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PROPOSAL FOR A STORAGE RING FOR RELATIVISTIC CHARGED PARTICLES

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A device suitable for storing charged particles, such as electrons or positrons, in a ring is proposed: the basic principle, believed to be new, follows.

In fig. 1 the diagram of the storage ring is shown: the ring is composed of two magnet sections and three RF cavities C_1, C_2 and C_3. The latter are tuned to a multiple of the particle revolution frequency, which depends only on the magnetic field due to the magnets.

·It is easily seen that if:

$$I - n_1 = n_2 - I = a^2 < a^2{}_{\max}(\theta) .$$

1. The particle revolution is energy-independent.
2. The system has focusing properties as regards both vertical and horizontal oscillations.
3. Variations of the stable orbit radius depend on energy as

$$\frac{|y|}{R_0} = \frac{|\Delta E|}{E} \frac{I}{a^2} .$$

4. If a perturbation is introduced, changing the direction of particle velocity of $x_1 = \mathrm{d}y/\mathrm{d}\theta$, the variation ΔT of the revolution period is:

$$\Delta T = K x_1$$

(where K is a constant independent of θ, the azimuth of the perturbation).

5. due to perturbation x_1, the energy of the particle moving in a closed orbit intersecting the middle orbit at $\theta = \theta_1$, is:

$$E_0 + H(\theta_1)\, x_1$$

that is the particle energy is perturbed by a factor $H(\theta_1)x_1$.

The effect of the RF system is as follows:

a. the magnetic field of C_2 (due to the inherent gradient of the electric field) changes the direction of particle velocity.

b. the electric field of C_3 has an analogous effect.

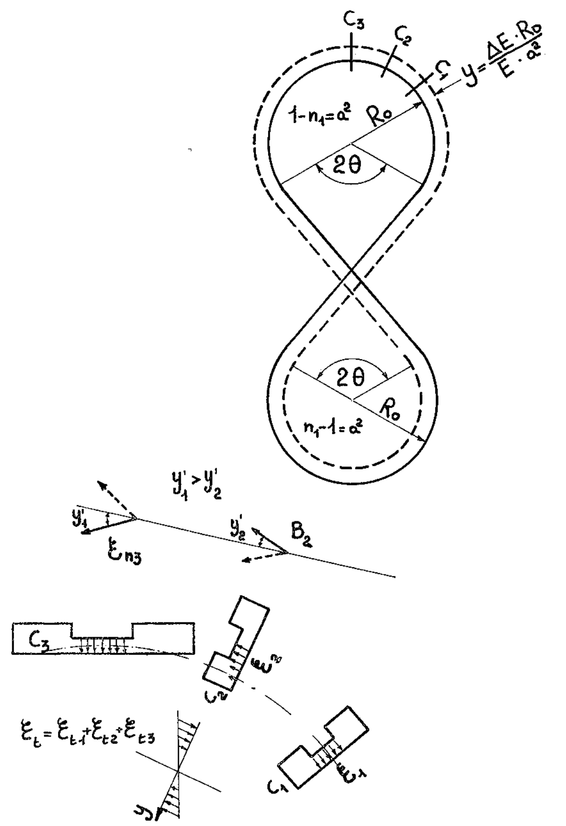

Fig. 1. Storage ring diagram.

c. the electric fields due to C_1, C_2 and C_3 change particle energy proportionally to the distance from the equilibrium orbit.

If C_3 is in the ring's magnetic field, it may be seen that, with a suitable choice of the amplitude and phase of the RF, the equations of motion become:

$$\frac{d\alpha}{dn} = - G_0^2 \sin\alpha$$

$$\frac{d(E - E_0)}{dn} = - (E - E_0 - \Delta E_1)\, G_1^2 \cos\alpha$$

$\Delta E_1 = H \sin\alpha$
n = number of turns.
One can see that:

$$E \to E_0 \quad \text{and} \quad \alpha \to 0 \qquad \text{for } n \to \infty\,.$$

It may be interesting to note that particles are influenced by a pseudo-Poynting vector $E_3 \times B_2$, which has a constant direction and versus. The particle trajectory is curved during interaction. An analogous situation exists when the particle radiates: also in this case the Poynting vector is in the direction of motion and particles are captured in the storage rings.