United States Patent [19]

Curran

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[54] **ISOMETRIC STRENGTH TESTING METHOD AND EQUIPMENT FOR DISABILITY EVALUATION**

[76] Inventor: **Thomas M. Curran,** 464 Springbrook, Saline, Mich. 48176

[21] Appl. No.: **92,432**

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[51] **Int. Cl.**[4] **A61B 5/10; A61B 5/22**

[52] **U.S. Cl.** **364/413.02;** 364/551.01; 128/782; 73/379

[58] **Field of Search** 128/782; 73/379; 364/413, 415, 551, 413.27, 413.02, 551.01; 358/107

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Primary Examiner—Clark A. Jablon

Attorney, Agent, or Firm—James M. Deimen

[57] **ABSTRACT**

New disability testing and evaluation software combined with an isometric strength testing machine provides a very complete and standardized means of determining disability in comparison with the norms of the general population. The software utilizes not only the machine but also the digitization of photographs taken of the subject person during each strength test. Combining the digitized photographic data, the force monitor information from the load cell of the machine and extensive anthropomorphic data the software calculates for loading of the weakest joint in the subject person and compares this loading to normative values from the general population. In this manner a percentage disability for a subject person can be calculated with reasonable assurance of the validity and reproducibility of the result. New specialized hand grips for an isometric strength testing machine are disclosed to test grip strength and torsional strength of the hand.

12 Claims, 7 Drawing Sheets

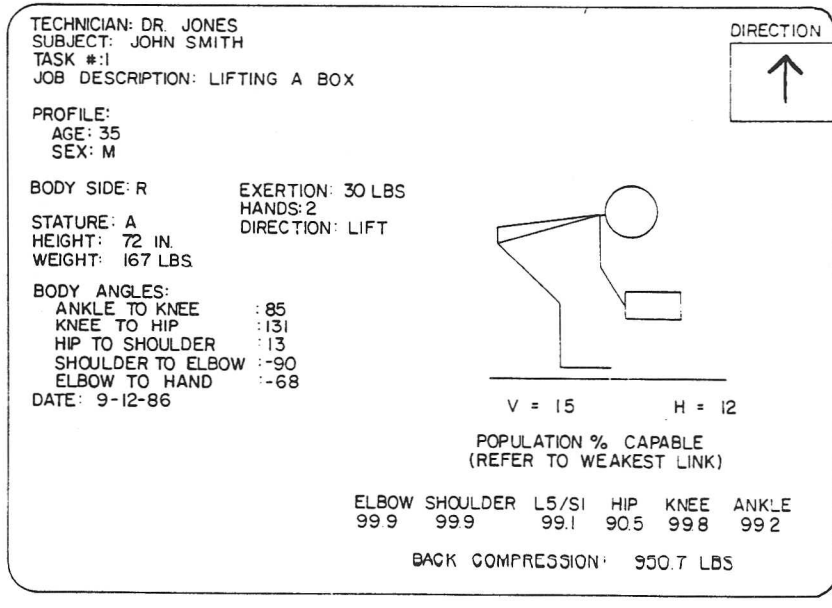

FIG.1

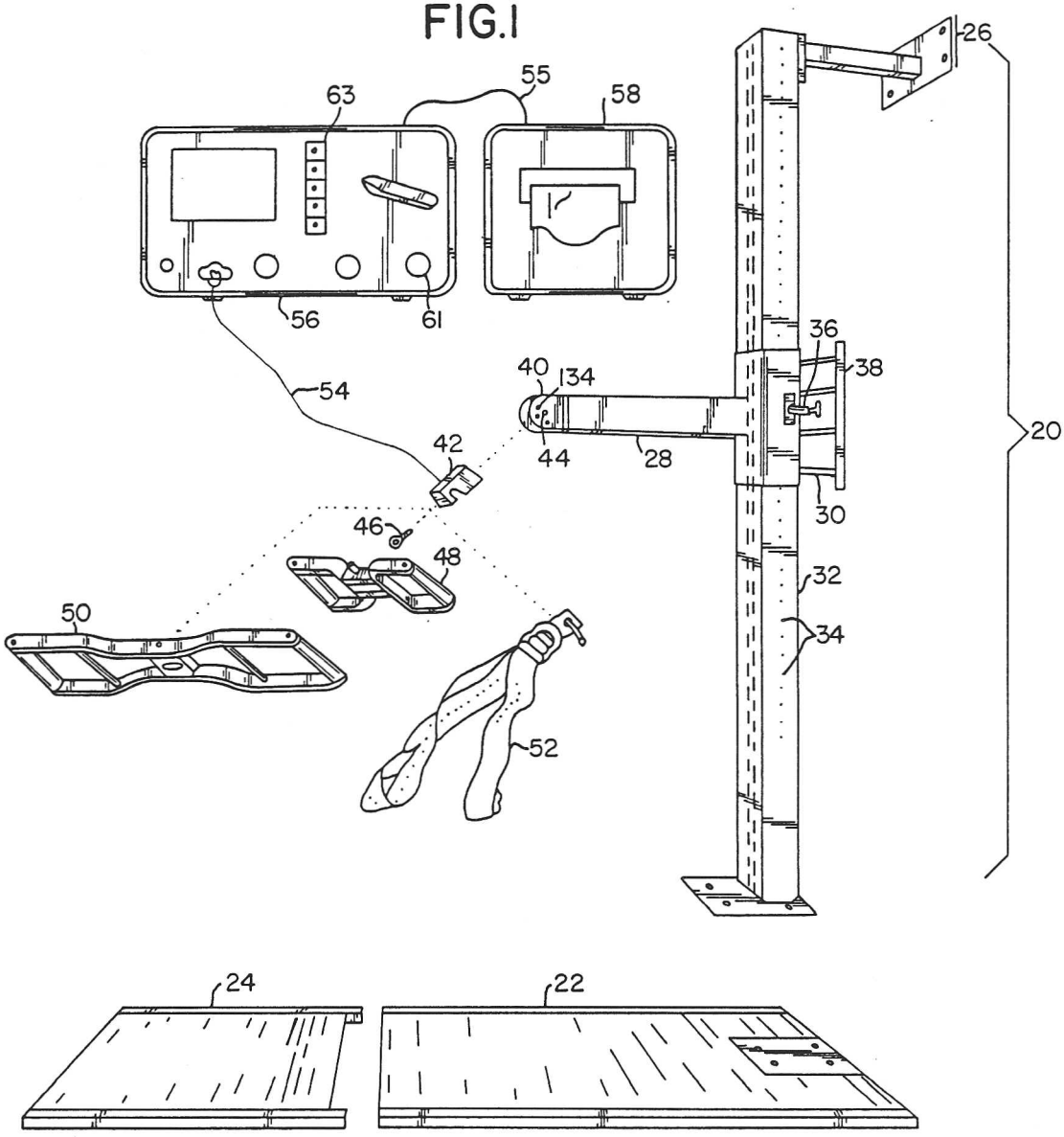
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FIG.2

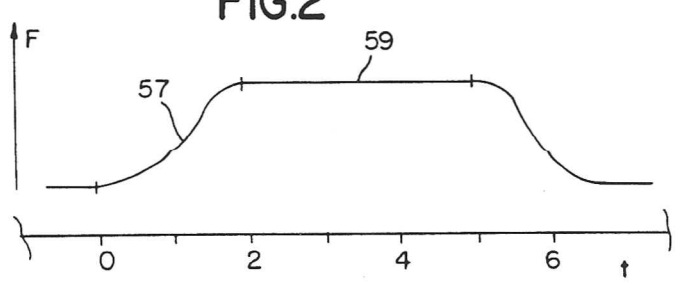
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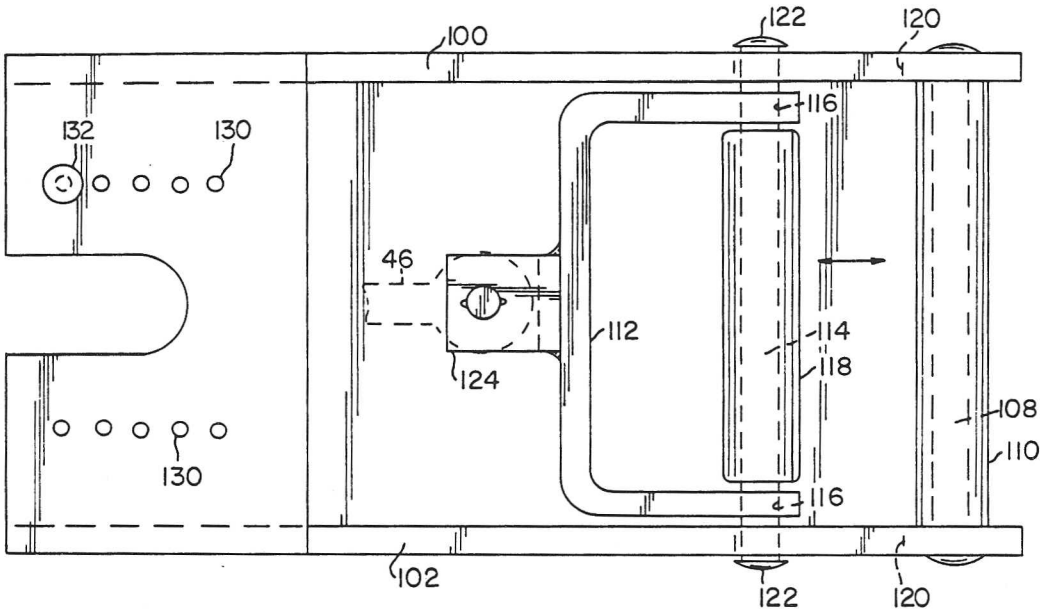
FIG.6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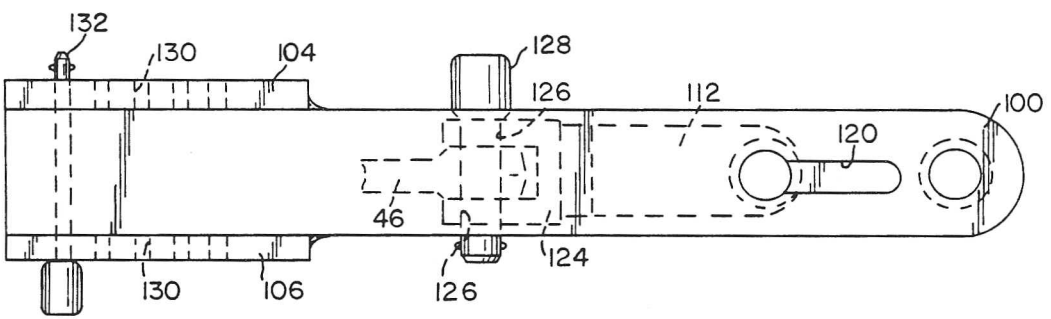
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FIG.7

FIG. 8

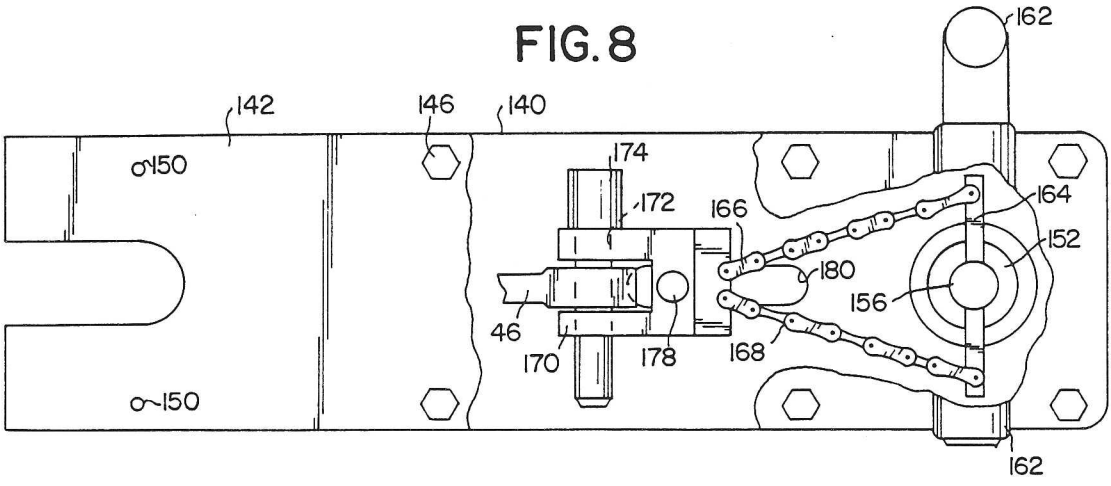

FIG. 9

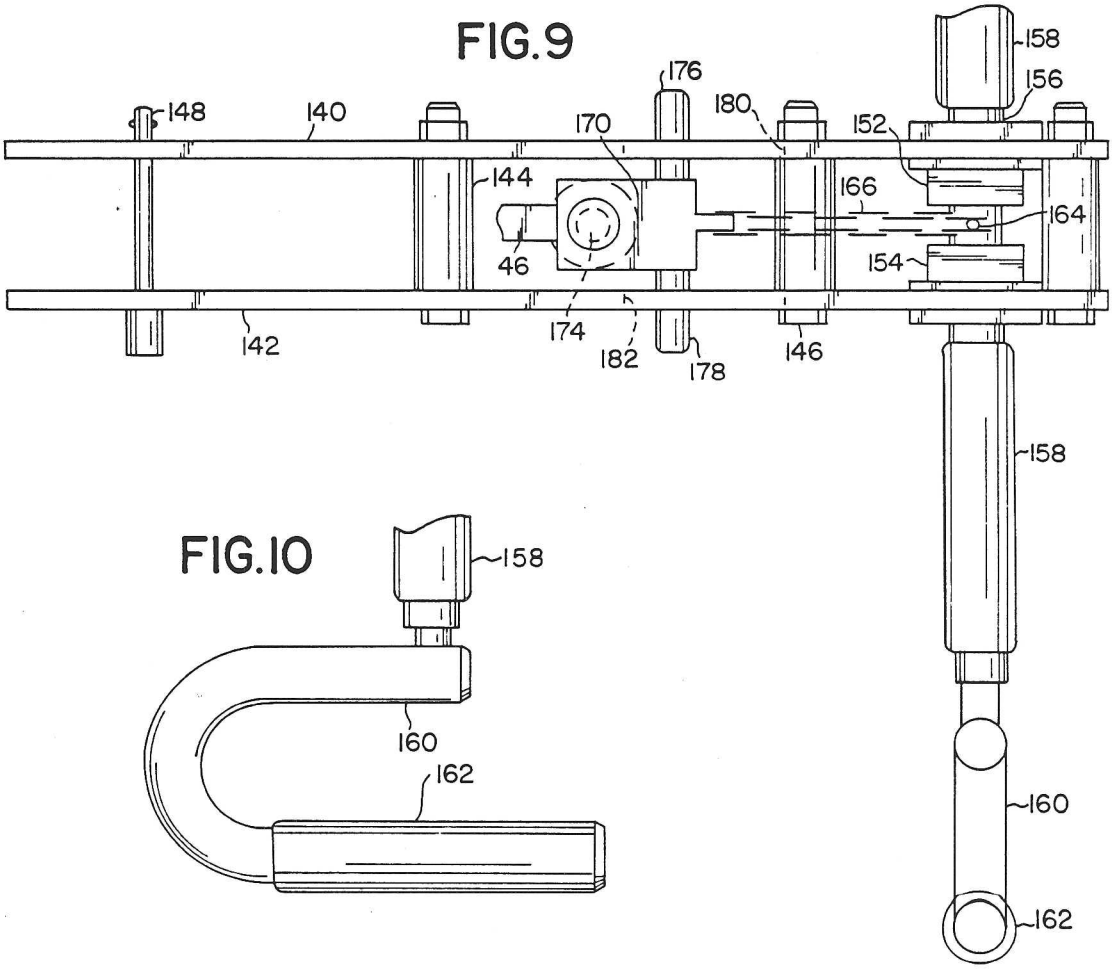

FIG. 10

ISOMETRIC STRENGTH TESTING METHOD AND EQUIPMENT FOR DISABILITY EVALUATION

BACKGROUND OF THE INVENTION

The field of the invention pertains to biomechanical strength testing of individual persons and, in particular, to the careful isometric strength testing of individuals disabled as a result of injuries. Strength testing relates to disability evaluations, pre-employment examination, job redesign and work conditioning.

In recent years, the importance of careful biomechanical modeling and the repeatability of results from strength testing to assure validity of the results has taken on great importance to assure that the physical labor required in a job is properly matched with the individual worker. More importantly, avoidance of injury and the proper evaluation of disabling injuries has become important not only because of the cost to the disabled but also the cost to society that also results.

Extensive research and careful analysis of the human body structure under physical stress is disclosed and summarized in a recent book by Don B. Chaffin, Ph.D. and Gunnar Andersson, M.D. entitled, "Occupational Biomechanics", 1984 John Wylie & Sons, Inc. The book presents extensive biomechanical guidelines and considerations for the physical work and workplace of an individual. On the bases of these guidelines and considerations, limits are suggested for various physical activities in various workplace situations.

A publication by the U.S. Department of Commerce, National Technical Information Service, sponsored by the U.S. Department of Health and Human Services, is entitled, "Work Practices Guide for Manual Lifting" and was published in March of 1981 with reference number TB 82-178948. This technical report summarizes research on the hazards of manual materials handling in industry and recommends means to reduce the human and economic burden imposed by improper materials handling. Such recommendations include the safe load, weight, size, location and frequency of handling by a worker. Worker training and selection criteria are listed and engineering guidelines are provided for the design of the workplace.

At the University of Michigan in Ann Arbor, Mich., an isometric strength testing machine was developed with an electric sensor or load cell employed to sense the load applied to the machine by the subject individual. The purpose of the machine is for job analysis and employment screening and the electric sensor is directly connected to interface means to directly record the load applied to the machine by the subject. The machine and considerable supporting mainframe computer software was developed under a National Aeronautics and Space Administration supported contract. The principal publication arising from the research is Garg, A. and Chaffin, D. B., The Human Strength Simulations, Biomechanical Division NASA/MSC Contract #NAS9-10973, April 1972.

The machine comprises a vertical assembly post and a horizontal platform. At various heights on the vertical assembly post, a horizontal arm may be positioned. The horizontal arm contains the necessary sensor and a single or double hand grip for the subject to apply a load to the machine. Depending on the height of the hand grip, the subject may be in various postures, such as partially bent over to lift a load from the platform, pushing against the hand grip, or raising a load over the subject's head. As a result of the development of the machine and the mainframe software, considerable research was accomplished in job analysis and employment screening.

SUMMARY OF THE INVENTION

The invention comprises new specialized hand grips for the testing machine and new software combined with the machine specifically directed toward disability evaluation of subjects. The disability evaluation software utilizes not only the testing machine but also the digitization of photographs of the subject taken in each isometric position as the subject is performing the load test on the machine. The new software combines the digitized information taken from the photographs and the information from the load cell or sensor of the machine along with other information about the subject. The software calculates from this information a number of body dimensions and angles, certain loads and weights that are critical to disability evaluation and the percentage capabilities of various body joints relative to the capability of a large percentage of the general population. The new combination of software and hardware allows the technician to evaluate a subject by having the subject perform the simulated lifting of a load from the platform by isometrically attempting to lift the load over three separate five second intervals. The photographs are taken as the subject is exerting maximum force on the hand grip of the machine. At the same time, the load on the machine is being recorded on a strip chart which typically results in a somewhat bell-shaped curve over each five second time period. The data from the photographs and the strip chart recorder may then be immediately digitized and processed by the disability software or processed subsequently.

For the lifting of a load from the platform, a "tote pan" simple hand grip on the testing machine may be used. The hand grip may be raised to higher positions including an overhead position on the machine. However, two new specialized hand grips have been developed for use in combination with the machine. The first of the new grips provides a simple hand squeezing motion wherein the squeezing motion is strictly limited to sliding motion of the grip. A purely tensile load is placed on the grip by the hand and the grip is insensitive to right-side-up or upside-down placement of the hand. The other new grip comprises a torque sensing attachment. The torque sensing attachment, depending on hand placement and movement, senses flexion/extension torque, pronation/supination torque, and ulnar/-radial deviation torque. With each test, the instantaneous load sensed by the testing unit is printed out on a strip chart recorder and the test repeated.

One of the important advantages of the new test methods, software analysis and specialized hand grips is that with repeated testing such as three repeated tests for each load position prescribed, a very confident prediction of the percent disability of the subject in comparison with statistical norms developed from the general population results. Any attempted malingering by the subject also faults the test or appears clearly in the test results.

DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates an exploded view of the basic platform and vertical assembly plus electronics of the testing machine;