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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
61/129,970	08/04/2008		105	1052-45		

CONFIRMATION NO. 1794

Yossi Azancot
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Rosh HaAyin, 48092
ISRAEL

FILING RECEIPT

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Date Mailed: 09/05/2008

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Applicant(s)

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Power of Attorney: None

If Required, Foreign Filing License Granted: 09/04/2008

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 61/129,970**

Projected Publication Date: None, application is not eligible for pre-grant publication

Non-Publication Request: No

Early Publication Request: No

**** SMALL ENTITY ****

Title

Inductive power receiver

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PTO/SB/16 (07-07)
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PROVISIONAL APPLICATION FOR PATENT COVER SHEET – Page 1 of 2

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

Express Mail Label No. _____

INVENTOR(S)		
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Alfred	**Leibovitz**	**Petach Tikva, Israel**

Additional inventors are being named on the _____ *separately numbered sheets attached hereto*

TITLE OF THE INVENTION (500 characters max):

Inductive Power Receiver

Direct all correspondence to: **CORRESPONDENCE ADDRESS**

☐ The address corresponding to Customer Number:

OR

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ENCLOSED APPLICATION PARTS *(check all that apply)*

☐ Application Data Sheet. See 37 CFR 1.76

☐ CD(s), Number of CDs _____

☑ Drawing(s) *Number of Sheets* 3

☐ Other (specify) _____

☑ Specification (e.g. description of the invention) *Number of Pages* 9

Fees Due: Filing Fee of $200 ($100 for small entity). If the specification and drawings exceed 100 sheets of paper, an application size fee is also due, which is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

METHOD OF PAYMENT OF THE FILING FEE AND APPLICATION SIZE FEE FOR THIS PROVISIONAL APPLICATION FOR PATENT

☐ Applicant claims small entity status. See 37 CFR 1.27.

☐ A check or money order is enclosed to cover the filing fee and application size fee (if applicable).

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105

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The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

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SIGNATURE /Yossi Azancot/ /Amir Ben Shalom/ /Arik Rofe/ /Oola Greenwald/ **/Alfred Leibovitz/** **Date** 31st July 2008

TYPED or PRINTED NAME Yossi Azancot Amir Ben Shalom Arik Rofe Oola Greenwald **Alfred Leibovitz**
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TELEPHONE +972 3 902 1057 Docket Number 1052-45

Inductive Power Receiver

Field of the Invention

The present invention is directed to providing an inductive power receiver for interfacing between an inductive power outlet and an electrical device. More specifically, the invention is directed to providing an inductive power receiver which whilst in operation, may be manipulated safely by hand.

Background

With the increase in the number of portable electronic devices such as music players, computers and their peripherals, it is often necessary for a user to store a great many connecting wires. Connecting cables are generally unsightly, often become tangled and can present a significant hazard.

Inductive power coupling allows energy to be transferred from a power supply to an electric load without connecting wires. Inductive power outlets may reduce the number of power cables and other trailing wires required for powering electrical devices.

In any inductive power transfer system a power supply is wired to a primary coil and an oscillating electric potential is applied across the primary coil which induces an oscillating magnetic field. The oscillating magnetic field may induce an oscillating electrical current in a secondary coil, placed close to the primary coil. In this way, electrical energy may be transmitted from the primary coil to the secondary coil by electromagnetic induction without the two coils being conductively connected. An electric load wired in series with such a secondary coil may draw energy from the power source when the secondary coil is inductively coupled to the primary coil.

Because of the nature of inductive power transfer, the induced current in the secondary coil is always an alternating current (AC). Often, though, direct current (DC) is required by the electric load, for example when charging an electrochemical cell. Typically, therefore, in inductive power transfer system the power receiving units housing the secondary coil further include a rectifier such as a diode bridge, for converting the AC output of the secondary coil to a DC input to the electrical load.

Inductive power providing systems are known, for example the system described in United States Patent No. 6,803,744, to Sabo, titled "Alignment independent and self aligning inductive power transfer system". Sabo's device

includes a plurality of inductors arranged in an array and connected to a power supply via switches which are selectively operable to activate the respective inductors. The inductors serve as the primary coil of a transformer. The secondary coil of the transformer is arranged within the appliance. When the appliance is positioned proximate to the power transfer device with the respective coils in alignment, power is inductively transferred from the device to the appliance via the transformer.

Another wireless power providing system is described in United States Patent No. 7,164,255 to Hui. In Hui's system a planar inductive battery charging system is designed to enable electronic devices to be recharged. The system includes a planar charging module having a charging surface on which a device to be recharged is placed. Within the charging module, and parallel to the charging surface, is at least one, and preferably an array of primary windings that couple energy inductively to a secondary winding formed in the device to be recharged.

Hui's system also provides secondary modules, or power receivers, for interfacing between the inductive charging surface and conventional electronic devices not supplied with secondary windings. Hui's inductive power receivers may be may be adequate for low power applications such as charging batteries. However high power systems such as for powering a computer, small handheld power receiving units may be impractical as they typically generate a lot of heat.

The secondary coil itself may be heated by the current flowing therethrough. Moreover, in high frequency switching power supplies diode rectifiers generally dissipate a lot of heat. The heat produced by high power inductive receivers results in high temperatures which may reduce overall efficiency, reduce the reliability of components and may make the receiving unit too hot to be manipulated by hand whilst in operation.

There is a need for an inductive power receiver which can be used to interface between an inductive power outlet and a high power electrical device and the present invention addresses this need.

Summary of the Invention

It is an aim of the invention to provide an inductive power adapter comprising: at least one inductive power receiver for receiving power from an inductive power outlet; at least one power connector for conductively connecting the power receiver to at least one electrical device; and a grip for handling the adapter, the grip being thermally isolated from the power receiver such that when the power receiver is in operation a user may handle the adapter without injury.

Typically, the inductive power receiver comprises at least one secondary inductive coil for coupling with a primary inductive coil connected to a power source. Optionally the primary inductive coil is connected to a power source via a driving unit for providing an oscillating voltage across the primary inductive coil.

In some embodiments of the invention, the adapter further comprises a rectifier for converting an AC input from the inductive power outlet into a DC output for powering the electrical device. Typically, the adapter further comprises a printed circuit board.

Typically, the power receiver is configured for providing power at a rate above 50W. Preferably, the power receiver provides power at a rate above 100W.

The adapter typically, comprises a cooling system for dissipating heat generated therein. Preferably, the cooling system comprises at least one air inlet, situated above the power receiver, and at least one air outlet, situated below the power receiver such that hot air heated by the power receiver flows out of the adapter through the air outlet and cool air from outside is drawn into the adapter through the air inlets.

Additionally, the adapter may additionally comprise a dust-guard for preventing dust from entering the air outlets. Optionally, the dust-guard comprises the power connector. Alternatively, the dust-guard comprises the grip.

Preferably, the adapter comprises at least one heat sink for dissipating heat generated by the power receiver. Typically, the heat sink is a metallic disk. In preferred embodiments, the diameter of the heat sink is smaller than the internal diameter of a casing of the adapter thereby allowing air to circulate between the heat sink and the casing.

Brief Description of the Figures

For a better understanding of the invention and to show how it may be carried into effect, reference will now be made, purely by way of example, to the accompanying drawings.

With specific reference now to the drawings in detail, it is stressed that the particulars shown are by way of example and for purposes of illustrative discussion of the preferred embodiments of the present invention only, and are presented in the cause of providing what is believed to be the most useful and readily understood description of the principles and conceptual aspects of the invention. In this regard, no attempt is made to show structural details of the invention in more detail than is necessary for a fundamental understanding of the invention; the description taken with the drawings making apparent to those skilled in the art how the several forms of the invention may be embodied in practice. In the accompanying drawings:

Fig. 1 shows schematic diagram of a computer being powered by an inductive power outlet via an inductive power adapter according to a first embodiment of the present invention;

Fig. 2a is an isometric projection of an inductive power adapter according to an exemplary embodiment of the invention;

Fig. 2b is an exploded view showing the internal components of the power receiver of the exemplary embodiment; and

Fig. 2c is a side view cross section of the power receiver of the exemplary embodiment.

Description of the Preferred Embodiments

Reference is now made to Fig. 1 showing a laptop computer 300 drawing power from an inductive power outlet 200 via an inductive power adapter 100, according to a first embodiment of the present invention. The adaptor is configured such that it can be safely handled by a user while it is operation.

The power adapter 100 includes an inductive receiver 120, housed in a casing 160 and a power connector 140 for connecting to an electrical device, such as the computer 300. The inductive receiver 120 includes a secondary inductor 122 configured to couple with a primary inductor 220 in the power outlet 200. Typically,

the primary inductor 220 is wired to a power source 240 via a driver 230. The driver 230 provides an oscillating driving voltage to the primary inductive coil 220.

Preferably, an alignment mechanism (not shown) is provided for aligning the secondary inductor 122 to the primary core 220. The alignment mechanism may consist of a primary magnetic element in the inductive outlet configured to snag and/or engage a secondary magnetic element in the power adaptor 100.

It will be appreciated that electrical components of power converters generate heat. There are a number of problems associated with the heat generated in an inductive receiver 120, particularly in systems running at high power above say 50W or 100W. Heat produces high temperatures which can reduce overall efficiency and may also reduce the reliability of components. Much design effort is typically required to overcome this problem, and other factors such as the dimensions of the system may be compromised as a result.

In practice, electrical components of the power adapter 100 are selected which function at high temperatures. However, the maximum temperature of the casing 160 is further constrained by the requirement that it is to be handled by the user. If the casing 160 reaches high temperatures, above 50 degrees Celsius or so, a user may find handling the adapter to be unpleasant and may even be at risk of injury. In order to allow a user to comfortably and safely handle the adaptor 100, it is a particular feature of the present invention that a heat dissipation system for directing heat away from the hand grip 162.

The heat dissipation system may be better understood with reference to Figs. 2a, 2b and 2c showing an exemplary inductive power adapter 1100 according to a second embodiment of the invention. Fig. 2a shows an isometric projection, Fig. 2b shows an exploded view and Fig. 2c shows a cross-section through the same embodiment of the power adaptor 1100.

The exemplary power adapter 1100 includes an inductive receiver 1120, and a heat sink 1130 housed between a lower casing 1160L, and an upper casing 1160U and a power connector 1140 which can be wound around a hand grip 1162 for storage.

The inductive power receiver 1120 consists of a secondary inductive coil 1122 a ferrite disk 1124 and a printed circuit board (PCB) 1126. The heat sink 1130 of the exemplary embodiment consists of a metallic disk sandwiched between the inductive receiver 120 and the upper casing 1160U. The ferrite disk 1124 may serve as a flux

guiding core to improve inductive coupling between the secondary inductive coil 1122 and a primary inductive coil 220 (Fig. 1) of an inductive power outlet 200.

When the power adapter 1100 is in operation, heat is generated by a number of components of the inductive receiver 1120. An alternating current is induced in the secondary inductive coil 1122 therefore causing the coil wire to heat up. Furthermore hot spots are typically generated around certain electrical components typically provided on the PCB 1126, such as rectifiers, diodes, MOSFETS, power regulators, LDOs, feedback transmitters or the like.

The heat sink 1130 is typically a thermal conductive material such as aluminum, copper or the like which serves to distribute heat more evenly around the inductive receiver 1120. Preferably, thermal vias are provided through the PCB 1126 and thermal grease or a similar agent is used to improve thermal contact between the heat sink 1130, PCB 1126, ferrite disk 1124 and secondary coil 1122.

Air outlets 1132 are provided in the top 1161 of the upper casing 1160U allowing hot air from inside the power adaptor to escape into the atmosphere. Air inlets 1134 are provided in the bottom 1165 and sides 1167 of the lower casing 1160L and on the sides 1163 of the upper casing 1160U allowing cool air to enter into the power adaptor from below. It is a particular feature of the exemplary embodiment that the outer diameter d of the heat sink is smaller the inner diameter D of the casing 1160 thus allowing air to circulate around the inductive receiver 1120. Thus hot air heated by the inductive power receiver 1120 flows out of the adapter 1100 through the outlets 1132 and cool air from outside is drawn into the adapter 1100 through said air inlets 1134. The hand grip 162 may be additionally protected from heat by a barrier of thermal insulating material.

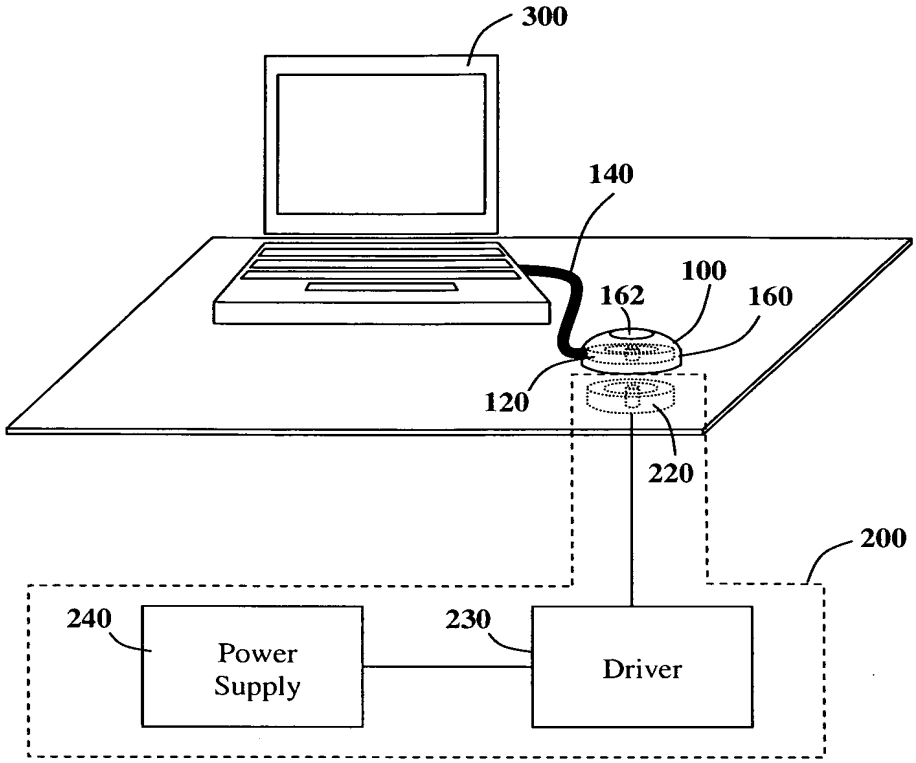
It is noted that the air outlets 1132 may allow dust to enter the power adapter 1100. In some embodiments therefore a dust-guard is provided to prevent dust from entering the outlets 1132. In the exemplary embodiment, the grip 1162 overhangs the outlets 1132 serving as a dust-guard to prevent dust from entering the adapter 1100 whilst in operation. When not in operation, the power connector 1140 may be wound around the hand grip 1162, thereby providing further protection against dust.

In certain embodiments, the PCB 1126 includes a light emitting diode (not shown) used as a feedback transmitter for sending signals to an optical detector in the power outlet 200 (Fig. 1). It will be appreciated that in such embodiments, it is

necessary that a clear line-of-sight is maintained between the optical emitter and detector. To this end, in preferred embodiments an optical window, transparent to the wavelength of the wavelength of the optical transmission, is provided through the secondary inductive coil 1122, ferrite disk 1124, lower casing 1160L and other layers between the PCB 1126 and the primary coil 220 (Fig. 1).

The scope of the present invention is defined by the appended claims and includes both combinations and sub combinations of the various features described hereinabove as well as variations and modifications thereof, which would occur to persons skilled in the art upon reading the foregoing description.

In the claims, the word "comprise", and variations thereof such as "comprises", "comprising" and the like indicate that the components listed are included, but not generally to the exclusion of other components.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Power Supply
230
Driver

Fig. 1

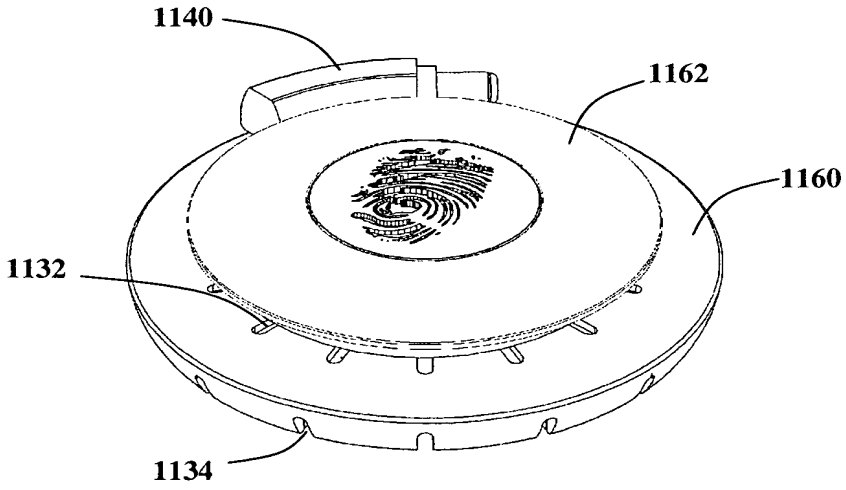
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Fig. 2a

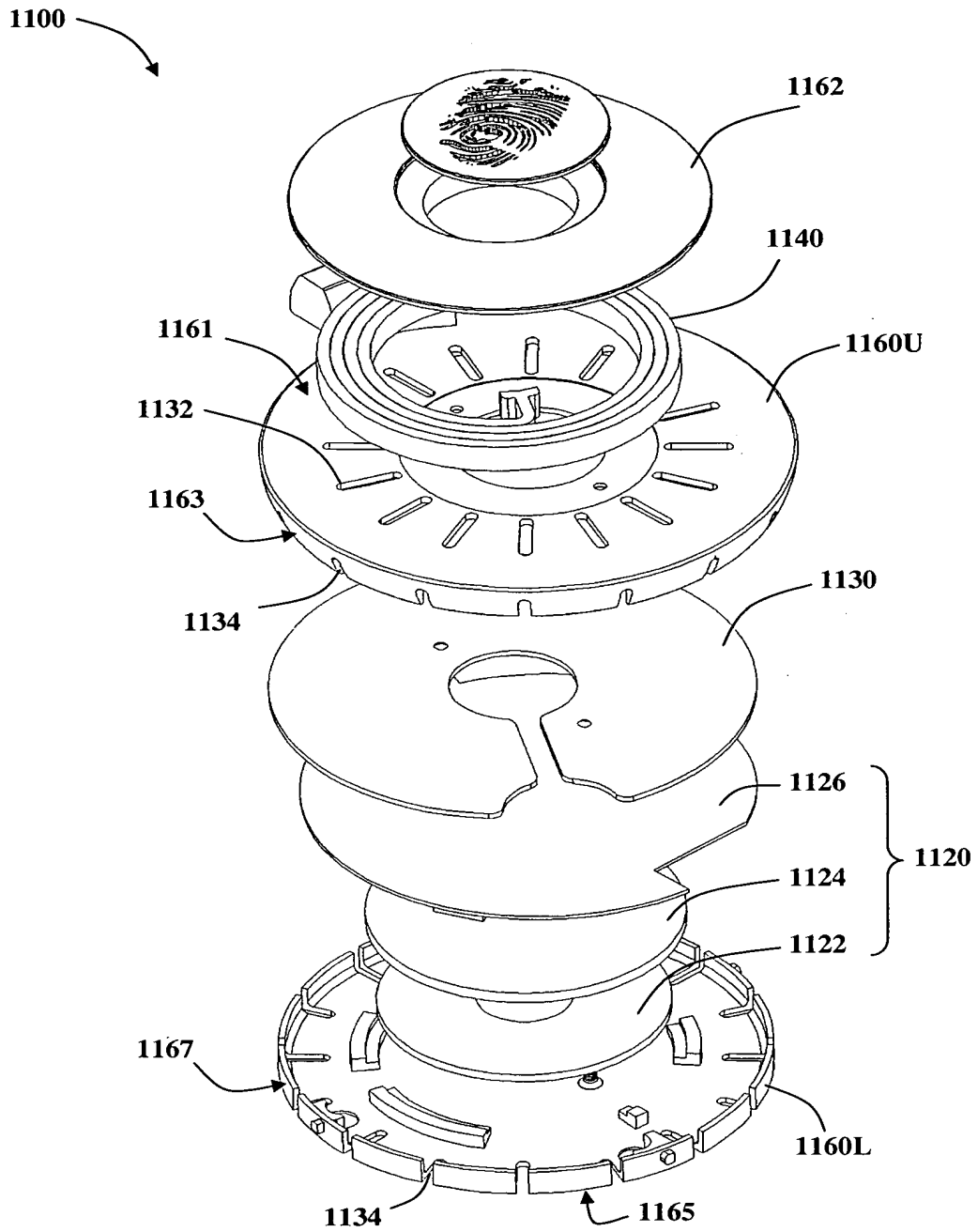
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Fig. 2b

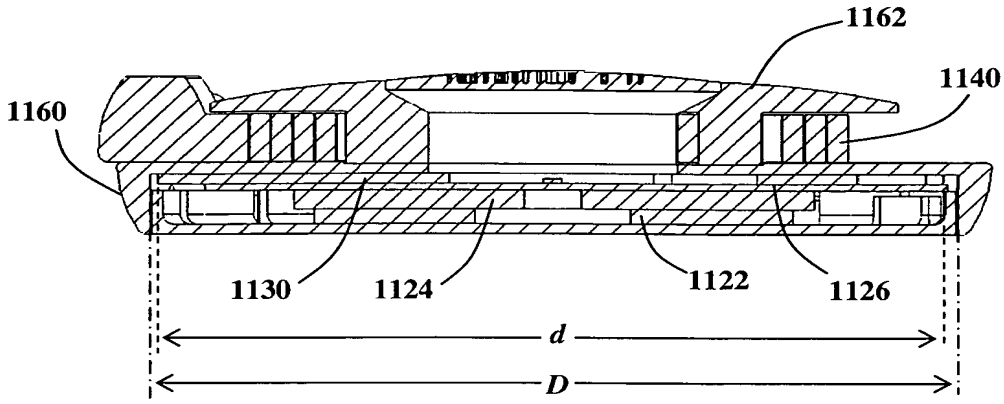

Fig. 2c

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