I. D. Novikov. *Physical properties of a time machine.* It has been suggested recently[1] that the known laws of physics apparently do not preclude in principle the construction of a time machine (T-machine) that would make it possible to travel into the past. A schematic of such a machine was proposed in Ref. 1, another version has been proposed in Ref. 2.

In order to realize either variant of the T-machine we must first construct an appropriate complex topology of three-dimensional space. Such a construction has been proposed in Ref. 3. It consists of two holes, A and B, connected by a topological handle. A two-dimensional analog is shown in Fig. 1. The length S of the handle does not depend on the separation R of the holes in the exterior space, hence it is possible that $S \ll R$. One may enter and exit through holes A and B, and possibly travel through the handle from one hole to another (event horizons do not exist). The holes A and B may move with respect to one another in the exterior space without affecting the handle. In the version of Ref. 2 hole A is fixed, whereas hole B rotates around it at a radius R, with $S \ll R$. In the handle all inertial forces are finite, even in the stationary frame of reference. Given such motion a clock at B (B-clock) will lag behind a clock at A (A-clock) due to Lorenz time contraction. After a sufficient period of time

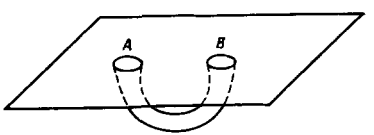

FIG. 1.

this time lag ΔT will become arbitrarily large. On the other hand, an observer at B can look at the A-clock through the handle, and since the distance S is negligibly small the A-clock appears nearby. From this point of reference the A-clock is moving at exactly the same rate as the B-clock and shows exactly the same time. Consequently, observer B can traverse the handle and exit from hole A at the same instant of time which was recorded by his B-clock as he entered hole B. But from the reference point of an observer at A the B-clock has fallen far behind the A-clock, and the observer B emerges at hole A in the remote past.

The existence of a T-machine would imply the existence of closed time lines. This would radically affect the Cauchy boundary problem for field equations and the entire notion of causality. In essence, if local causality is retained, the global separation of events into the past and the future along closed time lines is impossible. The materials of this report were published in Refs. 2, 4.

[1]M. S. Morris, K. S. Thorne, and U. Ywitsever, Caltech preprint GRP-164, 1988.
[2]I. D. Novikov, Preprint IKI AN SSSR, M., 1988.
[3]M. S. Morris and K. S. Thorne, Caltech preprint GRP-067, 1987.
[4]I. D. Novikov and K. S. Thorne, Caltech preprint, 1988.

Translated by A. Zaslavsky