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(72) Inventor: **De Felici, Andrea**

20059 Vimercate (Mi) (IT)

(74) Representative: **Giavarini, Francesco**

ABB Ricerca S.p.A.

Viale Edison, 50

20099 Sesto San Giovanni (MI) (IT)

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(71) Applicant: **ABB Sistemi Industriali SpA**

20099 Sesto San Giovanni (MI) (IT)

(54) **Method for supervising a rolling mill, particularly for the on-line control of the rolling process in sendzimir-type mills**

(57) A method for supervising a rolling mill, particularly for the on-line control of the rolling process in Sendzimir-type mills, characterized in that it comprises the steps that consist in:

- interfacing the user with a mathematical model which is suitable to generate rolling schedules on the basis of parameters related to the type of material to be rolled and to the type of mill used, and periodically activating the mathematical model;
- supplying the mathematical model with the parameters required to determine a rolling schedule which is suitable for the material to be rolled;
- activating the various functions of the mathematical model according to the current rolling events; and
- managing the output information of the model in order to feed it back to a higher-level supervisor system which is suitable to control the rolling process.

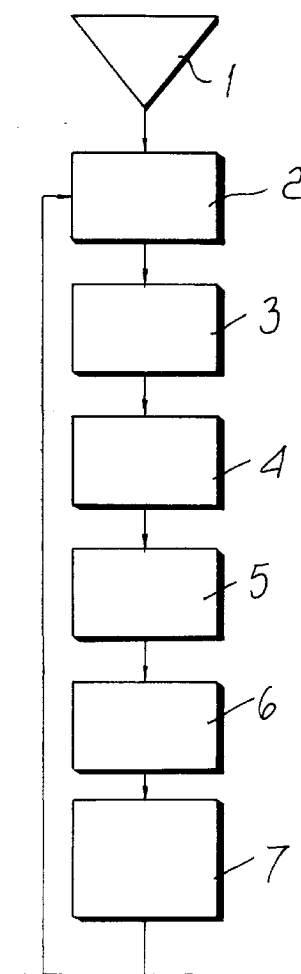


Fig. 1a

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Description

[0001] The present invention relates to a method for supervising rolling mills, particularly for the on-line control of the rolling process in Sendzimir-type mills. More particularly, the invention relates to a rolling supervision method which is suitable for mills of the reversible type with a single housing.

[0002] It is known that single-housing mills are used to roll steel coils which are unwound from a feeder reel ahead of the housing and are wound on a takeup reel after the housing.

[0003] In order to perform rolling, it is necessary to perform multiple passes through the housing and therefore the takeup and feeder reels reverse their direction of rotation each time so as to switch from feeding to take-up and vice versa.

[0004] Rolling schedules, that is to say, schedules which take into account the rolling parameters for the type of material, the final intended gauge, the type of mill used, any process tolerances et cetera, are currently prepared by manual input of these parameters by operators; the drawback of this method is that it requires the presence of specialized operators in addition to considerable time to prepare said schedules.

[0005] Furthermore, coils of material of the same type can be rolled differently by different operators, consequently not ensuring uniform production.

[0006] Manual input of the parameters by the operator requires considerable experience together with in-depth knowledge of the mill on which the operator intends to work.

[0007] This leads to drawbacks from the point of view of production times and from the point of view of costs.

[0008] Furthermore, the mill is never utilized to full capacity as regards its operating speeds and the type of rolling that can be performed on the steel strips to be rolled.

[0009] The aim of the present invention is therefore to provide a method for supervising mills, particularly for Sendzimir-type mills, in which schedule preparation is performed in an automated manner.

[0010] Within the scope of this aim, an object of the present invention is to provide a method for supervising mills, particularly for Sendzimir-type mills, in which there is a program providing an interface between a high-level mill supervisor program and a mathematical model meant to prepare the rolling schedules.

[0011] Another object of the present invention is to provide a method for supervising mills, particularly for Sendzimir-type mills, in which it is possible to monitor the rolling process on-line.

[0012] Another object of the present invention is to provide a method for supervising mills, particularly for Sendzimir-type mills, which is highly reliable, relatively easy to provide and at competitive costs.

[0013] This aim, these objects and others which will become apparent hereinafter are achieved by a method

for supervising a rolling mill, particularly for the on-line control of the rolling process in Sendzimir-type mills, characterized in that it comprises the steps that consist in:

- interfacing the user with a mathematical model which is suitable to generate rolling schedules on the basis of parameters related to the type of material to be rolled and to the type of mill used, and periodically activating said mathematical model;
- supplying the mathematical model with the parameters required to determine a rolling schedule which is suitable for the material to be rolled;
- activating the various functions of the mathematical model according to the current rolling events; and

managing the output information of the model in order to feed it back to a higher-level supervisor system which is suitable to control the rolling process.

[0014] Further characteristics and advantages of the invention will become apparent from the description of a preferred embodiment thereof, illustrated only by way of non-limitative example in the accompanying drawings, wherein:

- figures 1a-1b are flowcharts of a first routine of the method according to the present invention;
- figures 2a-2c are flowcharts of a second routine of the method according to the present invention;
- figures 3a-3e are flowcharts of a third routine of the method according to the present invention;
- figures 4a-4c are flowcharts of a fourth routine of the method according to the present invention; and
- figures 5a-5b are flowcharts of a fifth routine of the method according to the present invention.

[0015] With reference to the above figures, the method according to the present invention is configured as follows.

[0016] The system for supervising mills of the flat-bed reversible type, to which the present invention relates, includes among its functions a mathematical model for generating rolling schedules. Rolling schedules contain the preset parameters of the mill, such as rolling speed, rolling force, reel pulling force, gauge reduction for each rolling pass, et cetera.

[0017] First of all, the functions of a mathematical model provided for creating rolling schedules in an automated manner are described; this is followed by a description of the routines, shown in the various figures, which link the master mill supervision method to the mathematical model and allow on-line control of the rolling schedule during rolling so as to be able to optionally modify its parameters.

[0018] In particular, the above cited routines must allow users to request services to the mathematical model and in particular a rolling card and to configure and monitor the activity of the mathematical level.

[0019] Furthermore, the routines must allow to collect and supply to the mathematical model all the parameters required for its operation and in particular:

characteristics of the coil being rolled;
characteristics of the material being rolled;
process variables;
physical characteristics of the mill;
configuration parameters of the mathematical model itself.

[0020] The routines must furthermore activate the functions of the mathematical model at the appropriate time, according to the events that occur during the rolling process.

[0021] Finally, the routines must manage the output information of the mathematical model and in particular:

the mill preset rolling schedule;
updating of the schedule for the coil being rolled;
parameters that are automatically adapted by the mathematical model to be saved in a permanent database;
a graphic output related to the thermal condition and wear of the rollers.

[0022] Two databases are described herein: one is a so-called real-time database, which consists of a memory area for the rapid exchange of information among the various processes. The second database is a conventional database in which the data to be saved are stored.

[0023] The interaction between the above routines and the users occurs by means of man-machine interface means, advantageously constituted for example by on-screen pages by means of which the operators can interact with the mathematical model.

[0024] The characteristic functions of the mathematical model are now described schematically in order to better comprehend the routines that follow, which constitute the method according to the present invention, for the management of said mathematical model with interaction on the part of the user.

[0025] The above mathematical model comprises four main functions: a function designated hereinafter as SETPRE hereinafter; a function designated as SETUP; a function designated as CYCLIC and a function designated as ADAPT.

[0026] The SETPRE function is meant to determine a preliminary rolling schedule which contains the preset information for the mill for all the passes required to reduce the gauge of the material being rolled until it reaches an intended final value.

[0027] This function therefore calculates the optimum number of rolling passes required, accordingly determining, for each pass, the gauge of the strip being rolled that must be reached and all the rolling parameters as preliminary values.

[0028] The second function of the mathematical model, designated as SETUP, is meant to update, at the beginning of each rolling pass, the rolling schedule calculated earlier by the SETPRE function for the coil currently being processed. This function updates the preset information for one pass only, taking into account the current situation of the rolling mill.

[0029] The CYCLIC function is instead meant to acquire, analyze and calculate the actual rolling conditions and the parameters in order to continuously monitor the status of the mill, provide short-term adaptation of the parameters related to the rollers of the mill (wear, roughness and temperature) and preprocess the information that will be used at the end of the rolling pass by the ADAPT function.

[0030] The ADAPT function is meant to adapt the parameters related to the materials, to the mill, to operating practice tables et cetera.

[0031] Activation is automatic at the end of each rolling pass.

[0032] The routines shown in the figures then allow to retrieve the above cited functions of the mathematical model and to interface these functions with a higher-level mill supervision method in which the operator also intervenes.

[0033] The exchange of information between the mathematical model and the higher-level processes occurs by means of the following data structures:

mill data: this structure contains information related to the configuration of the mill;
material data: this structure contains all the information related to the characteristics of the steels rolled in the mill.

[0034] The information related to the materials is of the static type (physical characteristics, for example) or of the dynamic type (deformation strain strength curves which are adapted by the mathematical model according to the information acquired during rolling);

operating data, which supply the mathematical model with information according to the characteristics of the rolled strip;
result data generated by the CYCLIC function, which contain information on the current status of the mill;
data for transfer between the CYCLIC and ADAPT functions: the first function, that is to say CYCLIC, activated every 10 seconds, processes during rolling information related to the current status of the mill and makes it available by means of the transfer data to the ADAPT function, which is activated at the end of the rolling pass;
data related to the characteristics of the coil to be rolled or currently being rolled;
data related to the information generated by the SETPRE and SETUP functions, essentially data for

the rolling schedule to be sent to the lowest mill automation level;

process data: these data contain information related to the current status of the rolling process. The information is received periodically by the lower automation level and supplied by a mathematical model by means of the interface program according to the present invention;

model parameters: these data contain the configuration parameters for the mathematical model;

reliability data: these data contain all the information generated by a mathematical model during the execution of the various routines that compose the various functions.

[0035] Each routine generates messages of various kinds which allow to monitor the activity of the mathematical model;

data containing the modifications made by the operator to the rolling schedule generated by the mathematical model: the mathematical model receives this information as input and calculates a new schedule, taking into account the changes introduced by the operator.

[0036] The routines of figures 1 to 5 are now described in detail; said routines are executed as interface between the master mill supervision method and the mathematical model meant to generate the rolling schedule.

[0037] In detail, figure 1 illustrates the routine in charge of the activation of the SETPRE function of the mathematical model. This function is activated before the rolling of a coil begins and generates a "preliminary" rolling schedule.

[0038] Activation can be manual by the operator, by means of a suitable button which can be selected by means of an on-screen page, or automatic, when a coil to be rolled is identified by means of a suitable bar code reader which reads the bar code applied to the coil to be rolled.

[0039] The preliminary schedule contains all the preset information for the mill for all the passes required to reduce the gauge of the material to its intended final value.

[0040] In detail, after an initial step 1, control is transferred to a step 2 during which the routine waits for the start command from the interface of the mathematical model or from the bar code reader; the step 3 includes reading the code of the coil from the real-time database; the step 4 provides for the retrieval of the material data related to the coil to be rolled from the permanent database; the step 5 provides for the retrieval from the database of the information related to the characteristics of the coil to be rolled; the step 6 provides for the retrieval from the database of the data related to the process constraints of the strip to be rolled, as a function of the type of strip; the step 7 provides for the reading of information related to the current status of the mill, generated by the CYCLIC function, from the real-time database;

the step 8 provides for a reset of the data for the rolling schedule, of the information generated by a mathematical model during the execution of the various routines that compose the various functions, and of the modifications that the operator may have made to the schedule generated by the mathematical model; the subsequent step 9 is a call to the SETPRE function of the mathematical model. The subsequent step 10 is a step for verifying the information generated by a mathematical model; if the check is negative, step 11, an error is sent to the interface means of the mathematical model and control is transferred to a step 12 for storing the data generated by the mathematical model in the database. Otherwise, if the check performed in step 10 is positive, control is transferred to a step 13, which stores the data generated by the SETPRE function, that is to say, essentially data for the rolling schedule, in the database.

[0041] Reference is now made to figure 2 to illustrate the activation routine for the function of the mathematical model previously referenced by the name SETUP. This function is activated before each rolling pass begins and updates the rolling schedule processed earlier by the SETPRE function of the model for the coil currently being processed.

[0042] The function updates the preset information only for one rolling pass, taking into account the current situation of the mill.

[0043] Activation occurs automatically according to various events which can occur during the rolling process:

the rolling of a coil is about to begin and therefore the SETUP function is called to generate the updating of the schedule of the first rolling pass;

the speed reduction at the end of a pass begins: the SETUP function is called to generate the updating of the schedule for the next rolling pass;

five-minute timer: five minutes have elapsed since the end of a rolling pass and the rolling of the next pass has not yet resumed: in this case, the SETUP function is called to calculate a new update of the schedule for the current rolling pass.

[0044] In figure 2, an initial step 14 is followed by a step 15 in which the routine waits for one second. The subsequent step 16 is a checking step, during which a signal SYNC, which indicates an interaction between different processes (that is to say, one process can report to another process that a given situation has occurred, thus conditioning its execution), is checked. In this case, the signal SYNC checks whether a signal for starting the first rolling pass or for ending the rolling pass has been received or whether a five-minute timer expiration signal has been received. If the result is negative, the routine returns to step 15, otherwise it moves on to a step 17 which checks whether the situation is the rolling pass end situation. If the result is positive, the routine moves on to a step 18, during which the material data

are read from the real-time database; this step is followed by the step 19, during which the rolling pass counter is increased by one, and by a step 20, which checks whether the start of a first rolling pass is occurring. If the result is negative, control is transferred from step 17 directly to this step 20.

[0045] If the result of step 20 is positive, the routine moves on to a step 21, during which the code of the coil being rolled is read from the real-time database. The step 21 is followed by a step 21a, during which the code of the steel of the strip of the coil to be rolled is read from the real-time database; this step is followed by a step 22, during which the rolling schedule, calculated by the SETPRE function of the mathematical model, is extracted from the database.

[0046] A subsequent step 23 retrieves from the database information related to the characteristics of the coil to be rolled or currently being rolled; material data, that is to say, data related to the characteristics of the steels rolled in the mill; and data related to constraints affecting the rolling mill as a function of the characteristics of the strip being rolled. These constraints relate for example to gauge reduction constraints, temperature constraints, speed constraints, tension constraints, roller roughness constraints and the like.

[0047] The next step 24 sets the rolling pass counter to 1 and the next step 25 reads from the real-time database data related to the configuration of the mill; data related to the current status of the mill; the configuration parameters of the mathematical model; and the data updated manually by the user for the rolling schedule.

[0048] The next step 26 resets the reliability data, that is to say, the information of various kinds generated by the mathematical model during the executions of the various routines that compose the various functions.

[0049] The step 27 instead updates the information concerning the characteristics of the coil to be rolled or currently being rolled with the status of the actual process.

[0050] The next step 28 calls the SETUP function of the mathematical model, and the next step 29 checks the reliability data, that is to say, the messages generated by the mathematical model during the execution of the various routines. If the check yields a negative result, control is transferred to a step 30, which sends a mathematical model error signal to a lower mill automation level. Control is then transferred from step 30 to step 31, which deactivates the mathematical model, and then returns to step 15.

[0051] Considering step 20 again, if the check performed in said step is negative, control is transferred directly to step 25.

[0052] If the check of step 29 is positive, control is instead transferred from said step 29 to a step 32, which checks whether the transfer of the schedule update to the lower level is enabled. If the result is positive, control is transferred to a step 33, which sends the updated schedule to the lower automation level of the mill, and

then control is transferred to a step 34, in which the data generated by the SETUP function, that is to say, data for the rolling schedule, are written to the real-time database.

5 **[0053]** During step 32, if the result is negative control is transferred directly to said step 34.

[0054] Control is then transferred from step 34 to a step 35, in which the data of the schedule are stored in the database; then control is transferred to a step 36, in which the reliability data are stored in the same database.

10 **[0055]** Figure 3 illustrates the activation of the mathematical model function CYCLIC. This function is activated every 10 seconds and its main task is to continuously monitor the status of the mill in order to analyze a short-term adaptation of parameters related to the rollers of the mill (wear, roughness and temperature) and to preprocess information which will be used at the end of the rolling pass by the ADAPT function. Activation is automatic every 10 seconds.

15 **[0056]** In particular, the routine of figure 3 begins with the startup step 37, which is followed by a step 38, which resets the data related to the current status of the mill and the data exchanged between the CYCLIC and ADAPT functions of the mathematical model on the real-time database.

20 **[0057]** The next step 39 retrieves from the database the configuration parameters of the mathematical model and the data related to the configuration of the mill.

25 **[0058]** The next step 40 writes the parameters of the mathematical model and the data of the mill thus obtained from the database to the real-time database.

30 **[0059]** Then, step 41, the routine waits for one second and then moves on to the step 42, which reads the data related to the current status of the rolling process from the real-time database; this is followed by a step 43, during which these process data are accumulated, and by a step 44, during which reception of the SYNC signal, indicating the end of the execution of the ADAPT function, is checked for.

35 **[0060]** If this check is positive, control is transferred to a step 45, during which data related to the motors, to friction and to the material to be rolled are retrieved from the real-time database; this is followed by a step 46, during which reception of a signal SYNC, indicating a speed reduction of the rolling pass, is checked for.

40 **[0061]** If the result to the step 44 is negative, control is transferred directly to said step 46.

45 **[0062]** If the result is positive, control is transferred from step 46 to a step 47, during which the data related to the current status of the mill, the data related to the configuration of the mill and the data related to the exchange between the CYCLIC and ADAPT functions are written to the real-time database.

50 **[0063]** This is followed by the step 48, during which a start signal is sent to the routine for activating the ADAPT function.

[0064] This step is followed by a step 49, during which

reception of a signal SYNC, indicating a request for housing configuration data for positioning the line for the transit of the strip to be rolled, is checked for.

[0065] If the result is positive, control is transferred to a step 50, during which the housing configuration data for positioning the line for the transit of the strip to be rolled are sent to the lowest mill automation level; then control is transferred to a step 51, which checks whether 10 seconds have elapsed.

[0066] In step 49, if the result is negative, control is transferred to step 51; in step 51, if the result is negative, control returns to step 41.

[0067] In step 51, if the result is positive, control is transferred to step 52, which checks for the reception of the signal SYNC, indicating a change of the rollers.

[0068] If the result is positive, the routine moves on to step 53, which retrieves from the database the data related to the rollers; then control is transferred to a step 54, during which the data of the rollers are written to the real-time database; then an average for the process data is computed in step 55.

[0069] In step 52, if the result is negative, the routine moves on directly to said step 55.

[0070] In step 55, the routine moves on to a step 56, during which process data are written to the real-time database, and then on to a step 57, during which the code of the coil being rolled is read from the real-time database.

[0071] This is followed by a step 58, which checks whether the coil being rolled has changed. If the result is positive, the routine moves on to step 59, which retrieves from the database the information related to the characteristics of the coil that is to be rolled or is currently being rolled.

[0072] This is followed by a step 60, during which these characteristics are written to the real-time database, and by a step 61, during which a series of tables is retrieved from the database; said tables, according to the characteristics of the rolled strip, provide the mathematical model with information regarding the constraints which the rolling mill must comply with.

[0073] The next step 62 checks whether the code of the steel being rolled has changed or not.

[0074] If the result is positive, the routine moves on to a step 63, during which the data related to the material are retrieved from the database. This is followed by a step 64, during which said data are written to the real-time database.

[0075] The next step 65 reads from the real-time database the configuration parameters of the mathematical model, the information generated by the SETPRE and SETUP functions for the rolling schedule to be sent to the lower mill supervision level, and data related to the configuration of the mill.

[0076] In step 58, if the result is negative, control is transferred directly to said step 65; likewise, in step 62, if the result is negative, control is transferred to said step 65 again.

[0077] This is followed by a step 66, during which the reliability data are reset, followed by a step 67, in which the routine calls the CYCLIC function of the mathematical model.

5 **[0078]** The next step 68 stores reliability data in the database and the step 69 checks the reliability data. If the check is negative, the routine returns to step 41.

10 **[0079]** If the check is positive, control is transferred to a step 70, which checks whether 30 seconds have elapsed. If the result is negative, the routine returns to step 41, whilst if the result is positive, the routine moves on to a step 71, in which the dynamic data of the rollers are stored; the routine then returns to step 41.

15 **[0080]** With reference now to figure 4, a routine is described which is in charge of the activation of the ADAPT function of the mathematical model. This function is activated at the end of each rolling pass and its main task is to adapt the parameters related to the materials, to the mill, to tables related to constraints that the mill must meet, et cetera. Activation is automatic at the end of each rolling pass.

20 **[0081]** This routine begins with a startup step 72, followed by a step 73 during which the routine waits for one second.

25 **[0082]** This is then followed by a step 74, which checks whether the signal SYNC has been received by the CYCLIC function of the mathematical model.

30 **[0083]** If the result is negative, control is transferred to a step 75, which checks whether the signal SYNC has been received by the interface means of the mathematical model. If the result is negative, the routine returns to step 73, whilst if the result is positive, the routine moves on to a step 76, during which the parameters of the mathematical model and the data of the mill are retrieved from the database; this is followed by a step 77, which writes the parameters of the mathematical model and the mill data to the real-time database and then returns to the step 73.

35 **[0084]** In step 74, if the result is positive, the routine moves on to a step 78, which checks whether the SYNC signal, indicating the last rolling pass, has been received. If the result is negative, the routine moves on to a step 79, which checks whether there is an interlock between the ADAPT and SETUP functions of the mathematical model. If the result is negative, the routine then moves on to a step 80, which sends the SYNC signal to the SETUP function of the mathematical model, and then on to a step 81, during which the code of the coil being rolled is extracted from the real-time database. In step 78, if the result is positive, control is transferred directly to this step 81; likewise, in step 79, if the result is positive, control is again transferred to said step 81.

40 **[0085]** Step 81 is followed by a step 82, during which the data related to the constraints that the mill must meet and the parameters of the mathematical model are extracted from the database.

45 **[0086]** A step 83 then follows during which the data related to the mill, the material, information related to

the current status of the mill, the data related to the exchange between the CYCLIC and ADAPT functions, information related to the characteristics of the coil that is to be rolled or is currently being rolled and the data generated by the SETPRE and SETUP functions are read from the real-time database.

[0087] A step 84 then follows in which the reliability data are reset; this is followed by a step 85, during which the routine calls the ADAPT function of the mathematical model.

[0088] The next step 86 stores the reliability data in the database and the step 87 checks the reliability data.

[0089] If the check has a negative result, the routine moves on to a step 88, during which the parameters of the mathematical model are stored in the database; this is followed by a step 89, which checks whether a last rolling pass is being performed and whether the SETUP function has already been called.

[0090] If the result is negative, the routine returns to step 73; if the result is positive, control is transferred to a step 90, during which the SYNC signal is sent to the routine for activating the SETUP function of the mathematical model in order to activate said function. The routine returns from step 90 to step 73.

[0091] If the result is instead positive, the routine moves on from step 87 to a step 91 which writes to the real-time database the data related to the mill, to the material and to the parameters of the mathematical model.

[0092] This is followed by a step 92, during which the signal SYNC is sent to the routine of figure 3 to indicate that the process performed by the ADAPT function has ended.

[0093] This is followed by a step 93, which checks whether a last rolling pass is being performed and whether the SETUP function has already been called.

[0094] If the result is negative, control is transferred to a step 94, which sends the signal SYNC to the routine of figure 2 in order to start the SETUP function of the mathematical model.

[0095] This is followed by a step 95, during which the data of the parameters of the mathematical model are stored in the database. In step 93, if the result is positive, control is transferred directly to this step 95.

[0096] This is then followed by a step 96, which updates in the database the data related to the motors, to friction and to the material; this is then followed by a step 97, which checks whether a last rolling pass is being performed. If the result is negative, the routine returns to step 73; if the result is positive, the routine moves on to a step 98, during which the tables related to the constraints that the mill must meet according to the characteristics of the material are updated in the database.

[0097] The routine then again returns from said step to the step 73.

[0098] With reference now to figure 5, a routine is described which is in charge of the activation of the SETPRE function of the mathematical model. This function

is activated again after generating the preliminary schedule if the operator wishes to make changes to said schedule. The model compares the original schedule provided by the SETPRE function and the schedule modified by the operator and is capable of providing a new schedule, taking into account the recommendations of the operator.

[0099] Activation is manual on the part of the operator after he has modified the schedule.

[0100] This routine begins with a startup step 99, which is followed by a step 100 which waits for startup performed by the interface means of the mathematical model, that is to say, waits for activation by the operator.

[0101] The next step 101 reads the code of the coil and the code of the schedule from the real-time database.

[0102] The step 102 extracts from the database the data related to the material and the step 103 extracts from the database the characteristics of the coil to be rolled or currently being rolled. The step 104 extracts, according to the characteristics of the rolled strip, the constraints with which the mill must comply. The step 105 extracts the data calculated by the function 73 and the next step 106 reads the data related the mill, to the current status of the mill and the parameters of the model from the real-time database.

[0103] The next step 107 resets the data generated by the SETPRE and SETUP functions and the reliability data.

[0104] The step 108 then extracts a manual modification of the schedule of the database, and the step 109 calls the SETPRE function of the mathematical model.

[0105] The next step 110 checks the reliability data; if the check is negative, control is transferred to the step 111, during which an error is returned to the interface means of the mathematical model; this is followed by a step 114 for storing the reliability data in the database.

[0106] If instead the check is positive, the routine moves on to a step 112, which stores the information generated by the SETPRE function in the database; this is followed by a step 113, during which the manually updated data are written to the real-time database.

[0107] Control is then transferred from step 113 to the above described step 114 and from there the routine returns to step 100.

[0108] In practice it has been found that the method according to the invention fully achieves the intended aim, since it allows to interact on-line with the mathematical model that creates the rolling schedule, keeping under control both the data related to the mill and the data related to the material to be rolled, in addition to the data related to any changes made by the user during rolling.

[0109] The method thus conceived is susceptible of numerous modifications and variations, all of which are within the scope of the inventive concept; all the details may furthermore be replaced with other technically equivalent elements.

Claims

1. A method for supervising a rolling mill, particularly for the on-line control of the rolling process in Sendzimir-type mills, characterized in that it comprises the steps that consist in:

- interfacing the user with a mathematical model which is suitable to generate rolling schedules on the basis of parameters related to the type of material to be rolled and to the type of mill used, and periodically activating said mathematical model;
- supplying the mathematical model with the parameters required to determine a rolling schedule which is suitable for the material to be rolled;
- activating the various functions of the mathematical model according to the current rolling events; and
- managing the output information of the model in order to feed it back to a higher-level supervisor system which is suitable to control the rolling process.

2. A method according to claim 1, characterized in that said step for the cyclic activation of the mathematical model comprises the steps that consist in:

- activating said mathematical model before rolling begins, in order to generate a preliminary rolling schedule;
- activating said mathematical model before each rolling pass, in order to update the rolling schedule for the material being rolled; and

activating the updating of the rolling schedule if a time interval between one rolling pass and the next is longer than a preset time.

3. A method according to claim 2, characterized in that the step that consists in activating the mathematical model before rolling begins comprises the steps that consist in:

- reading the bar code of a coil of material to be rolled;
- extracting from a permanent database data related to the material to be rolled;
- extracting from said permanent database data related to the characteristics of the coil to be rolled;
- determining, by means of said mathematical model, presetting information for the mill related to each one of the rolling passes to be performed in order to roll the material to an intended final gauge.

4. A method according to claim 2, characterized in that

the step that consists in activating said mathematical model before each rolling pass comprises the steps that consist in:

- checking whether the rolling pass is a final pass or an initial pass;
- reading data of the material being rolled from a temporary database;
- detecting the status of the mill in the current rolling pass;
- updating the presetting information of the mill and generating an update of the rolling schedule for the next pass.

5. A method according to claim 1, characterized in that the step that consists in providing the mathematical model with the parameters required to generate the rolling schedule comprises the input of said parameters by means of a video interface.

6. A method according to claim 2, characterized in that the step that consists in providing the mathematical model with the parameters required to generate the preliminary rolling schedule comprises the subsequent modification of said preliminary schedule, said mathematical model comparing the preliminary schedule with the modified preliminary schedule in order to generate an actual working schedule.

7. A method according to claim 6, characterized in that the step that consists in modifying said preliminary schedule is called manually by the operator.

8. A method according to claim 1, characterized in that it furthermore comprises a step for the cyclic detection of the status of the mill in order to provide a short-term adaptation of the parameters related to rollers of the mill.

9. A method according to one or more of the preceding claims, characterized in that it comprises one or more of the described and/or illustrated characteristics.

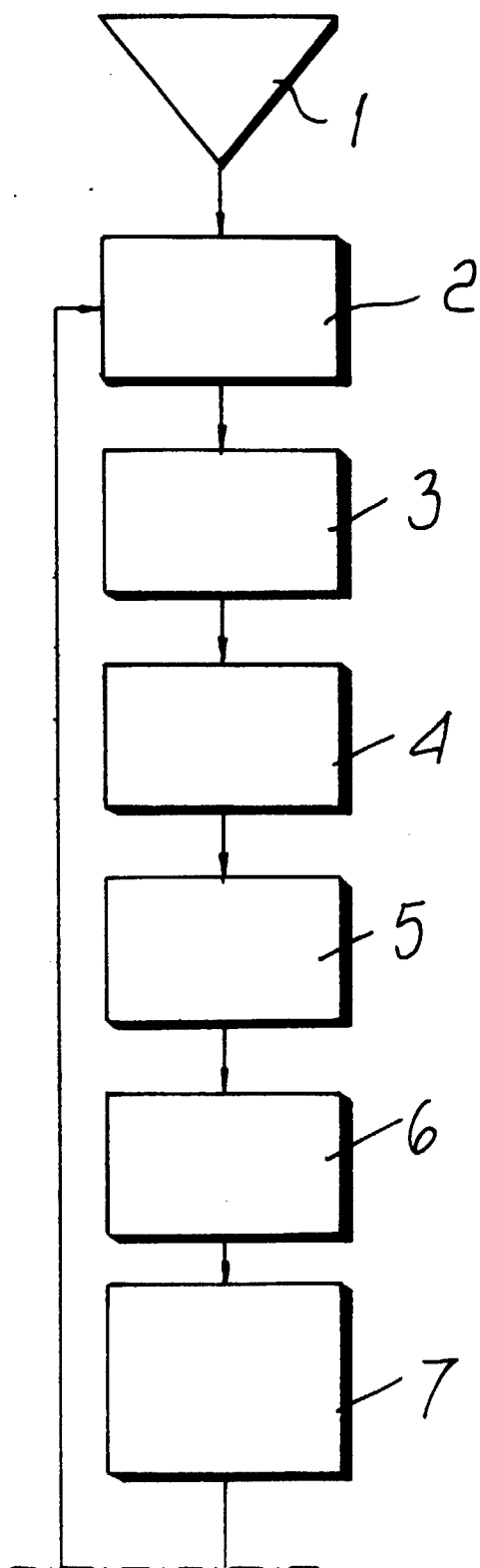


Fig. 1a

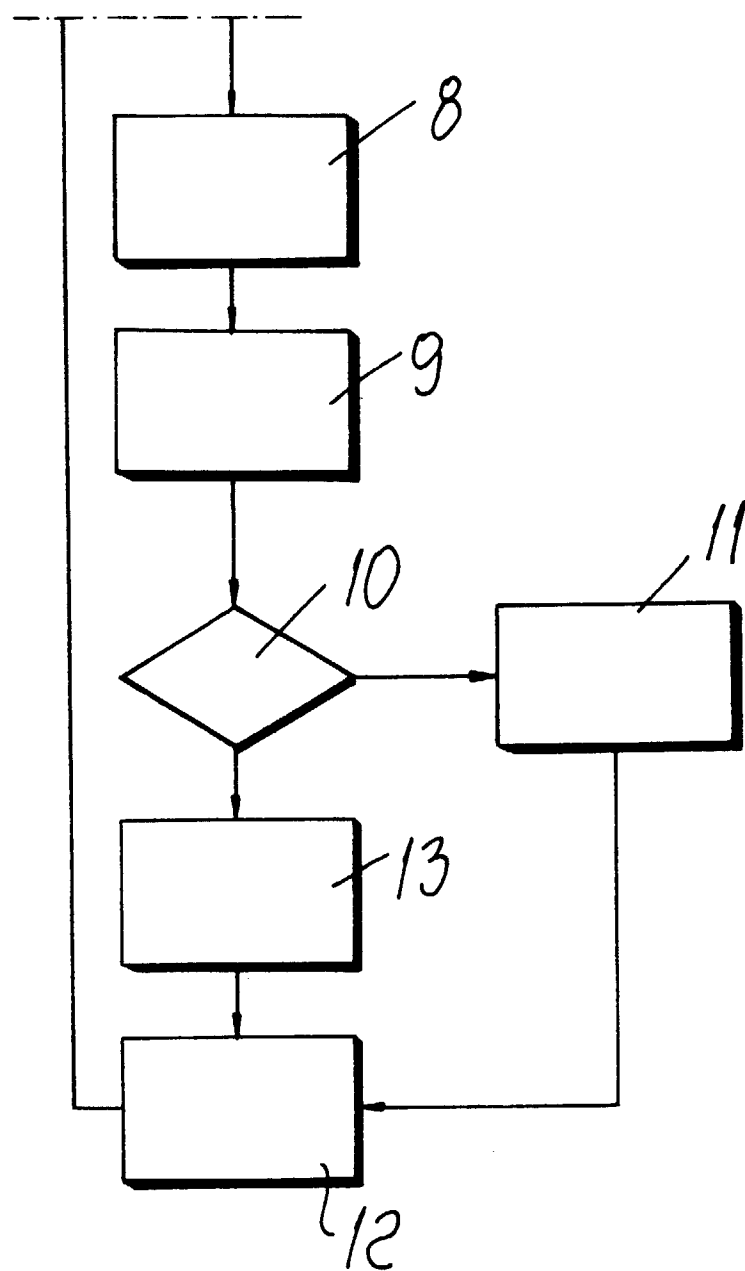


Fig. 1b

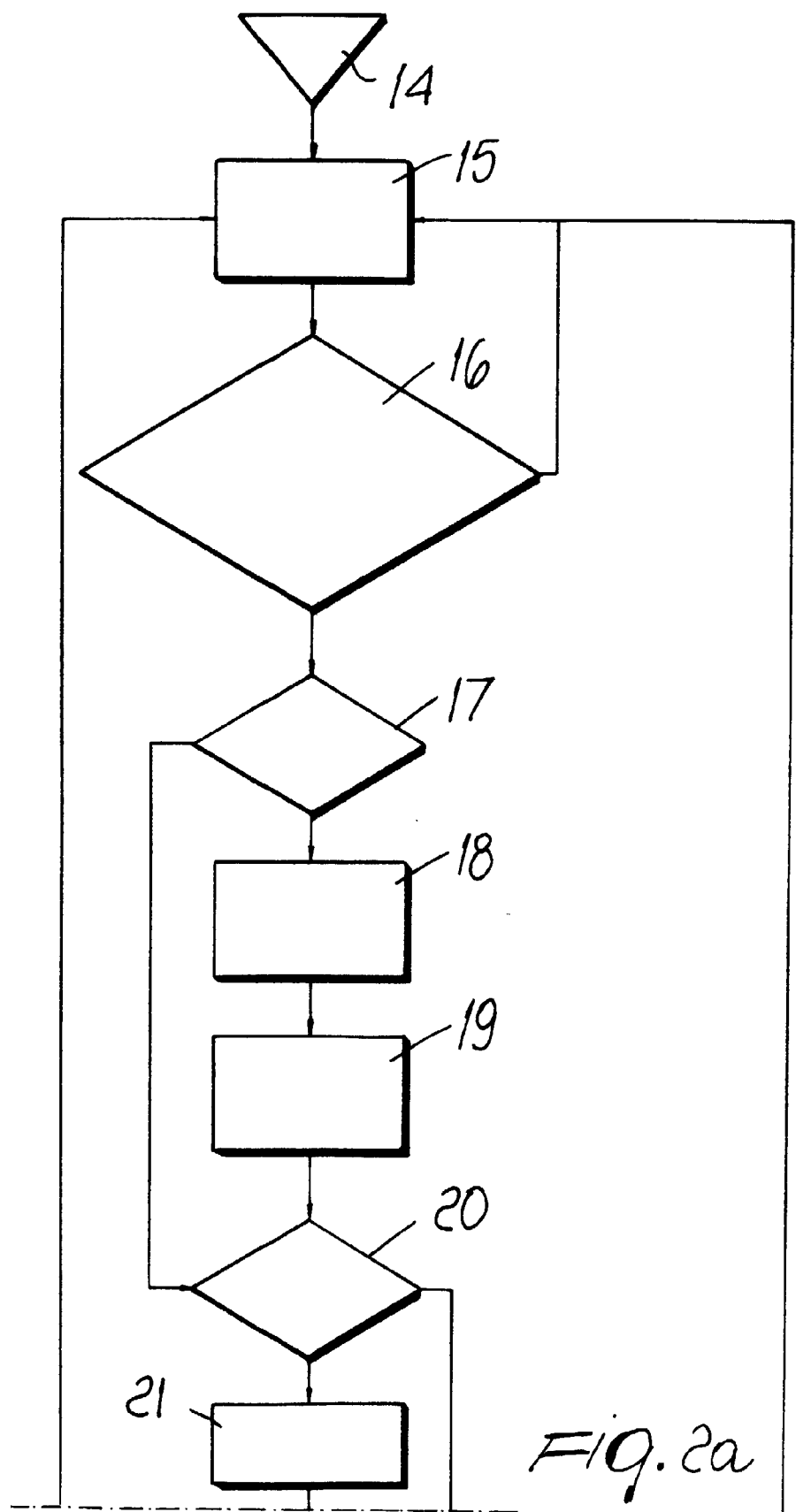
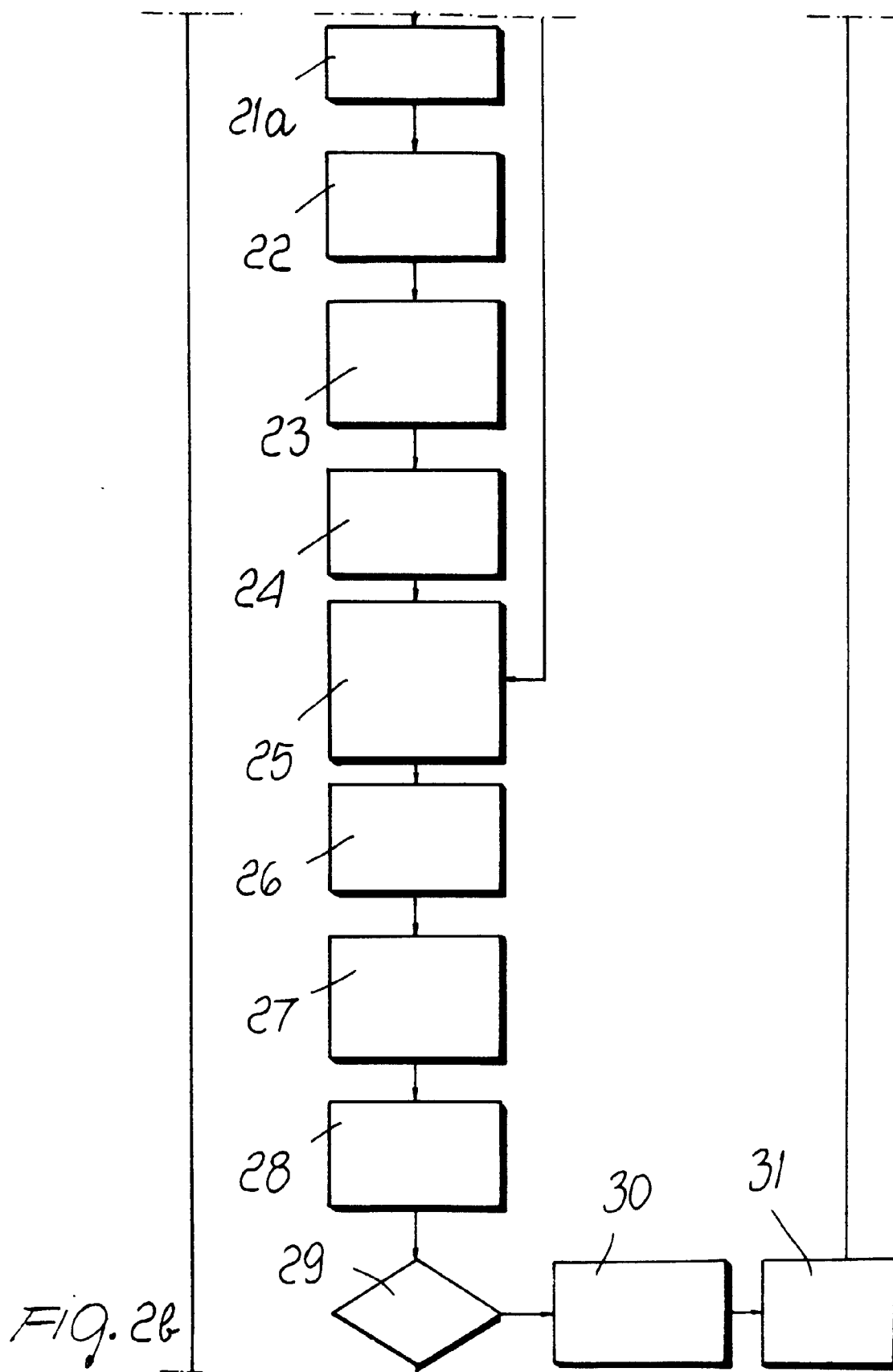


Fig. 2a



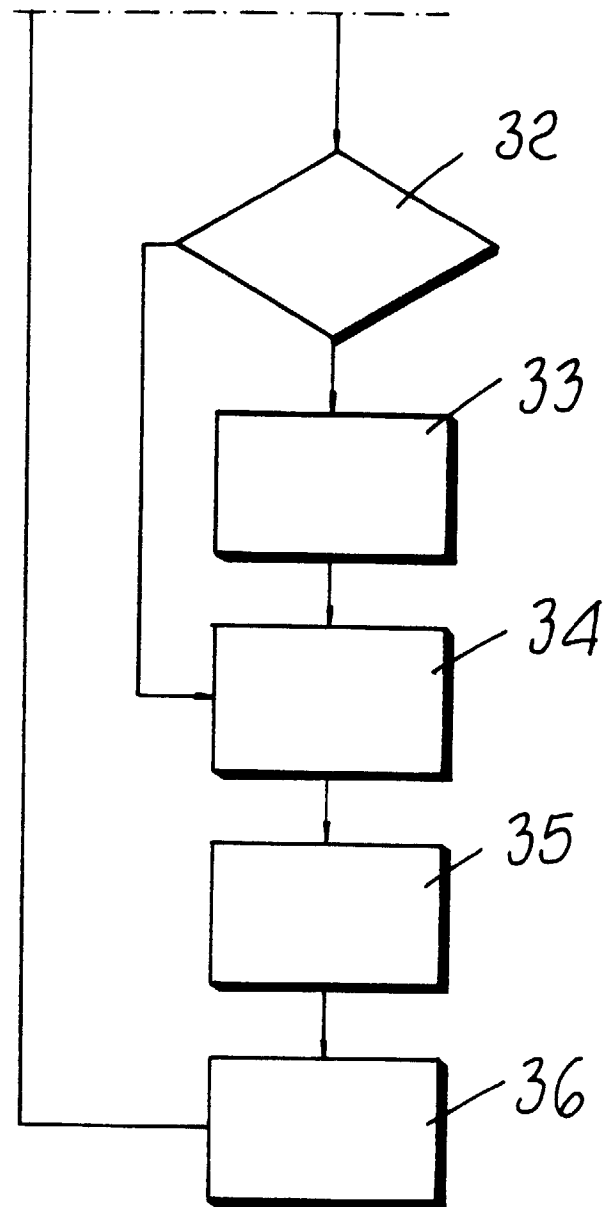
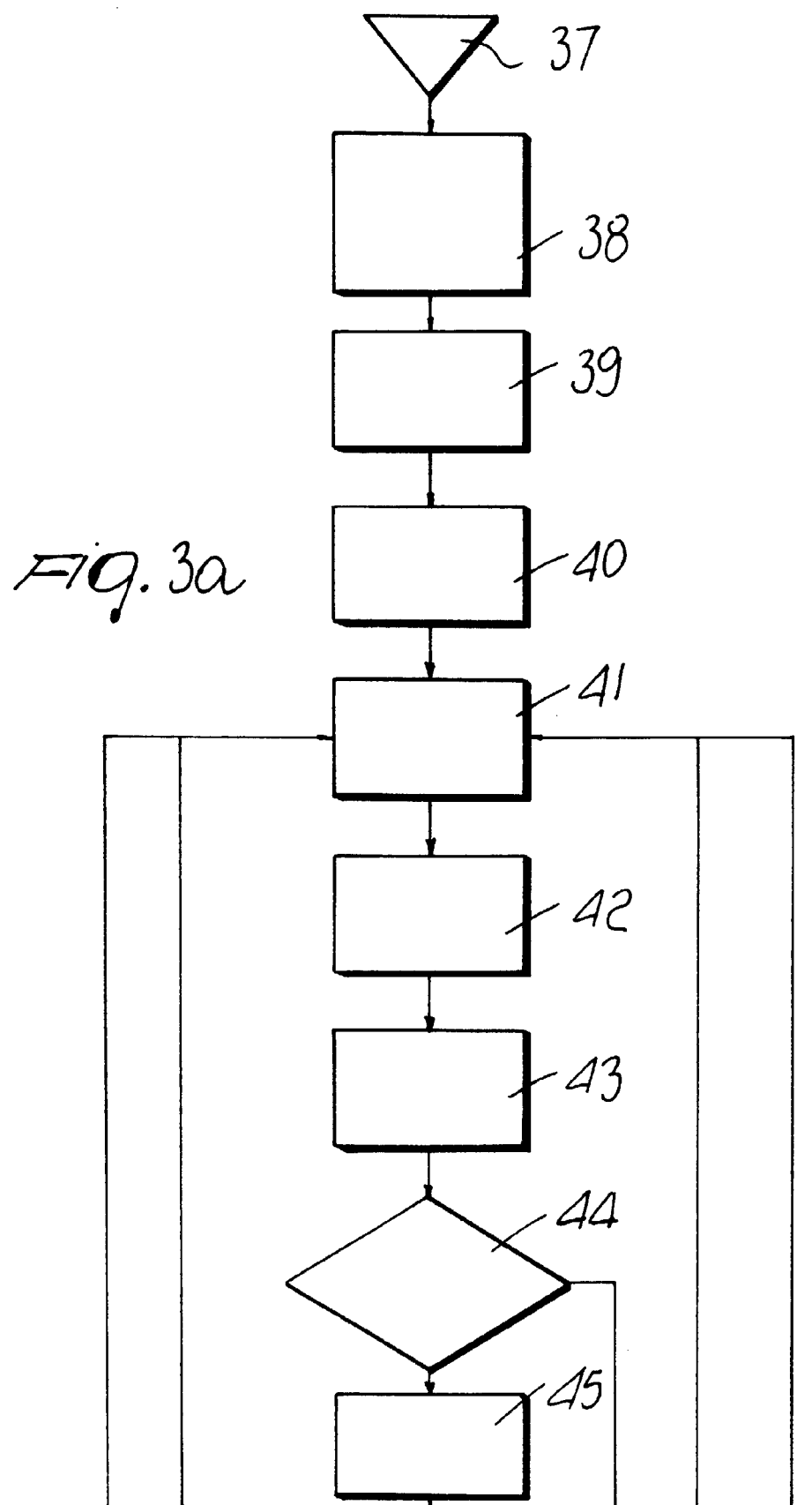
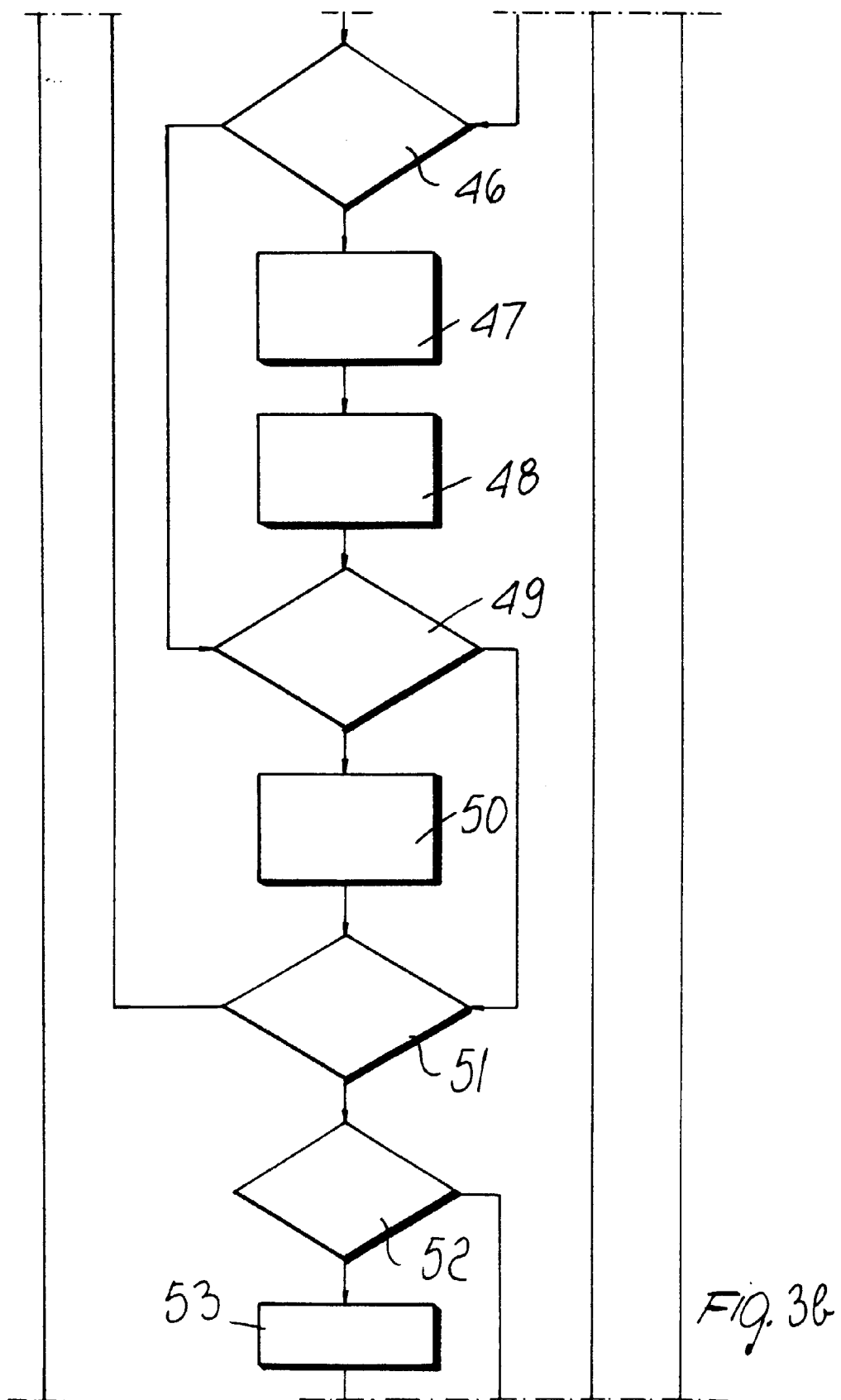
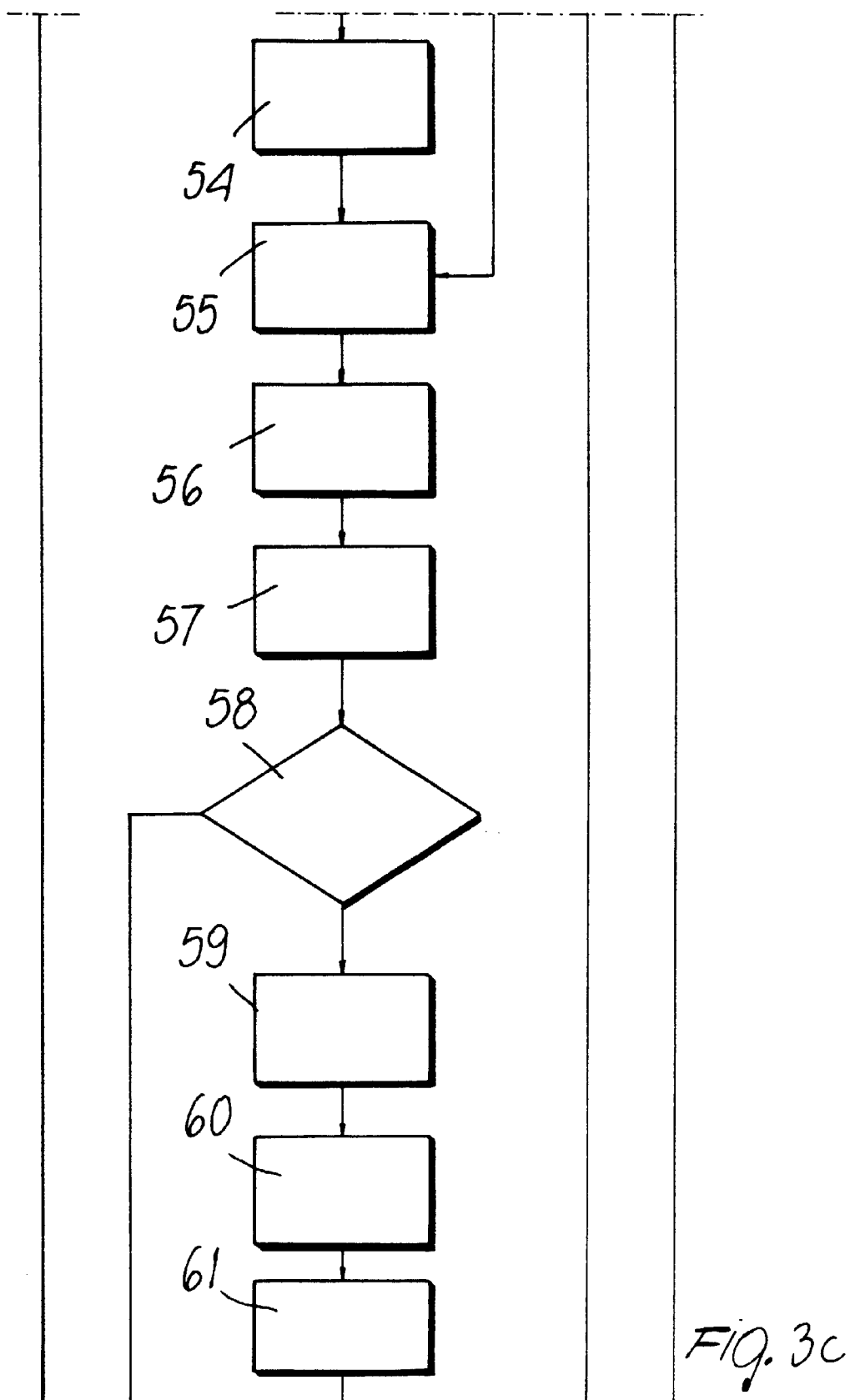


Fig. 2c







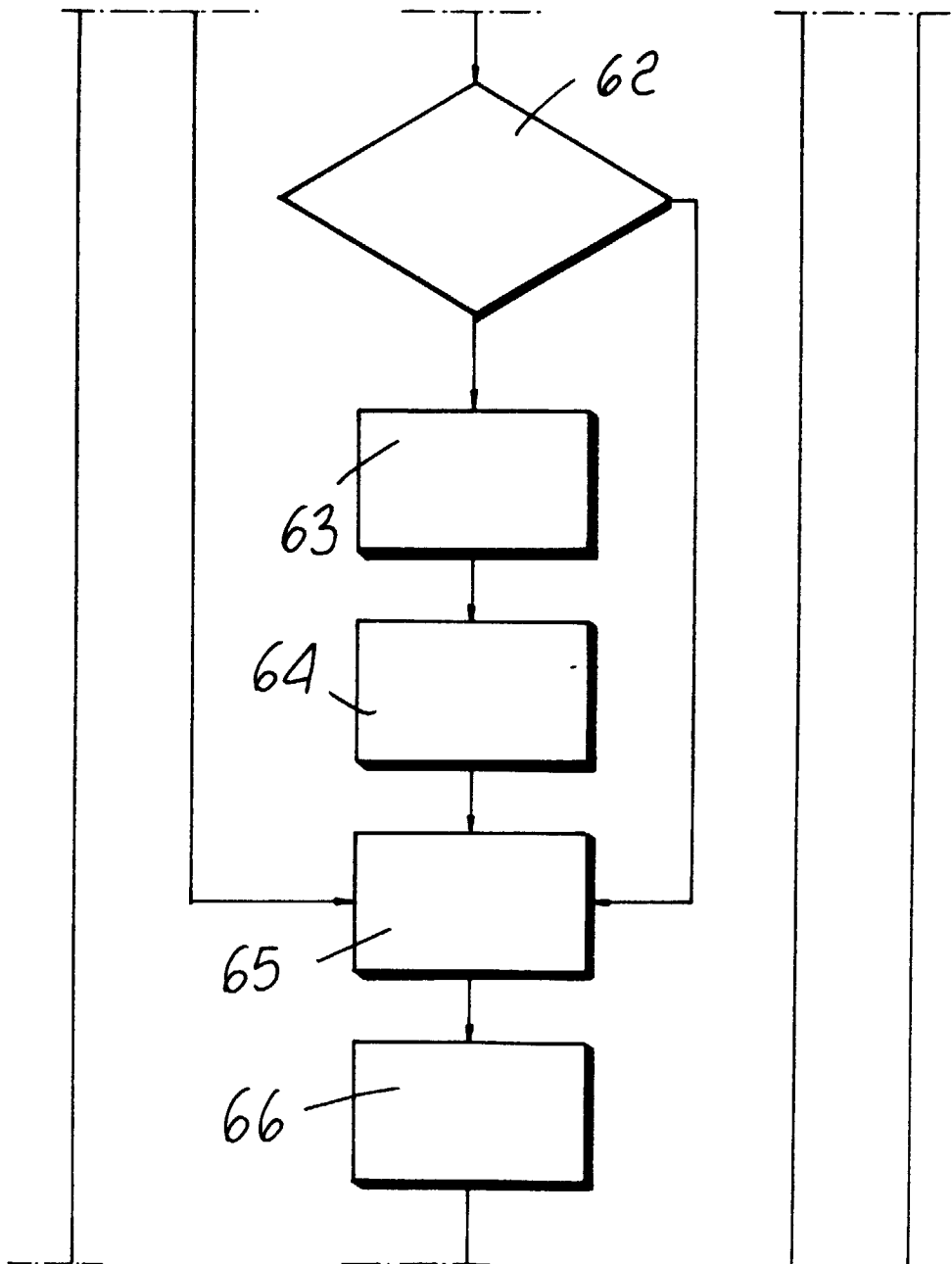


Fig. 3d

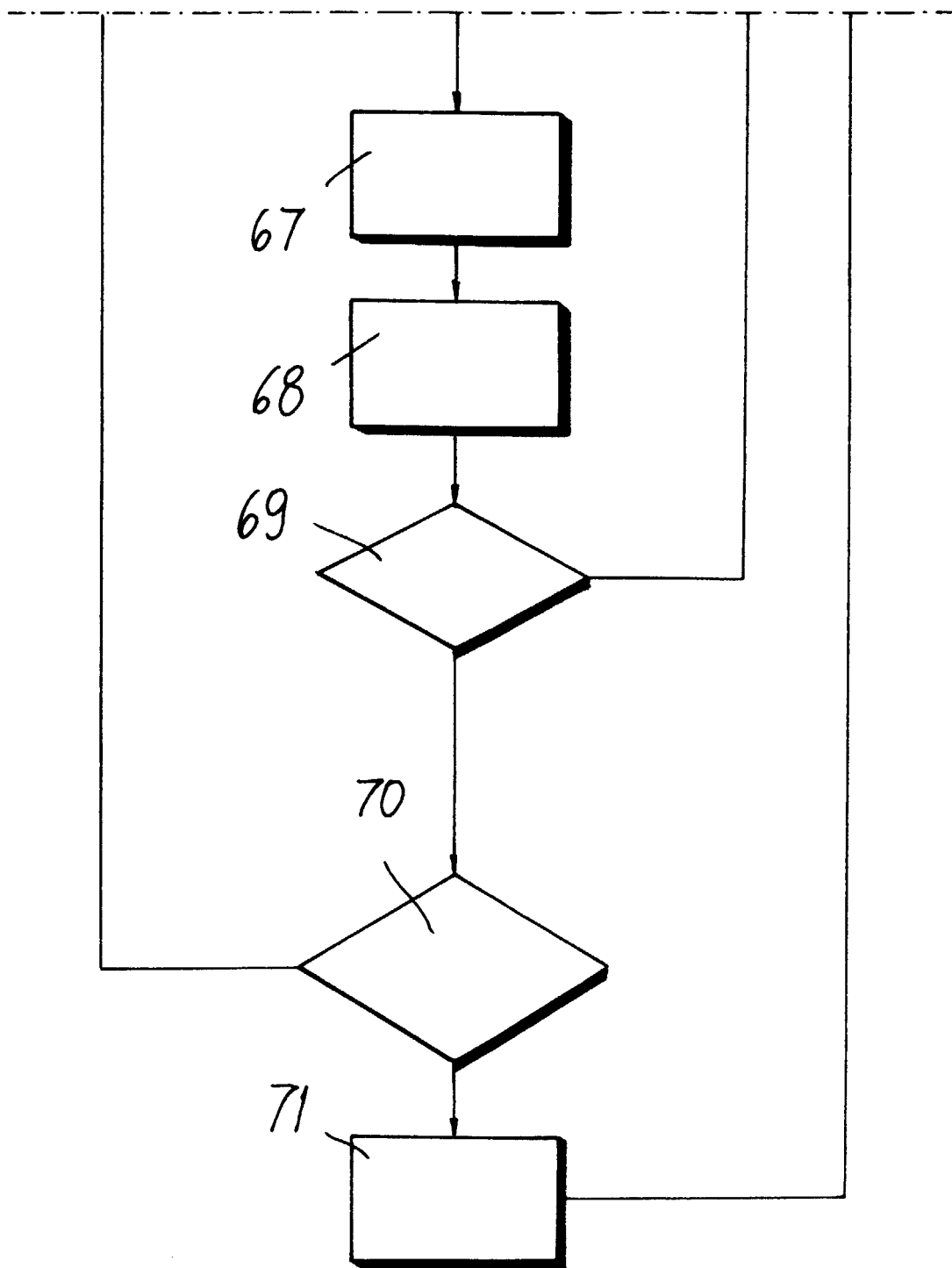


Fig. 3e

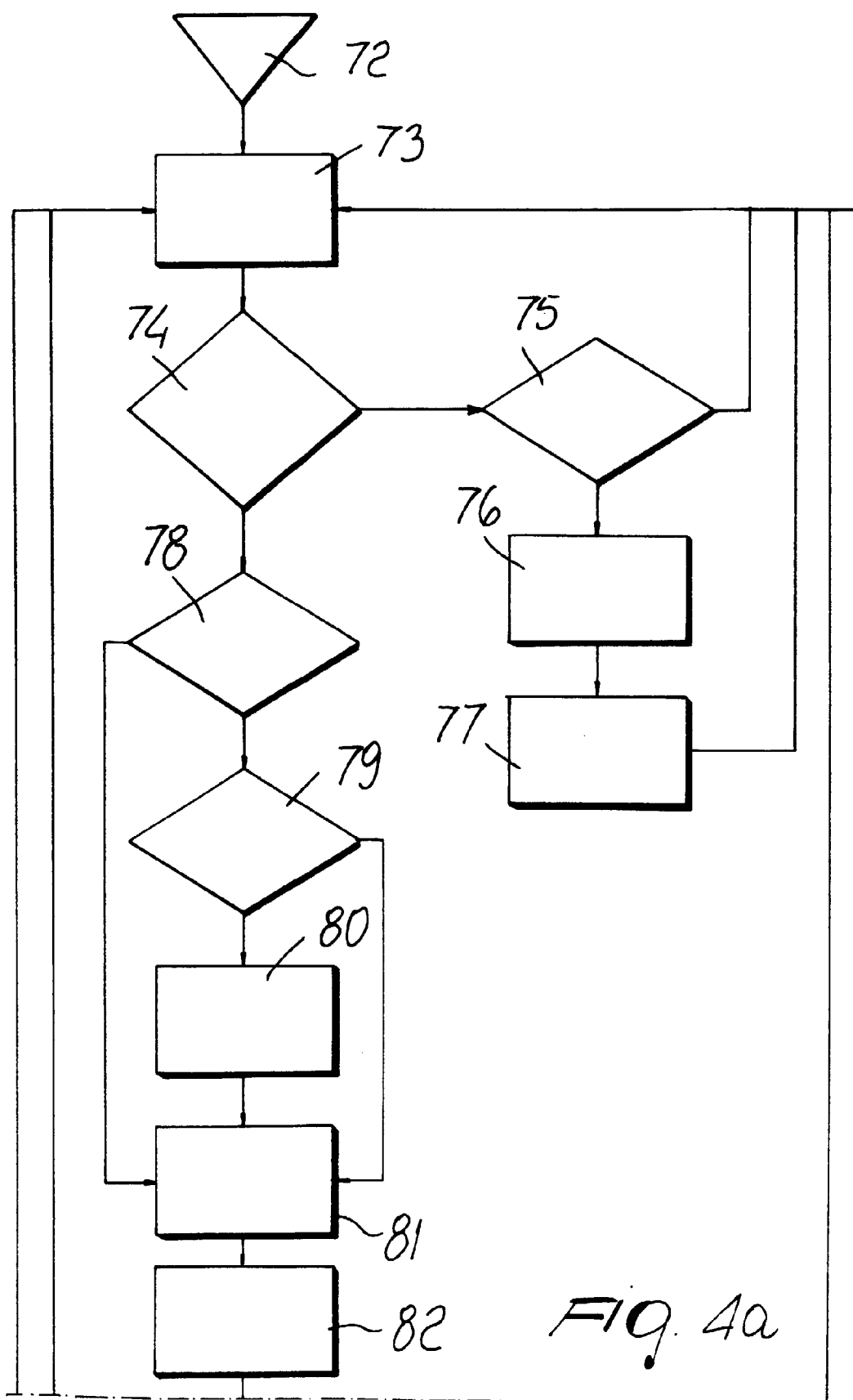
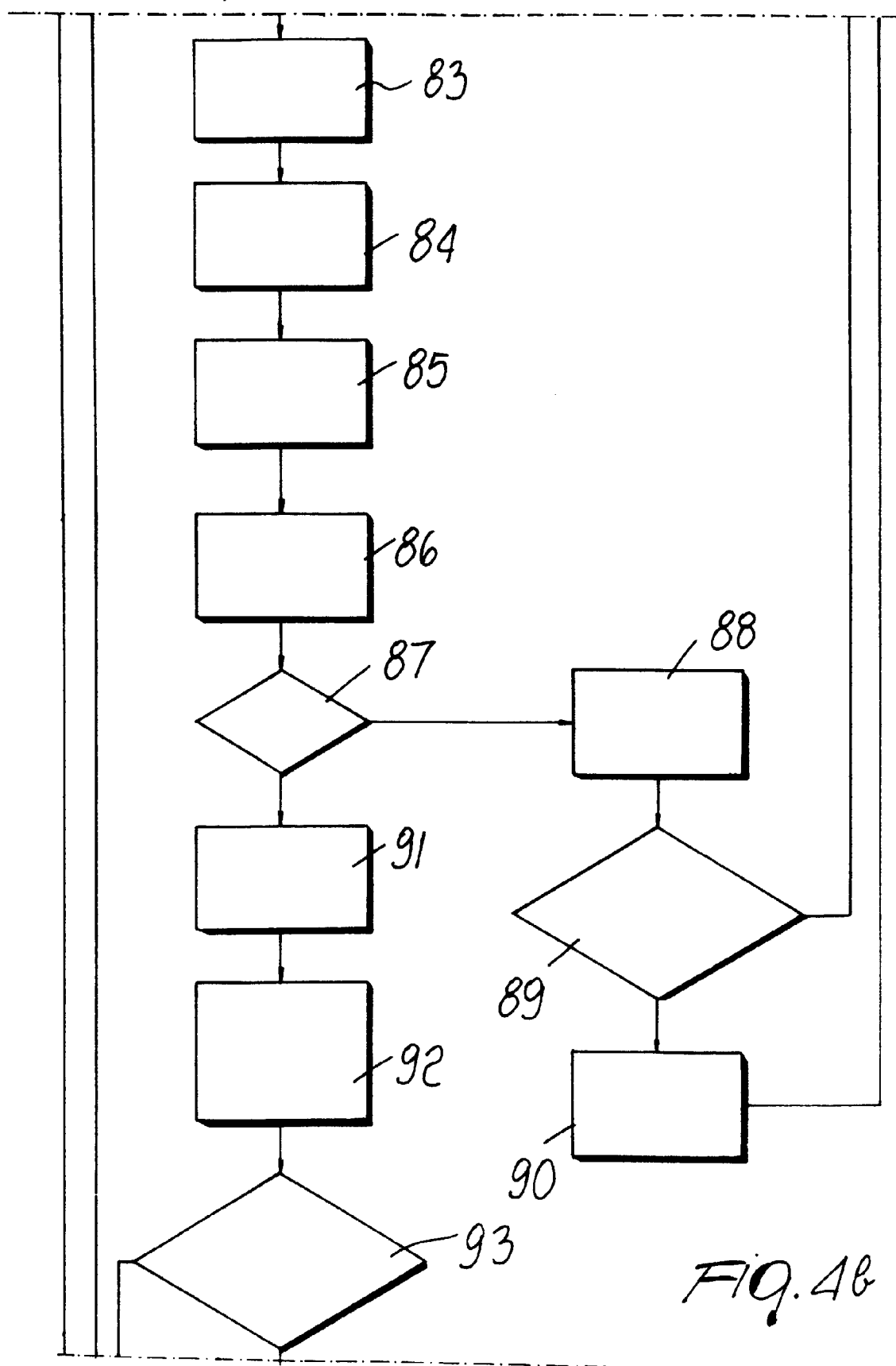


Fig. 4a



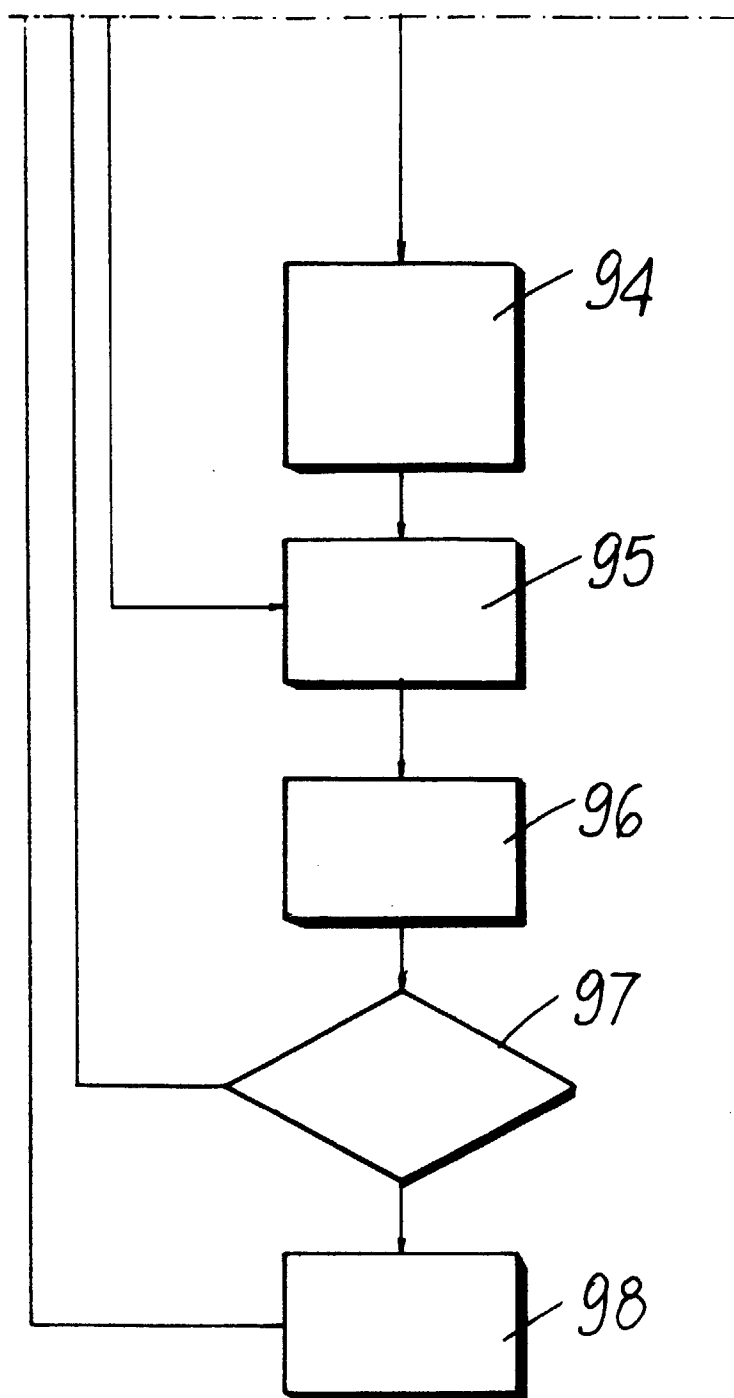
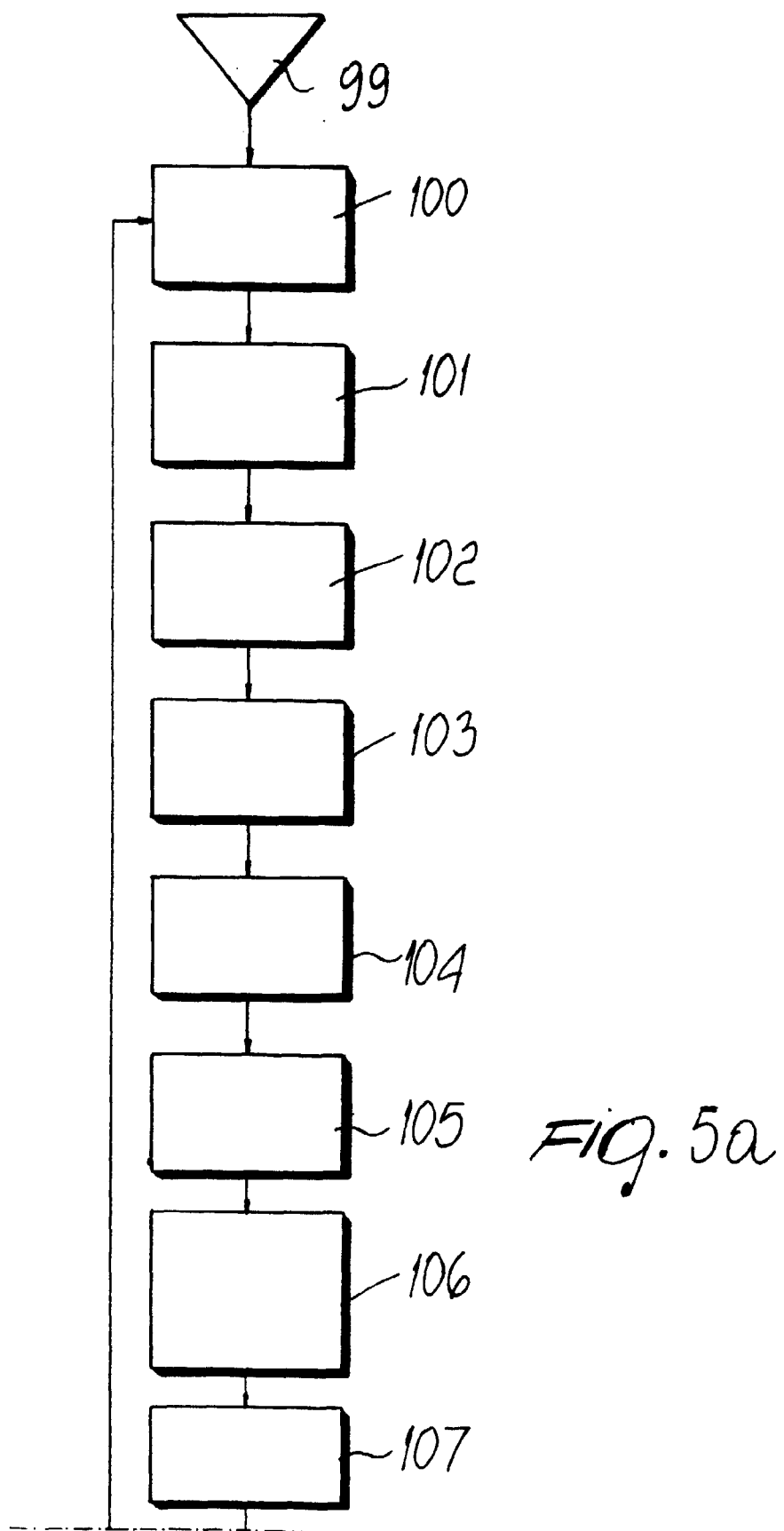


Fig. 4c



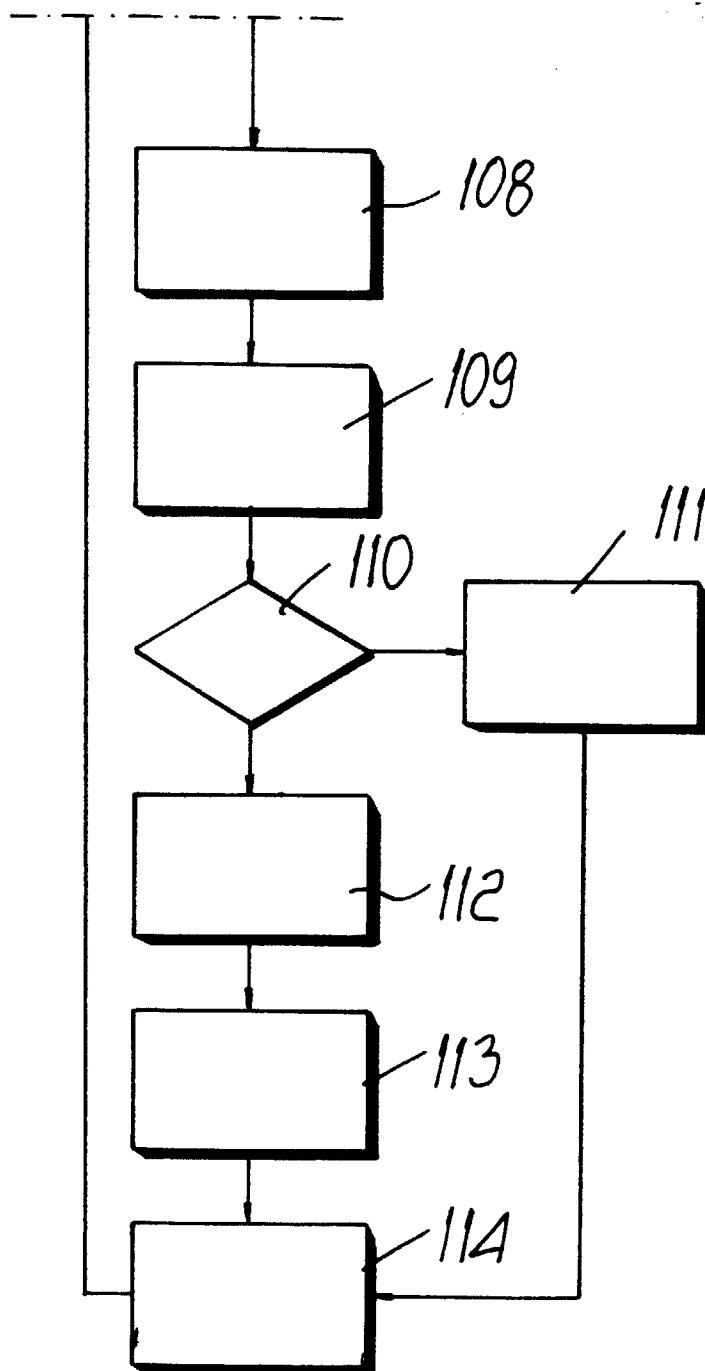


Fig. 5b