US 20120006505A1

(19) **United States**

(12) **Patent Application Publication**

Trojer

(10) **Pub. No.: US 2012/0006505 A1**

(43) **Pub. Date: Jan. 12, 2012**

(54) **COMMUNICATIONS NETWORK NODE**

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(21) Appl. No.: **13/255,947**

(22) PCT Filed: **Apr. 28, 2009**

(86) PCT No.: **PCT/EP2009/003083**

§ 371 (c)(1),
(2), (4) Date: **Sep. 22, 2011**

Publication Classification

(51) **Int. Cl.**
F25B 29/00 (2006.01)

(52) **U.S. Cl.** **165/48.1**

(57) **ABSTRACT**

Communications network node comprising communications equipment (**10**), an inlet region (**3**) for coolant to flow towards the equipment and an outlet region (**5**) for the coolant to flow away from the equipment, a pathway (**7***a*, **7***b*) from the outlet region to the inlet region, and, a heat exchanger (**9**) in thermal communication with the pathway.

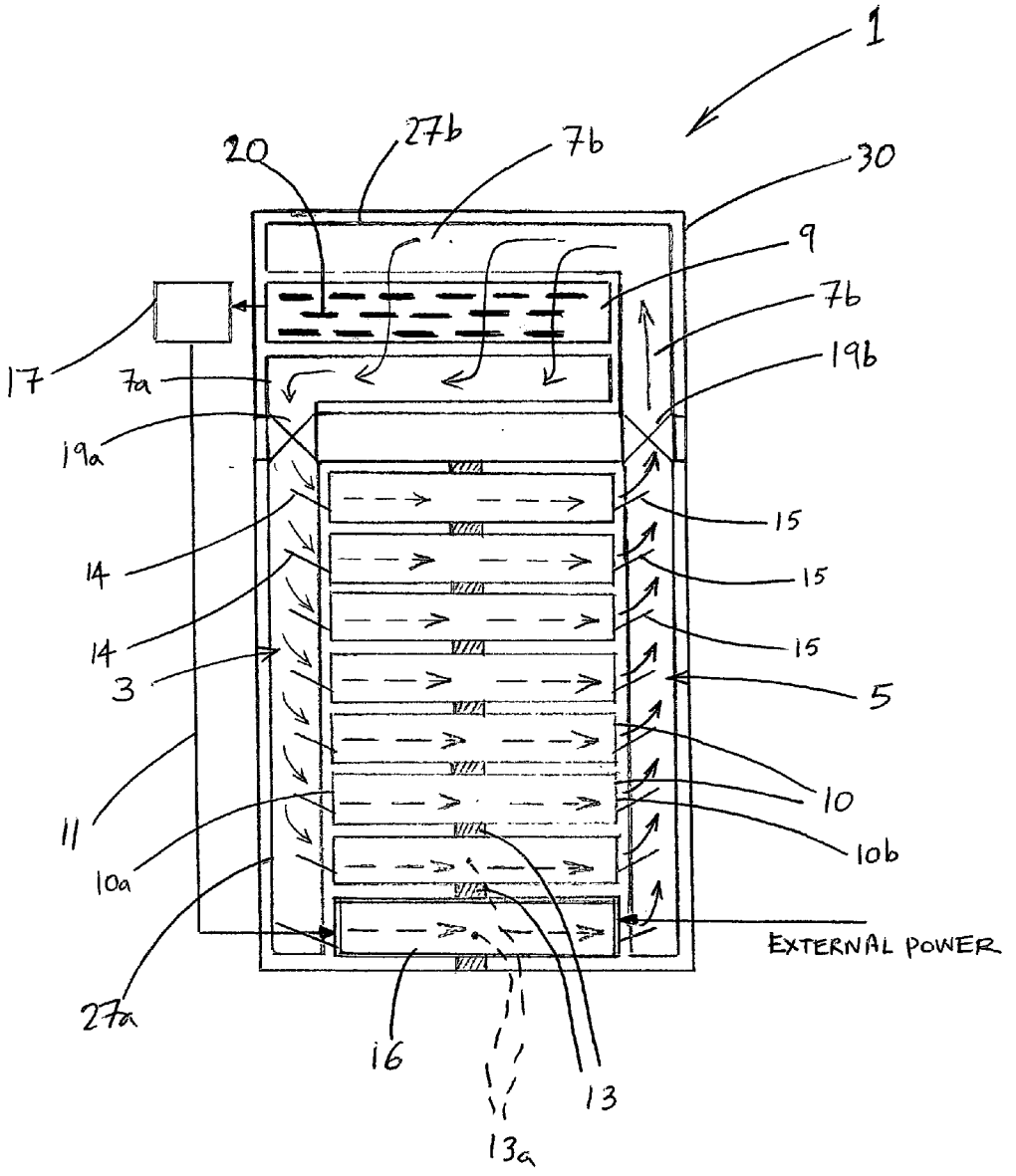
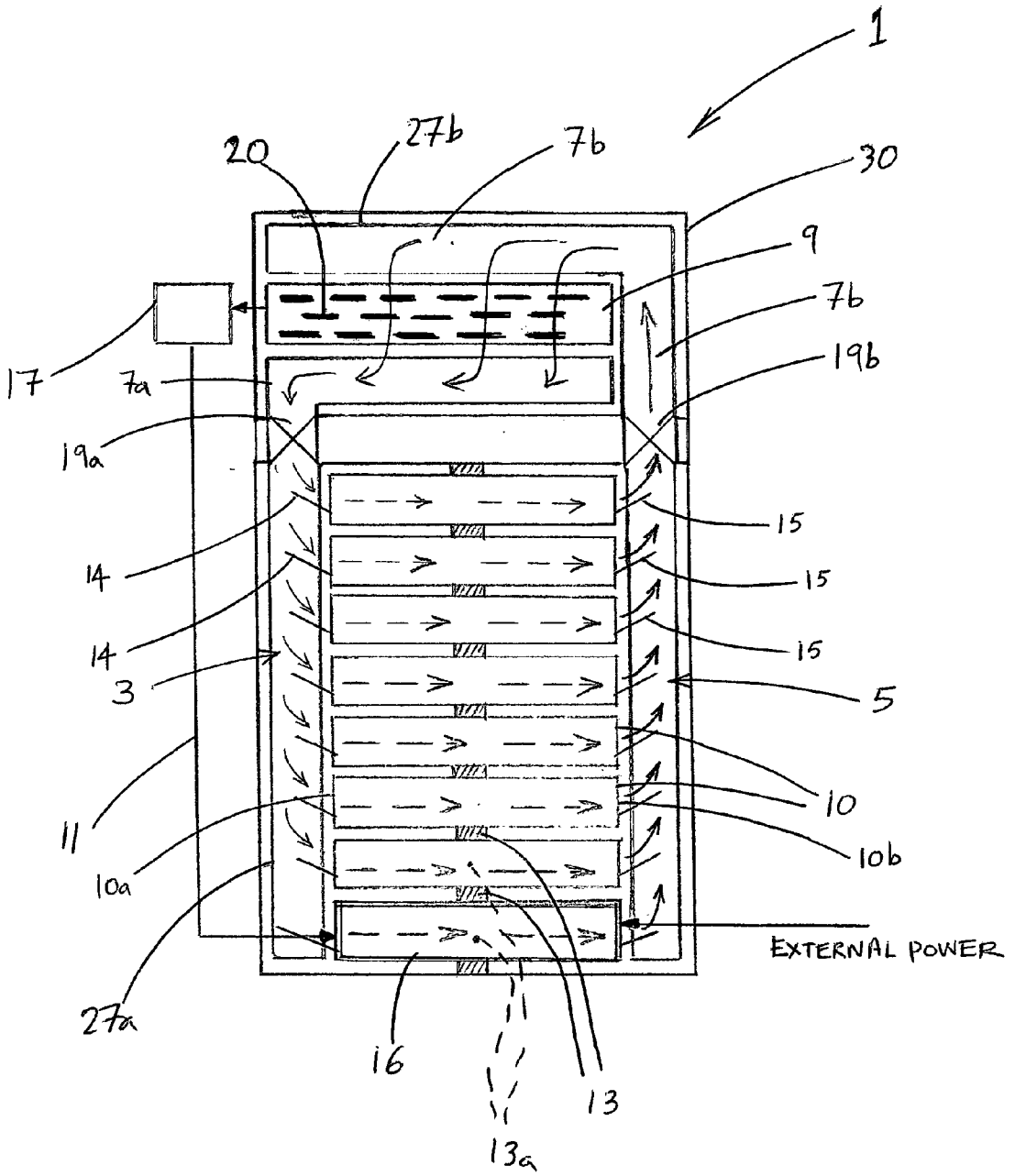


FIGURE 1


1
20
27b
7b
30
9
7b
19b
17
7a
19a
15
14
15
14
15
3
5
11
10
10a
10b
EXTERNAL POWER
27a
16
13
13a

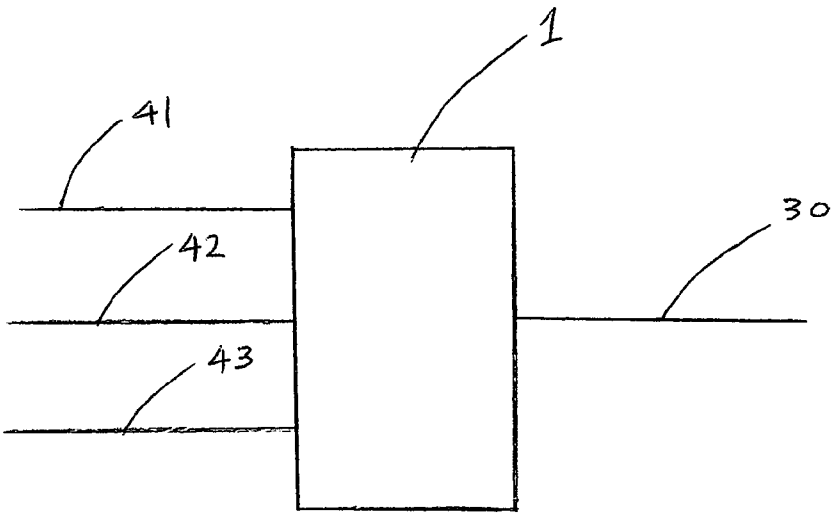


FIGURE 2

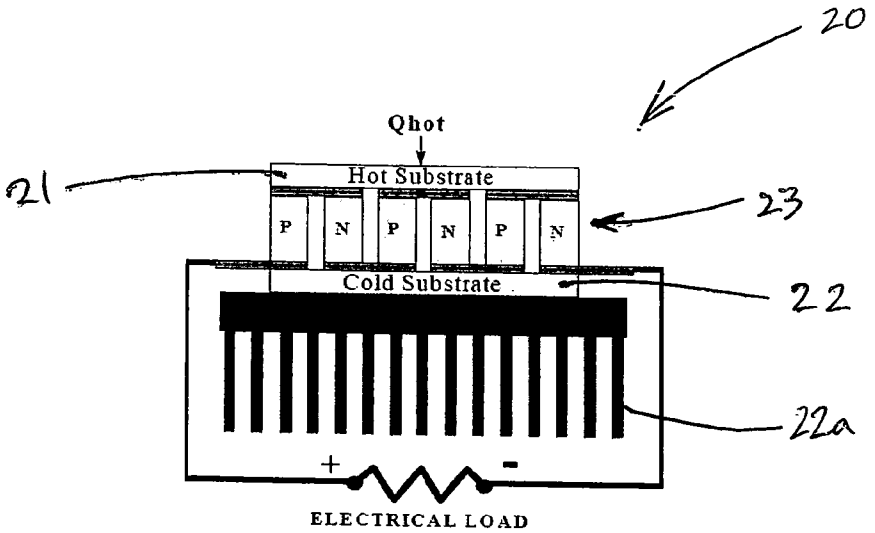


FIGURE 3

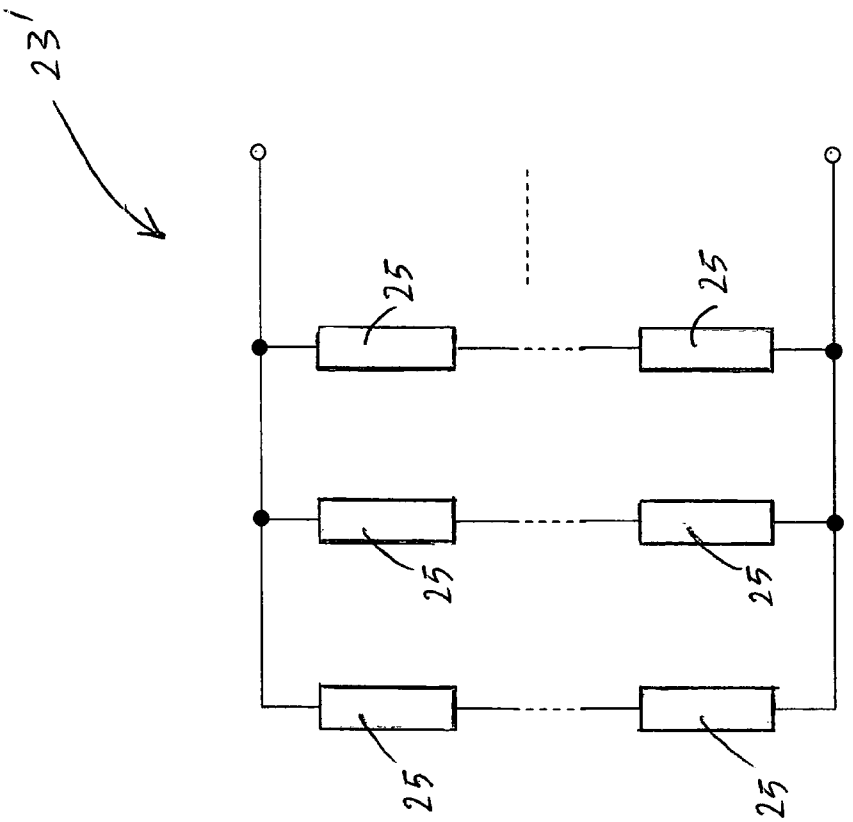


FIGURE 4

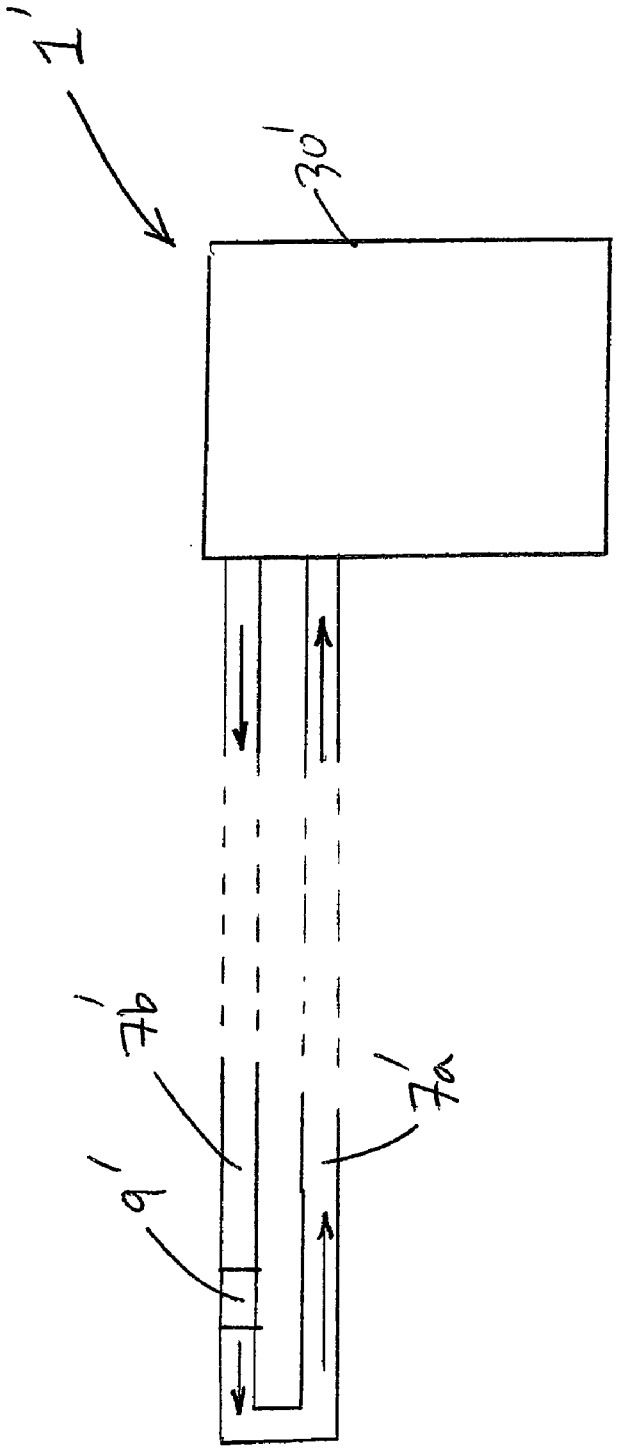


FIGURE 5

COMMUNICATIONS NETWORK NODE

TECHNICAL FIELD

[0001] The present invention relates generally to communications network nodes.

BACKGROUND

[0002] The growing demand for higher speeds in access networks, higher competition between network operators in the broadband market, and price erosion on optical components have led to an increased interest in fibre-based access technologies. In particular, the distance between the optical fibre and the end-user has reduced. In network architectures such as Fibre to the Curb (FTTC), Fibre to the Cabinet (FTTCab) and Fibre to the Neighbourhood (FTTN) local network equipment connects optical fibres from a local regional exchange to metallic cable, which metallic cable extends to the end user premises. In such network architectures a housing apparatus enclosing network node equipment, which terminates the metallic and optic fibres, is typically located outdoors in the vicinity of the end user premises to be serviced.

SUMMARY

[0003] We have realised that it would be beneficial to improve the way in which network node equipment is powered.

[0004] According to a first aspect of the invention there is provided a communications network node. The apparatus comprises communications equipment, an inlet region for coolant to flow towards the equipment and an outlet region for the coolant to flow away from the equipment. The apparatus further comprises a pathway from the outlet region to the inlet region, and, a heat exchanger in thermal communication with the pathway.

[0005] An advantage of one embodiment of the invention is that energy is recovered from the coolant which has received heat from the equipment is fed back to power the equipment.

[0006] Preferably the heat exchanger comprises a thermoelectric generator. The thermoelectric generator preferably comprises a plurality of thermocouple devices connected in serial and parallel arrangement.

[0007] The node may be arranged to supply electricity from the thermoelectric generator to the equipment.

[0008] The heat exchanger may be located above a region arranged to receive the equipment.

[0009] The node may comprise a divider structure which substantially thermally isolates the inlet region from the outlet region.

[0010] The divider structure is preferably arranged to receive the equipment such that an inlet portion of the equipment is located in communication with the inlet region and an outlet portion of the equipment is located in communication with the outlet region.

[0011] The node is desirably arranged to substantially prevent ingress of fluid into the pathway.

[0012] The fluid pathway preferably forms part of a closed circuit for the coolant.

[0013] The node is preferably arranged to guide fluid upwardly into the outlet region. The node most preferably comprises a guide surface to guide the fluid upwardly into the fluid outlet region.

[0014] A cold side of the heat exchanger is desirably in thermal communication with an external surface of the node.

[0015] The node may desirably be suitable for location in an outdoor environment. The node preferably comprises a street side cabinet.

[0016] The node preferably comprises a housing arranged to enclose the communications network node equipment, which equipment arranged to provide communication between communication network links. The housing preferably encloses the pathway and the heat exchanger.

[0017] The pathway may extend away from the housing, with the heat exchanger located remotely from the housing.

BRIEF DESCRIPTION OF DRAWINGS

[0018] Various embodiments of the invention will now be described, by way of example only, with relevance to the following drawings in which:

[0019] FIG. **1** is a schematic cross-sectional view of a communications network node,

[0020] FIG. **2** is a schematic view of a communications network node housing apparatus and connections to the apparatus,

[0021] FIG. **3** shows a thermoelectric generator,

[0022] FIG. **4** shows a circuit diagram, and

[0023] FIG. **5** shows a communications network node housing and a fluid pathway.

DETAILED DESCRIPTION

[0024] With reference to FIG. **1** there is shown a communications network node comprising a housing apparatus **1** enclosing network node equipment **10** and heat exchange apparatus. The housing apparatus **1** is of the type generally known as a street side cabinet, a dog-house or a manhole and is suitable for location in an outdoor environment. With reference to FIG. **2**, the network node equipment **10** serves to provide a bridge between an optical fibre **30**, which is connected to a regional or local exchange, and metallic cabling **41**, **42** and **43**, which are connected to respective user premises. The network node equipment **10** may comprise telecommunications network equipment such as a switch, Internet Protocol Digital Subscriber Line Access Multiplexer (IPDSLAM), or an Optical Network Unit (ONU), for example. As will be described below a thermoelectric generator arrangement converts heat produced by the equipment **10** to produce power which is fed back to an electrical power supply unit **16**.

[0025] As is described in detail below, the node comprises an inlet region **3** for coolant air to flow towards the equipment **10** and an outlet region for coolant air to flow away from the equipment, and the apparatus further comprises a pathway comprising pathway portions **7***a* and **7***b*, defined by respective conduit structures **27***a* and **27***b* to connect the inlet region **3** to the outlet region **5**. The node further comprises a heat exchange arrangement **9** which is in thermal communication with the pathway. Coolant air is circulated through the equipment and the pathway in order to ensure that the equipment does not overheat.

[0026] The equipment **10** comprises a plurality of equipment units which, as shown in FIG. **1**, are arranged in a rack assembly with the units arranged one above the other.

[0027] One end of **10***a* of each of the equipment units is arranged to receive air from the inlet region **3**. Adjacent to the

respective ends **10***a* there are provided guide surfaces **14** which save to deflect air towards said respective ends **10***a*.

[0028] On entering the equipment **10**, the air receives heat produced by the equipment and the heat air is conveyed towards respective opposite ends **10***b* of the equipment units. The heated air exits the equipment units at the ends **10***b* and enters into the outlet region **5**. Advantageously, guide surfaces **15** deflect the output heated air upwards, thereby assisting the conveyance of the air towards the pathway. The heated air rises from the outlet region towards an uppermost part of the pathway. Conveyance of the air towards the uppermost part of the pathway is assisted by a fan assembly **19***b* which urges the heated air upwards. On reaching the uppermost part of the pathway the air is drawn through the heat exchange arrangement **9**.

[0029] The heat exchange arrangement **9** comprises a plurality of thermoelectric generators **20**. One such generator is shown in FIG. **3**. The generator **20** comprises a hot side **21** and a cold side substrate **22**. The hot side substrate and the cold side substrate **22** sandwich an array **23** of p-pellets and n-pellets to form a thermocouple device. The hot side substrate is in thermal communication with the environment external of the apparatus. As can be seen in FIG. **3**, the cold side substrate is connected to cooling fin structure **22***a*.

[0030] The temperature gradient between the hot side substrate **21** and the cold side substrate **22** produces electrical power derived from the movement of electrical carriers through thermoelectric pellets brought on by a heat flow. Heat is effectively exchanged for electrical power. By the Seebeck effect, positive charge in one of the p-pellets and electrons in an adjacent n-pellet move towards the heat sink producing a small voltage. Since the p-pellets and the n-pellets are connected in series the total voltage produced by the generator is in the sum of the voltages. The voltage is fed to a DC/DC converter **17**, which in turn, is connected to the power supply unit **16** of the apparatus **1**. Although serial connection of n-pellets and p-pellets is shown, pairs of the pellets may be arranged in parallel formation, or in a serial/parallel arrangement. Such a hybrid serial/parallel arrangement **23'** is shown in FIG. **4**, with respective pairs of n-pellets and p-pellets shown schematically as circuit elements **25** and multiple elements **25** connected in series on each parallel branch. Advantageously, by connecting the pellets in this manner the need for the DC/DC converter is obviated.

[0031] The region **3** and the outlet region **5** are substantially thermally isolated from one another by virtue of a divider wall structure **13**. This ensures that there is substantially no conduction of heat between air at the inlet region **3** and air at the outlet region **5**. As can be seen from FIG. **1**, suitably dimensioned vertically-spaced apertures **13***a* are conveniently provided in the divider structure **13** to allow racking of the equipment units **10** and the power supply unit **16**.

[0032] Outer casing **30** of the housing apparatus **1** is advantageously sealed such that ingress of air from the exterior environment is substantially prevented into the internal volume of the apparatus, or at least into the pathway. This results in the coolant air being circulated in a closed system and accordingly the accumulation of dust in the fans of the equipment units **10** and the power supply **16** is significantly reduced. Advantageously, this will result in reduced maintenance time required to service the housing apparatus **1** in respect of replacing or renewing fan components, such as dust filters, in view of dust accumulation which brings about energy inefficiencies in powering the fans. The same advantages of reduced maintenance apply in respect of the fans **19***a* and **19***b*.

[0033] Advantageously, by feeding back power to the power supply unit recovered from heat to output by the equipment units **10** and the power supply unit itself, the external power required to be supplied to the apparatus is reduced. This would otherwise have been energy which would simply have been dissipated into the exterior environment. A further important advantage is that by converting the produced heat to electrical energy, the quantity of heat inside the apparatus is reduced. This, in turn means that the energy required to achieve sufficient cooling is reduced.

[0034] Coolant air follows a substantially horizontal path through the equipment units **10** stemming from the fact that the housing apparatus **1** is fixed in a substantially upright position. However, in an alternative embodiment the housing apparatus **1** is arranged in a tilted condition such that the inlet ends **10***a* of the equipment units **10** are higher than the outlet ends **10***b*. The housing could be inclined at an angle of around 20° to 30° relative to the vertical. Alternatively, the housing **1** could remain upright whereas the rack assembly is arranged to hold the equipment units **10** at a suitable angular attitude. In both of those embodiments the angular inclination of the passage of air through the units acts to increase the flow of air therethrough which reduces the energy required for cooling.

[0035] In an alternative embodiment, additional cooling of the air could be achieved by using the electrical power derived from output heat to power a Peltier cooler device.

[0036] In a further alternative embodiment comprising a housing apparatus **1'** shown in FIG. **5**, a pathway **7***a'* , **7***b'* extends remotely from an exterior casing **30'** of the apparatus which encloses telecommunication units to a heat exchange arrangement **9'** which is also remotely located. The heat exchange arrangement **9'** could be located at domestic or commercial premises and could be arranged to transfer heat from the coolant air to heat water (or another fluid) for example for use in providing heating to the premises.

[0037] In another embodiment, coolant conduits of multiple housing apparatus, which are in proximity to each other, are connected to a common or shared heat exchanger.

[0038] In further alternative embodiments, liquid, such as water, would be used as the coolant fluid.

1-17. (canceled)

18. A communications network node comprising:

communications equipment;

an inlet region for coolant to flow towards the equipment;

an outlet region for coolant heated by the communications equipment to flow away from the communications equipment;

a pathway from the outlet region to the inlet region, the pathway forming part of a closed circuit for the coolant; and

a heat exchanger in thermal communication with the pathway, the heat exchanger being arranged to cool the heated coolant, and at least one thermoelectric generator comprised in the heat exchanger, the thermoelectric generator arranged to produce electricity from the heated coolant and supply electricity to the communications equipment.

19. The node according to claim **18**, wherein the thermoelectric generator comprises a plurality of thermocouple devices connected in serial and parallel arrangement.

20. The node according to claim **18**, wherein the heat exchanger is located above a region arranged to receive the equipment.

21. The node according to claim **18**, comprising a divider structure which substantially thermally isolates the inlet region from the outlet region.

22. The node according to claim **21**, wherein the divider structure is arranged to receive the equipment such that an inlet portion of the equipment is located in communication with the inlet region and an outlet portion of the equipment is located in communication with the outlet region.

23. The node according to claim **18**, arranged to substantially prevent ingress of external fluid into the pathway.

24. The node according to claim **23**, wherein the fluid pathway forms part of a closed circuit for the coolant.

25. The node according to claim **18**, arranged to guide fluid upwardly into the outlet region.

26. The node according to claim **25**, which comprises a guide surface to guide the fluid upwardly into the fluid outlet region.

27. The node according to claim **18**, wherein a cold side of the heat exchanger is in thermal communication with an external surface of the node.

28. The node according to claim **18**, arranged to be suitable for location in an outdoor environment.

29. The node according to claim **18**, which comprises a street side cabinet.

30. The node according to claim **18**, which comprises a housing arranged to enclose the communications equipment, which equipment arranged to provide communication between communication network links.

31. The node according to claim **30**, wherein the housing encloses the pathway and the heat exchanger.

32. The node according to claim **30**, wherein the pathway extends away from the housing and the heat exchanger is located remotely from the housing.

* * * * *