EXTENSIONS TO NETWORK GRAFTING

INVENTOR:

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Description

Fault management:

Detect signal level changes to indicate that a switch has occurred and worked. Likewise, monitor for a drop or raise in profile initiated. Depending on which CMs change and how, which experienced outage before the switch and which just switched, one can localize the fault.

Force a switch over to isolate faults and failures in the network. By switching to the alternate path, and running any of a number of PNM tests, one can see which impairments disappear, and thereby localizing the faults better. RxMER and spectrum analysis are best for finding faults, but even FEC stats, PreEQ settings, and other tests can be used.

If we add a signal monitoring ability to the switching points that would further help isolate faults. A quiet period (US and DS in active link) allows an opportunity for a quick switch to the other link as a signal test and capture spectrum for analysis, supporting proactive troubleshooting, and fault localization. Depending on the construction of the switch, there may not need to be a switch over (and thus no need for a quiet period), as the switch may be built to look at the "disconnected" link spectrum through a high loss connection. The switching point makes an excellent test point because it can test-capture the RF signal in the segments separately (US and DS).

The switch action could be forced either by the signal quality dropping or a CM indicating it is not receiving signal (though this is problematic).

Note that a technician can bring along a grafting link (wired or wireless) for maintenance, so that they may be installed on demand and used for the duration, being removed completely when done. This would relate it to Rapid coax cutover (D5113).

Maintain service:

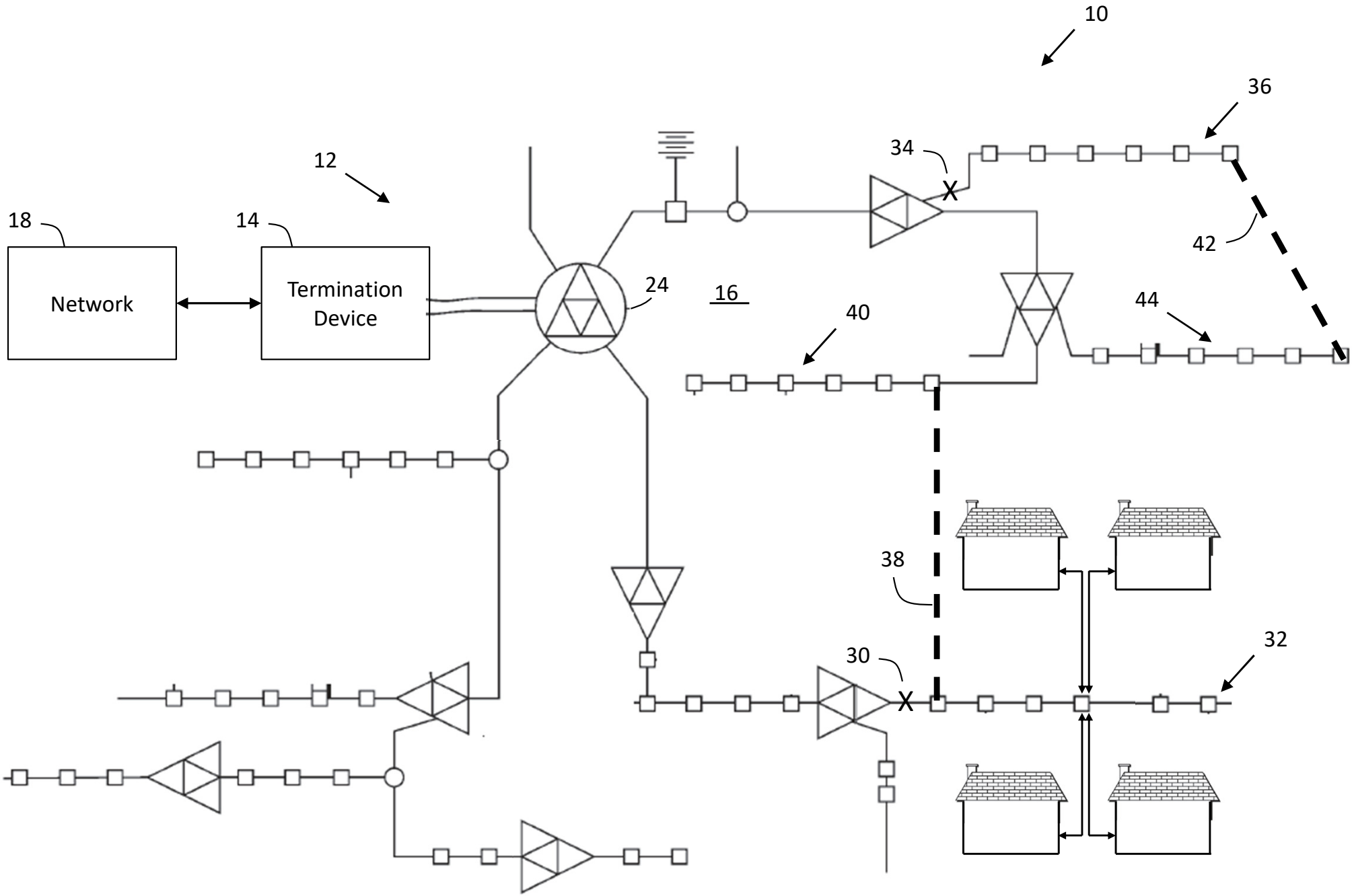
When working on the line (provisioning, maintenance, digging in area, etc.) in a way that could force an outage, the switch can be used to move the potentially affected customer group onto the backup link, allowing for the maintenance to happen without taking out service. This amounts to manually initiating the switch in the grafter of Fig. 2 and-or Fig. 3.

Congestion:

In the case of network congestion, if the switch connects two branches to different nodes (RPD, RMD, or Optical Node of any type), an application at the provider's network can determine that a branch switch over would relieve congestion, and then initiate the

switch. Switching back can be determined the same way, or after a model of traffic indicates that it is safe to switch back and not have congestion. See Fig. 1, link 38 where this switch could be initiated, assuming the amplifiers near the connection points were to be remote nodes.

Further, with an appropriate filter placed at the switch, it can use different US grants to send US data on both links, potentially to different remote PHY or MACPHY nodes, sharing bandwidth more efficiently. Likewise, in the DS, if different DS frequencies are used on different remote PHY or MACPHY nodes, more DS bandwidth could be provided. (say allowing a leg connected to a remote node that is not capable of using a frequency band as needed by a CM or CMs on the leg, to then filter the needed frequencies over to a node that is capable, and thus taking better advantage of the mix of node capabilities). If the switching was rapid enough, the frequencies used in the DS could be shared for US too (while one link is sending DS, the other can send US in the same frequency bands or a subset, thus allowing two remotes with different capabilities to expand their capabilities to more CMs, increasing richness of service offering). The CM involved may be able to send and receive in the same frequencies then (potentially receiving from one remote and sending to another), if configured to do so. Note that this is a lot like full duplex DOCSIS technology, but utilizing two connections to PHY devices for the CM, and the switch having filters and appropriate timing switching; this could be viewed as an extension of the FDX switch prototyped by CableLabs a few years ago. For figures that support this set of ideas, see Fig 2 and Fig 3 in the attached, and replace the grafter with the appropriate filters (say allow a frequency to be received in one direction but sent in the other direction through use of duplex filters) or a set of switches and filters (use duplex filters to separate frequency bands, and then have independent switches on each filter range to allow independent control of the fluencies and which leg connects through which path).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36
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Network
Termination Device
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Fig. 1

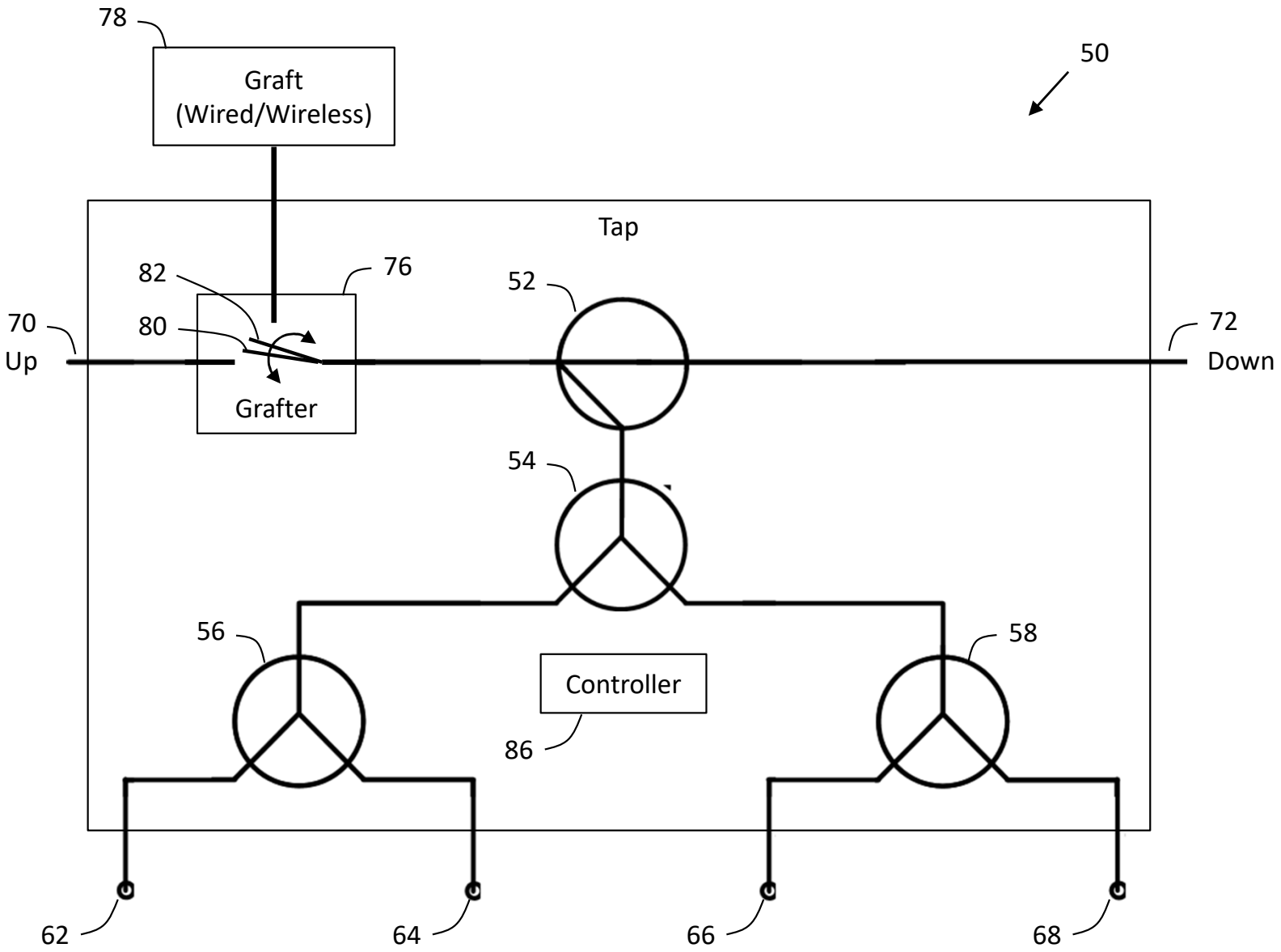
78
Graft
(Wired/Wireless)
50
Tap
82
76
52
70
Up
80
72
Down
Grafter
54
56
58
Controller
86
62
64
66
68

Fig. 2

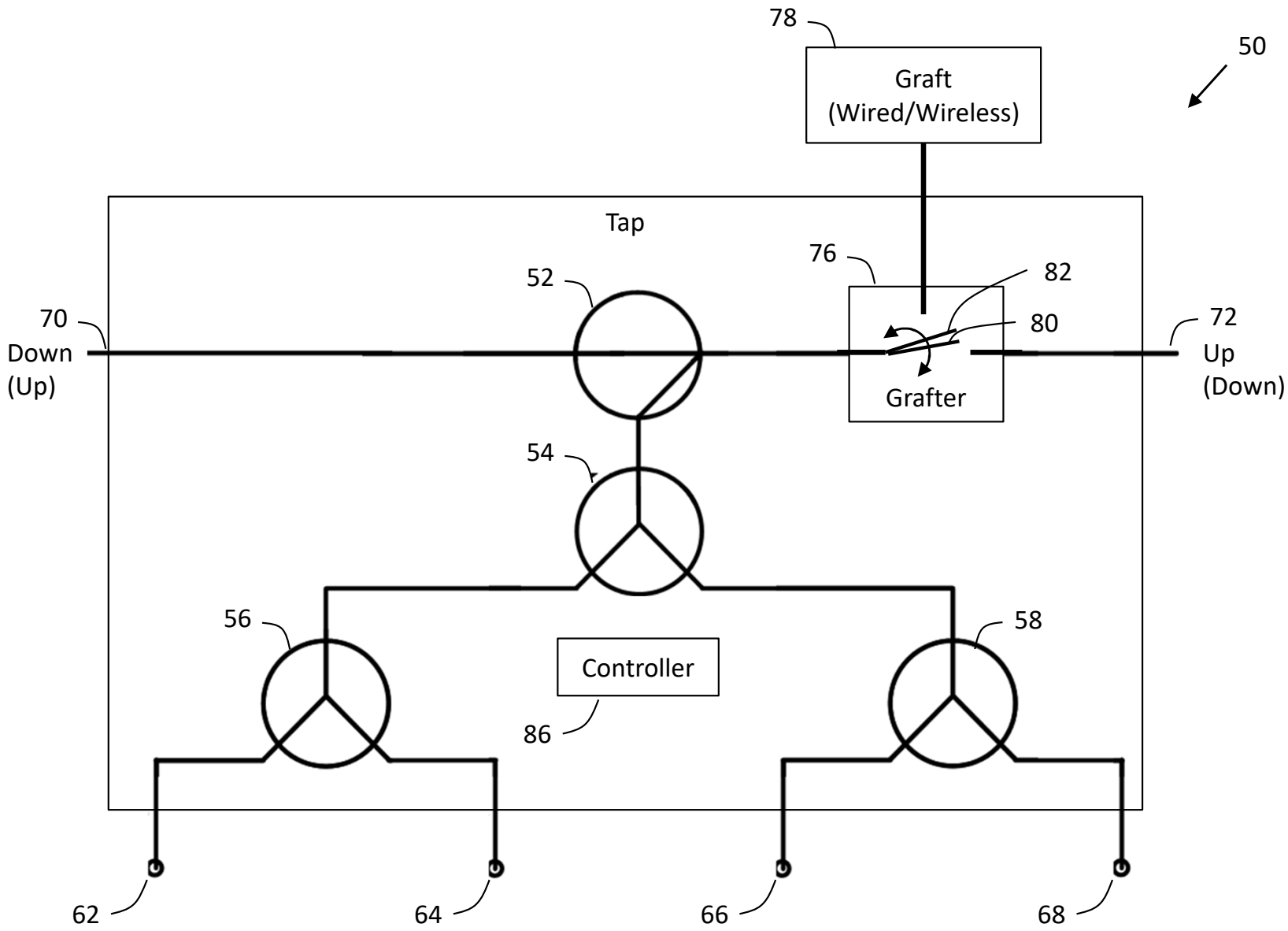
78
Graft
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Fig. 3

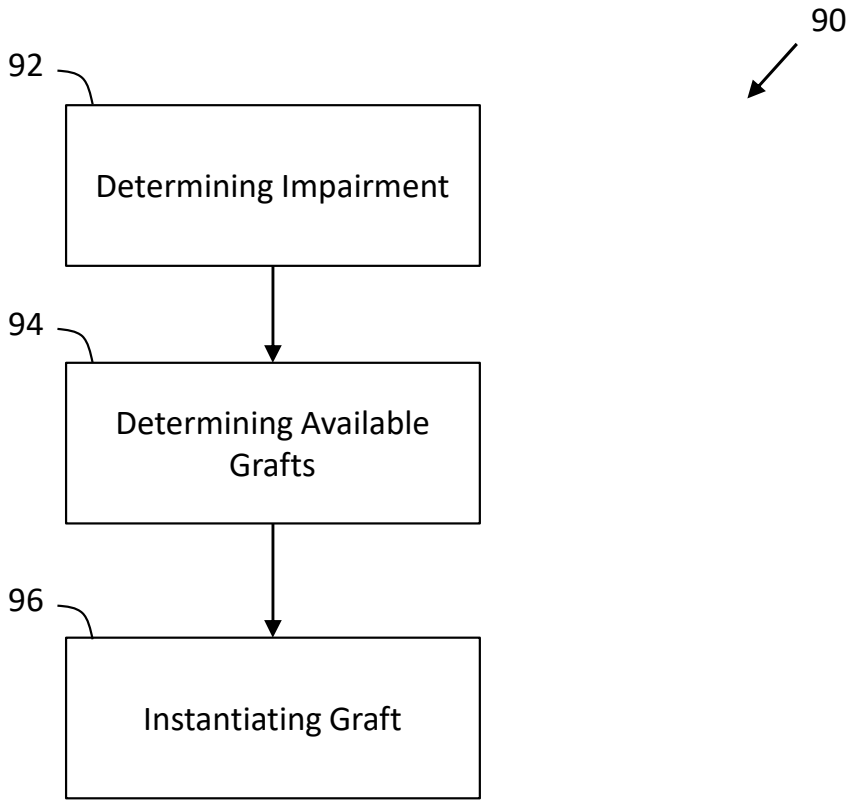
90
92
Determining Impairment
94
Determining Available Grafts
96
Instantiating Graft

Fig. 4