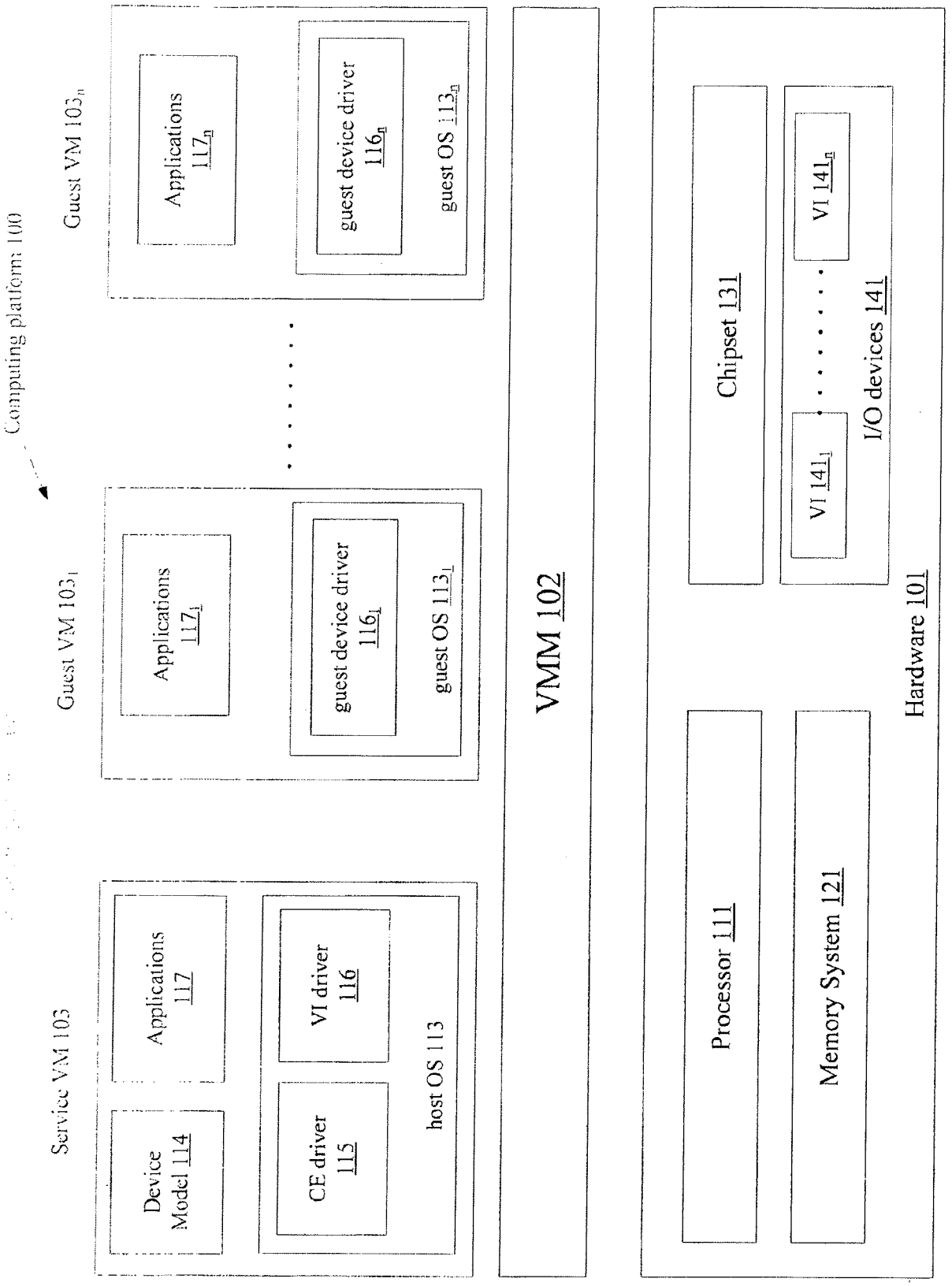

Computing platform 100
Service VM 103
Device Model 114
Applications 117
CE driver 115
VI driver 116
host OS 113
Guest VM 103$_1$
Applications 117$_1$
guest device driver 116$_1$
guest OS 113$_1$
Guest VM 103$_n$
Applications 117$_n$
guest device driver 116$_n$
guest OS 113$_n$
VMM 102
Hardware 101
Processor 111
Memory System 121
Chipset 131
I/O devices 141
VI 141$_1$
VI 141$_n$

Fig 1

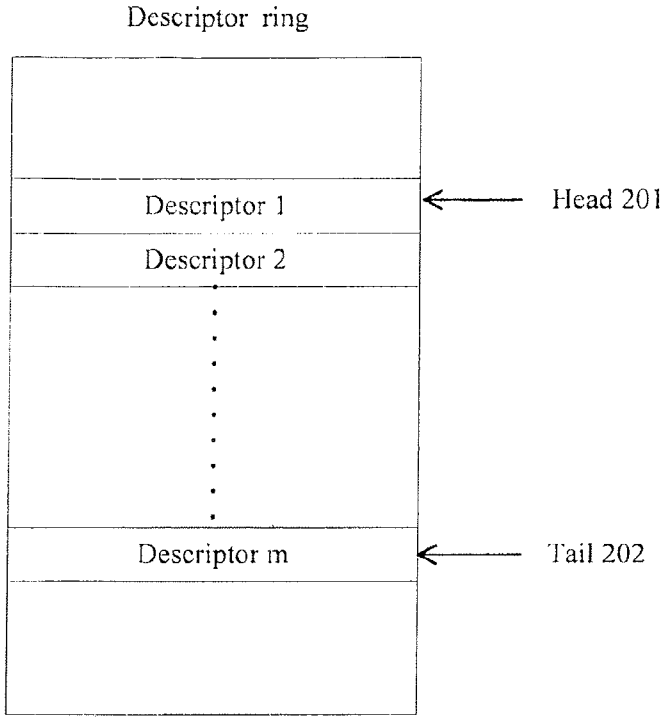

Descriptor ring
Descriptor 1
Head 201
Descriptor 2
Descriptor m
Tail 202

Fig 2a

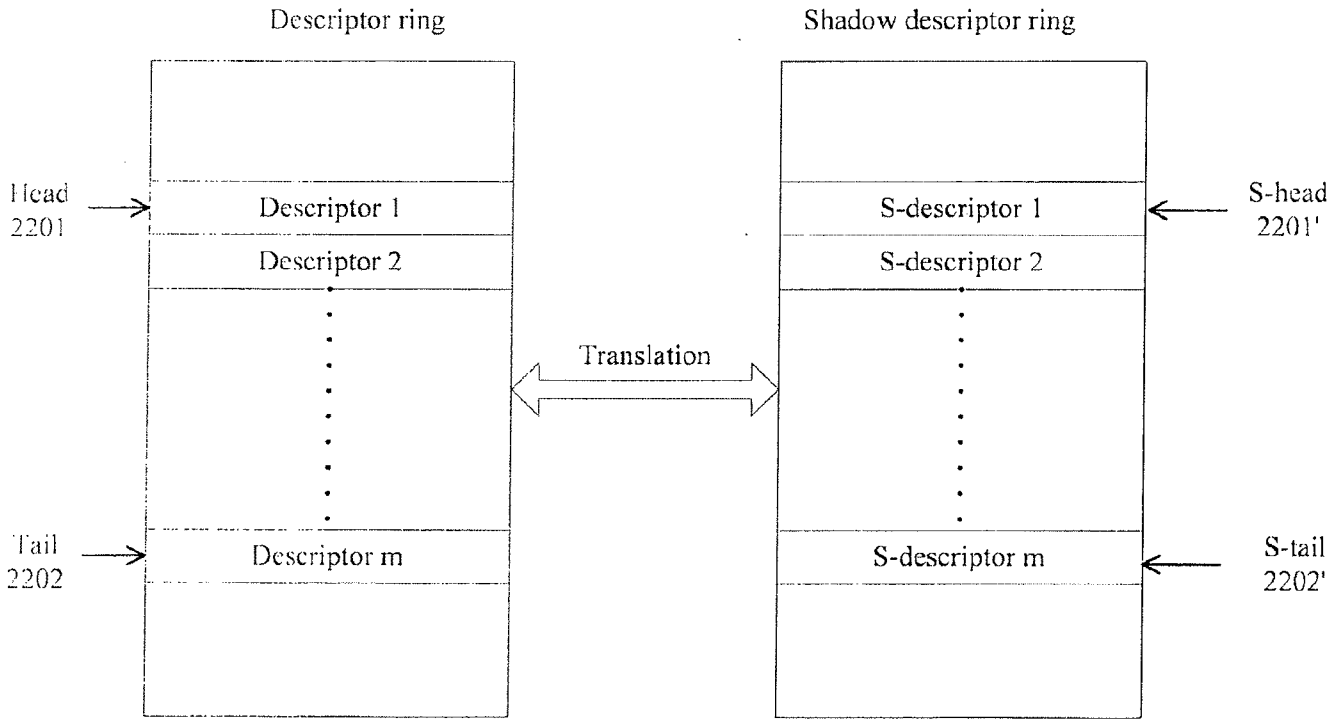

Descriptor ring
Shadow descriptor ring
Head
2201
Descriptor 1
S-descriptor 1
S-head
2201'
Descriptor 2
S-descriptor 2
Translation
Tail
2202
Descriptor m
S-descriptor m
S-tail
2202'

Fig 2b

IOMMU table

Guest address	Host address
⋮	⋮

Fig 3

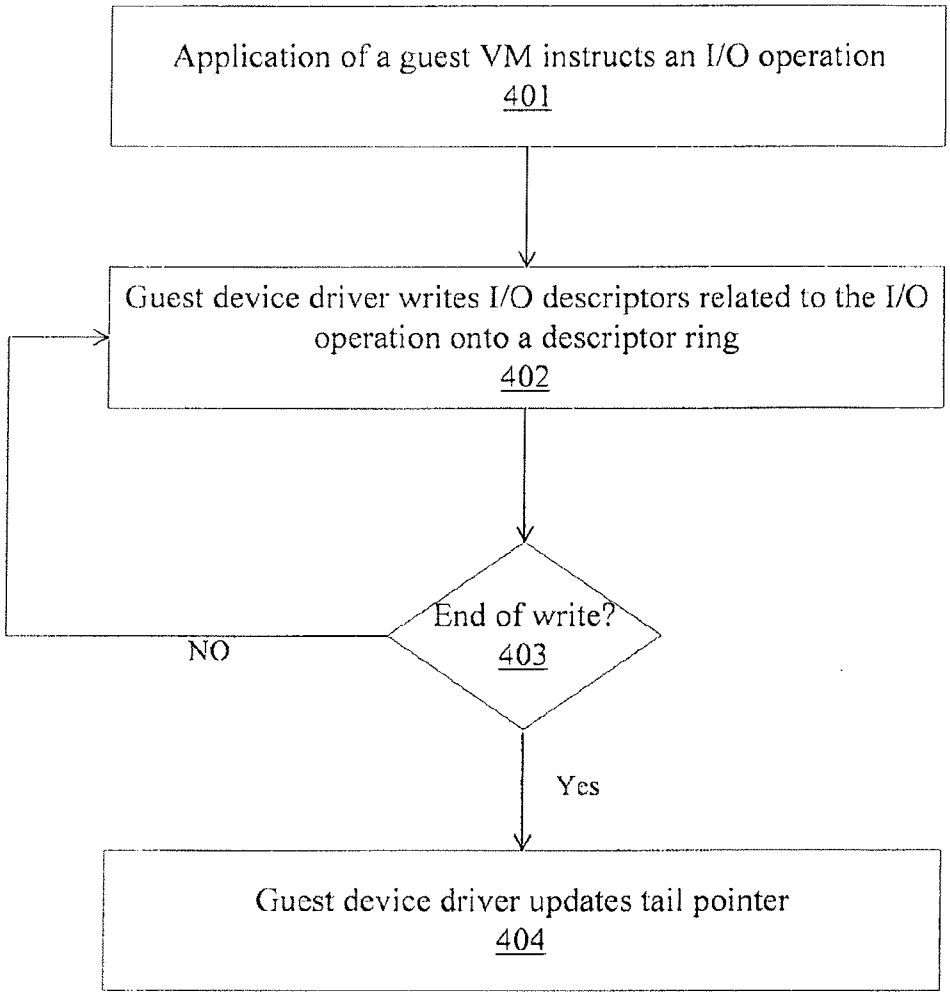

Application of a guest VM instructs an I/O operation
401
Guest device driver writes I/O descriptors related to the I/O operation onto a descriptor ring
402
End of write?
403
NO
Yes
Guest device driver updates tail pointer
404

Fig 4

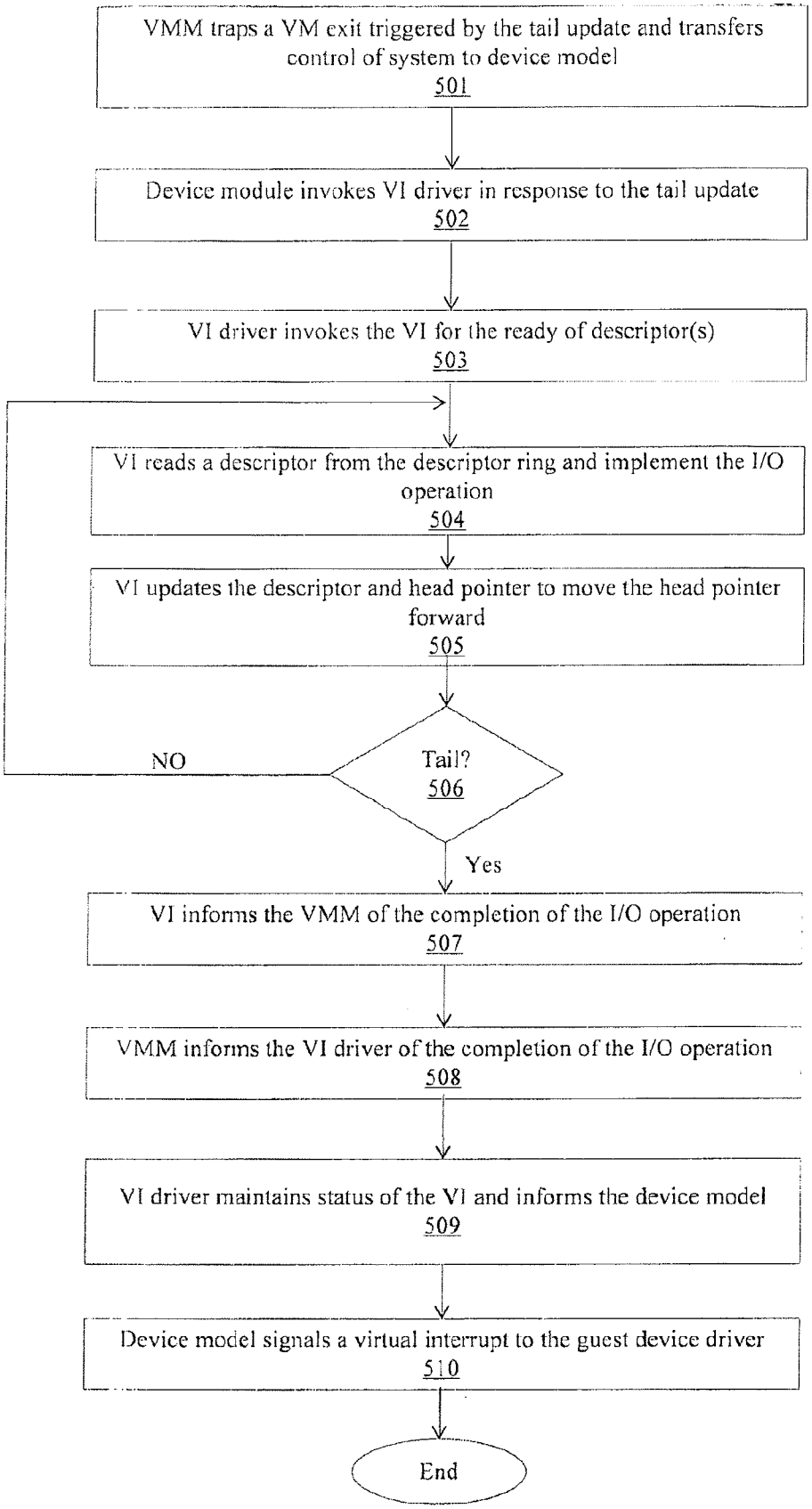

VMM traps a VM exit triggered by the tail update and transfers control of system to device model
501
Device module invokes VI driver in response to the tail update
502
VI driver invokes the VI for the ready of descriptor(s)
503
VI reads a descriptor from the descriptor ring and implement the I/O operation
504
VI updates the descriptor and head pointer to move the head pointer forward
505
Tail?
506
NO
Yes
VI informs the VMM of the completion of the I/O operation
507
VMM informs the VI driver of the completion of the I/O operation
508
VI driver maintains status of the VI and informs the device model
509
Device model signals a virtual interrupt to the guest device driver
510
End

Fig 5

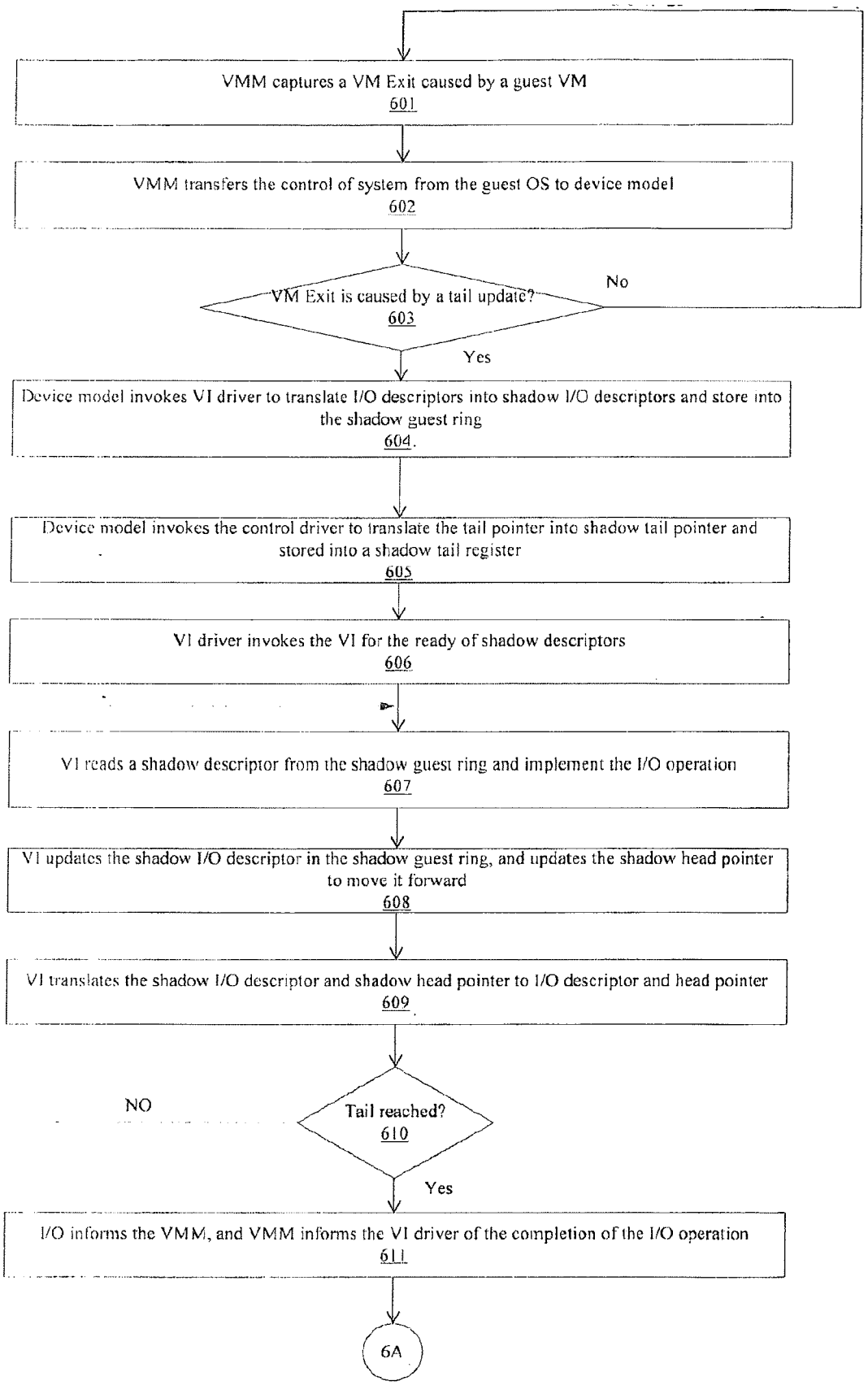

VMM captures a VM Exit caused by a guest VM
601
VMM transfers the control of system from the guest OS to device model
602
VM Exit is caused by a tail update?
603
No
Yes
Device model invokes VI driver to translate I/O descriptors into shadow I/O descriptors and store into the shadow guest ring
604.
Device model invokes the control driver to translate the tail pointer into shadow tail pointer and stored into a shadow tail register
605
VI driver invokes the VI for the ready of shadow descriptors
606
VI reads a shadow descriptor from the shadow guest ring and implement the I/O operation
607
VI updates the shadow I/O descriptor in the shadow guest ring, and updates the shadow head pointer to move it forward
608
VI translates the shadow I/O descriptor and shadow head pointer to I/O descriptor and head pointer
609
NO
Tail reached?
610
Yes
I/O informs the VMM, and VMM informs the VI driver of the completion of the I/O operation
611
6A

Fig 6A

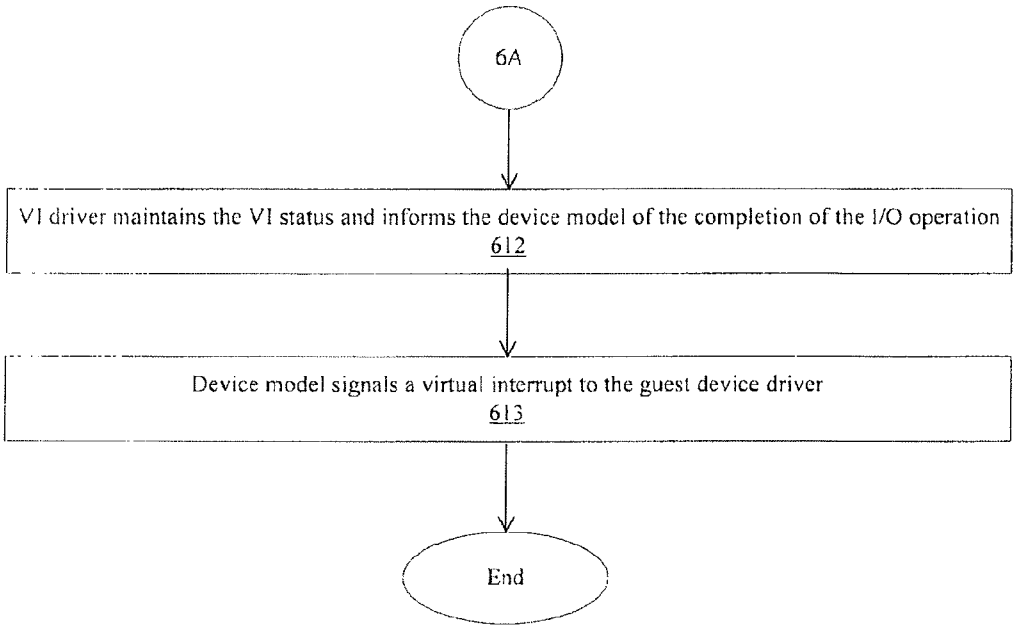

6A
VI driver maintains the VI status and informs the device model of the completion of the I/O operation
612
Device model signals a virtual interrupt to the guest device driver
613
End

Fig 6B