# United States Patent [19]

## Church et al.

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[45] **Date of Patent:** Dec. 12, 1995

[54] **LIFTING MONITORING AND EXERCISE TRAINING SYSTEM**

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[73] Assignee: **Empi, Inc.**, St. Paul, Minn.

[21] Appl. No.: **152,082**

[22] Filed: **Nov. 15, 1993**

### Related U.S. Application Data

[63] Continuation of Ser. No. 657,954, Feb. 21, 1991, abandoned, which is a continuation of Ser. No. 319,850, Mar. 6, 1989, abandoned, which is a continuation of Ser. No. 938,830, Dec. 8, 1986, abandoned.
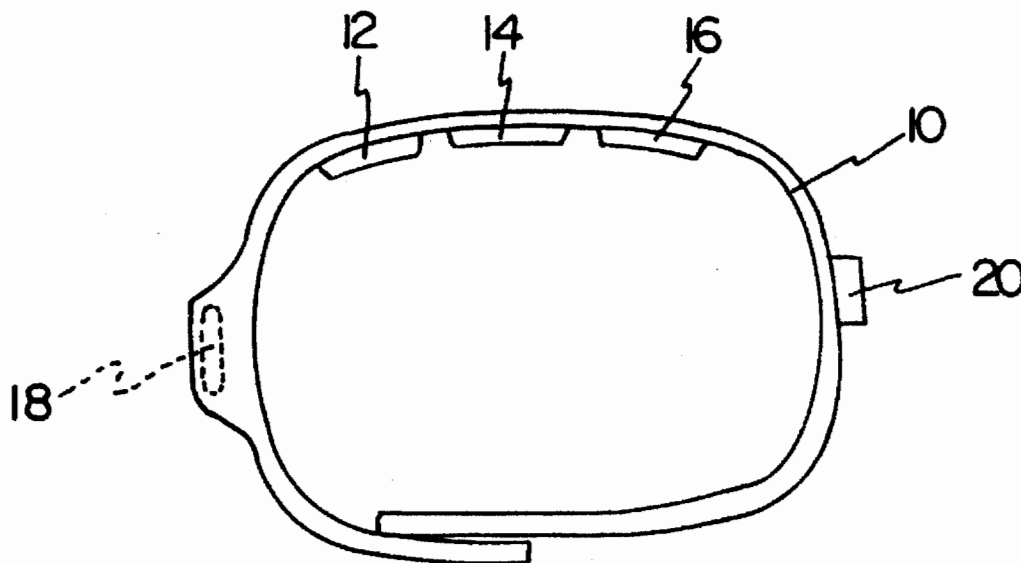
[51] **Int. Cl.⁶** ....................................... **A61B 5/04**
[52] **U.S. Cl.** ............................. **128/733**; 128/782
[58] **Field of Search** .................... 128/733, 736, 128/774, 775, 781, 782; 340/573; 33/571, 512; 73/865.1

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[57] **ABSTRACT**

The invention is directed to a microprocessor based system utilizing electromyographic sensor to monitor muscle force for lift training and exercise training. In the lift training embodiment the electrodes of the electromyographic sensor are secured to a belt so that they are located adjacent to the lower back of the user when wearing the belt. The lift training embodiment is also provided with a goniometer to measure lifting angle during training, which together with muscle force generated by the lower back is compared in the microprocessor to a programmed lifting parameters and if these parameters are exceeded the user is warned by and audible indicator. The lift trainer embodiment also periodically measures interelectrode impedance to insure actual usage. The exercise training embodiment has a bar graph display displaying muscle intensity and two light emitting diodes alerting a user when to contract or relax a monitored muscle group. The microprocessor is programmed with a exercise routine and alerts a user when the routine is to begin, the duration of muscle contraction and relaxation, and the repetitions required. During exercise the user can monitor muscle intensity from the bar graph display and or auditory feedback element. An alternate lift training systems comprises a belt mounted goniometer which is operatively coupled to a microprocessor having an electronic memory for time logging a lifting session. To insure actual usage the belt is also provided with temperature and/or motion sensors.
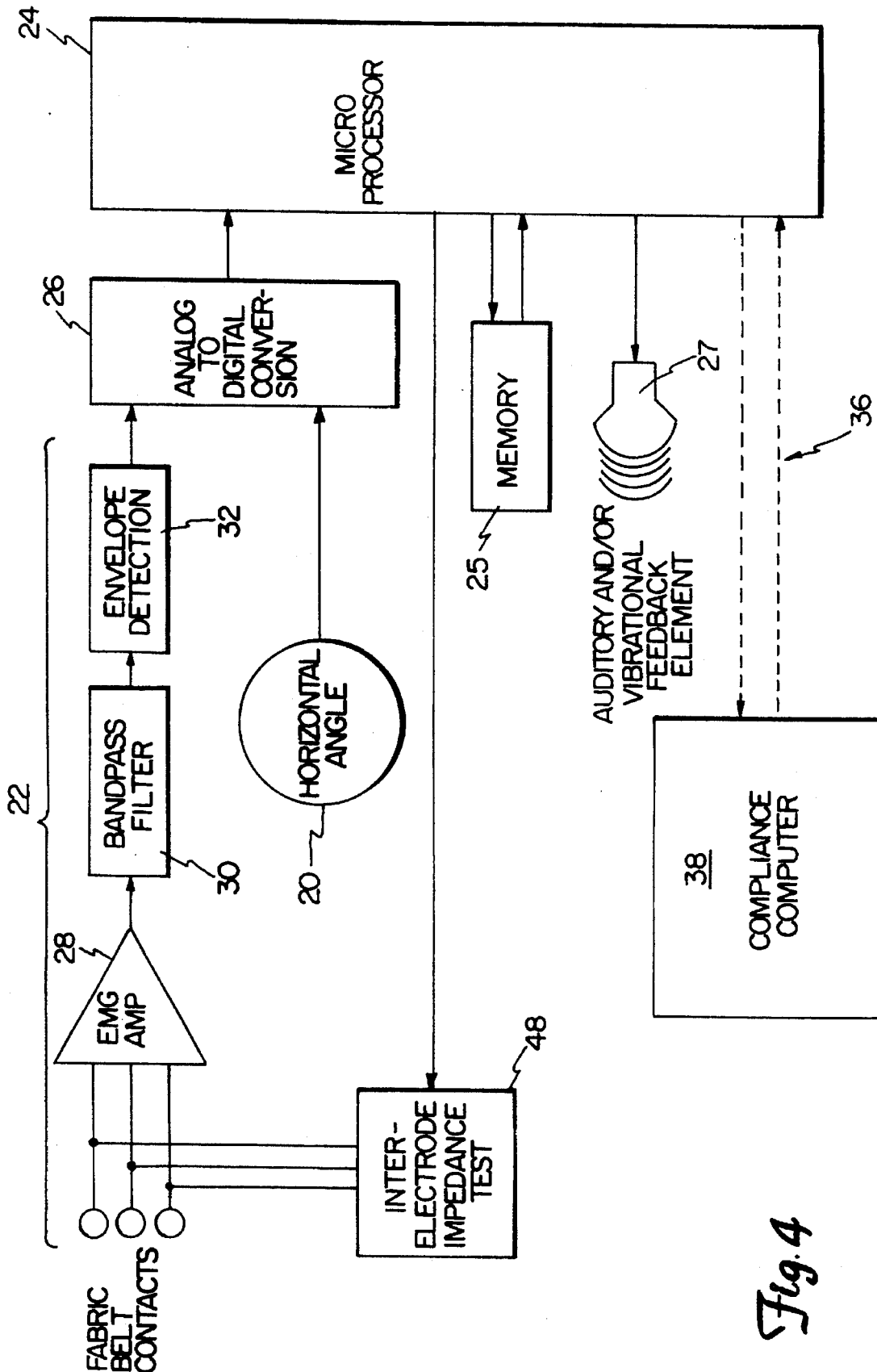
**18 Claims, 11 Drawing Sheets**
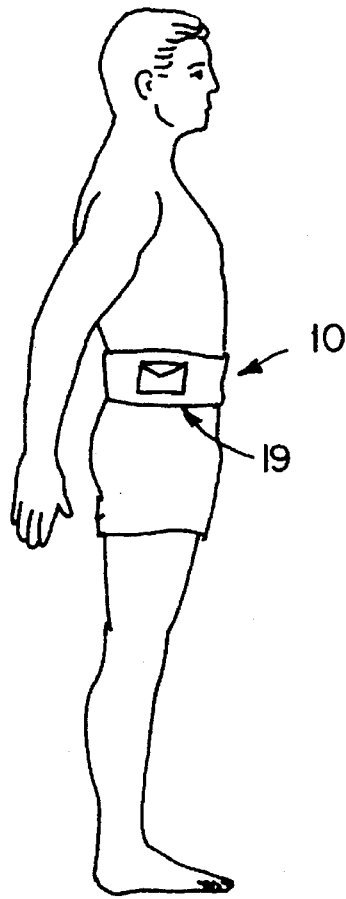
*Fig. 1*

*Fig. 2*

*Fig. 3*

*Fig. 4*

*Fig. 5 A*

START LIFT     TIME     END LIFT

- LIFTING NO LOAD
- BACK STRAIGHT
- KNEES BENT

*Fig. 5 B*

START LIFT     TIME     END LIFT

- LIFTING LOAD
- BACK STRAIGHT
- KNEES BENT

90°

EMG ····
ANGLE —

0°

START
LIFT

TIME

END
LIFT

- LIFTING NO LOAD
- BACK BENT
- KNEES LOCKED

*Fig. 5C*



90°

EMG ····
ANGLE —

0°

START
LIFT

TIME

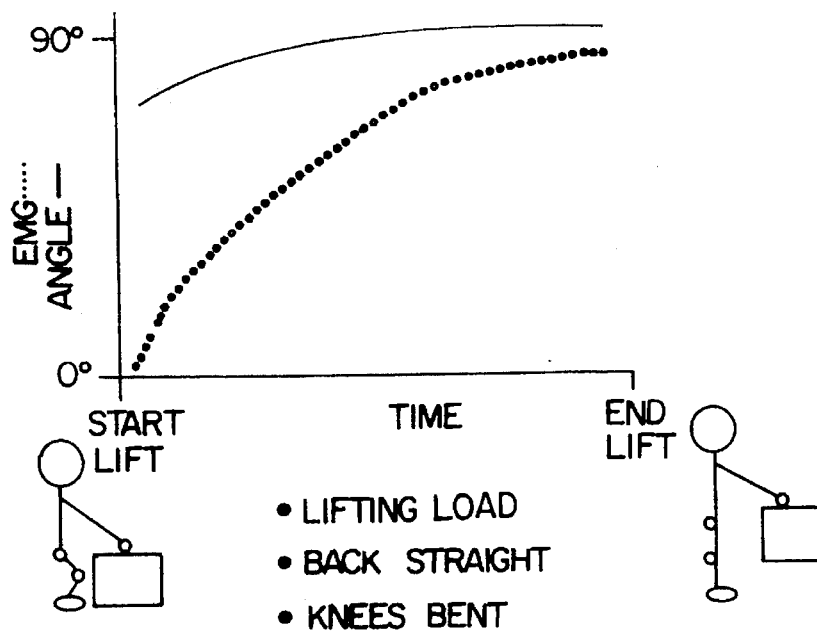END
LIFT

- LIFTING LOAD
- BACK BENT
- KNEES LOCKED
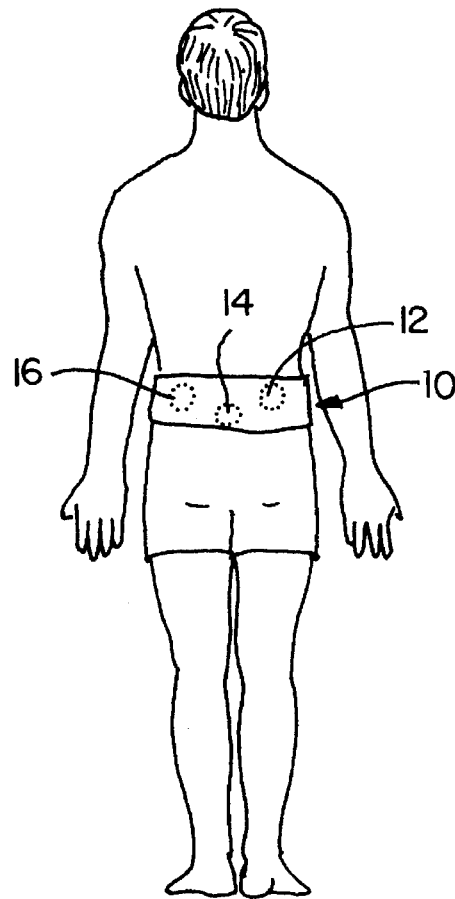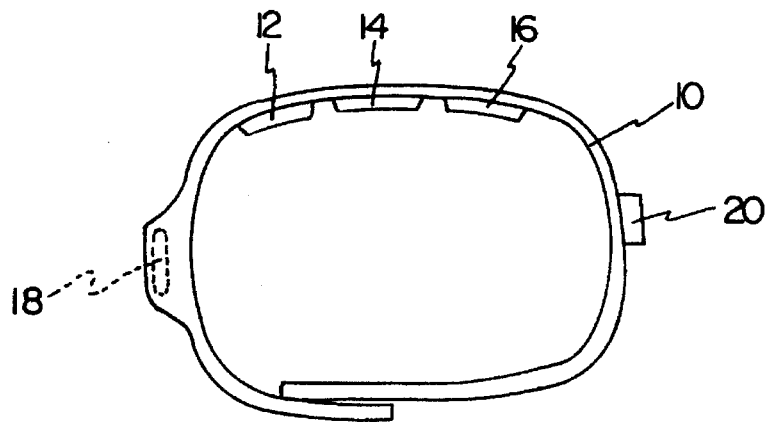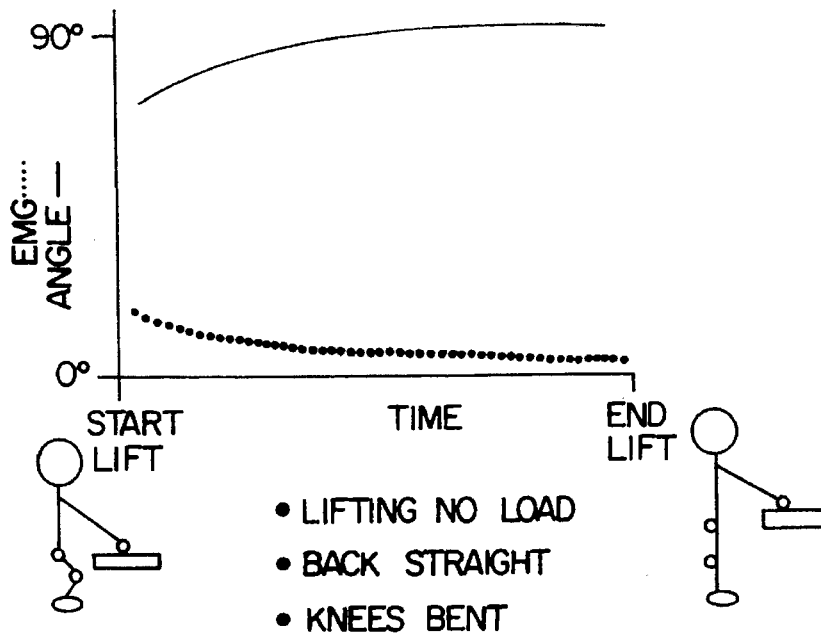
*Fig. 5 D*

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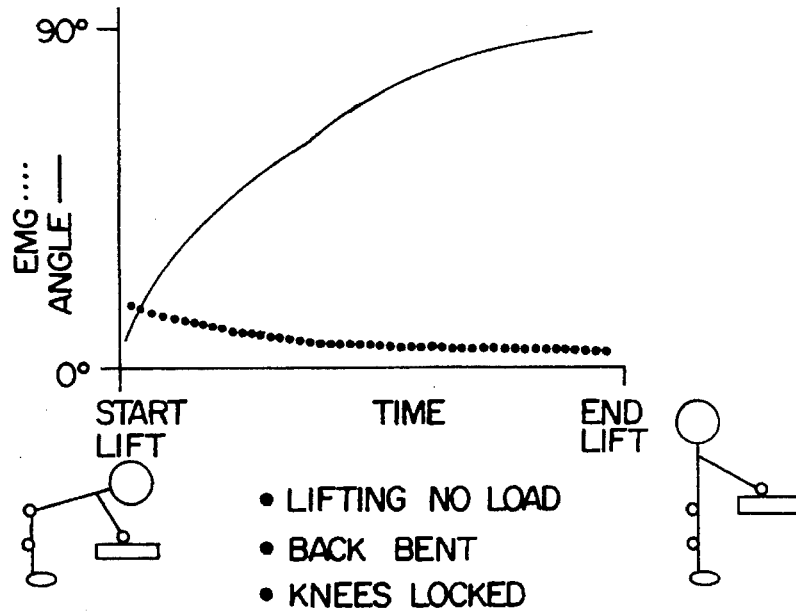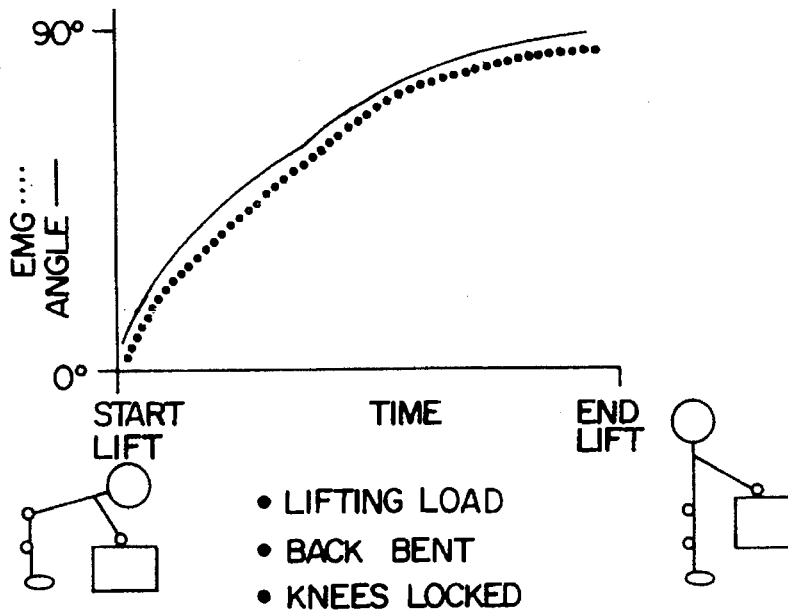
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