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**Konda**

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(54) **FULLY CONNECTED GENERALIZED BUTTERFLY FAT TREE NETWORKS**

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(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 273 days.  
This patent is subject to a terminal disclaimer.

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(51) **Int. Cl.**  
**H04L 12/28** (2006.01)

(52) **U.S. Cl.** ..... **370/408**

(58) **Field of Classification Search** ..... 370/351–357, 370/359–360, 369–370, 372, 375, 380, 386–390, 370/400, 408, 422, 427, 901, 902–903  
See application file for complete search history.

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Primary Examiner — Derrick Ferris  
Assistant Examiner — Omar Ghowrwal

(57) **ABSTRACT**

A generalized butterfly fat tree network comprising  $(\log_d N)$  stages is operated in strictly nonblocking manner for unicast and in rearrangeably nonblocking manner for arbitrary fan-out multicast when  $s \geq 2$ , and is operated in strictly nonblocking manner for arbitrary fan-out multicast when  $s \geq 3$ , includes a leaf stage consisting of an input stage having

$$\frac{N}{d}$$

switches with each of them having  $d$  inlet links and  $s \times d$  outgoing links connecting to its immediate succeeding stage switches, and an output stage having

$$\frac{N}{d}$$

switches with each of them having  $d$  outlet links and  $s \times d$  incoming links connecting from switches in its immediate preceding stage. The network also has  $(\log_d N) - 1$  middle stages with each middle stage, excepting the root stage, having

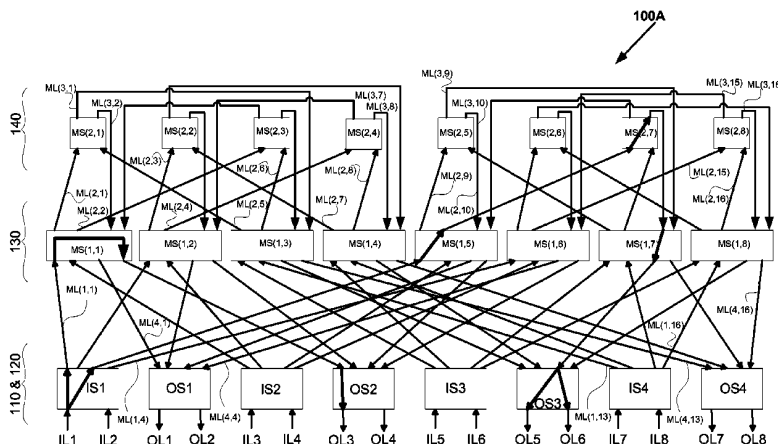
$$\frac{s \times N}{d}$$

switches, and each switch in the middle stage has  $d$  incoming links connecting from the switches in its immediate preceding stage,  $d$  incoming links connecting from the switches in its immediate succeeding stage,  $d$  outgoing links connecting to the switches in its immediate succeeding stage,  $d$  outgoing links connecting to the switches in its immediate preceding stage, and the root stage having

$$\frac{s \times N}{d}$$

switches, and each switch in the middle stage has  $d$  incoming links connecting from the switches in its immediate preceding stage and  $d$  outgoing links connecting to the switches in its immediate preceding stage.

**22 Claims, 20 Drawing Sheets**

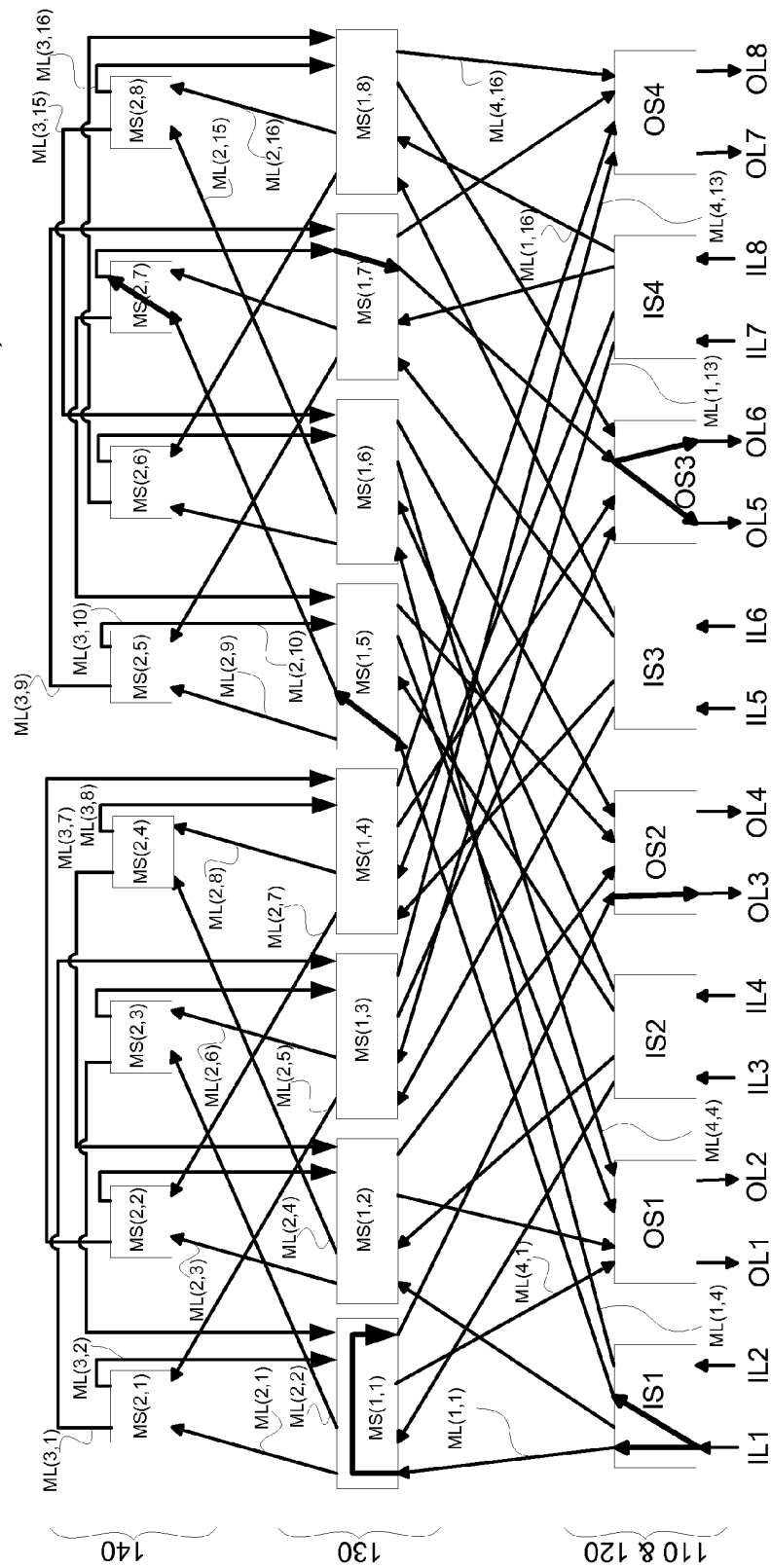


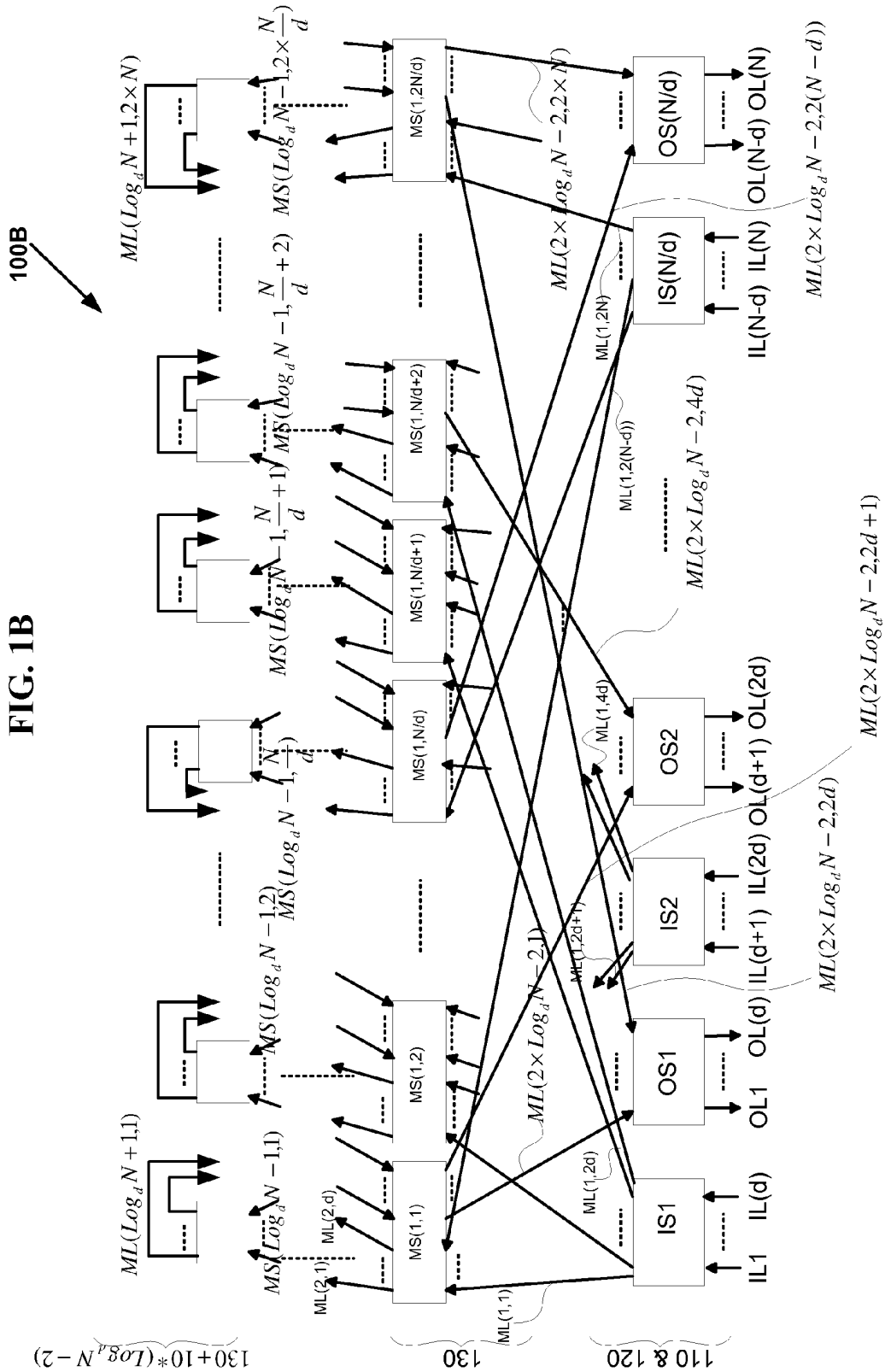
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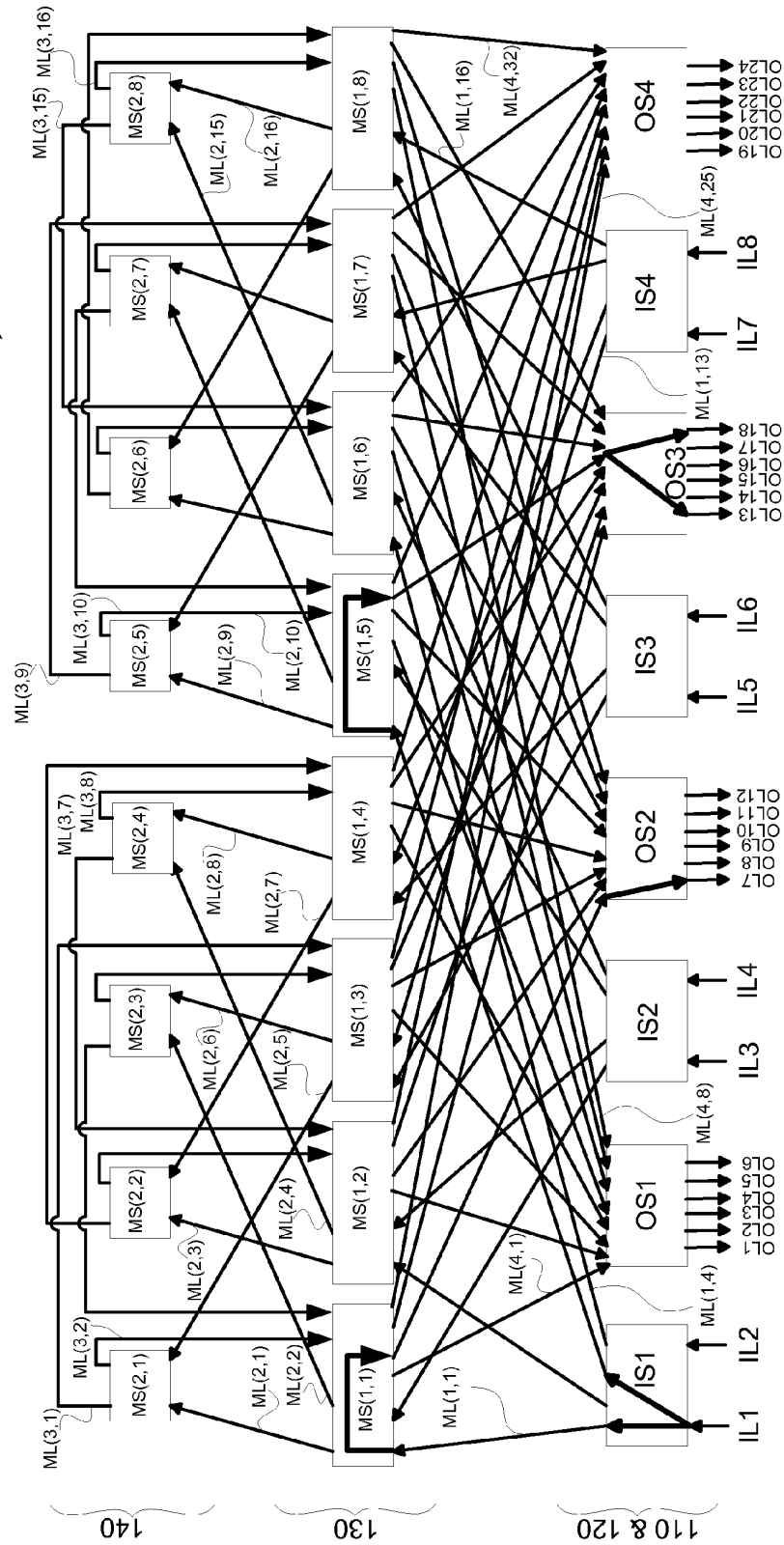
FIG. 1A  
100A





100C

FIG. 1C



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