have been continuously maintained for long periods with heat extraction rates up about 2×10^4 ergs/cycle and with cycle periods as small as two minutes. The tests have shown the accuracy of the detailed theoretical computations of the performance of the engine presented by two of us some time previously.[9]

The apparatus shown in Fig. 1 consists of 15 g of potassium chromium alum as the working substance, suspended in a vacuum chamber which is immersed in a liquid helium bath at about 1°K. The working substance (upper salt) is connected on the one hand to the bath via a Pb thermal "valve" V_1 which is in the form of a thin ribbon, and, on the other hand, via a similar Pb valve V_2 to the refrigerated reservoir R. In our preliminary experiments the reservoir has been a paramagnetic salt sample identical with the working substance of the engine.

The cycle of operations is as follows (see also reference 1): first the working substance B is magnetized in a field of 9500 gauss with the upper "valve" V_1 to the helium bath "open" so that the heat of magnetization is conducted to the bath. The lower valve V_2 is closed. Before demagnetization of the paramagnetic salt (working substance) the upper valve V_1 is "closed" and on demagnetization the salt B cools. The lower valve V_2 is then opened and the working substance and the reservoir R equalize temperatures. This completes the cycle. To repeat the cycle the lower valve is closed, the upper opened, and then the above operations repeated. The lower Pb valve is controlled by a small air core solenoid producing a magnetic field of 1200 gauss. The upper is controlled by the stray field of the main electromagnet.

In Fig. 2 we show the temperature of the reservoir (and of the bath) as a function of time in a typical run extending for 64 successive cycles. From minutes 5 to 21 the cycle periods were two min, whereas from minutes 40 to 72 the cycle periods were three min. More recent experiments using iron ammonium alum as the working substance and better salt to metal contact have shown greater efficiency and ease of operation.

It is proposed to publish complete details of the construction and operation elsewhere. Our plans for its future use include the establishment of a visible bath of liquid helium down to 0.2°K, the establishment of a more favorable initial temperature platform for magnetic cooling processes, and the establishment of an isothermal enclosure at about 0.2°K for experiments on nuclear paramagnetism.

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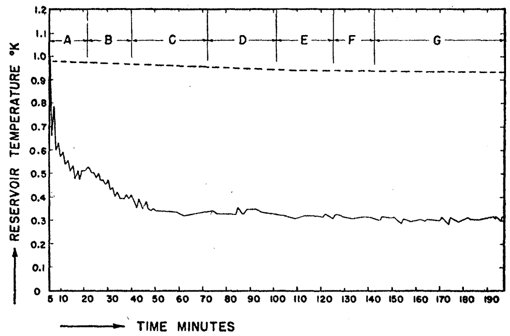

FIG. 2. Plot of typical run extending for 64 cycles. The full curve gives the reservoir temperature. The regions A, B, $\cdots G$ involve different values of the cycling variables, data for which are given in the table below.

Region	Initial magnetic field on B gauss	Final magnetic field on B gauss	Time of magnetization min	Time valve V_2 was open min
A	9500	1500	1	1
B	9500	600	1	1
C	9500	600	1	2
D	9500	385	1	2
E	9500	385	1	2
F	9500	285	1	2
G	9500	220	1	2

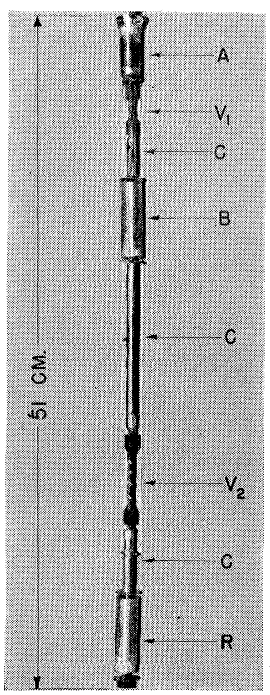

FIG. 1. Photograph of refrigerator and reservoir removed from its vacuum case. The over-all length is 51 cm. A is the anchor to the liquid helium bath at about 1°K, B is the working substance (upper salt), C are carbon resistance thermometers, V_1 and V_2 are the valves, and R is the low-temperature reservoir.

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Superconducting Compounds

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IN previous notes[1,2] it had been shown how the nonsuperconducting transition elements form superconducting compounds with semiconductors. The Co, Rh, Ir column has now been completed by establishing superconductivity in Rh_3Ge_2 at 2.12°K,[3] thus lying between $CoSi_2$ (1.3°) and IrGe (4.7°).

The element following rhodium in the periodic system is palladium, and the superconducting PdTe and PdSb have already been mentioned.[2] In addition to these, $\alpha PdBi_2$ and PdBi become superconducting at 3.42° and 3.74°. Alekseevskij[4] reported recently the transition temperature for $PdBi_2$ at 1.75°. $\alpha PdBi_2$ and PdBi seem to be the first superconducting compounds crystallizing in a monoclinic system.[5]

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