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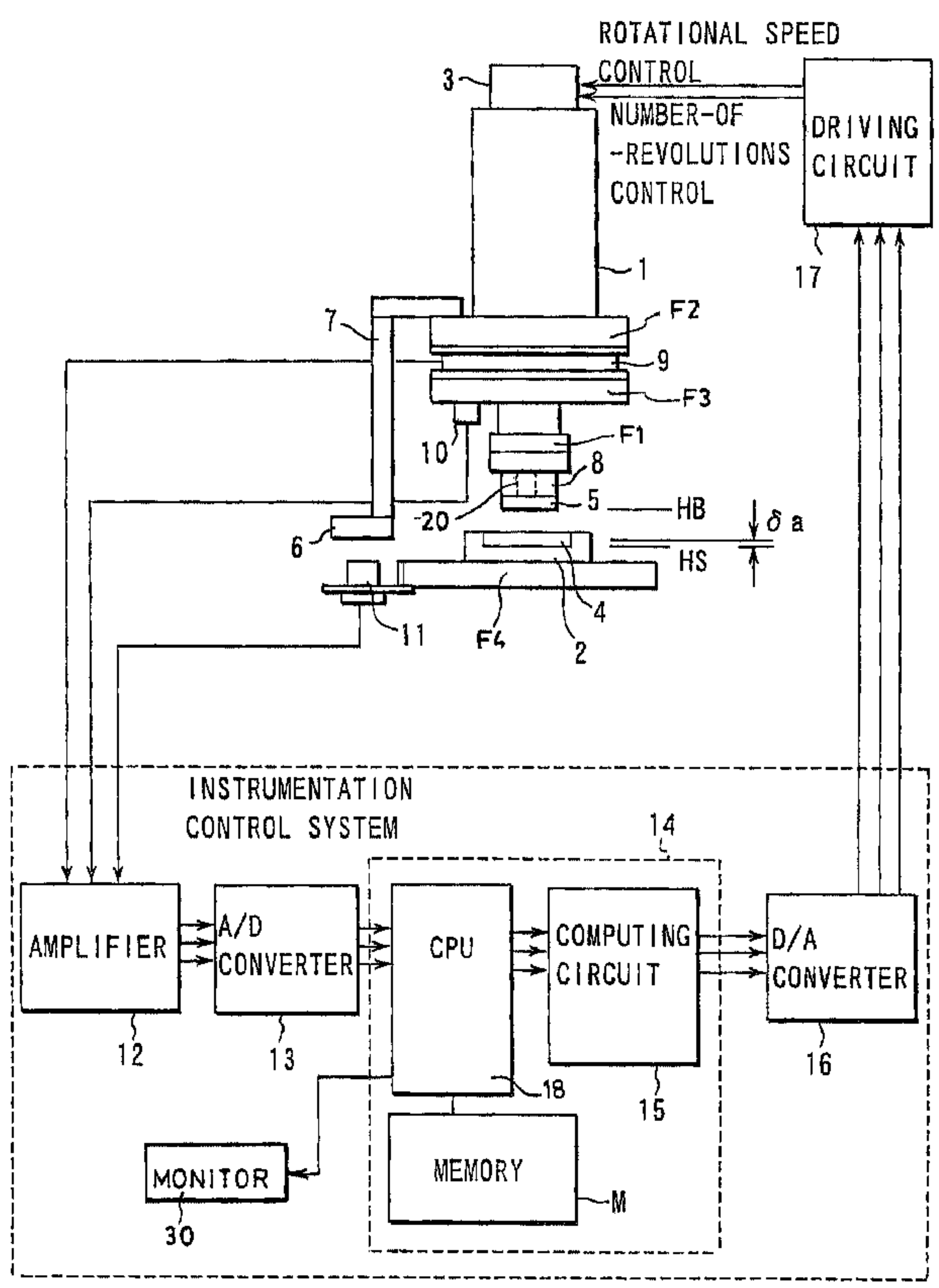
(54) Title: METHOD FOR CONTROLLING IC HANDLER AND CONTROL SYSTEM USING THE SAME



(57) Abrégé/Abstract:
The pressing force, operation speed, and displacement of a test hand are properly controlled according to the type of IC and the type of socket. The method comprises sensing the load, acceleration or speed, and push displacement of the IC so as to compare the pressing force exerted on the IC (5) placed on a socket (2) by means of a pusher (8) of a test hand (1) with an

(57) Abrégé(suite)/Abstract(continued):
allowable pressing force determined from the synthetic spring constant of the socket (2) and the IC (5), and controlling the movement of the test hand (1) according to the result of the comparison so as to keep the pressing force below the allowable pressing force.

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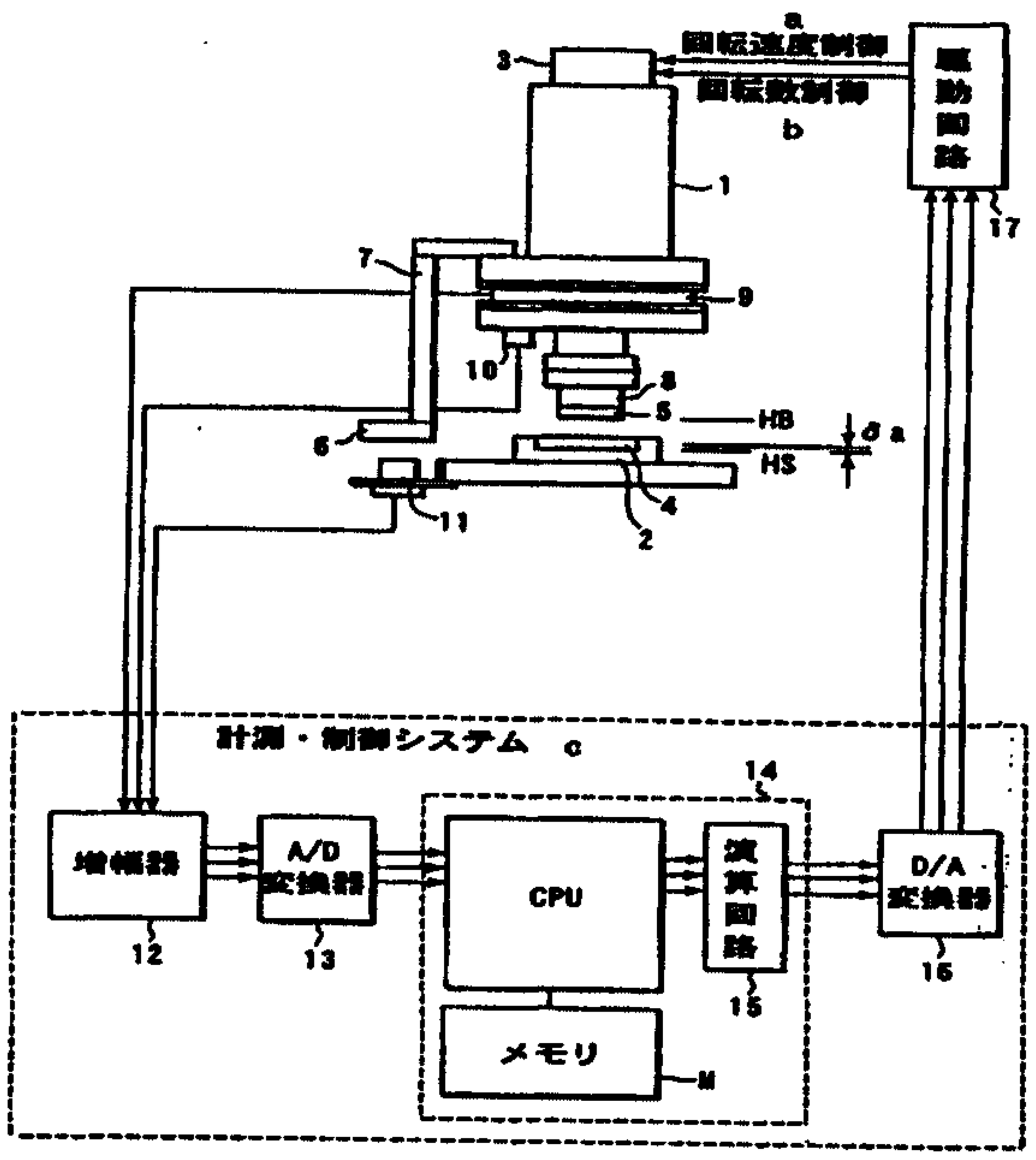
(54)Title: METHOD FOR CONTROLLING IC HANDLER AND CONTROL SYSTEM USING THE SAME

(54)発明の名称 ICハンドラーの制御方法及びこれを用いた制御システム



a...ROTATIONAL SPEED CONTROL
b...NUMBER-OF-ROTATIONS CONTROL
17...DRIVING CIRCUIT
c...MEASUREMENT/CONTROL SYSTEM
12...AMPLIFIER
13...A/D CONVERTER
M...MEMORY
15...ARITHMETIC CIRCUIT
16...D/A CONVERTER

(57) Abstract

The pressing force, operation speed, and displacement of a test hand are properly controlled according to the type of IC and the type of socket. The method comprises sensing the load, acceleration or speed, and push displacement of the IC so as to compare the pressing force exerted on the IC (5) placed on a socket (2) by means of a pusher (8) of a test hand (1) with an allowable pressing force determined from the synthetic spring constant of the socket (2) and the IC (5), and controlling the movement of the test hand (1) according to the result of the comparison so as to keep the pressing force below the allowable pressing force.

DESCRIPTION

METHOD FOR CONTROLLING IC HANDLER AND CONTROL SYSTEM USING THE SAME

Technical Field

This invention relates to a method of controlling the operation of a test hand for pressing down an IC device (hereinafter, referred to as an IC) properly on a socket according to the types of the IC and socket in an IC handler used for a semiconductor tester, a recording instrument and a controlling/operating system.

Background Art

An IC handler has been in common use as a semiconductor tester. In the IC handler, an IC transferred from the IC loader is placed on the socket of the measuring section. In this state, the pusher of the test hand presses the IC against the socket to bring the contact section of the IC, such as the lead pins, into contact with the contactor of the socket. From the result of electric conduction, the tester judges whether the IC characteristic is acceptable. Then, the unloader separates the IC from a reject and holds it.

In recent years, the types of ICs to be tested have been diversified and consequently the types of sockets to hold them have also been diversified.

Thus, the operating performance of the test hand should be changed so as to deal with the type of IC. Since the semiconductor tester is requested to process many ICs in a short time, it is desirable that the IC handler should function at high speed. However, the faster the processing speed becomes, the more increase the impact of the pusher on the IC when the pusher is pressed against the IC, and thus the service life of the lead pins of the IC and the socket contactor may become shorter.

To overcome those problems, a handler, which has been disclosed in Jpn. Pat. Appln. KOKAI Publication No. 9-89983, is developed. In this handler, the data of allowable contact pressure in each type of IC has been inputted in a FD (floppy disk) beforehand. When the operator specifies the type of IC, the CPU sends a signal to the control valve on the basis of the data from the FD, thereby the hydraulic cylinder pressure for driving the test hand can be adjusted.

Furthermore, Jpn. Pat. Appln. KOKAI Publication No. 10-227834 has disclosed a mechanism for making fine adjustments to the proper pressure, speed, and displacement of IC pressed into a socket according to the type of IC.

In the above methods currently in use, however, it is required to input IC handler data for each type of IC into the computer in advance. And what is more, these data may be obtained through experience based on the pin pressure per lead pin, the number of pins and the allowable displacement of the socket contactor.

However, since the IC is pressed down by the test hand as it is in a socket, it may not be assured that the values based on the specified data items are always proper. For example, as the working speed of the test hand is increased to process the IC at high speed, the impact on the IC happens and becomes larger when the test hand hits the IC package. In addition, the impact force is likely to exceed the material strength of the IC leads or socket contactor and do damage to the IC package.

Summary of Invention

Accordingly, the present invention is to provide an operation method and system for an IC handler to control properly the pushing pressure, operating speed and displacement of the test hand according to the types of IC and socket.

According to the present invention, there is provided a method of controlling a test hand for pressing down an IC loaded in the socket of an IC handler, comprising the steps of:

causing said test hand to press down the IC on the socket more than once and detecting the load, the acceleration or velocity, and the thrusting displacement of the IC by corresponding sensors;

calculating the combined spring constant for the IC and socket from the measured data items beforehand; and

determining the operation of the test hand from the calculated spring constant so that the impact force exerted on the IC is controlled to be equal to or smaller than an allowed value.

According to the present invention, there is also provided a method of controlling an IC handler comprising the steps of:

comparing a pushing pressure developing when the pusher of a test hand presses an IC placed on a socket with a preset allowable press force; and

controlling the operation of the test hand at a press force equal to or lower than said allowable press force on the basis of the result of the comparison.

According to the present invention, there is also provided an instrumentation control system for a test hand comprising:

a load sensor for detecting the press force of the test hand applied to an IC;

an acceleration sensor for detecting the operating velocity or acceleration of said test hand;

a displacement sensor for measuring the thrusting displacement during the time from when said test hand comes into contact with the IC until it stops; and

control means for not only calculating the combined spring constant for the IC and a socket on the basis of the data items from the individual sensors, but also controlling the driving of the test hand on the basis of the individual data items so that the press force, velocity, and displacement may reach such values that make the impact force acting on the IC equal to or smaller than an allowed value and speed up the operation of the test hand to the maximum.

Brief Description of Drawings

FIG. 1 illustrates a schematic block diagram of a test hand control system according to an embodiment of the present invention.

FIG. 2 shows a flowchart to explain the operation of the computer in the embodiment of FIG. 1.

FIG. 3 shows a sectional view showing a state where the pusher provided at the tip of the test hand presses an IC against the socket.

FIG. 4 shows a perspective view of an example of an IC to be tested.

FIG. 5 shows a perspective view of an example of a socket used with the IC of FIG. 4.

FIG. 6 is a perspective view showing a state where the pusher presses down the protective plate of the socket via the IC package, causing the contact pins of the socket of FIG. 5 to project from the protective plate.

Best Mode for Carrying Out the Invention

FIG. 1 is a block diagram showing the overall configuration of a control system for the best hand in an IC handler according to an embodiment of the present invention.

The upper half of FIG. 1 schematically shows an IC test section composed of a pulse motor 3, a driving circuit 17, a test hand 1, a pusher 8 provided on a support plate F1, an IC 5, a contactor 4, and a socket 2. At the tip of the test hand 1, a load sensor 9 using a strain gauge load transducer and a strain gauge accelerometer 10 are provided between frames F2 and F3. A noncontacting displacement sensor 11 using an eddy-current displacement measuring device is provided on a frame F4 that supports the socket 2. A lightweight, rigid aluminum arm 7 to hold a target 6 of the displacement sensor 11 is provided above the pusher 8.

The lower half of FIG. 1 shows a system for collecting and processing the electric signals sent by the sensors 9 to 11. The control system is composed of an amplifier 12, an A/D converter 13, a computer 14, and a D/A converter 16. The electrical signals are digitized by an A/D converter and then the arithmetic process is executed by a computer. When the operation of the pulse motor 3 has to be adjusted, a control signal is sent to the driving circuit 17. Detailed explanation will be given below.

In FIG. 1, the pulse motor 3 is fixed on the top end of test hand body 1. At the lower end of the test hand body 1, the pusher 8 is provided in such a manner that it can move up and down freely. At the tip of the pusher 8, a suction hole 20 for causing the IC 5 to adhere to the tip by suction at air pressure is made. The suction hole 20 is connected to a compressor 21 via an air hole made inside the pusher 8 and test hand body 1.

Because the support plate F1 is joined to the pulse motor 3 and the pusher 8 is fixed onto the support plate F2 via a load sensor 9 and a frame F3, the pusher 8 and support plates F2, F3 are moved up and down as one piece by the pulse motor 3.

On the other hand, the socket 2 on the frame F4 is provided below the pusher 8. The contactor 4 is provided at the IC acceptor of the socket 2 so that it may touch the contacts of the IC 5, such as the leads.

The sensor arm 7, made of lightweight aluminum, is fixed rigidly to the frame F2. At the lower end of the sensor arm 7, the target 6 for a displacement sensor is provided in such a manner that it faces the displacement sensor 11 provided on the frame F4 on which the socket 2 is placed.

The acceleration sensor 10 is provided onto the lower frame F3 of the pair of frames F2, F3.

The test hand 1 has the pusher 8 at its lower end. Adhering the IC 5 by suction at its tip, the pusher 8 is moved up and down by the pulse motor 3. The test hand 1 can adjust the pushing pressure on the IC 5 and socket 2, the working speed, and the thrusting displacement of IC by controlling the number of revolutions and rotational speed of the pulse motor 3. As described later, the test hand 1 is designed to be decelerated just before the tip of the pusher 8 comes into contact with the socket 2 so as to alleviate its impact on the IC 5 and socket 2.

The load sensor 9 is for detecting the pushing pressure of the test hand 1, or the pusher 8, on the IC 5 and socket 2. The load sensor is provided between the frames F2 and F3. The acceleration sensor 10 is used for detecting the acceleration or a change of the velocity when the test hand 1 goes down. A strain gauge sensor or piezoelectric sensor can be used as the acceleration sensor 10. An acceleration sensor may be used in place of the velocity sensor. In this case, the velocity can be obtained by differentiating numerically the digitized data of displacement by means of the computer 14. The displacement sensor 11 is for measuring the displacement D from the position just before the IC 5 stuck by suction to the pusher 8 comes into contact with the contactor 4 of the socket 2 to the position at which the pusher 8 stops after being thrust down. In the embodiment, an eddy current noncontacting measuring device is used as the displacement sensor 11.

Hereinafter, the configuration of the control system for controlling the operation of the test hand 1 will be explained by reference to FIG. 1.

The pulse motor 3 and the compressor (not shown) are connected to the driving circuit 17, which controls the number of revolutions and rotational speed of each of them.

On the other hand, the output terminal of each of the load sensor 9, acceleration sensor 10, and displacement sensor 11 is connected to the amplifier 12. The amplifier 12 amplifies the faint electrical signal, which is then converted by the A/D converter 13 into a digital signal. The digital signal is supplied to the CPU 18 of the computer 14. The computer 14, which includes a computing circuit 15 connected to the CPU 18 and a memory M, controls the operation of the entire system. The memory M includes a ROM in which the operating programs for the CPU 18 are stored and a RAM for temporarily storing the data used in the computing circuit 15 is recorded.

The output data from the computing circuit 15 is converted by the D/A converter 16 into an analog signal, which is supplied as an instruction to the driving circuit 17 for operating the pulse motor 3 and compressor.

In the above system configuration, the amplifier 12 amplifies the faint analog electric signals from the sensors 9 to 11. The A/D converter 13 digitizes the amplified analog signals and sends the resulting signals to the computer 14. According to the setting program, the CPU 18 of the computer 14 will make the computing circuit 15 to perform the arithmetic processing for comparison the measured data with the stored data in the memory M and give an instruction the test hand 1 to do an optimum work correspondingly with the types of the IC 5 and socket 2. The operator can keep watch on the monitor what the process is going in every time.

Hereinafter, referring to FIGS. 3 to 6, a state where the IC 5 is pressed against the contactor 4 of the socket 2 and the configuration of the socket 2 will be explained.

In FIG. 3, the base 2a of the socket 2 is placed on the frame F4. As shown in FIGS. 5 and 6, contact pins 2b are set straight at the base 2a. The tips of the contact pins 2b are inserted into the through holes 2a made in a protective plate 2c.

The protective plate 2c are held above the base 2a by the four supports or protective pins 2e inserted into through holes made in the four corners of the plate 2c and the coil springs 2f provided around the protective pins 2e in such a manner that the plate 2c can move up and down. As shown in FIG. 5, the coil springs 2f are normally set so that they may have such tension as raises the protective plate 2c to the extent that the contact pins 2b will not project from the surface of the protective plate 2c.

When the IC 5 conveyed by an IC loader (not shown) is stuck by suction to the tip of the pusher 8 and placed on the socket 2 and the pusher 8 presses down the IC 5 on the socket 2, the protective plate 2c which allows the contact pins 2b to project from the surface to the protective plate 2c as shown in FIG. 6, is forced to move downward. FIG. 3 shows a state where the IC 5 stuck by suction to the tip of the pusher 8 has just come into contact with the protective plate 2c.

The socket 2 put on the frame F4 is fixed and protected by covers 23 and 24.

As shown in FIG. 4, for example, the IC 5 has a square shape of thin flat-plate and a plural number of lead pins 5b are stuck out from each side of a plate.

In addition to the case shown in FIG. 4, there are various methods of securing an electrical connection between the IC and the socket. They include a spring contact method in which the IC's lead pins are brought into contact with the socket by the spring and a conductive rubber method in which the minute solder balls formed at one surface of the IC plate is brought into contact with the conductive particles embedded in a rubber socket (not shown).

While in the embodiment, the IC 5 is stuck by suction to the pusher 8 on the test hand 1, the IC may be placed on the socket directly from the IC loader so as to be pressed by the pusher.

The operation of the IC handler constructed as described above will be explained.

First, using the data from the sensors 9 to 11, the CPU 18 determines the pushing pressure, the allowable impact force, the working speed, and the thrusting displacement as follows.

Pushing Pressure

If the spring constant of the IC leads 5b is K1 and the resultant spring constant of coil springs 2f of the socket 2 is K2, a combined spring constant K can be obtained by adding the spring constant of the IC 5 and that of the socket 2 as follows:

$$K = (K1 + K2)/K1 \cdot K2$$

Using the pushing pressure load P detected by the load sensor 9 with the pusher 8 in contact with the IC 5 and the thrusting displacement δ of the IC 5 measured by the displacement sensor 11 when the IC 5 is lowered a specific distance from the position where the pusher 8 makes contact with the IC 5 within the socket 2, the value of K is also given by:

$$K = P/\delta$$

Where, the thrusting displacement δ of the pusher 8 is the distance from the position of the pusher 8 when the acceleration of the pusher 8 changes from zero to a specific negative value at the moment the IC 5 comes into contact with the protective plate 2c to the position to which the pusher 8 is lowered a specific distance predetermined by the IC 5, or to the position at which the pusher 8 is brought to a stop by the computer 14 when the pushing pressure load P has exceeded a prescribed value. The thrusting displacement δ is the sum ($\delta = \delta 1 + \delta 2$) of the amount of deflection $\delta 1$ when the lead pins 5b of the IC 5 are pressed by the contact pins 2d of the socket 2 and the length of contraction $\delta 2$ of the coil springs 2f supporting the protective plate 2c. The values of $\delta 1$ and $\delta 2$ are determined by the spring constants K1 and K2, respectively.

Impact Force

When the IC 5 comes rapidly into contact with the protective plate 2c serving as the contactor 4, the impact force may be produced and can be evaluated from a change in the velocity ($\Delta V = V1 - V0$) of the pusher 8 during the time of Δt before and after the contact. The impulse force is given by:

$$F = m \cdot (\Delta V / \Delta t)$$

As seen from the above equation, if the velocity V0 of the pusher 8 before contact has been decreased sufficiently compared to the given working velocity of the test hand 1 and it could be kept constant until the IC 5 stuck by suction to the tip of the pusher 8 comes into contact with the protective plate 2c, the impact force at the time of contact can be extremely small or zero. In the above equation, $\Delta V / \Delta t$ is defined as the acceleration and it can be detected by the acceleration sensor 10.

On the other hand, the reaction force generated by the contact of the IC 5 with the socket protective plate 2c is equal to the pushing force P applied to the IC 5. The force P is detected by the load sensor 9 (load cell) provided above the pusher 8. Let the mass of the pusher 8 at the tip of the test hand 1 m, the impact force F can be evaluated as the product of m and acceleration as shown in the above equation.

Working Velocity

The working velocity V(t) of the pusher 8 of the test hand 1 at a given time t can be evaluated from either the displacement data D(t) measured by the sensor 11 or the acceleration data A(t) measured by the sensor 10 as follows:

$$V(t) = \{D(t) - D(t - \Delta t)\}/\Delta t$$

$$V(t) = V(t - \Delta t) + A(t) \cdot \Delta t$$

Thrusting Displacement

The thrusting displacement $\delta(t)$ can be obtained from the data D(t) measured by the displacement sensor 11 as follows:

$$\delta(t) = D(t) - D(t - \Delta t)$$

On the other hand, the following data items have been inputted into the memory M of the computer 14 in advance:

(1) The working velocity V of the test hand 1 (pusher 8). This is determined by the number of revolutions and rotational speed of the pulse motor 3.

(2) The braking position HB and position to be

stopped HS (see FIG. 1) of the test hand 1.

(3) The decreased velocity V0 of the pusher 8 after braking. This can be determined by regulating the number of revolutions and rotational speed of the pulse motor 3.

(4) The allowable thrusting displacement δa (the amount of displacement from the position where the IC 5 comes into contact with the protective plate 2c of the socket 2 to the position where the pusher 8 stops).

(5) The allowable pushing force Pa (evaluated from the thrusting displacement δ of the pusher 8 and the combined spring constant K).

The data processing and computing processes carried by the CPU 18 will be explained by reference to the flowchart of FIG. 2.

First, the pusher 8 of the test hand 1 presses repeatedly the IC 5 against the contactor 4 of the socket 2 or the protective plate 2c to measure the load P and displacement D, and then calculates the combined spring constant K of the IC 5 and socket 2 (step S0). The pushing pressure is set under the prescribed value given to the IC 5 and socket 2. Pressing the IC 5 more than once and averaging the results will minimize errors in the measured data of load P and displacement D, and then the more precise data may be obtained.

In the next step S1, the initial conditions, including the operating velocity V of the test hand 1, the braking position HB and the position to be stopped HS of the test hand 1, the decreased velocity V0 after braking, the allowable thrusting displacement δa, and the allowable pushing pressure Pa, are inputted together with the combined spring constant K obtained at step S0 into the memory M.

If necessary, the pulse motor 3 driven by the driving circuit 17 is adjusted at step S21.

After preparations for startup have been made, the operator turns on the start switch at step S22, which starts the control operation. Then, the pulse motor 3 rotates at high speed and the pusher 8 of the test hand 1 moves downward rapidly from the initial position. The CPU 18 checks the number of revolutions of the pulse motor 3 by counting the number of pulses sent from the driving circuit 17. When the number of pulses has amounted to the number corresponding to the braking position of the test hand 1, the CPU 18 sends the driving circuit 17 an instruction to brake the pulse motor 3.

At this stage, the CPU 18 takes in the input data from the sensors 9 to 11 at step S23. As a result, load data P(t), acceleration data A(t), and displacement data D(t) at time t are stored in the memory M at steps S3, S4, and S5, respectively.

Using acceleration data A(t) taken in at step S4, the decreased velocity V1(t) of the pusher 8 is determined at step S7. At the same time, using displacement data D(t) taken in at step S5, the alternative decreased velocity V2(t) of the pusher 8 is determined at step S8.

A check is made to see if the velocity V1(t) is equal to the velocity V2(t) at step S9. If the difference between them is within the allowable error range, one of the velocity data items, for example, V2(t) is compared with the initial velocity V0 after braking set at step S10. If the difference between them is within the normal range, the next operation will be proceeded.

When the measured velocity is larger than the initial set value V0, the change of the braking position HB is set at step S11. Then, the control proceeds from step S24 to step S2, where the braking position HB is changed to a position closer to the socket S2.

After the braking position HB has been changed, the data is taken in again and the velocity are compared at steps S4, S5, S7, S8, S9, and S10.

On the other hand, in parallel with this, the contact pressure force P(t) between the IC 5 and socket 2 is measured directly by the load sensor 9 at step S3. This measured load is assigned to P1(t). At step S6, the contact pressure force P(t) is calculated from the mass m of the pusher 8 and the acceleration A(t). The result of the calculation is P2(t). P1(t) is compared with P2(t) at step S12. Even when they are equal or differ slightly, the load, for example, P1 is compared with the allowable pushing pressure Pa in the memory M at step S13.

As a result, when $P(t) \leqq Pa$, or when the impact force is within the allowable range, the next operation is to be continued. If P(t) is larger than Pa, the number of revolutions or rotational speed V of the pulse motor 3 is decreased at step S14, and then control returns to step S24.

Furthermore, the displacement data D(t) obtained at step S5, which is the thrusting displacement of the IC 5 to the socket 2, is compared with the allowed value δa in the memory M. When D(t) exceeds δa, the change of the stop position HS of the pusher 8 of the test hand 1 is set at step S16, and control returns from step S24 to step S2. The change of HS is made by changing the stroke of the pusher 8 of the test hand 1, or the total number of revolutions from the start to stop of the pulse motor 3.

Watching the monitor 30 connected to the CPU 18, the operator can verify whether the operating speed of the pusher 8 is proper at step S10 or whether the operating states at steps S13 and S15 are acceptable. Therefore, when the original set values are proper, the operator use them as they are, whereas when they are improper, the operator corrects them. Furthermore, the capability of the test hand 1 to process the IC 5 can be maximized by increasing the operating speed V of the test hand 1 in the range that meets the requirements at steps S13 and S15. Since the IC 5 stuck by suction to the pusher 8 at the tip of the test hand 1 comes into contact with the socket 2 and is slowed down to V0 immediately before it is lowered further, the impact force can be limited considerably even when the operating speed V is somewhat large.

As described above, the test hand can be operated properly in a short time even with different types of ICs and sockets by incorporating the control method and instrumentation control system of the present invention into an IC handler.

Industrial Applicability

A method of controlling an IC handler according to the present invention and a control system using the method are used to cause a contact provided at the surface of an IC device to make good contact with the test probe of a semiconductor test unit in testing the IC device. The invention enables the operation to be performed quickly and accurately, which enables a large number of IC devices to be tested rapidly and accurately at the time of shipment.

C L A I M S

1. A method of controlling a test hand for pressing down an IC loaded in the socket of an IC handler, comprising the steps of:

causing said test hand to press down the IC on the socket more than once and detecting the load, the acceleration or velocity, and the thrusting displacement of the IC by corresponding sensors;

calculating the combined spring constant for the IC and socket from the measured data items beforehand; and

determining the operation of the test hand from the calculated spring constant so that the impact force exerted on the IC is controlled to be equal to or smaller than an allowed value.

2. A method of controlling an IC handler comprising the steps of:

comparing a pushing pressure developing when the pusher of a test hand presses an IC placed on a socket with a preset allowable press force; and

controlling the operation of the test hand at a press force equal to or lower than said allowable press force on the basis of the result of the comparison.

3. The method of controlling an IC handler according to claim 2, characterized by further comprising the step of calculating said preset allowable press force from the combined spring constant

for the socket and IC beforehand.

4. The method of controlling an IC handler according to claim 2, characterized by further comprising the step of controlling said pusher in such a manner that the operating speed of said pusher is constant before and after said pusher comes into contact with the IC on said socket.

5. The method of controlling an IC handler according to claim 3, characterized in that the step of calculating the allowable press force from the combined spring constant for said socket and IC includes the step of taking the average of the combined spring constants obtained by causing said pusher to press the IC on said socket more than once.

6. An instrumentation control system for a test hand (1) comprising:

a load sensor for detecting the press force of the test hand applied to an IC;

an acceleration sensor for detecting the operating velocity or acceleration of said test hand;

a displacement sensor for measuring the thrusting displacement during the time from when said test hand comes into contact with the IC until it stops; and

control means for not only calculating the combined spring constant for the IC and a socket on the basis of the data items from the individual sensors, but also controlling the driving of the test hand on the basis of the individual data items so that the press force, velocity, and displacement may reach such values that make the impact force acting on the IC equal to or smaller than an allowed value and speed up the operation of the test hand to the maximum.

7. The instrumentation control system according to claim 6, characterized in that said control means has a memory for storing the working velocity of the test hand, the braking position and stop position of the test hand, and the working velocity of the test hand after braking, the allowable thrusting displacement, and the allowable press force as initial conditions beforehand.

8. The instrumentation control system according to claim 6, characterized in that said allowed value is calculated by said control means from the thrusting displacement of the IC and said combined spring constant.

9. The instrumentation control system according to claim 8, characterized by further comprising means for moving said test hand to said braking position at high speed and, from said braking position on, moving said test hand at low speed.

10. The instrumentation control system according to claim 6, characterized by further comprising a monitor for displaying the contents of control performed by said control means.

11. The instrumentation control system according to claim 7, characterized by further comprising means for comparing said set initial conditions with the measured data items from said individual sensors and means for correcting said initial conditions when the result of the comparison has shown that said measured data items differ from said initial conditions.

12. A storage medium for storing data denoting the operation of the test hand determined in the determining step of the method of controlling the test hand according to claim 1.

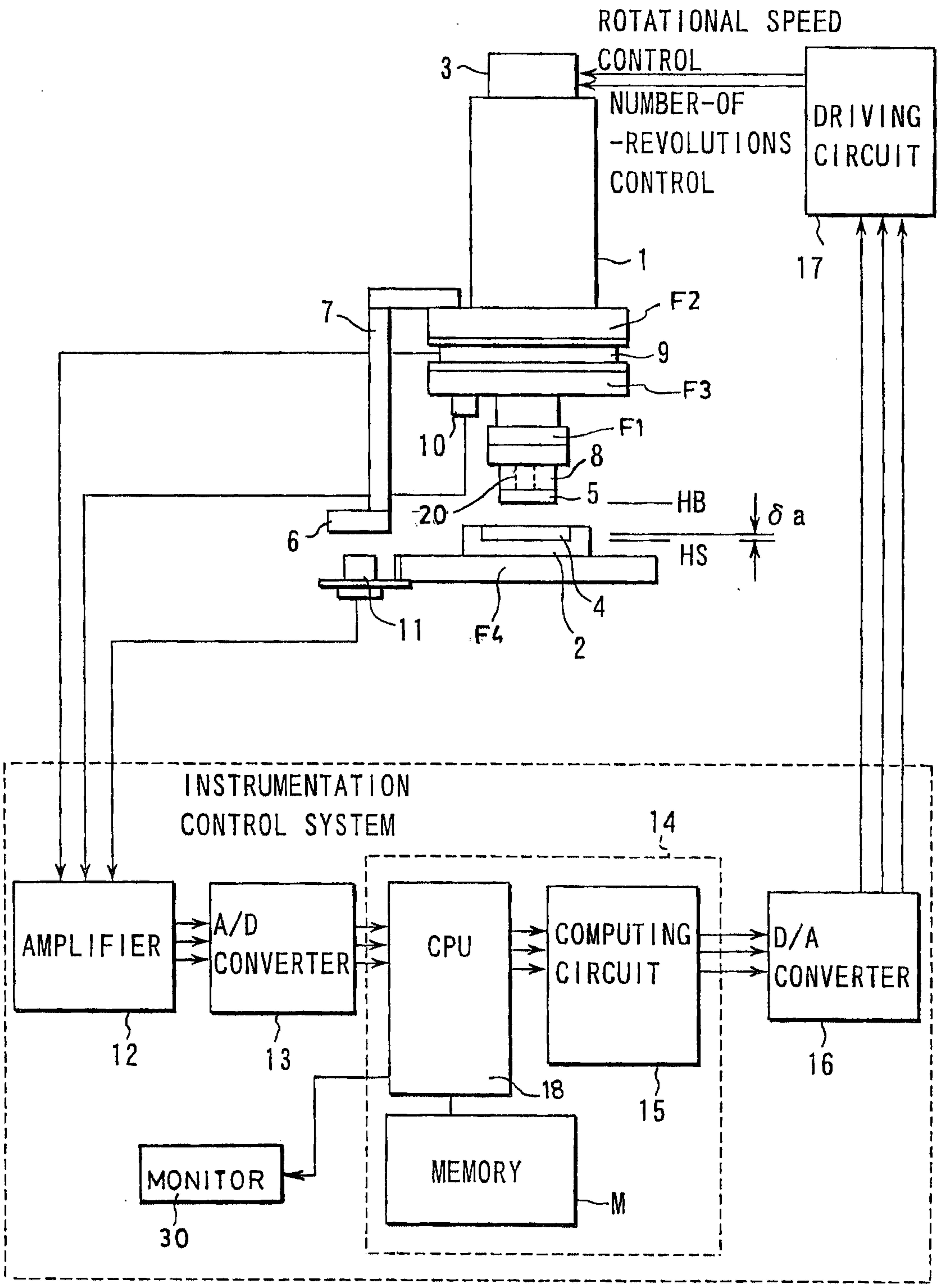

ROTATIONAL SPEED CONTROL
NUMBER-OF -REVOLUTIONS CONTROL
DRIVING CIRCUIT
3
1
17
7
F2
9
F3
10
F1
8
5
HB
20
δ a
6
HS
4
11
F4
2
INSTRUMENTATION CONTROL SYSTEM
14
AMPLIFIER
A/D CONVERTER
CPU
COMPUTING CIRCUIT
D/A CONVERTER
12
13
18
15
16
MONITOR
MEMORY
M
30

FIG. 1

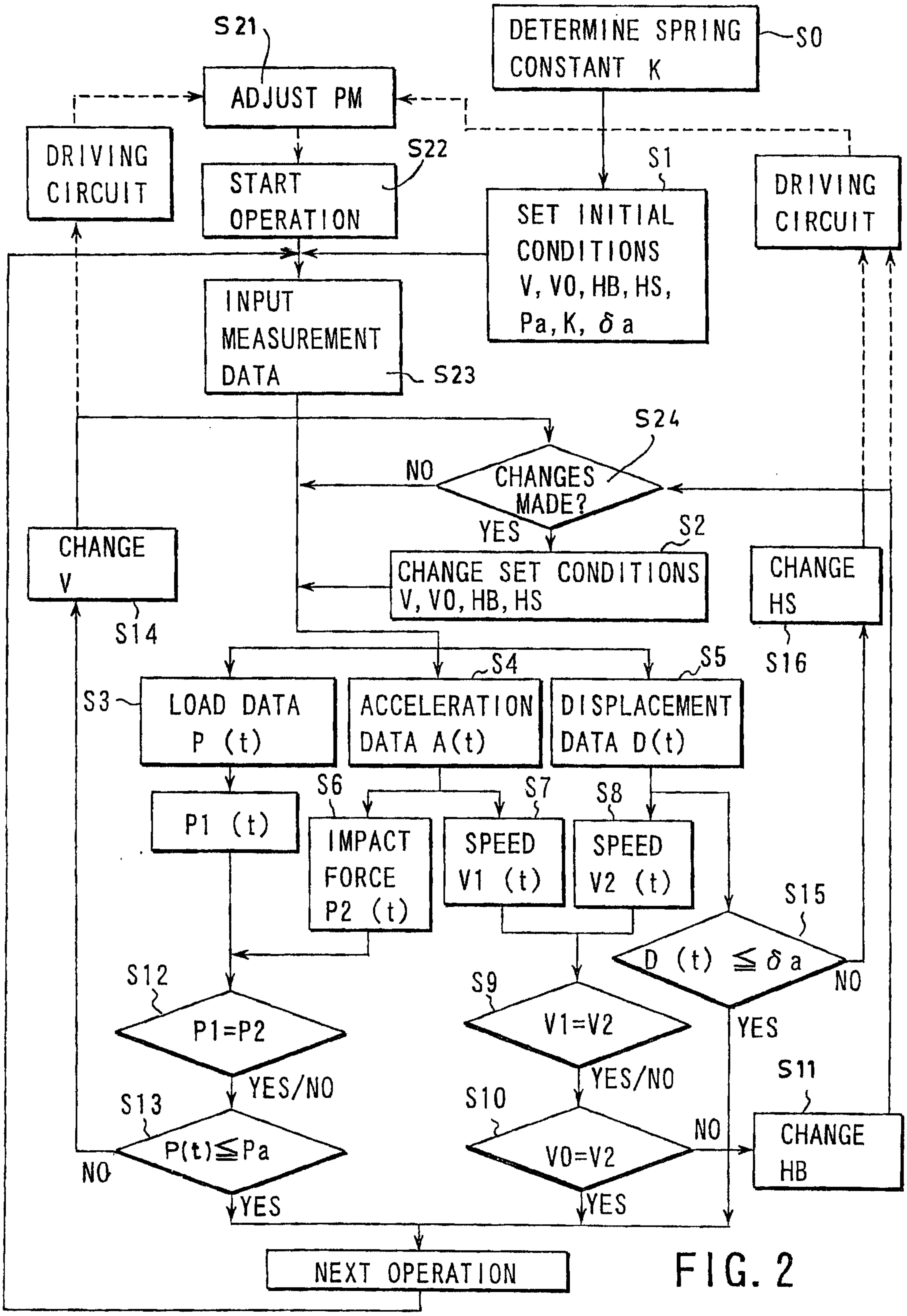

DETERMINE SPRING CONSTANT K
S0
S21
ADJUST PM
DRIVING CIRCUIT
S22
START OPERATION
S1
SET INITIAL CONDITIONS V, V0, HB, HS, Pa, K, δa
DRIVING CIRCUIT
INPUT MEASUREMENT DATA
S23
S24
NO
CHANGES MADE?
YES
S2
CHANGE V
CHANGE SET CONDITIONS V, V0, HB, HS
CHANGE HS
S14
S16
S4
S5
S3
LOAD DATA P (t)
ACCELERATION DATA A(t)
DISPLACEMENT DATA D(t)
S6
S7
S8
P1 (t)
IMPACT FORCE P2 (t)
SPEED V1 (t)
SPEED V2 (t)
S15
D (t) ≦ δa
NO
S12
S9
YES
P1=P2
V1=V2
YES/NO
YES/NO
S11
S13
S10
NO
CHANGE HB
P(t)≦Pa
V0=V2
NO
YES
YES
NEXT OPERATION

FIG. 2

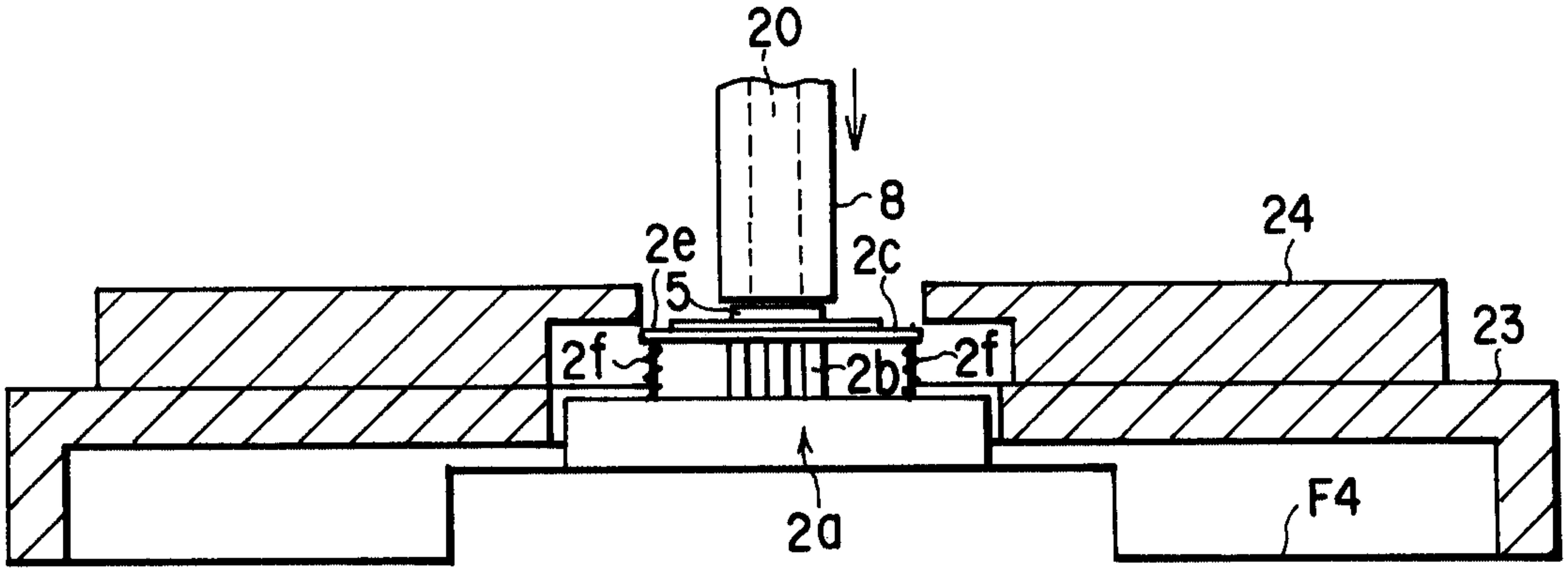
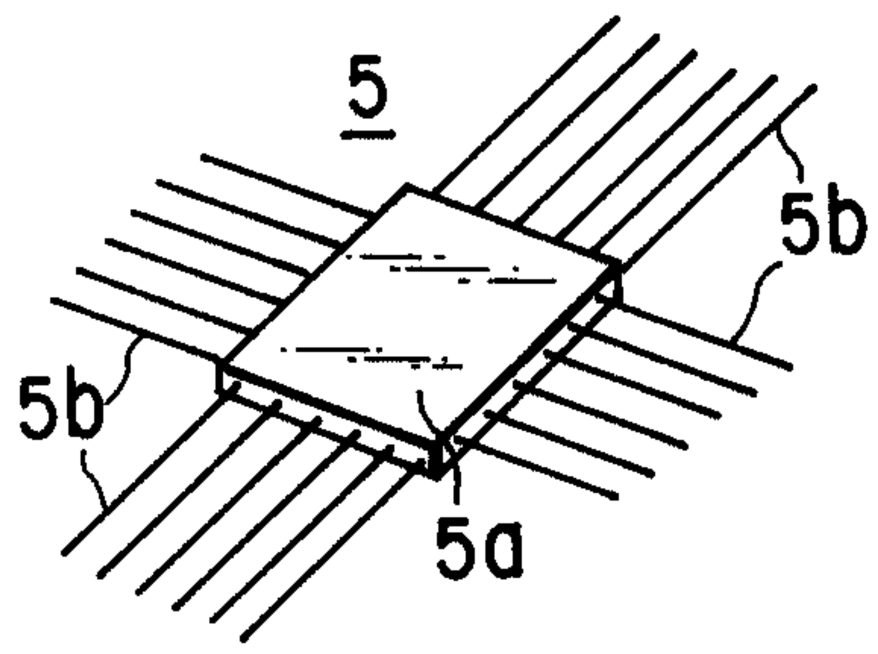


FIG.3

FIG.4



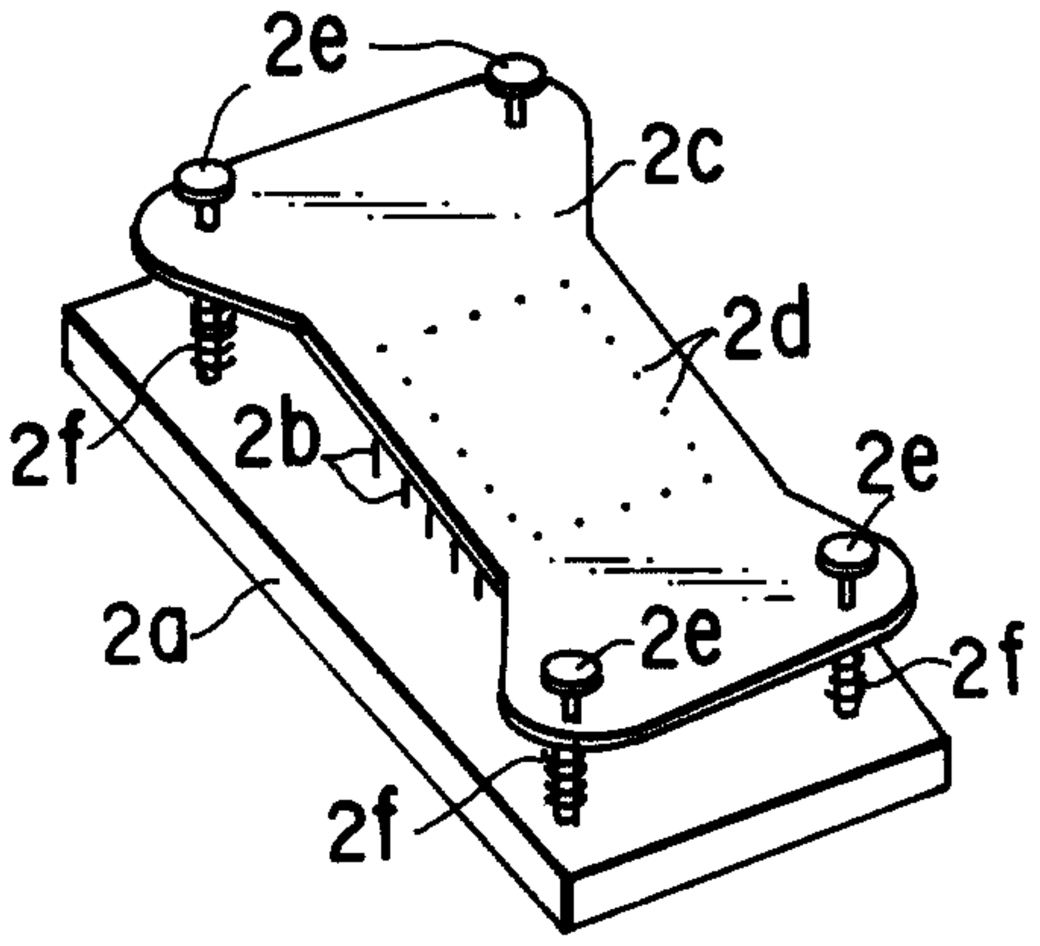


FIG.5

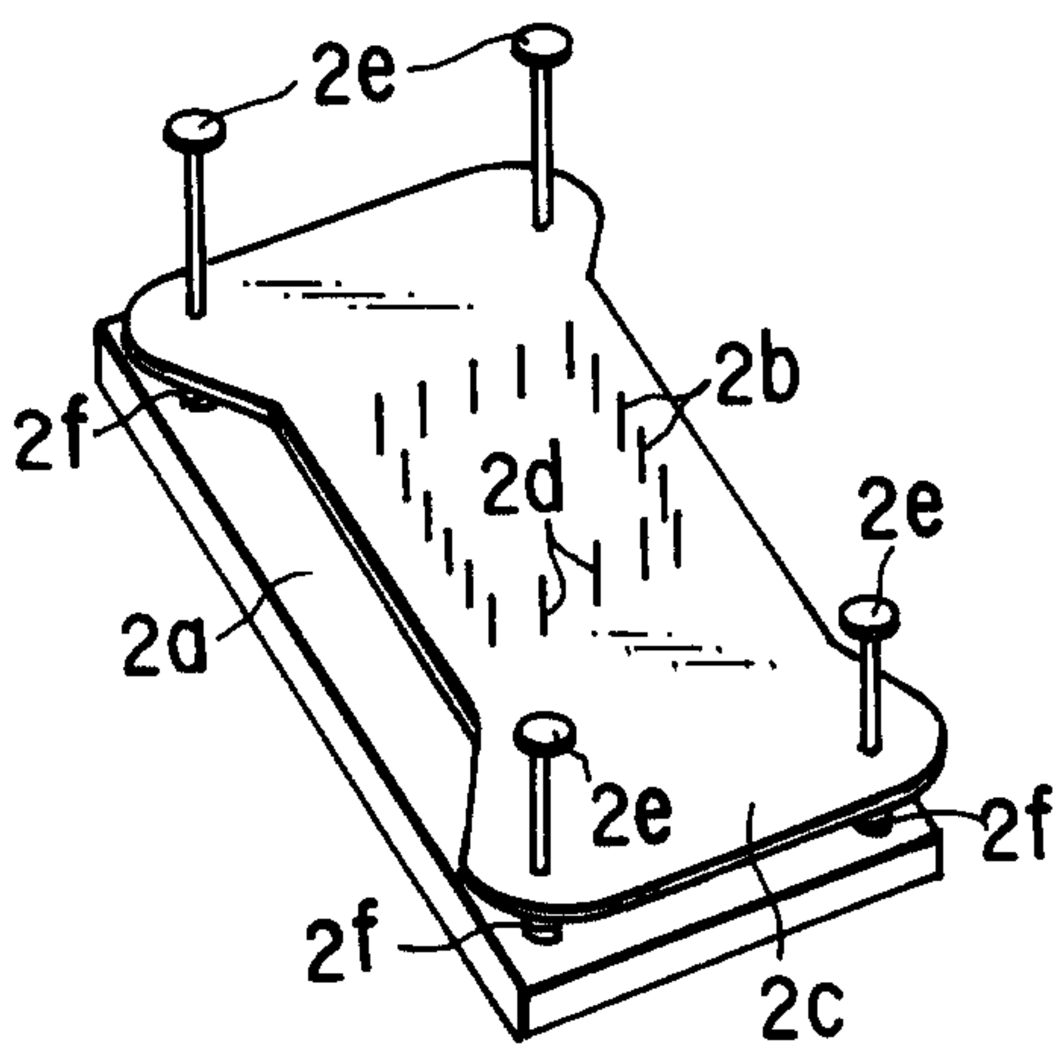
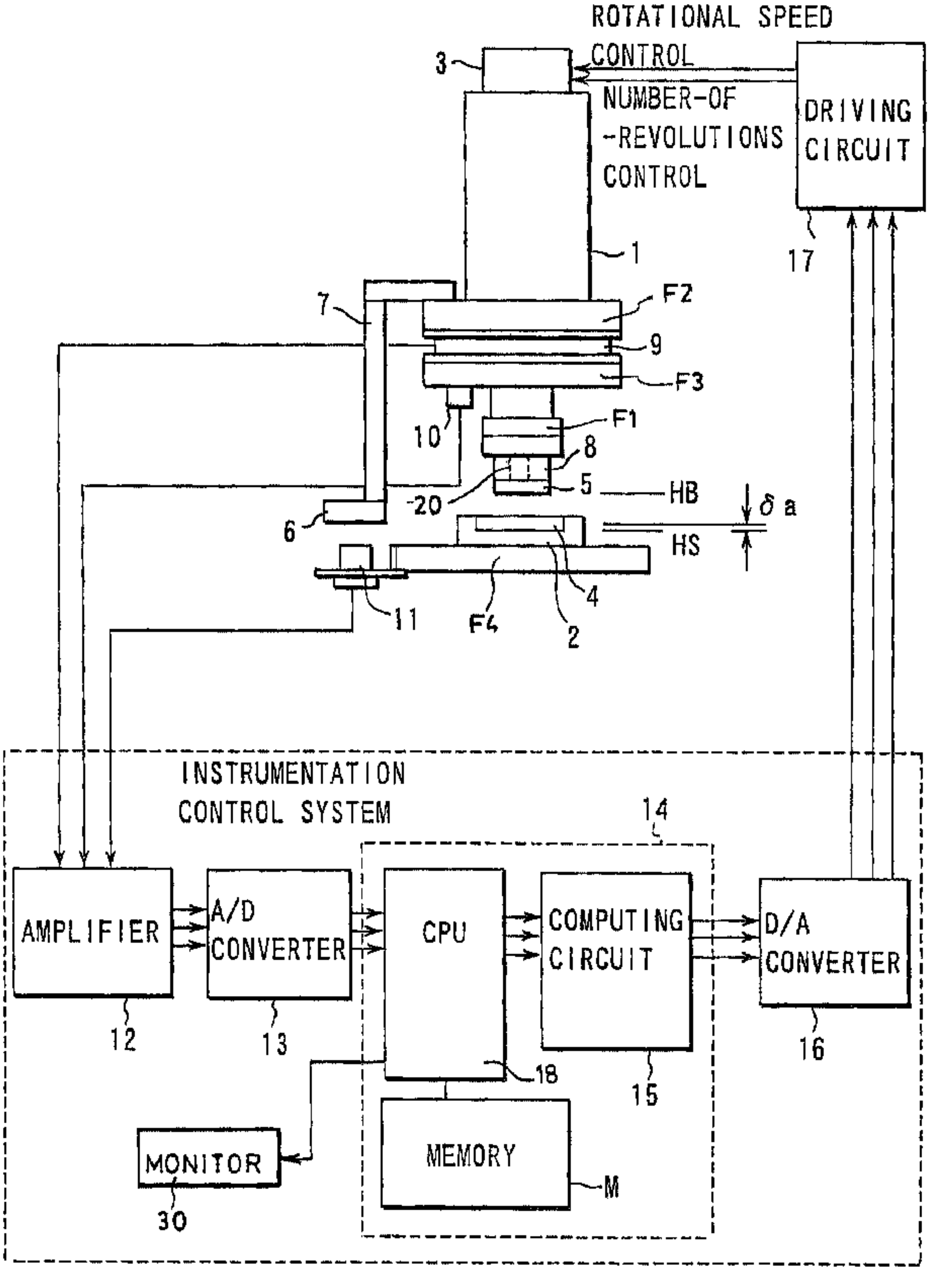


FIG.6


ROTATIONAL SPEED CONTROL
NUMBER-OF-REVOLUTIONS CONTROL
DRIVING CIRCUIT
3
1
17
7
F2
9
F3
10
F1
8
20
5
HB
δ a
6
HS
4
11
F4
2
INSTRUMENTATION CONTROL SYSTEM
14
AMPLIFIER
A/D CONVERTER
CPU
COMPUTING CIRCUIT
D/A CONVERTER
12
13
18
15
16
MONITOR
MEMORY
M
30