



(12) **United States Patent**
Marcinkiewicz et al.

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(54) **SENSORLESS CONTROL SYSTEMS AND METHODS FOR PERMANENT MAGNET ROTATING MACHINES**

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(75) Inventors: **Joseph G. Marcinkiewicz**, St. Peters, MO (US); **Prakash B. Shahi**, St. Louis, MO (US); **Michael I. Henderson**, North Yorkshire (GB)

(73) Assignee: **Emerson Electric Co.**, St. Louis, MO (US)

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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 137 days.

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(Continued)

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Primary Examiner—Karen Masih
(74) *Attorney, Agent, or Firm*—Harness, Dickey & Pierce, P.L.C.

(65) **Prior Publication Data**

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(57) **ABSTRACT**

Related U.S. Application Data

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(51) **Int. Cl.**
H02P 23/00 (2006.01)

(52) **U.S. Cl.** **318/807**; 318/561; 318/615; 318/431

(58) **Field of Classification Search** 318/807, 318/508.18, 568.22, 561, 615, 616, 618, 318/560, 430, 431, 432, 433, 434; 388/805, 388/814, 820; 364/459

See application file for complete search history.

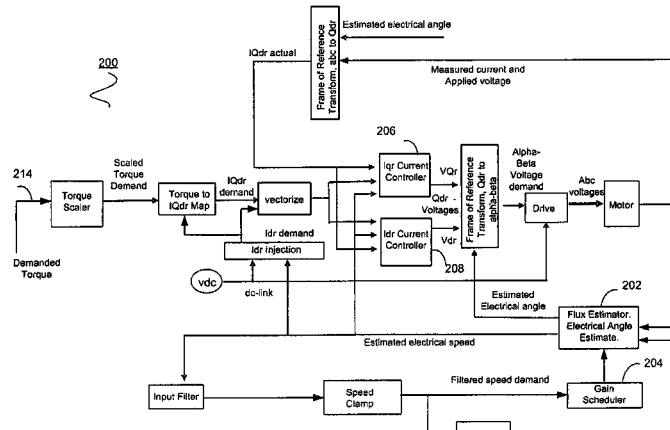
Systems and methods for controlling a rotating electromagnetic machine. The rotating machine, such as a permanent magnet motor or hybrid switched reluctance motor, includes a stator having a plurality of phase windings and a rotor that rotates relative to the stator. A drive is connected to the phase windings for energizing the windings. A controller outputs a control signal to the drive in response to an input demand such as a demanded speed or torque. Control methods (which can be implemented separately or in combination) include varying the gain of an estimator as a function of a demanded or estimated speed to position control system poles at desired locations, decoupling control system currents to achieve a constant torque with motor speed, compensating flux estimates of the estimator for saturation operation of the stator, estimating rotor position using averages of sample values of energization feedback, and calculating a trim adjusted speed error from a plurality of speed estimates.

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23 Claims, 13 Drawing Sheets



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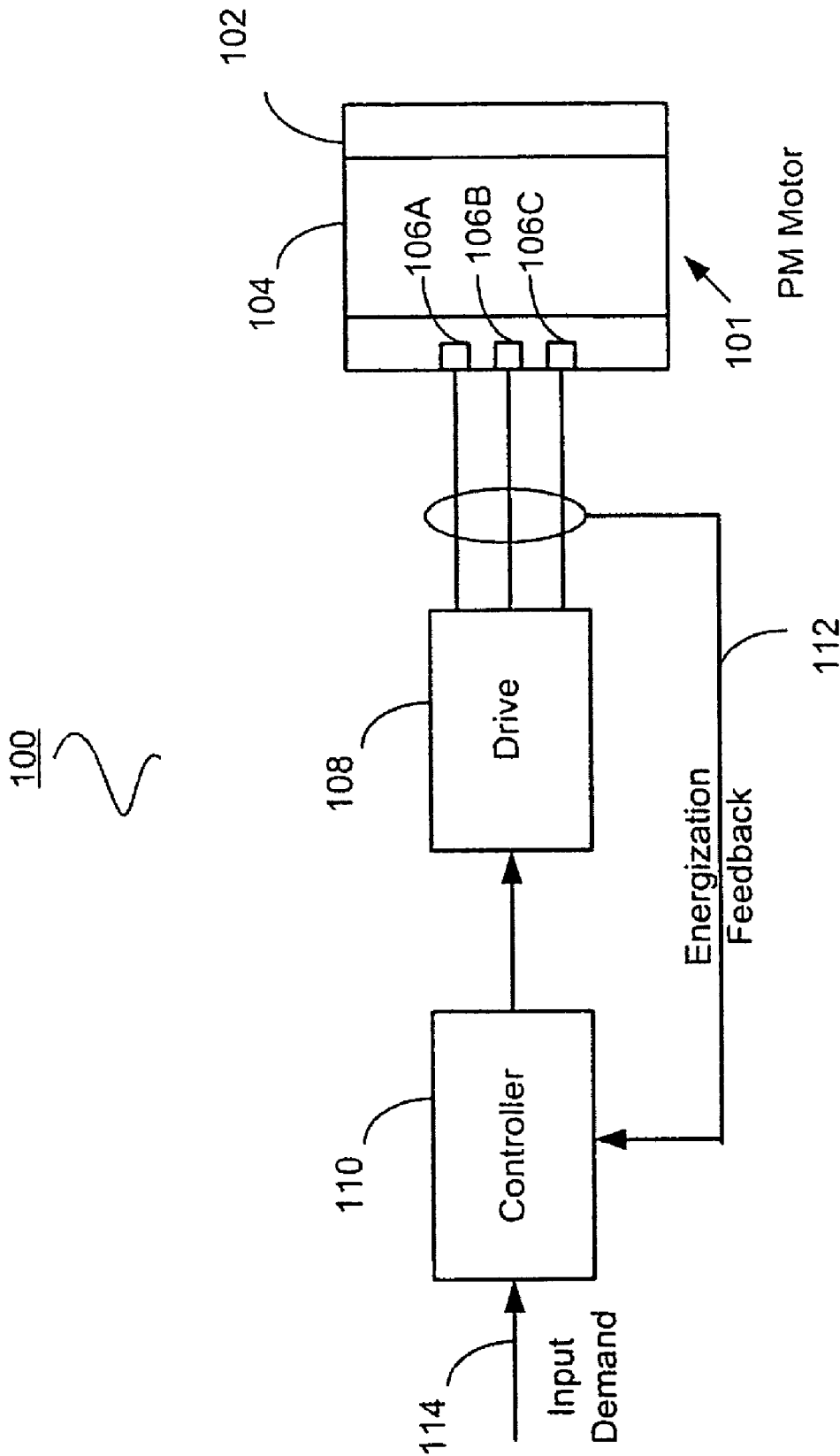


FIG. 1

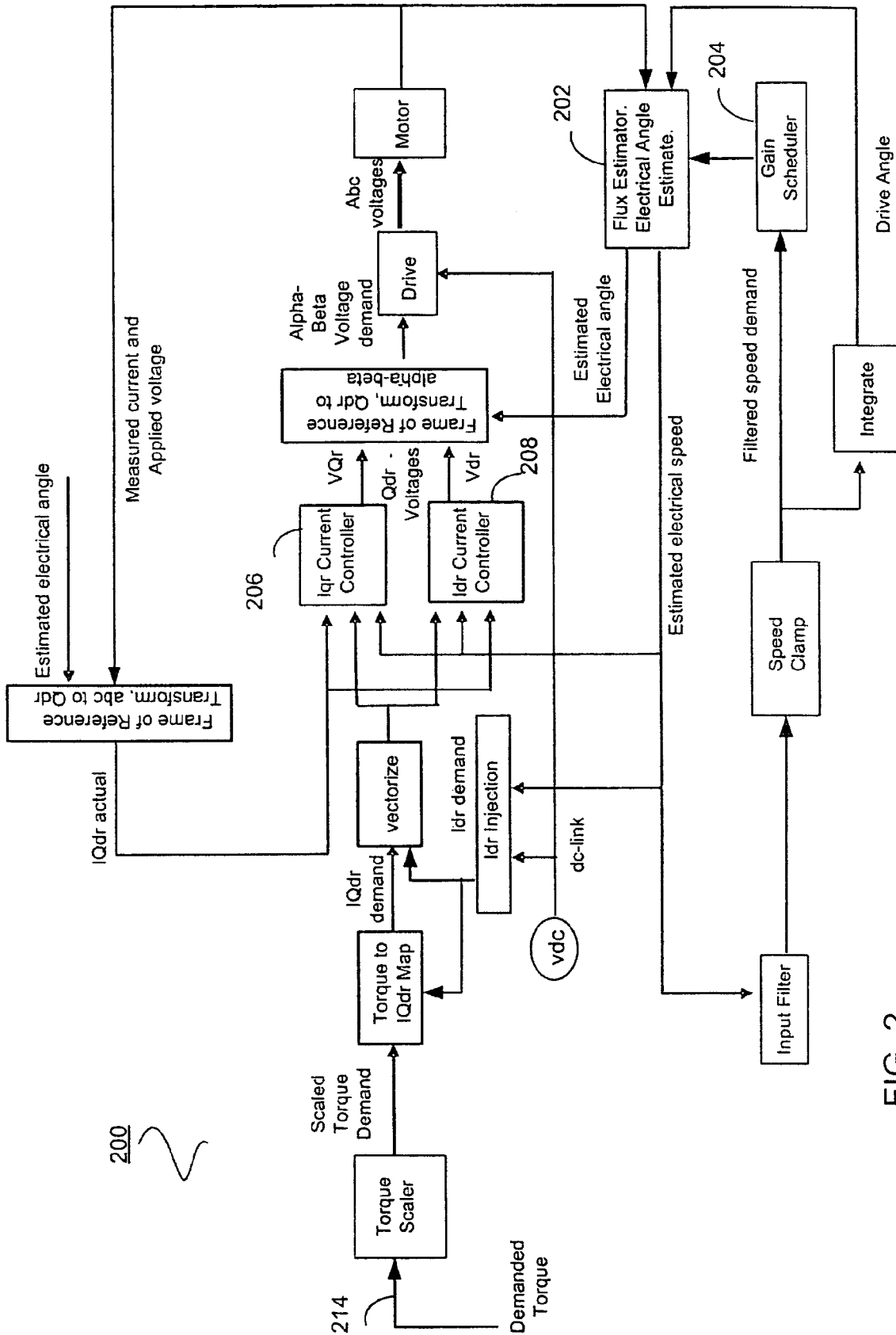


FIG. 2

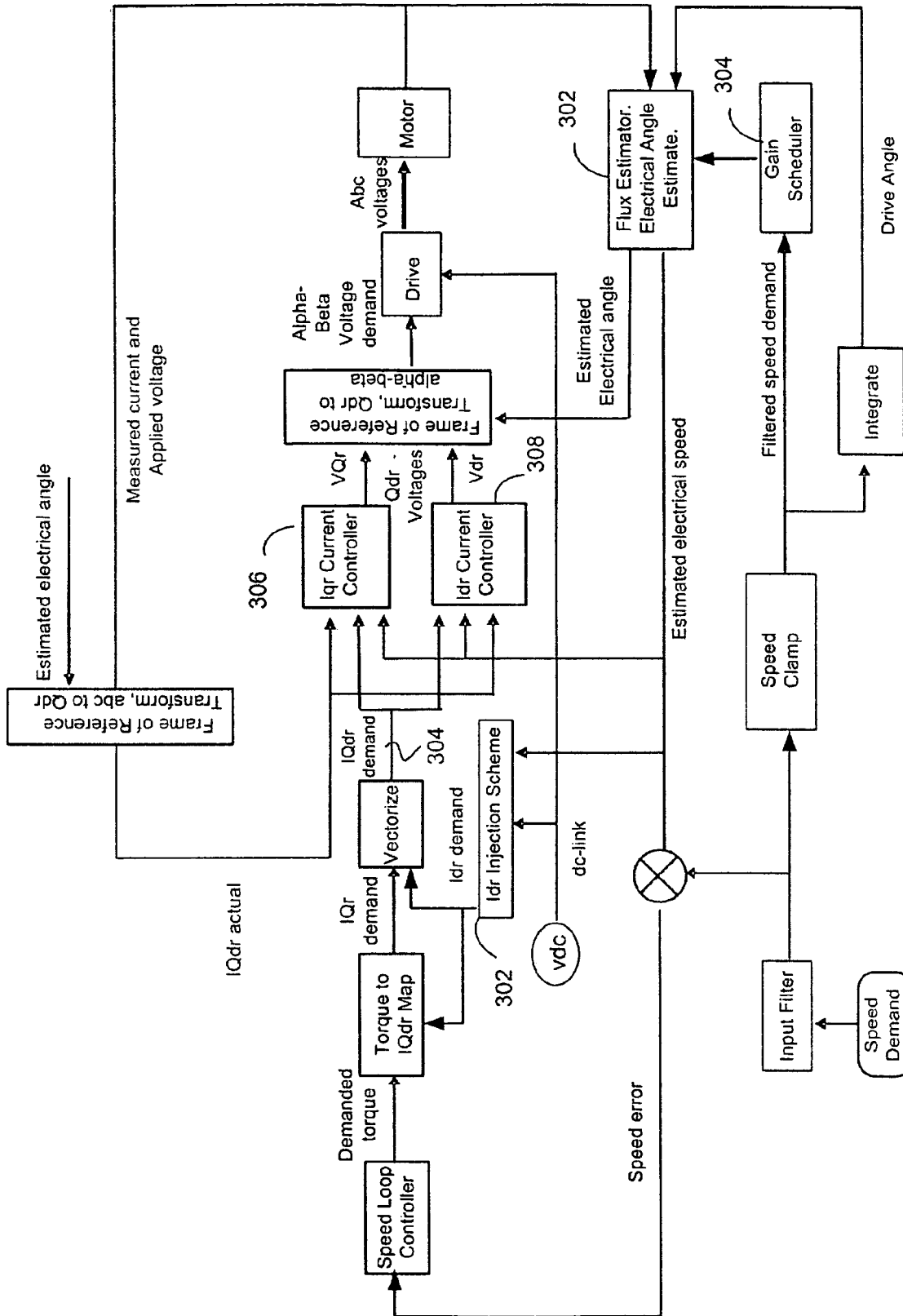


FIG. 3

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