



# United States Patent [19]

[11] **Patent Number:** **6,116,363**

**Frank**

[45] **Date of Patent:** **\*Sep. 12, 2000**

[54] **FUEL CONSUMPTION CONTROL FOR CHARGE DEPLETION HYBRID ELECTRIC VEHICLES**

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[73] Assignee: **Frank Transportation Technology, LLC**, El Macero, Calif.

[\*] Notice: This patent is subject to a terminal disclaimer.

[21] Appl. No.: **09/063,995**

[22] Filed: **Apr. 21, 1998**

### Related U.S. Application Data

[63] Continuation-in-part of application No. 08/963,037, Nov. 3, 1997, Pat. No. 5,842,534, which is a continuation of application No. 08/455,104, May 31, 1995, abandoned.

[51] **Int. Cl.<sup>7</sup>** ..... **B60K 6/04**

[52] **U.S. Cl.** ..... **180/65.2; 180/65.4; 180/65.8**

[58] **Field of Search** ..... **180/65.1, 65.2, 180/65.3, 65.4, 65.8; 318/587; 701/22, 36**

### [56] References Cited

#### U.S. PATENT DOCUMENTS

- 4,042,056 8/1977 Horwinski .
- 4,180,138 12/1979 Shea .
- 4,269,280 5/1981 Rosen .
- 4,335,429 6/1982 Kawakatsu .

- 4,400,997 8/1983 Fiala .
- 4,533,011 8/1985 Heidemeyer et al. .
- 4,697,660 10/1987 Wu et al. .
- 5,115,183 5/1992 Kyoukane et al. .
- 5,117,931 6/1992 Nishida .
- 5,343,970 9/1994 Severinsky .
- 5,923,025 7/1999 Ellers .

#### FOREIGN PATENT DOCUMENTS

- 2310238 1/1977 France .
- 2494642 5/1982 France .
- 4206360 9/1993 Germany .

#### OTHER PUBLICATIONS

Wood's Gas-Electric Car, Instruction No. 80, Dyke's Encyclopedia, 1935.

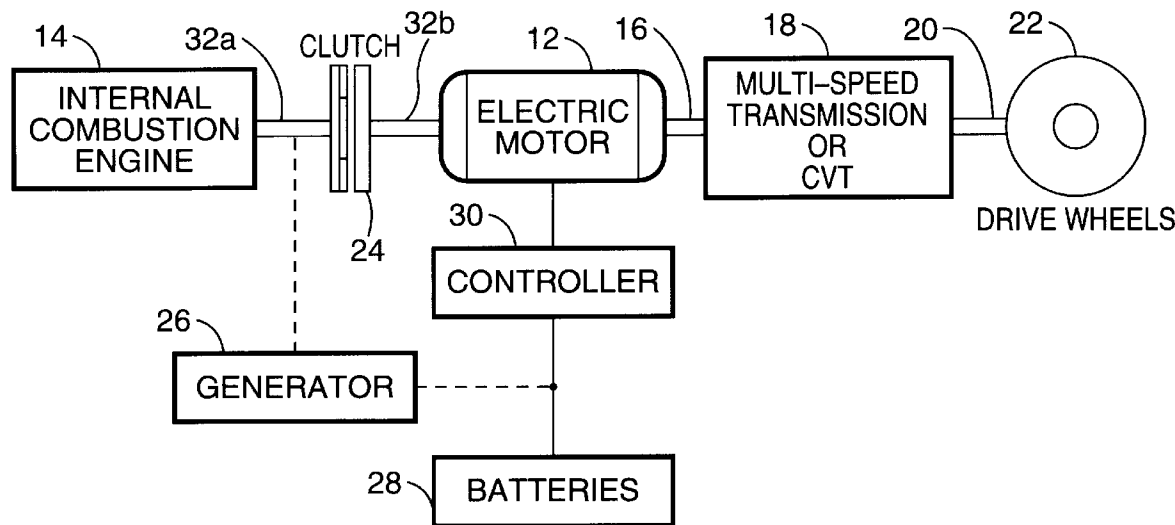
Frank et al., "Computer Simulation of the University of Wisc. Hybrid-Electric Vehicle Concept", May 1973.

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### [57] ABSTRACT

A charge depletion method and apparatus for operating the electric motor and auxiliary power unit, such as an internal combustion engine, in a hybrid electric vehicle (HEV) separately or together depending upon the driving conditions. Operation of the electric motor and auxiliary power unit are coordinated as a function of a control policy for the auxiliary power unit based on desired least fuel consumption and/or vehicle emissions characteristics.

**6 Claims, 7 Drawing Sheets**



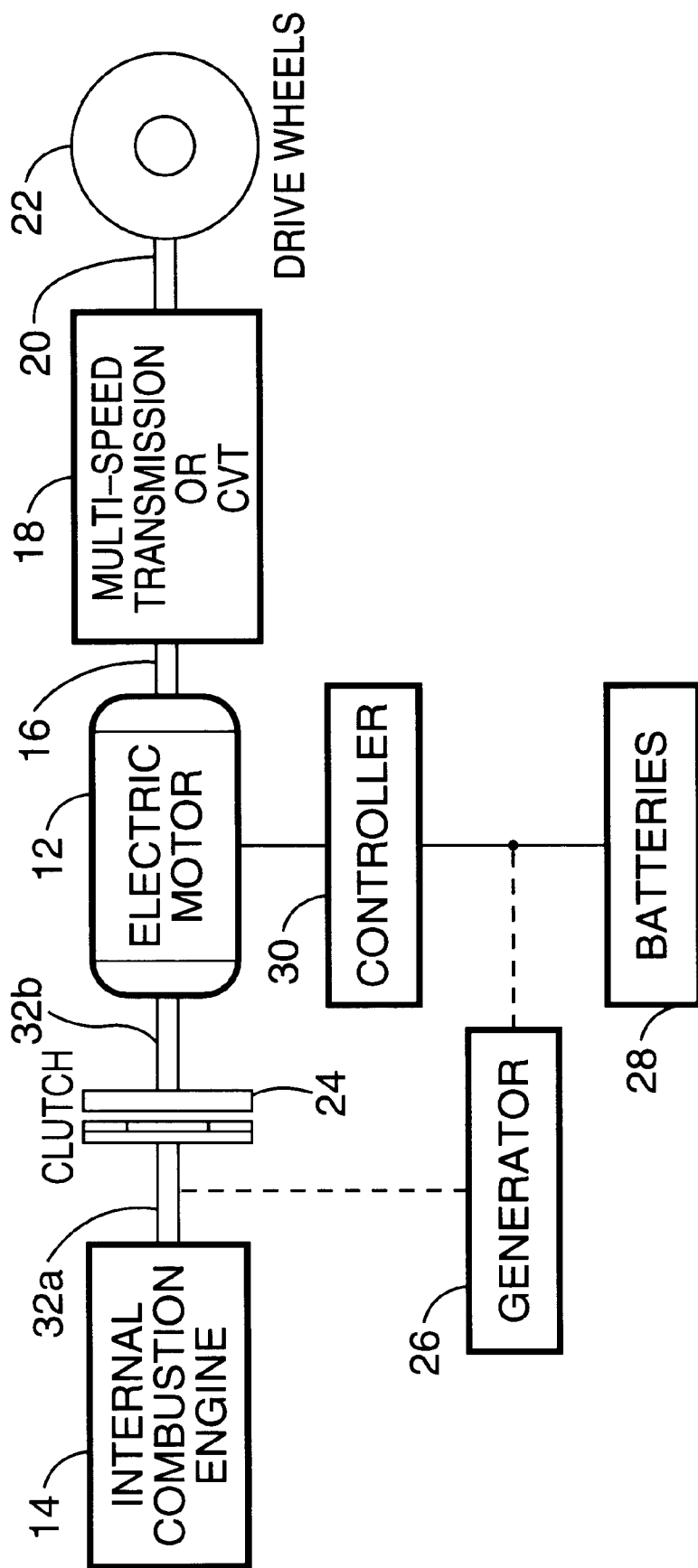


FIG. - 1

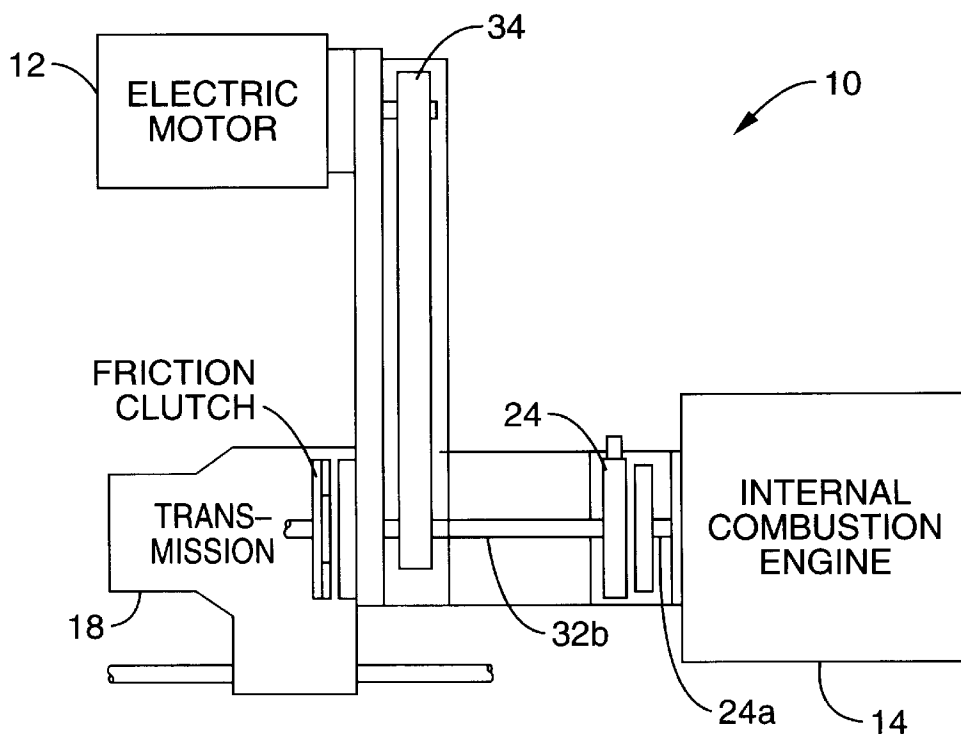


FIG. - 2

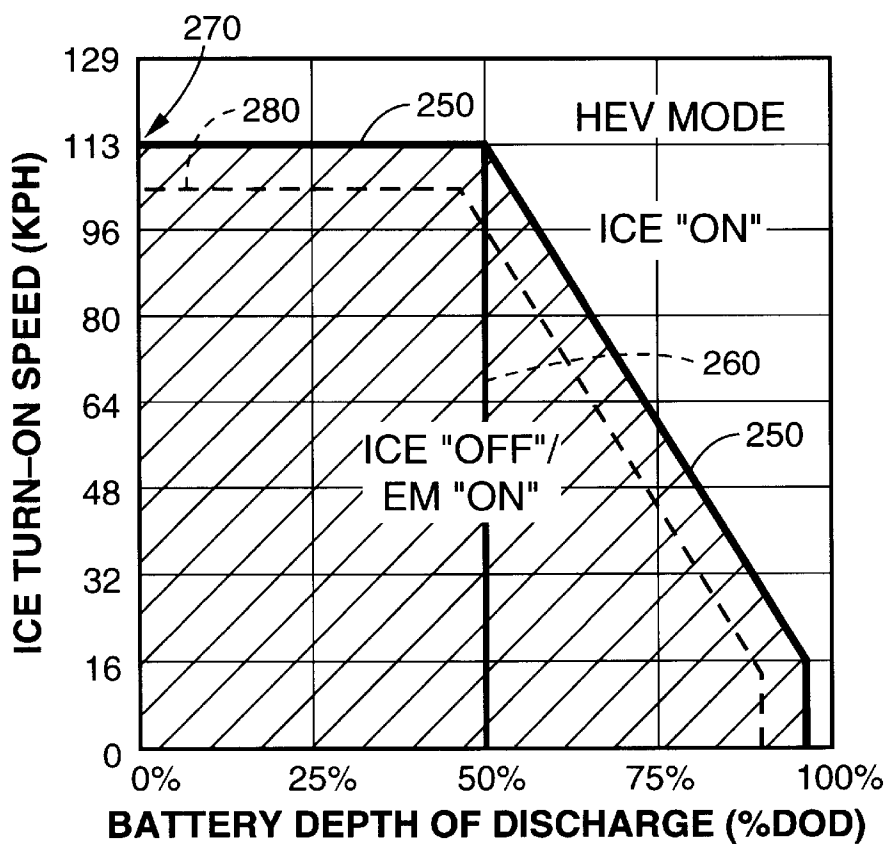
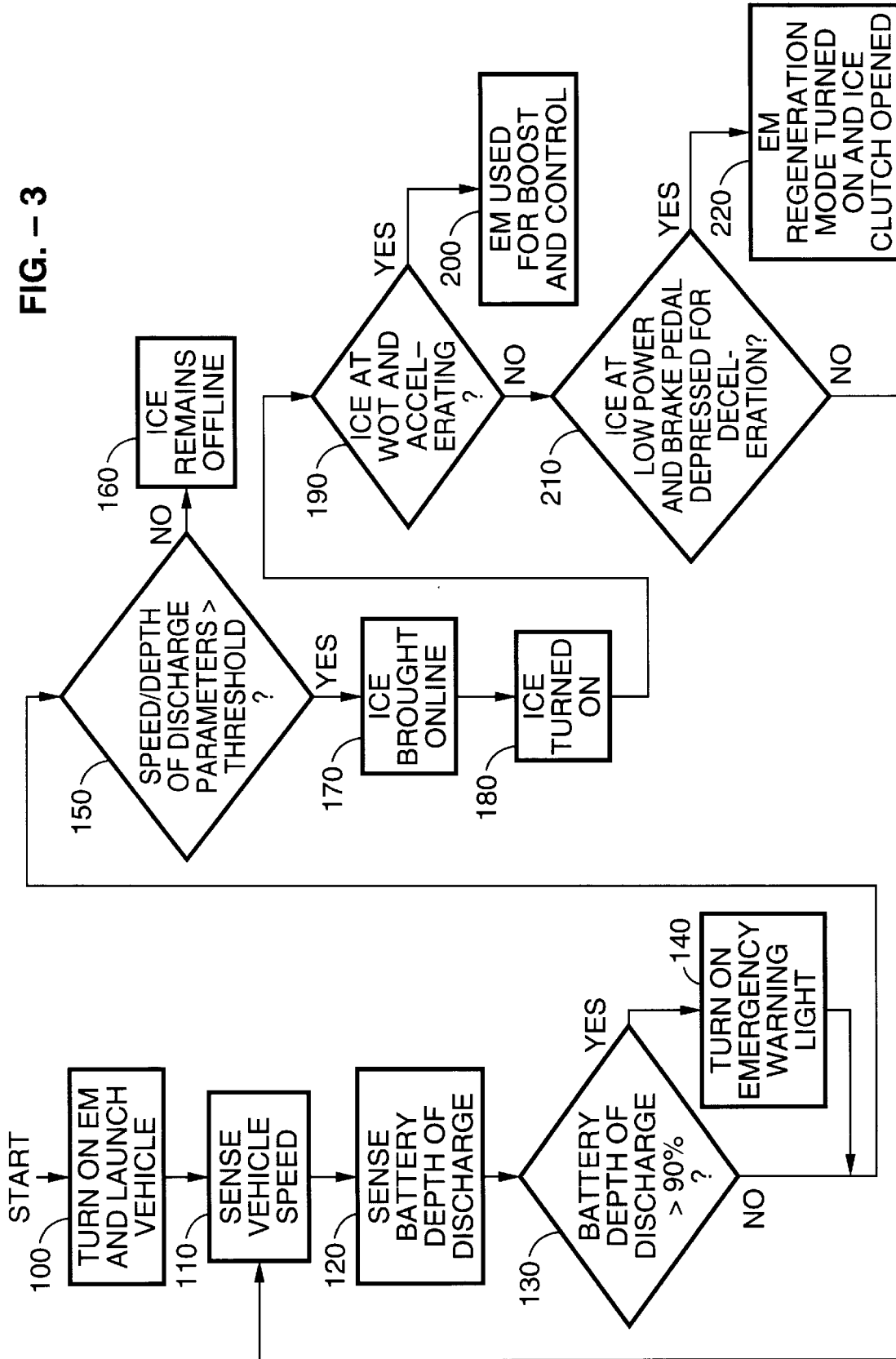


FIG. - 4

FIG. - 3



% of  
Travelers  
Commuters

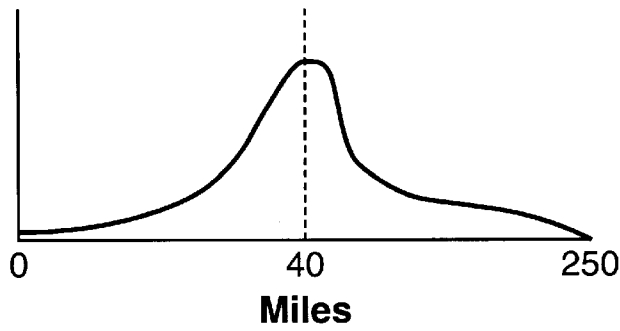


FIG. - 5

Total Fuel  
Used (gal.)

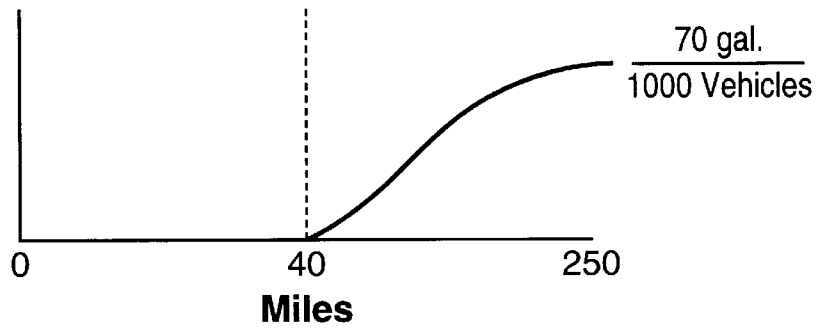


FIG. - 6

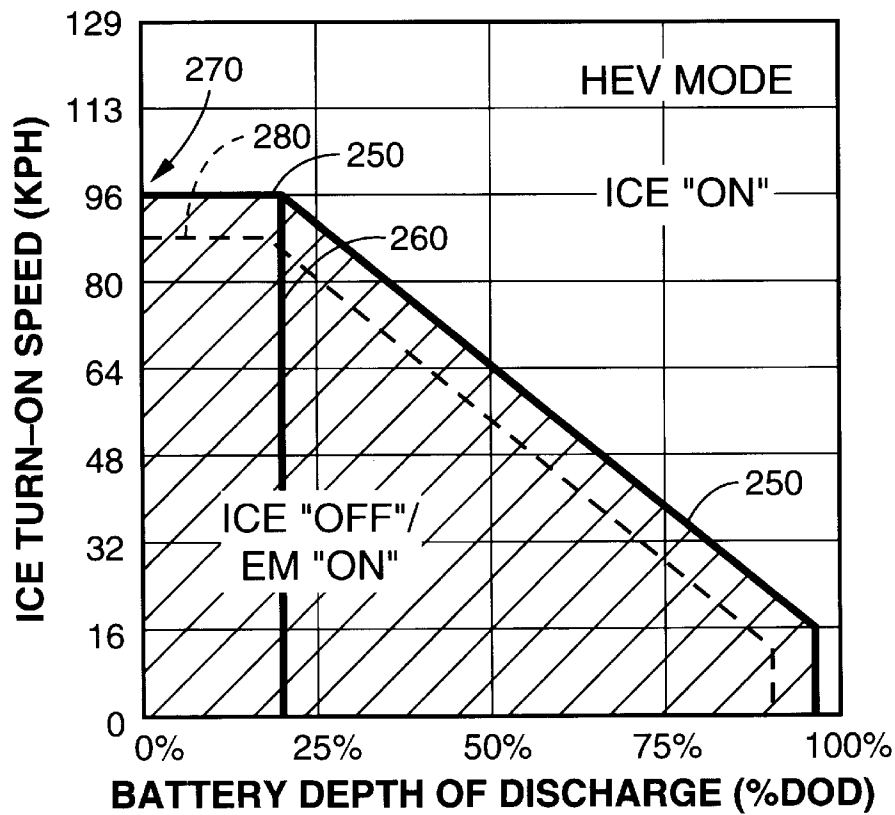


FIG. - 7

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