

[54] **METHOD AND APPARATUS FOR ANALYZING THE FEASIBILITY OF PERFORMING A PROGRAMMED SEQUENCE OF MOTIONS WITH A ROBOT**

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[22] Filed: **Oct. 27, 1980**

**Related U.S. Application Data**

[63] Continuation-in-part of Ser. No. 137,234, Apr. 4, 1980, Pat. No. 4,305,028.

[51] Int. Cl.<sup>3</sup> ..... **G05B 19/42; B25J 9/00; G06F 11/30**

[52] U.S. Cl. .... **364/551; 318/568; 364/513; 414/1**

[58] Field of Search ..... **364/578, 513, 174, 190, 364/193; 318/565, 568**

[56] **References Cited**

**U.S. PATENT DOCUMENTS**

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Primary Examiner—Felix D. Gruber

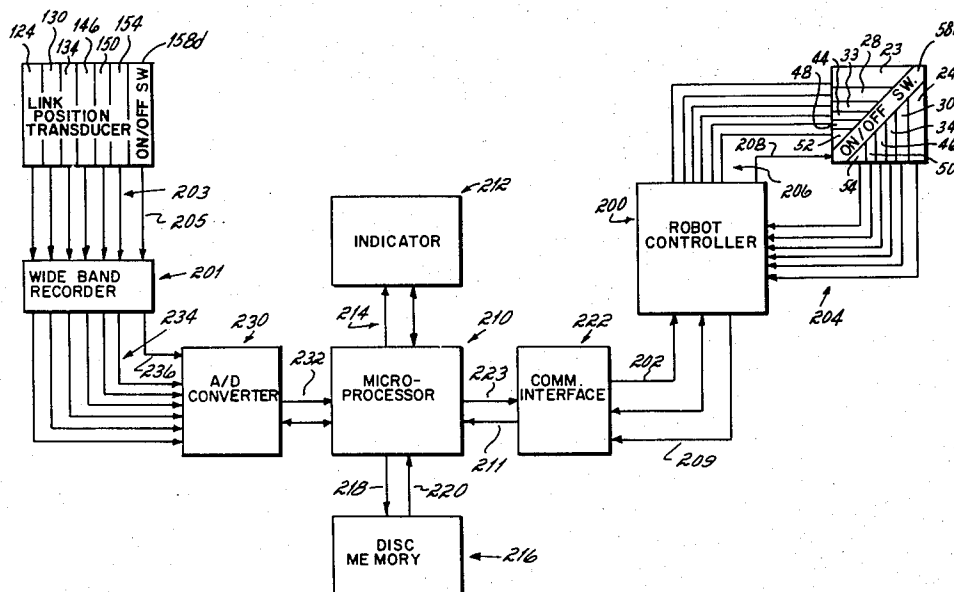
Attorney, Agent, or Firm—Wood, Herron & Evans

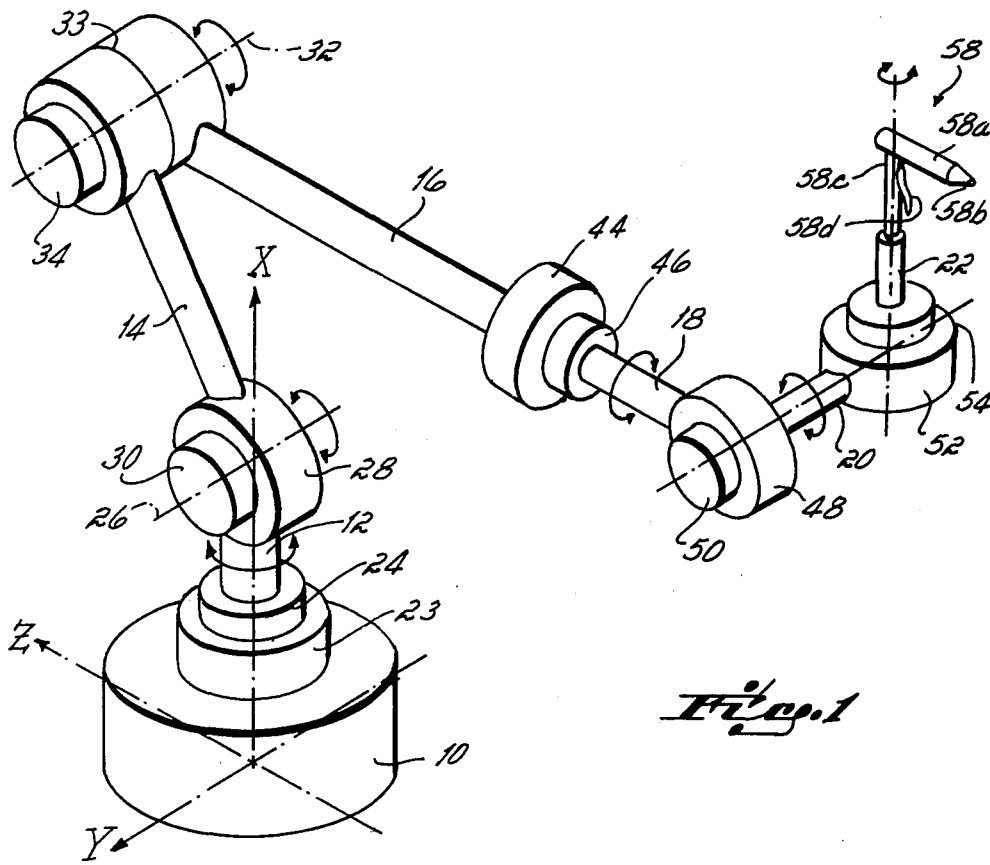
[57] **ABSTRACT**

An apparatus and method for determining the feasibility of performing a programmed sequence of motions with a robot. Included is a work robot at a first location having a plurality of power-driven, signal-controlled, relatively massive links interconnected to permit rela-

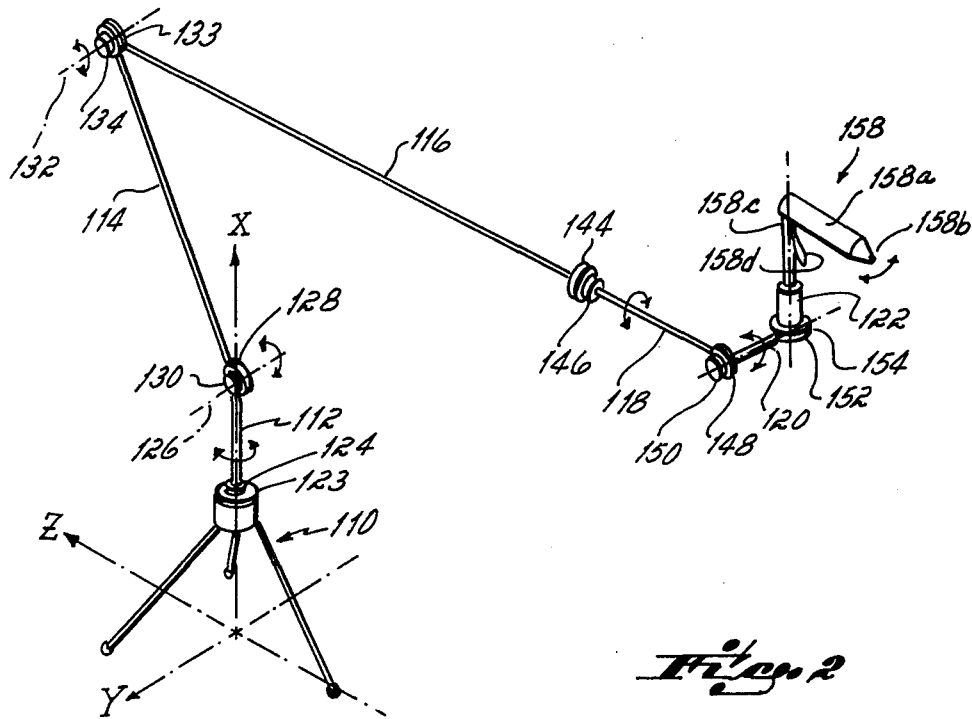
tive motion in plural degrees of freedom, the work robot having a given mechanical response characteristic. Associated with each link of the work robot is a position transducer which generates a signal representative of the actual position of its associated work robot link. Also included is a portable, relatively lightweight, manually manipulable simulator robot located remote from the work robot. The simulator robot has a plurality of different interconnected links adapted for manual movement in different degrees of freedom for setting a program of desired mechanical responses, with the links and degrees of freedom of the simulator robot simulating those of the work robot. Associated with each link of the simulator robot is a position transducer for generating a signal representative of the position of its associated simulator robot link. A signal recorder is provided at the location of the simulator robot for storing the position signals representative of the program of desired mechanical responses imparted to it by the operator. A work robot controller is provided at the site of the work robot which is responsive to the stored position signals for manipulating the work robot links to perform the movements corresponding to the program of desired mechanical responses limited only by the given mechanical response characteristic of the work robot. An analyzer responsive to the actual and desired position signals of the work robot links is provided for generating error signals correlated to the extent to which the work robot is capable of performing the program of desired mechanical responses manually imparted to the simulator robot. An indicator responsive to the analyzer provides a humanly perceptible indication of the feasibility.

**14 Claims, 9 Drawing Figures**

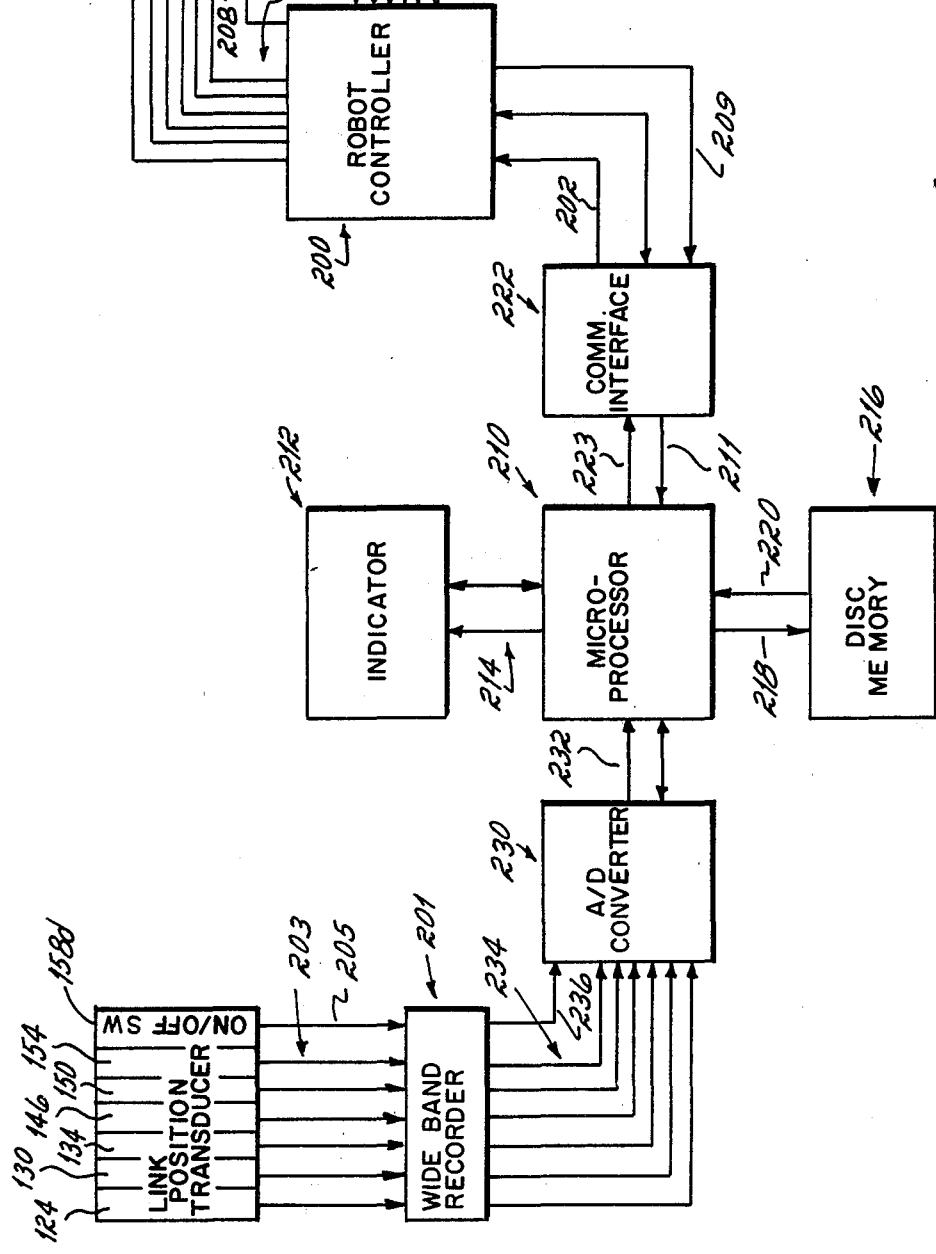




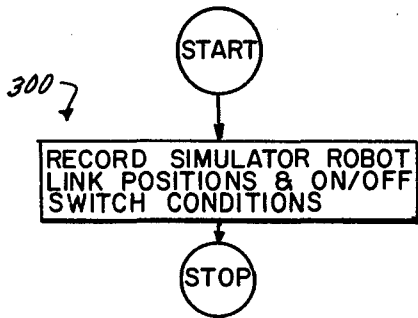
*Fig. 1*



*Fig. 2*

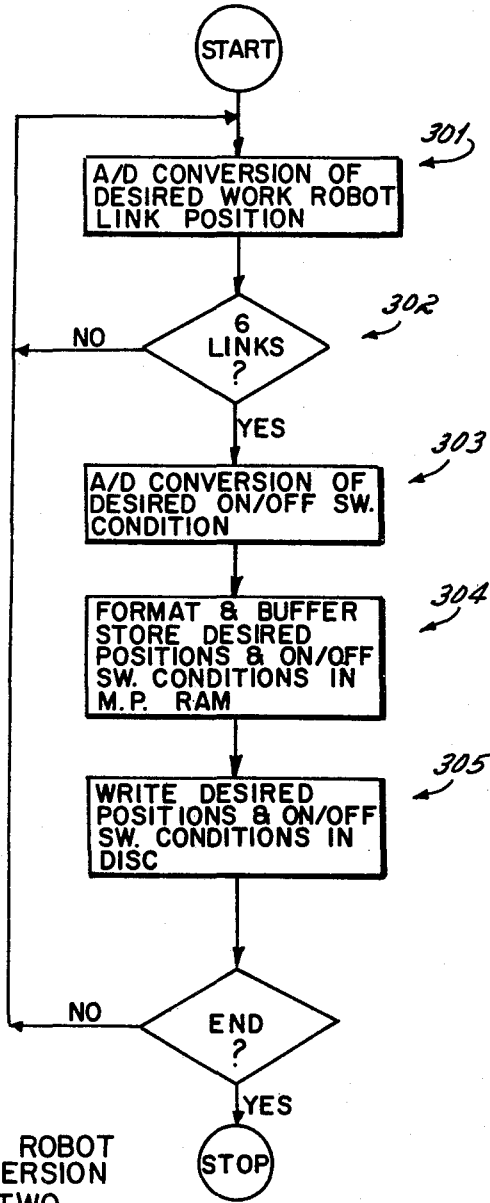


*Fig. 3*



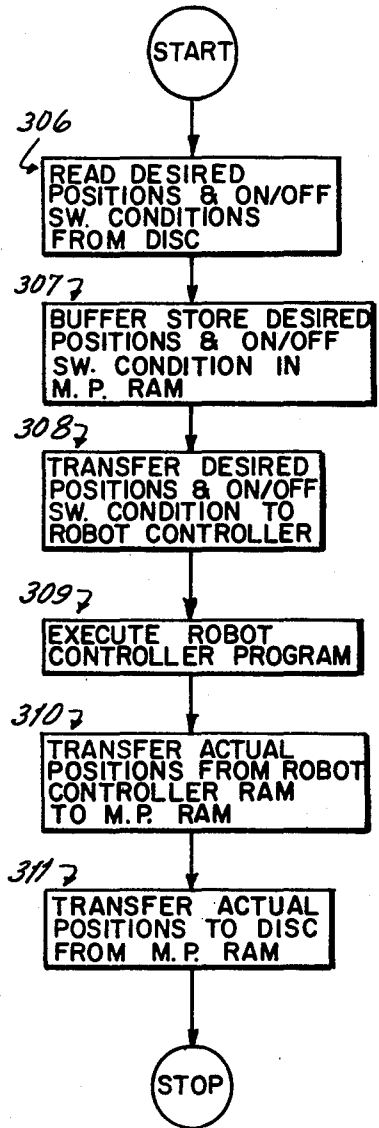
SIMULATOR ROBOT DATA COLLECTION  
PHASE ONE

*Fig. 4a*



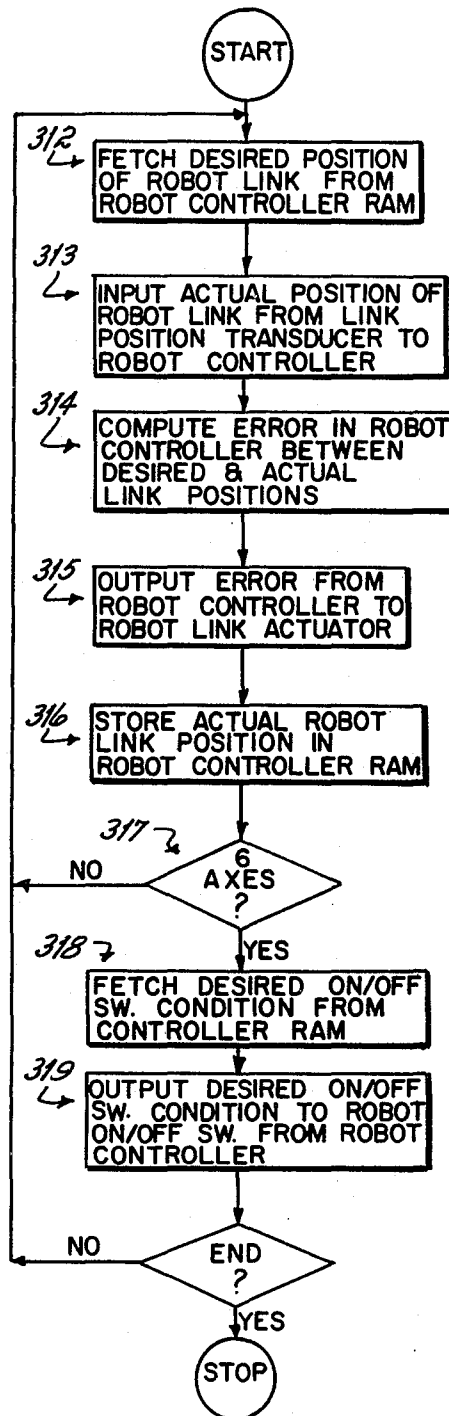
SIMULATOR ROBOT DATA CONVERSION  
PHASE TWO

*Fig. 4b*



WORK ROBOT DRIVE  
PHASE THREE

*Fig. 4c*



ROBOT CONTROLLER  
PROGRAM EXECUTION  
PHASE FOUR

*Fig. 4d*

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