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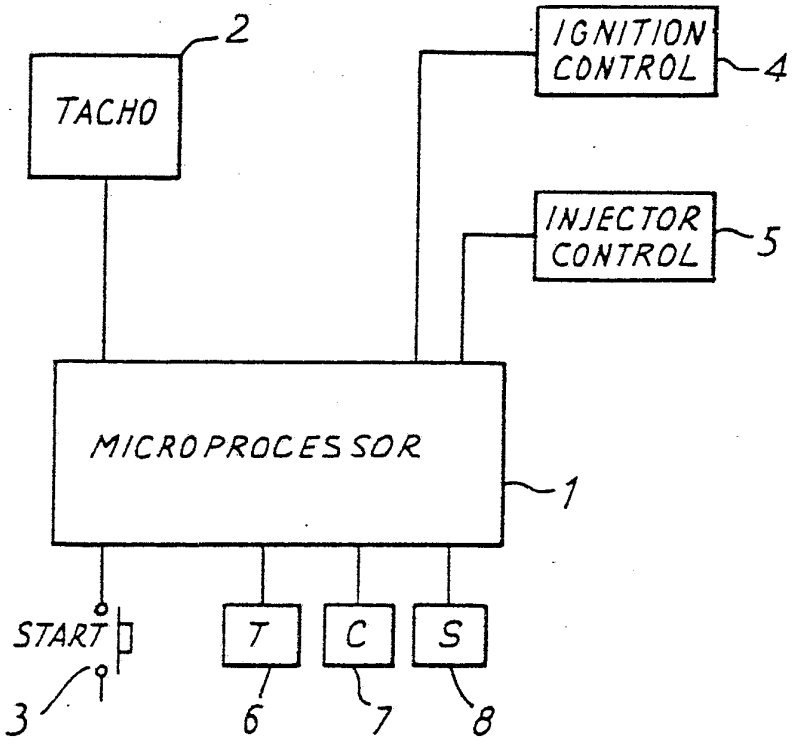
(54) Title: ADJUSTMENT OF INTERNAL COMBUSTION ENGINES

(57) Abstract

An internal combustion has preset but adjustable ignition timing control (4) and/or preset but adjustable fuel injection control (5). A microprocessor (1) is programmed to adjust the controls (4) and (5) so that the operator (e.g. driver of a vehicle incorporating the engine) can 'tune' the engine by pressing a start button (3) to energise the microprocessor. The latter illuminates a lamp (6) instructing the driver to depress the accelerator rapidly. The microprocessor measures the time taken to accelerate the engine (under no load) from one speed to another the speeds being measured by a tachometer (2). This time is compared with a stored value obtained when the engine is in tune. If the time exceeds the stored value, the microprocessor makes an incremental adjustment to one of the controls (4, 5) and signals the driver by lamp (6) to repeat the test. If the result is worse, the adjustment is reversed and the test repeated, adjusting both controls (4, 5) until an optimum result is obtained and indicated by a lamp (7).



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ADJUSTMENT OF INTERNAL COMBUSTION ENGINES

This invention relates to the adjustment or 'tuning' of internal combustion engines.

It is well known that between services, the performance of an internal combustion engine gradually deteriorates and that part of this deterioration is due to what amounts to a 'drift' away from the optimum of one or more of the settings of engine controls for example for ignition (or injection) timing and fuel-air mixture strength (or fuel charge injected).

According to the present invention there is provided an apparatus for adjustment of an internal combustion engine comprising means for generating a performance signal representative of the angular acceleration of the engine in response to an acceleration test, means for effecting adjustment of at least one engine control and control means arranged in operation to carry out an adjustment sequence comprising: initiating an acceleration test; comparing the performance signal with a predetermined value; and, if the comparison indicates that the acceleration is less than the predetermined value, carrying out the further steps of adjusting the engine control in one sense, repeating the acceleration test and comparing the performance signal with a stored value of the performance signal previously measured to determine the sense for further adjustment, and repeating the steps of adjustment, test and comparison as necessary until the performance signal attains the predetermined value or the adjustment sequence is terminated. Where more than one control is to be adjusted, the sequence is carried out in respect of each such control.

The invention will be further described, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 is a block diagram of an adjustment apparatus embodying the invention;

Figure 2 is a flow chart showing the sequence of operation of the apparatus of Figure 1; and

Figures 3 and 4 are flow charts showing in more detail certain of the steps shown in Figure 2.

Referring to Figure 1, an adjustment apparatus for the internal combustion engine of a vehicle is shown. A microprocessor has input ports connected to a tachometer 2, and start button 3.

Output ports control ignition timing circuitry 4 and fuel injection control 5. Although there is no reason why the apparatus should not be employed to control systems using mechanical ignition and/or a carburettor it is assumed that electronic ignition and fuel injection are employed and, indeed, the test arrangement described here can be particularly conveniently employed in cases where microprocessor fuel injection is already employed (as described in our co-pending International application PCT/GB82/00199). Although the apparatus could be used as a remote service tool, it is assumed to be permanently installed in the vehicle: the microprocessor may also serve for other engine and vehicle management and control functions although these form no part of the present invention and will not be described here. Further output ports of the microprocessor drive indicator lamps 6,7,8 which serve respectively to request the driver to depress the throttle, to indicate that the tune is complete, and to signal the necessity for a service.

The principle of operation of the apparatus is that, when, with the engine at working temperature and at tickover, it is instructed to carry out a tuning procedure, it will firstly carry out a test to establish whether the performance of the engine meets a pre-set standard. It instructs the driver to open the throttle, and establishes the comparative efficiency of the engine by measuring the time taken to accelerate the engine from tickover, or a somewhat higher speed, to a predetermined point in the engine speed range as measured by the tachometer 2 - i.e., the time taken to overcome the inertia of the moving parts - this providing a measure of the acceleration of the engine. This is compared with a standard time previously established by the engine manufacture and stored in the microprocessor memory.

The first run will indicate whether the performance meets the set standard, and, if so, the driver is informed "tune complete" and no further action is taken. If the performance is below this limit, the apparatus carries out further tests, making variations in ignition timing and fuelling, to optimise these variables, as will be further described below. If the test sequence fails to result in the expected performance, the driver is informed that a service is required, to identify other adjustments or faults requiring attention.

The test sequence is indicated in Figure 2 as a flow chart. It is assumed that it is entered at 10 from a sequence including other control functions carried out by the microprocessor. If (11) "tune"

mode has been selected, i.e. the start button 3 has been depressed, a test sequence is commenced. The test can be carried out at any time, although in a preferred arrangement the apparatus can be arranged to provide visual warning to the driver that tuning is due, when a predetermined time (in terms of so many miles or engine revolutions) has elapsed since the last adjustment.

A test (12) is then initiated, as detailed in Figure 3. The light 6 is illuminated (20) to instruct the driver to open the throttle, and a wait sequence 21 is entered until the engine speed as measured by the tachometer is rising, and (22) reaches 2000 r.p.m. The time (T) is then measured (23) for the speed to reach 5000, and T is stored (24). To protect the engine, a check 25 is made for an engine speed greater than say 6000 r.p.m. and if this occurs, the ignition is cut (26) until the speed falls below this figure. This check continues until (27) the throttle angle is less than 10° - i.e. the driver has released the throttle. The ignition is then reinstated (28).

Returning again to Figure 2, the time T_1 for the first test is compared (13) with the reference time T_N (times for successive tests are designated (T_1,T_2, ...T_x .....etc). If the time is less than or equal to the reference, the "tune complete" indicator 7 is illuminated (14). Otherwise an adjustment sequence 15 is entered, following which it is checked whether (16) the time is now less than or equal to the standard T_N, whereupon the sequence is terminated: otherwise the adjust sequence is repeated, unless (17) the number of tests has exceeded a predetermined maximum. In this case the tune is abandoned, as it is assumed that there is a mechanical fault, and the driver is instructed, by illuminating (18) the warning light 8, that a service is required.

One possible adjustment sequence 14 is shown in Figure 4. First (30) the increment Q for the ignition timing I_N is set to a desired value (e.g. 2°), and added (31): a test count (x) is incremented (32). The test is then run (33) to establish the time (T_x) for the new setting (the test sequence being as in Figure 3). The time is then compared (34) with the previous time, to see if an improvement has occurred. If it has, or there is no change, the sequence is repeated (35) to advance the ignition timing further, until a deterioration in performance is noted, whereupon the sequence is repeated with Q negative, to retard the ignition timing until again

a deterioration is noted. As this implies that the ignition has been retarded too far, it is advanced again (36), to the optimum. Thus the apparatus searches on both sides of the existing ignition timing setting, to find a minimum in T_x. The test of Q (37) serves to identify the end of the second run round the loop.

The timing having been adjusted, an increment R for the fuel setting F_N is set and, x reset to 1 (38), and a further test (39) carried out; an adjustment sequence for the fuel setting, identical to that for the ignition timing, is then followed.

The apparatus could also be arranged to display the figures measured, as acceleration times, or converted to an efficiency or horsepower figure, plus the actual ignition and fuel settings. These could be displayed digitally, and in the case of an external unit a printed record could also be made available.

CLAIMS:

1. Apparatus for adjustment of an internal combustion engine comprising means for generating a performance signal representative of the angular acceleration of the engine in response to an acceleration test, means for effecting adjustment of at least one engine control and control means arranged in operation to carry out an adjustment sequence comprising : initiating an acceleration test; comparing the performance signal with a predetermined value; and, if the comparison indicates that the acceleration is less than the predetrmined value, carrying out the further steps of adjusting the engien control in one sense, repeating the acceleration test and comparing the performance signal with a stored value of the performance signal previously measured to determine the sense for further adjustment, and repeating the steps of adjustment, test and comparison as necessary until the performance signal attains the predetermined value or the adjustment sequence is terminated.

2. Apparatus according to claim 1, wherein the control means includes a device for instructing an operator of a power output control of the engine to abruptly accelerate the engine each time a test step is to be performed.

3. Apparatus according to claim 1, wherein the adjustment effecting means serve to adjust ignition timing means of the engine.

4. Apparatus according to claim 1, wherein the adjustment effecting means serve to adjust fuel delivery rate.

5. Apparatus according to claim 1, wherein the adjustment effecting means serve to adjust both ignition timing means and the fuel delivery rate for the engine.

6. Apparatus according to claim 1 wherein the control means comprises a microprocessor programmed to carry out the said adjustment sequence.

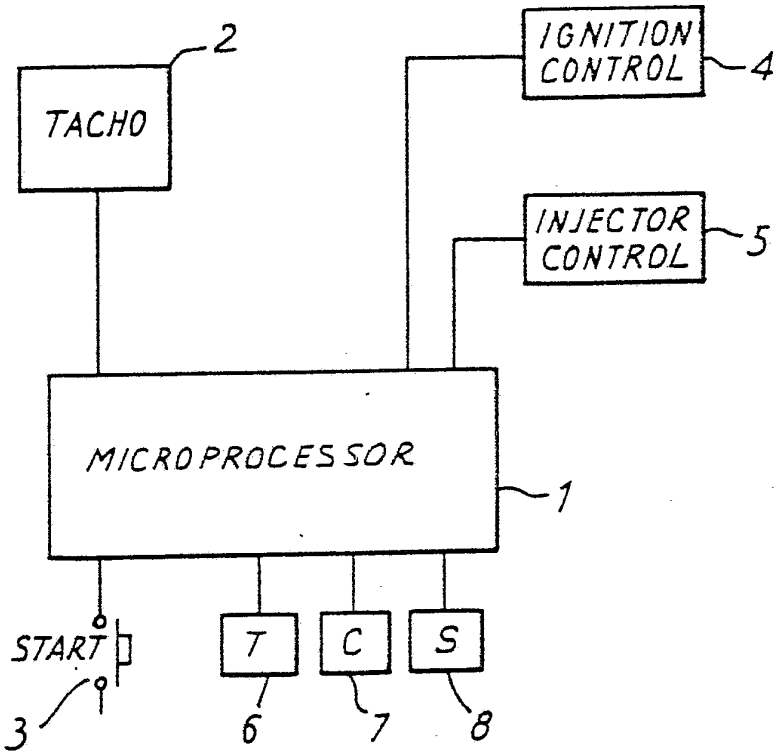

FIG.1

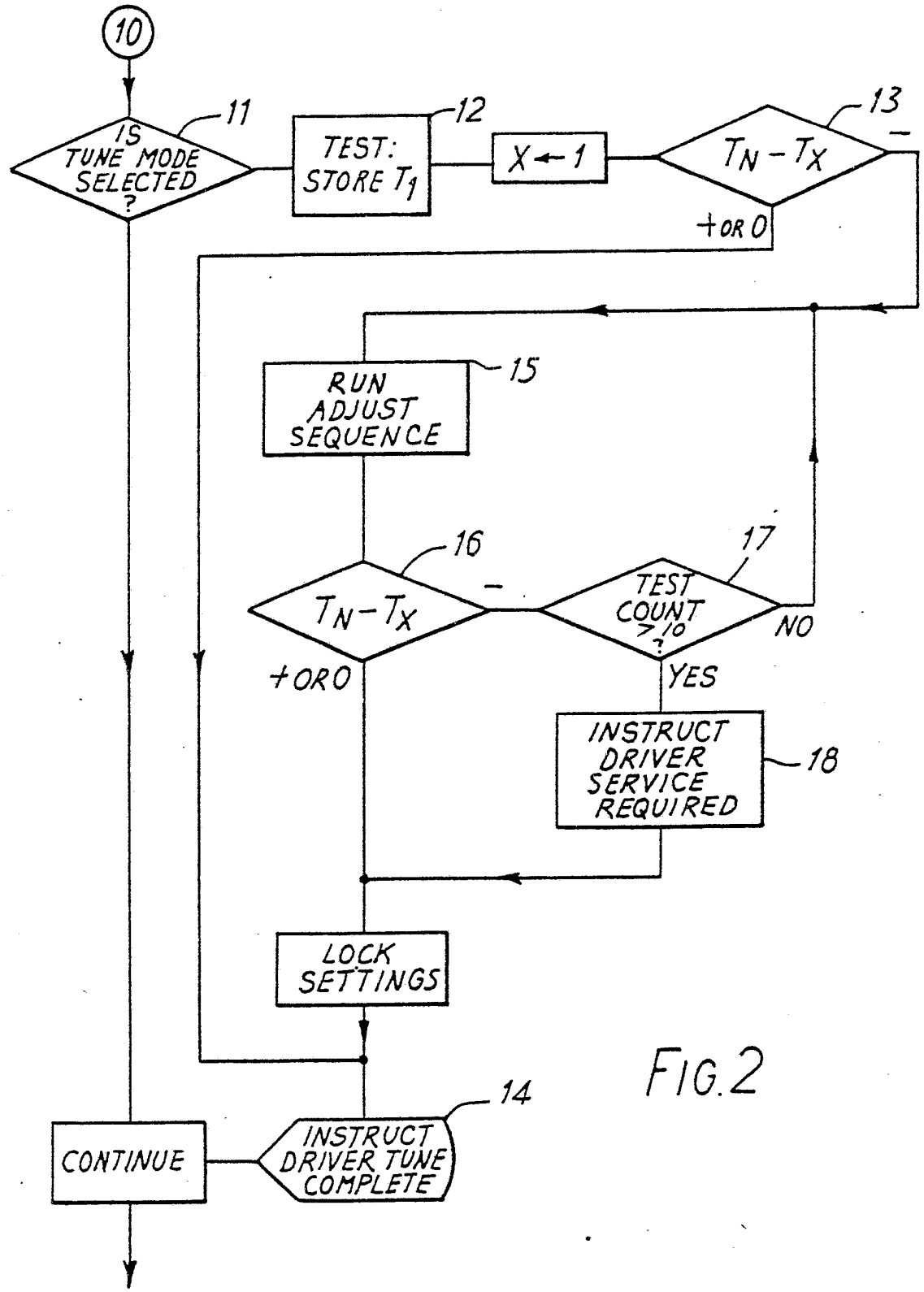

FIG. 2

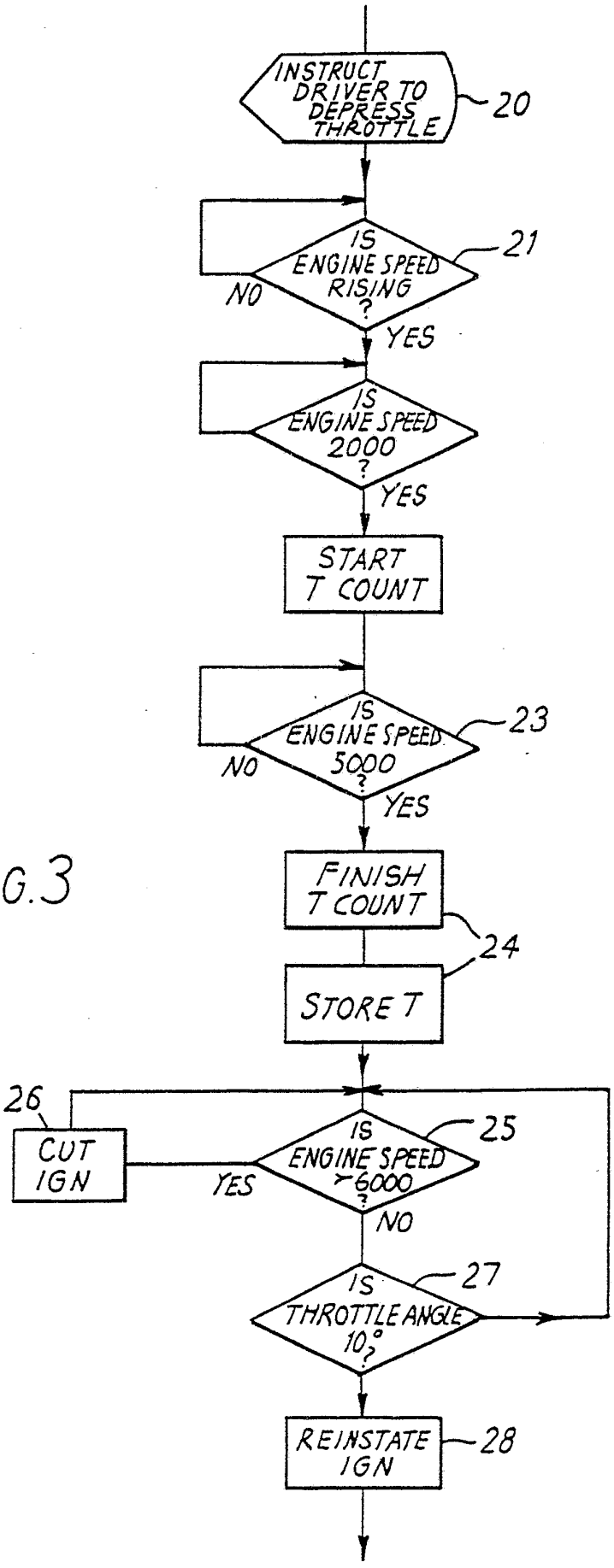

FIG.3

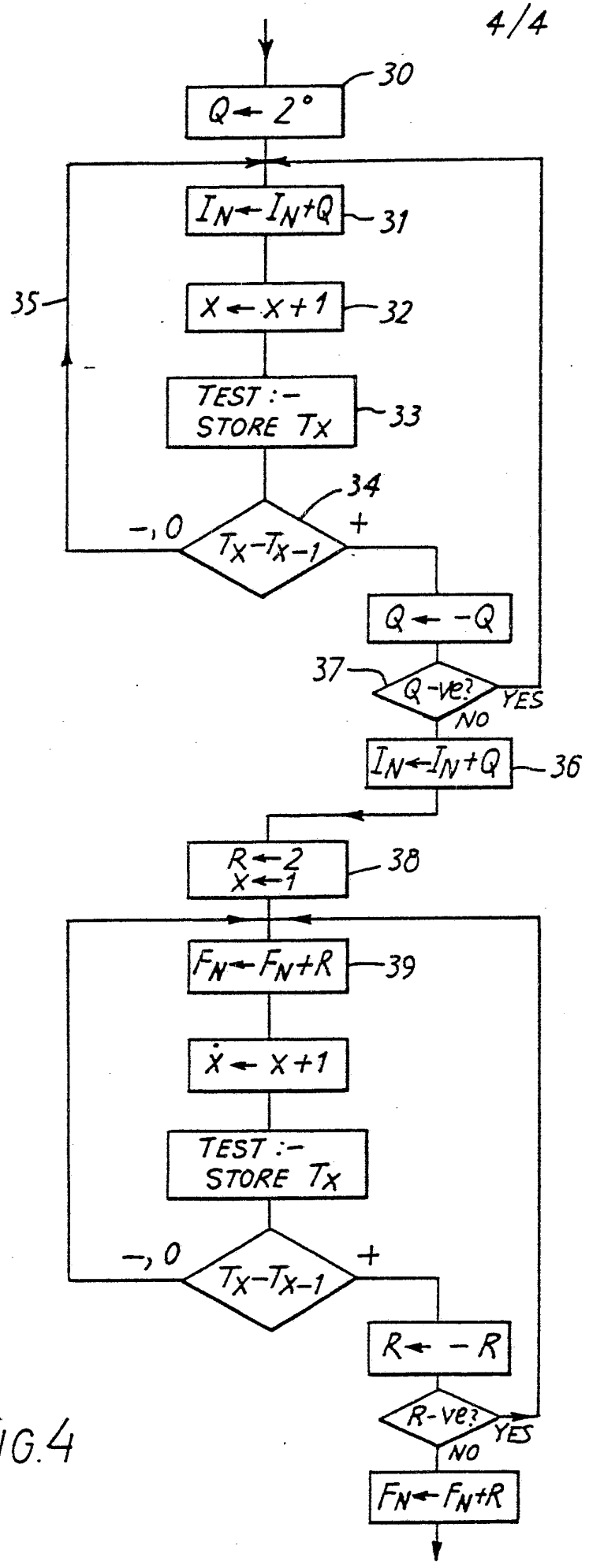
Q ← 2°
30
IN ← IN+Q
31
X ← X+1
32
35
TEST :- STORE TX
33
34
−, 0
TX−TX−1
+
Q ← −Q
37
Q -ve?
YES
NO
IN ← IN+Q
36
R ← 2
X ← 1
38
FN ← FN+R
39
Ẋ ← X+1
TEST :- STORE TX
−, 0
TX−TX−1
+
R ← −R
R-ve?
YES
NO
FN ← FN+R

FIG.4

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 83/00030

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[3]: F02P 17/00; G 01 M 15/00

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
IPC[3]	F 02 P; F 02 D; G 01 M

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
Y	US, A, 4100793 (H.E. GOETSCH et al.) 18 July 1978 see the entire document	1-6
Y	US, A, 4181944 (TERUO YAMAUCHI et al.) 1 January 1980 see figure 1; page 1, abstract; column 1, lines 41-61; column 3, line 36 - column 4, line 68	1-6
A	US, A, 4130095 (L.L. BOWLER) 19 December 1978 see figure 7; page 1, abstract; column 14, ligne 29 - column 15, line 50	1
A	GB, A, 2017348 (R. BOSCH) 3 October 1979 see the entire document	1,3,6
A	US, A, 3587764 (R.E. BOWLES) 28 June 1971 see the entire document	1

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* Special categories of cited documents: [15]

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IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
9th May 1983	26 MAI 1983
International Searching Authority [1]	**Signature of Authorized Officer [20]**
EUROPEAN PATENT OFFICE	G.L.M. Kruydenberg

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III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, 16 with indication, where appropriate, of the relevant passages 17	Relevant to Claim No 18
A	FR, A, 2477633 (R. BOSCH) 11 September 1981 see the entire document ------	1