[12,13,4] and, therefore, magnitude of the corresponding '*periodic effect*'[1,4,14,15] and especially $-\Delta i$.[31] (*b*) Also on this view, the relative $-\Delta i$ should increase (numerically) by increasing *ceteris paribus* the surface area in the excited system. (*c*) On the other hand, use of high potentials and especially heating would cause irreversible desorption and depolarisation of the ions and other particles constituting the semi-gas, electrode layer; these would instabilise it, and therefore, reduce the corresponding $-\Delta i$ and also the '*periodic effect*'.[1,4,14,15] These predictions *a,b,c* are fully borne out by experimental results. In $-\Delta i$ the minimum time-lag[6,7,2,13] is remarkably small, of the order of a micro-second or even less. It is not unlike the 'relaxation time', as suggested particularly by the production of an appreciable $-\Delta i$ *under H-F. discharge*. This indicates that compared with the '*periodic effect*',[1,4,14,15] $-\Delta i$ originates from a more elementary and reversible light-action such as, *e.g.*, an ionic exchange or/and orientation between the electrode layer and space charge in the excited gas.

§4. It is significant for the general mechanism of the *light-effect* phenomenon that $-\Delta i$ is much wider occurrent than the positive effect, $+\Delta i$. The latter, however, is to be anticipated from the greater probability of photo-ionisation of pre-excited particles.[11a,5] Large $+\Delta i$ has been observed[1,9] in numerous cases under insufficiently understood conditions such as, special coating materials on the angular walls, *e.g.*, *with* $KI_3 + KI$ mixture, vapours of iodine, phosphorus and sulphur. An abnormal working of a metal oxide type detector; spontaneously, after long 'aging' at a constant V in a semi-ozoniser excitation, etc.; a *low* applied V would appear to favour $+\Delta i$ under these conditions. A *positive* effect is also observed especially under heavy inputs to a triode, tetrode and pentode. The photo-electric action is assumed to be fundamental to the general *light-effect* mechanism (*vide* §3).[12,13] From equation (i), $+\Delta i$ implies (subject to the assumptions discussed in §2) an *increase* of the conduction current $1/R_g$, or/and of the capacities C_w and C_g. The electrode-layer mechanism suggests that $+\Delta i$ may be attributed to an emission of the positive ions under light, which comparatively is less frequent than the electronic emission. The author's finding *that the high frequency region of i is the chief seat of the light effect*[8,6,9] has now been substantiated by numerous results over a wide range of conditions of excitation and detection. It is of considerable interest, therefore, to record here the observation of over 40 per cent. *positive* effect reproducible *ad libitum* in chlorine with but ordinary light, *under H-F. excitation near* V_m; and *also at low frequency excitation*, when the relative surface is multiplied by introducing powdered wall material in the annular space; this was suggested by the marked significance to the *light-effect* phenomenon of the solid-gas interface and its immediate neighbourhood in the gas phase.[1,9,5,16] With both these modes of excitation (up to a limit, §2), a larger V reveals the more familiar $-\Delta i$ as large as 40 to 70 per cent. current decrease; the transition $+\Delta i \rightleftharpoons -\Delta i$ is potential reversible; near the