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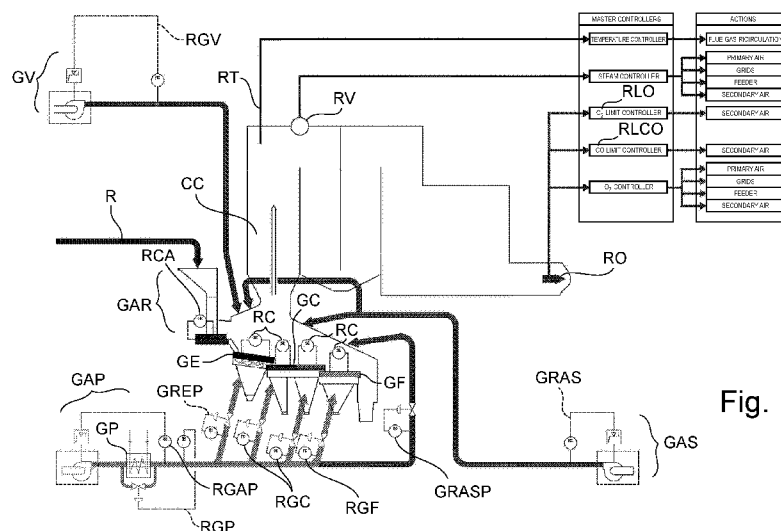


Fig. 1

(57) **Abstract:** Automatic combustion control system for a waste disposal plant, wherein said plant comprises a combustion chamber (CC) where waste is burned, which is arranged on at least one combustion grid formed by a plurality of moving assemblies that move relative to one another, thereby causing the waste to advance on the grid. Said grid is divided into portions (GE, GC, GF) and comprises a waste feeding assembly (GAR) for laying the waste on the grid, and a primary air supply assembly (GAP) for supplying said air both above and under the grid.

AUTOMATIC COMBUSTION CONTROL SYSTEM FOR A WASTE TO
ENERGY PLANT

The present invention relates to a control system for a waste to energy plant treating solid urban waste and the like.

The plant to which the control system is applied is typically a waste disposal plant in which said waste is burned and then disposed of as ashes.

Such plants (as diagrammatically shown in Figure 1) generally comprise a combustion chamber CC where waste is burned on a combustion grid, through which a suitable amount of air is blown. The combustion grid is suitable for supporting and advancing the waste during its combustion, while at the same time allowing for forced blowing of combustion air under the waste bed.

The grid constitutes the lower part of the combustion chamber. The combustion chamber physically begins immediately above the grid. In some cases, the walls of the combustion chamber are cooled, whether totally or partially, by evaporating tube bundles protected by the refractory itself.

The flame produced by the combustion of waste develops inside the combustion chamber, reaching

temperatures in excess of 1,200 °C. The surface of the grid is struck only occasionally by the radiation of the flame, since it is normally protected by the waste bed in transit.

The surface of the grid consists of plates (typically known as "fire bars"), which are usually made from molten steel with a high chrome content to ensure good hot-wear characteristics. Waste advance is obtained via relative movement of the fire bars, which may have different characteristics. The fire bars are provided with openings or holes to allow the combustion air to flow through the waste from below the grid plane. A primary air supply assembly GAP supplies such air to the grid, which is advantageously preheated by a preheating assembly GP. The combustion air actually has the dual function of providing oxygen for waste oxidation and of cooling the fire bar in order to keep it at an acceptable temperature and preserve its mechanical characteristics. Cooling is necessary because, although the grids normally operate covered by the combustible being transported, they may nonetheless be directly exposed to the combustion flames.

The grid further comprises a plurality of moving assemblies, each formed by the above-mentioned fire

bars organized into a bundle, which move relative to each other and cause the waste to advance on the grid. In particular, the fire bars are divided into fixed fire bars and mobile fire bars that, by means of slides, generate a to-and-fro motion, sliding one over the other and determining the advance of the waste in each moving assembly, and thus on the grid as a whole.

The waste is laid on the grid by means of a waste feeding assembly GAR.

The grid can be logically divided into a first drying portion GE, where moisture is removed from the waste, a second combustion portion GC, and a third finishing portion GF.

The waste on the grid is also supplied with secondary air by a secondary air supply assembly GAS, which further promotes the combustion thereof, while combustion fumes are directed towards the upper part of the combustion chamber by a fume recirculation fan assembly GV.

In addition to being currently characterized by highly technological contents, disposal of urban solid waste is a particularly sensitive activity as far as reliability and effectiveness are concerned. The complex integrated waste disposal system

(accumulation, collection, transportation, storage and disposal) requires the technological components used in the last step of the process to ensure continuous operation 24 hours a day, as well as to minimize the risk of a shutdown due to damage (whether minor or catastrophic).

In a waste to energy plant, the achievement of a high-quality combustion process is especially hindered by continuous and inevitable variations in the specific weight and caloric power of the waste being burned.

The present invention describes a structure and methodology for automatic combustion control that allow keeping the thermal potentiality of the furnace in stable design conditions, by adjusting the continuous hourly steam production in the presence of a constant excess of air, and hence of free oxygen in the fumes, and of a uniform temperature in the combustion chamber, thereby ensuring high efficiency of the combustion process.

Once the caloric power of the waste and the required steam production have been manually set, the logic of the control system according to the present invention provides for automatically adjusting and controlling the combustion process.

One aspect of the present invention concerns an automatic control system for a waste to energy plant according to the features set out in claim 1.

The features and advantages of the system according to the present invention will become more apparent from the following explanatory and non-limiting description of one embodiment thereof with reference to the annexed drawings, wherein:

- Figure 1 is a schematic representation of the waste to energy plant, highlighting in particular the parameters of the plant that the automatic system of the present invention will detect and control;
- Figure 2 is a block diagram of the control system according to the present invention;
- Figures 3a and 3b show the logic diagram for the calculation and adjustment of the steam flow rate;
- Figure 4 shows the logic diagram for the calculation and adjustment of the total air flow rate;
- Figures 5a and 5b show the logic diagram for the calculation and adjustment of the grid dwell time;
- Figure 6 shows the logic diagram for the calculation and adjustment of the secondary air flow rate;
- Figures 7a and 7b show the logic diagram for the

calculation and adjustment of the grid dwell time;

- Figure 8 shows the logic diagram for the calculation and adjustment of the temperature in the first boiler channel;
- Figure 9 shows the logic diagram for the calculation and adjustment of the grid wait time;
- Figures 10a and 10b show the logic diagram for the calculation and adjustment of the CO and O₂ limit controllers;
- Figure 11 shows the logic diagram for the adjustment of the controller of the temperature in the first boiler channel;
- Figures 12a-12f show the logic diagram for the calculation of the combustion data matrix.

With reference to the above-listed drawings, the waste to energy plant comprises a combustion chamber CC where waste is burned on a combustion grid, through which a suitable amount of air is blown. The combustion grid is suitable for supporting and advancing the waste during its combustion, while at the same time allowing for forced blowing of combustion air under the waste bed.

The grid constitutes the lower part of the combustion chamber. The combustion chamber physically begins immediately above the grid. In some cases, the walls

of the combustion chamber are cooled, whether totally or partially, by evaporating tube bundles protected by the refractory itself.

The surface of the grid consists of plates (typically known as "fire bars"), which are usually made from molten steel with a high chrome content to ensure good hot-wear characteristics. Waste advance is obtained via relative movement of the fire bars, which may have different characteristics. The fire bars are provided with openings or holes to allow the combustion air to flow through the waste from below the grid plane. A primary air supply assembly GAP supplies such air both under and above the grid; said primary air is advantageously preheated.

The combustion air actually has the dual function of providing oxygen for waste oxidation and of cooling the fire bar in order to keep it at an acceptable temperature and preserve its mechanical characteristics. Cooling is necessary because, although the grids normally operate covered by the combustible being transported, they may nonetheless be directly exposed to the combustion flames.

The grid further comprises a plurality of moving assemblies, each grid comprising at least one of said moving assemblies, each formed by the above-mentioned

fire bars organized into bundles, which move relative to each other, thereby causing the waste to advance on the grid. Preferably, the fire bars are divided into fixed fire bars and mobile fire bars that, by means of slides, generate a to-and-fro motion, sliding one over the other and determining the advance of the waste in each moving assembly, and thus on the grid as a whole.

Waste R is laid on the grid by means of a waste feeding assembly GAR.

The grid is advantageously divided into portions. In the exemplary Figure 1, the grid is divided into a first drying portion GE, where moisture is removed from the waste, a second combustion portion GC, and a third finishing portion GF.

Of course, each one of the three portions may be subdivided into further portions; for example, the combustion portion may be subdivided into two adjacent portions as shown.

Said motion of the fire bars causes the waste to advance from one assembly to the next.

The waste on the grid is also supplied with secondary air blown above the grid by a secondary air supply assembly GAS, which further promotes the combustion thereof, while combustion fumes are directed towards

the upper part of the combustion chamber by a fume recirculation fan assembly GV.

Depending on the hourly steam production required from the plant and on the estimated caloric power of the waste, at each point of the combustion diagram the theoretical primary and secondary air flow rates, the degree of primary air preheating, and the theoretical values of the grid motion frequencies are predefined as control loop setpoints.

The automatic control system of the present invention is provided with at least one electronic processing unit, and comprises a general primary air adjustment assembly RGP, which also supplies primary air to each grid assembly, in particular to a primary air adjustment assembly for the drying grid RGE, a primary air adjustment assembly for the combustion grid RGC, a primary air adjustment assembly for the finishing grid RGF. Such assemblies are the so-called under-grid primary air adjustment assemblies, while the system also comprises an above-grid or above-vault primary air adjustment assembly GRAPS.

The system further comprises a travel adjustment assembly RC for each grid and a travel adjustment assembly RCA for the feeder, a secondary air adjustment assembly GRAS, a fume ventilation

adjustment assembly RGV, and a primary air preheating adjustment assembly RGP.

The parameters based on which the control system controls such adjustment assemblies of the plant are essentially the steam production, the wet oxygen content in the fumes, and the temperature in the post-combustion chamber (top of first boiler channel). Suitable temperature sensors RT, steam sensors RV and oxygen sensors RO are arranged in the combustion chamber, from which the control system detects values continuously. Included are also a maximum carbon oxide limit sensor RLCO in the chamber and a maximum oxygen limit sensor RLO.

The control system requires that the following functional parameters, accessible to the operator, be set manually beforehand:

- required hourly steam production **[t/h]**
- theoretical value of the caloric power of the waste **[kcal/kg]**.

These parameters allow calculating all of the combustion process variables, upstream of the whole iterative process of the adjustment unit. The manually set values are then verified, to ensure that the limits imposed by the combustion diagram are observed. Particularly as concerns caloric power, the

manually set value is subject to upper and lower limits, so that it cannot be out of the operating range, e.g. 1,800-3,600 [kcal/kg].

According to a characteristic of the present invention, said processing unit determines the total quantity of secondary air to be supplied to the grid, which is the sum of the above-vault primary air supplied by the above-grid or above-vault primary air adjustment assembly (GRAPS) and the secondary air supplied by the secondary air adjustment assembly (GRAS).

The distribution of the two currents is entrusted to a splitter that allows adjusting the distribution of the two air flows.

Said processing unit is equipped with a combustion data matrix Z01 that defines, as a function of the manually set caloric power and hourly steam production, "calculation factors" derived from design data and from combustion sizing balances in different thermal load conditions of the furnace and with different waste caloric power values. Based on the data contained in the matrix and on the detections made, the parameter values to be sent to the adjustment assemblies are calculated.

Said processing unit is also equipped with a primary air distribution calculation matrix Z02 that defines, on the basis of the caloric power of the waste, the distribution of primary air to the different under-grid zones.

According to the present invention, the control system preferably operates as follows.

In order to stabilize as much as possible the wet oxygen content in the combustion fumes, and hence keep constant the thermal combustion power, the supply of total air (Σ under-grid primary air + total secondary air) is kept constant once the input parameters of the control system ACC (required steam flow rate and theoretical caloric power) have been defined.

The process starts from manually set values, i.e. the hourly steam production S01 required from the plant and the estimated caloric power S02 of the waste.

Based on these theoretical data, which are compatible with the plant's capacities, all "setpoints" are calculated for the supply assemblies. Thus, on the basis of the theoretical values, the values of the process variables are established, i.e.:

- total under-grid primary air flow rate
- total secondary air flow rate

- primary air temperature controller setpoint
- Feeder dwell time
- Grid dwell time (1 - 4)
- Recirculation fume controller setpoint
- under-grid primary air flow rate controller setpoint (1 - 4)
- secondary air flow rate controller setpoint (above-vault / fan)

Such values are then kept constant by the master controllers.

Based on the data contained in the matrix, a first calculation block C01 calculates the wet oxygen value at the boiler output, as a function of design combustion data for different thermal load conditions of the furnace. In said calculation, it is considered that the oxygen content in the fumes will remain constant after fixing and keeping constant the caloric power of the waste.

As for the theoretical steam flow rate, a second calculation block C02 (Figures 3a-b) obtains the actual steam flow rate by comparing the set theoretical value with the data contained in said combustion data matrix Z01. In particular, upper and lower limits are defined for the manually set hourly steam production value, so that the process limits

specified in the combustion diagram cannot be exceeded. The manually set value must be compatible with the maximum steam production estimated as a function of the caloric power of the waste, and hence with the combustion diagram. Should it turn out to be particularly difficult to reach the required steam flow rate, e.g. because of an overloaded grid, the steam flow rate setpoint will be automatically lowered (by setting a lower upper limit).

A sixth calculation block C06 calculates the primary air temperature, and hence the degree of primary air preheating, which depends on the caloric power of the waste.

A further calculation block C16 (Figure 8) calculates the combustion chamber temperature starting solely from the caloric power of the waste.

Further calculation blocks calculate various other setpoints by also using the values calculated by previous blocks. In particular, a (fourth) calculation block C04 (Figure 4) calculates the total quantity of combustion air, indicated as the sum of the under-grid primary air and the total secondary air, starting from the values of said combustion data matrix and on the basis of the value of the actual steam flow rate calculated in block C02.

According to the present invention, adjustment blocks R01-R03 are adapted to adjust said quantities calculated in the previous calculation blocks C01, C02 and C16, receiving the values that are continuously detected by the above-mentioned sensors. In particular, the steam flow rate adjustment block R01 is preferably a PID (proportional, integral, derivative) controller, which ensures a balance in the combustion process. The output of the PID adjustment unit is a signal that may vary within a range of (-50 to +50) %. The optimal setpoint is obtained when the output of the controller is set to about 0 %; in particular, as steam production decreases, the output signal will increase (inverse-type controller). The output signal of adjustment block R01 is a value that will be used in the calculations that will be carried out by further calculation blocks of the system, which in turn will determine the values to be sent to the adjustment assemblies. In particular, steam controller R01 is useful for controlling the primary and secondary air adjustment assemblies, the motion of the grids, and the feeding of waste to the plant.

Adjustment block R02 for adjusting the wet oxygen content in the fumes is also a PID (proportional,

integral, derivative) controller, configured for ensuring faster adjustments than steam controller R01. Furthermore, as the (wet) O_2 content in the fumes decreases, the output signal will decrease (direct-type controller).

The (wet) O_2 content in the fumes is a fundamental quantity for controlling and keeping constant the thermal combustion power; a decrease in the oxygen content will indicate a thermal power increase.

The output signal of adjustment block R02 is a value that will be used in the calculations that will be carried out by further calculation blocks of the system, which in turn will determine the values to be sent to the adjustment assemblies. In particular, wet oxygen controller R02 is useful for controlling the primary and secondary air adjustment assemblies, the motion of the grids, and the feeding of waste to the plant.

Fume temperature adjustment block R03 (Figure 11) allows to obtain a uniform temperature profile in the post-combustion chamber, minimizing thermal NO_x formation and limiting the phenomenon of flying ashes sticking to the boiler walls.

The controller is a PID controller, wherein as the fume temperature decreases the output signal will

decrease as well (direct-type controller). The output signal of master controller R03 is a value that will be used for internal calculations set by the control unit, not a value physically related to a process variable.

The output of controller R03 intervenes directly in the calculation of the setpoint of the recirculation fume flow rate.

The system includes two further adjustment blocks L1-01 and L1-02 (Figures 10a-b), which act as limit controllers and correct, through an integral function, the total secondary air flow rate.

The O₂ limit controller is based on two redundant measurements, so as to ensure the utmost reliability of the system. In the event that one of the two readings at the boiler output (OR logic) is below the minimum alarm value of wet oxygen at the boiler output (e.g. 3%), then the controller will activate automatically to increase, through an integral function, the total secondary air flow rate. The CO limit controller is also based on a 1 out of 2 logic: if the higher one of the two measured values (one at the boiler output and one at the chimney) exceeds the alarm threshold (e.g. 8 mg/Nm³), then the controller will activate automatically to increase, through an

integral function, the total secondary air flow rate. Both controllers will turn off as soon as the values are back within specifications.

The adjustment assemblies return corrected values that will then be used by the next calculation blocks C03, C05, C7-C11, C13, C14 and C15.

In particular, block C03 calculates the primary air flow rate on the basis of design combustion data, wherein the theoretical flow rate is calculated as a function of the steam flow rate setpoint and the estimated caloric power. The previously calculated theoretical value can be further corrected by a primary air excess manual factor S03 ($\pm 0,2\%$). This corrector is automatically and gradually reset to zero after a certain time t . This calculation block also receives the outputs of the controllers R1 and R2, appropriately weighed as a function of the estimated caloric power. Considering that the total air flow rate, which is the sum of primary air and total secondary air, is kept constant, the primary air setpoint is limited upwards when the theoretical value of the total secondary air goes below the minimum operating limit.

Calculation block C05 calculates the fume recirculation flow rate starting from the values of

combustion matrix Z01 (Figures 12a-f) and from the heat calculated in the steam flow rate block C02.

Blocks C07-C11 calculate the various primary air flows to be supplied to the various portions of the grid. Starting from the theoretical values outputted by the primary air data matrix Z02, the setpoints for the distribution of the primary air flow rate are calculated as follows: the theoretical value for each portion is calculated as a product of the primary air flow rate setpoint C03 by the degree of distribution outputted by matrix Z02 as a function of the caloric power of the waste; the calculated theoretical value is then corrected with the output of steam controller R01. A primary air flow meter M04 and a secondary air flow meter M06 determine such calculation.

Calculation block C13 (Figures 5a-b) calculates the grid advance speed by calculating the cycle time thereof through the motion sequence. Grid frequency is a function of the calculated cycle time, which is common to all grids, and of the speed chosen among the predefined sequences. Advantageously, the cycle time can be manually modified according to the nature of the waste.

The grid cycle time is calculated as follows: based on the design combustion data, the theoretical value

is calculated (by matrix Z01) as a function of the steam flow rate setpoint and of the estimated caloric power; the theoretical value is corrected with the outputs of controllers R01 and R02, appropriately weighed as a function of the estimated caloric power. Advantageously, the value can be adapted by means of a manual corrective factor S07. The calculated frequency is converted into a grid stand-by time. In the illustrated embodiment, the logic of the control system uses different stand-by times for the four grids, so as to ensure a uniform and optimal distribution of the waste on the grids.

Block C14 (Figure 6) calculates the total secondary air flow rate as a difference between the total air flow rate setpoint (block C04) and the under-grid primary air flow rate, calculated as the lower one of the setpoint value and the measured value M04, advantageously corrected by means of a manual factor calculated in a correction block S05 as follows: the total secondary air flow rate is further corrected by the CO and O₂ limit controllers L01-01 and L01-02.

If the theoretical value of the total secondary air reaches the minimum limit, any further increase of under-grid primary air will be prevented.

The total secondary air is the sum of the above-vault secondary air (derived from the primary air collector) and the secondary air coming from the corresponding dedicated fan. The distribution of the two currents is entrusted to a splitter.

The waste feeder travel calculation block C15 (Figures 7a-b) calculates the feeder stand-by time. The latter is calculated between a complete travel (forwards and backwards) and the next, starting from the calculated steam flow rate value (block C02). Advantageously, the feeder frequency can be modified manually, depending on the nature of the waste, through the calculation block S06.

In turn, the values calculated by said assemblies are transferred to the process variable adjustment assemblies.

When the measured actual steam flow rate RV is higher than the set point value calculated by block C02, in a suitable calculation block F02 (Figure 9) a "waiting flag" is activated, which inhibits grid motion; this command stays active until the steam flow rate returns within the defined stability limits. Once the waiting flag has been deactivated, the grid will move in accordance with the manually set stand-by time. When wet O₂ content is below the

minimum limit or when the measured steam production exceeds the maximum limit allowed by the design data, the control system will act upon the grids by setting the stand-by time of each grid to the maximum allowable value (which time will be, of course, different for each grid).

The following table summarizes the corrections made by adjustment blocks R01, R02 and R03 to the process variables of the automatic control system according to the present invention:

CONTROLLER	R 01 STEAM		R 02 WET O ₂		R 03 TEMP.	
[VM-SP]	> 0	< 0	> 0	< 0	> 0	< 0
controller output	< 0	> 0	> 0	< 0	> 0	< 0
CORRECTED PROCESS VARIABLE	EFFECT					
under-grid primary air	▼	▲	▲	▼	—	—
total secondary air (*)	▲	▼	▼	▲	—	—
feeder travels/hour	▼	▲	▲	▼	—	—

grid travels/hour	▼	▲	▲	▼	-	-
recirculation fumes	-	-	-	-	▲	▼

Where:

PV-SP indicates the offset of the measured variable from the setpoint value,

▼ indicates a decrease,

▲ indicates an increase,

- indicates no correction.

The corrections made by the controllers are weighed as a function of the caloric power of the waste. In particular, for very wet waste with low caloric power, the adjustments to be made to the process variables will be quite marked; for waste with high caloric power, on the contrary, the corrective actions will be weaker. Any correction acting directly upon the primary air will also indirectly affect the total secondary air. This means that, once the steam production and the caloric power have been defined, the combustion process is optimized without changing the furnace setpoint, but by adjusting the distribution of the combustion air currents (primary air and total secondary air) in the furnace. In fact, the secondary air is not adjusted by directly changing the secondary air flow rate, but as a

difference between the total combustion air, which remains constant due to the system setup, and the total primary air.

The system according to the present invention ensures better energetic performance, in that it maximizes the efficiency of the furnace/boiler system, optimizes the thermal load stability of the furnace/boiler system, and provides optimized transient control, hence increasing the overall mean steam production.

The system according to the present invention ensures optimized environmental performance; in fact, the better stability of the combustion process allows to keep the combustion parameters at optimal values and to control the emissions at the boiler output, thereby reducing emission peaks and optimizing reagent consumption in the fume line.

The system according to the present invention provides:

1) Improved environmental performance

- mean emission values
- pollutant oscillations (peaks)

2) Better management

- operating flexibility

- conduction (uniformity, resource rationalization)
- reliability
- transient control
- operating costs (maintenance, chemicals)

3) Improved energetic performance

- stability of the combustion process
- transient control
- efficiency

The present automatic combustion control system allows to significantly improve the reliability of the combustion system, leading to advantages in terms of performance, management and costs.

The results attained by using the control system according to the present invention are achieved by keeping the thermal potentiality of the furnace in stable design conditions by adjusting the continuous hourly steam production in the presence of a constant excess of air, and hence of free oxygen in the fumes, and of a uniform temperature in the combustion chamber.

CLAIMS

1. An automatic combustion control system for a waste disposal plant, wherein said plant comprises

- a combustion chamber (CC), in which waste arranged on at least one combustion grid is burned,
- said grid comprising a plurality of moving assemblies that move relative to one another, thereby causing the waste to advance on said grid,
- said grid being divided into portions (GE, GC, GF), each comprising at least one of said moving assemblies,
- at least one waste feeding assembly (GAR), for laying the waste on the grid,
- at least one primary air injection assembly (GAP), for supplying said air both above and under the grid,
- at least one secondary air supply assembly (GAS), for supplying said air above the grid,
- a fume recirculation fan assembly (GV), for conveying the combustion fumes towards the upper part of the combustion chamber (CC),

said system comprises

- temperature sensors (RT), steam sensors (RV) and oxygen sensors (RO) arranged in the combustion chamber, from which said control system detects values continuously,
- a primary air adjustment assembly (RGP), which comprises under-grid primary air adjustment assemblies, at least one above-grid or above-vault primary air adjustment assembly (GRAPS), and a primary air preheating adjustment assembly (RGP),
- a secondary air adjustment assembly (GRAS),
- an electronic processing unit, which receives data from said sensors and controls said adjustment assemblies on the basis of the required hourly steam production of the system and of the estimated caloric power of the waste,

characterized in that said processing unit comprises calculation blocks (C03-01,C03-02,C04,C14) for determining the total quantity of secondary air to be supplied to the grid, which is the sum of the above-vault primary air supplied by the above-grid or above-vault primary air adjustment assembly (GRAPS) and the secondary air supplied by the secondary air adjustment assembly (GRAS).

2. System according to claim 1, wherein the

distribution of the two air currents, i.e. above-vault primary air and secondary air, is entrusted to a splitter which allows, through a calculation block (C14), to adjust the distribution of the two flows.

3. System according to claim 1, further comprising a travel adjustment assembly for each grid (RC) and a travel adjustment assembly for the waste feeder (RCA), the adjustment parameters of which are calculated in the calculation blocks (C13,C15).

4. System according to claim 1, wherein the grid is divided into a waste drying portion (GE), a combustion portion (GC) and a finishing portion (GF), and said under-grid air adjustment assembly comprises a primary air adjustment assembly for the drying grid (RGE), a primary air adjustment assembly for the combustion grid (RGC), a primary air adjustment assembly for the finishing grid (RGF).

5. System according to claim 1, wherein the value of the target hourly steam production and the theoretical value of the caloric power of the waste are set manually by an operator.

6. Control system according to claim 1, wherein said processing unit includes a combustion data matrix (Z01) that defines, as a function of the manually set caloric power and hourly steam

production, the calculation factors derived from design data and from combustion sizing balances in different thermal load conditions of the furnace and with different waste caloric power values, and a primary air distribution calculation matrix (Z02) that defines, on the basis of the caloric power of the waste, the distribution of primary air to the different under-grid zones.

7. Control system according to claim 6, comprising adjustment blocks (R01,R02,R03) for adjusting quantities calculated on the basis of the calculation factors of said matrices and from values continuously detected by the above-mentioned sensors.

8. Control system according to claim 7, wherein an adjustment block (R01) adjusts the steam flow rate and controls the primary air adjustment assemblies, the motion of the grids and the feeding of waste to the plant.

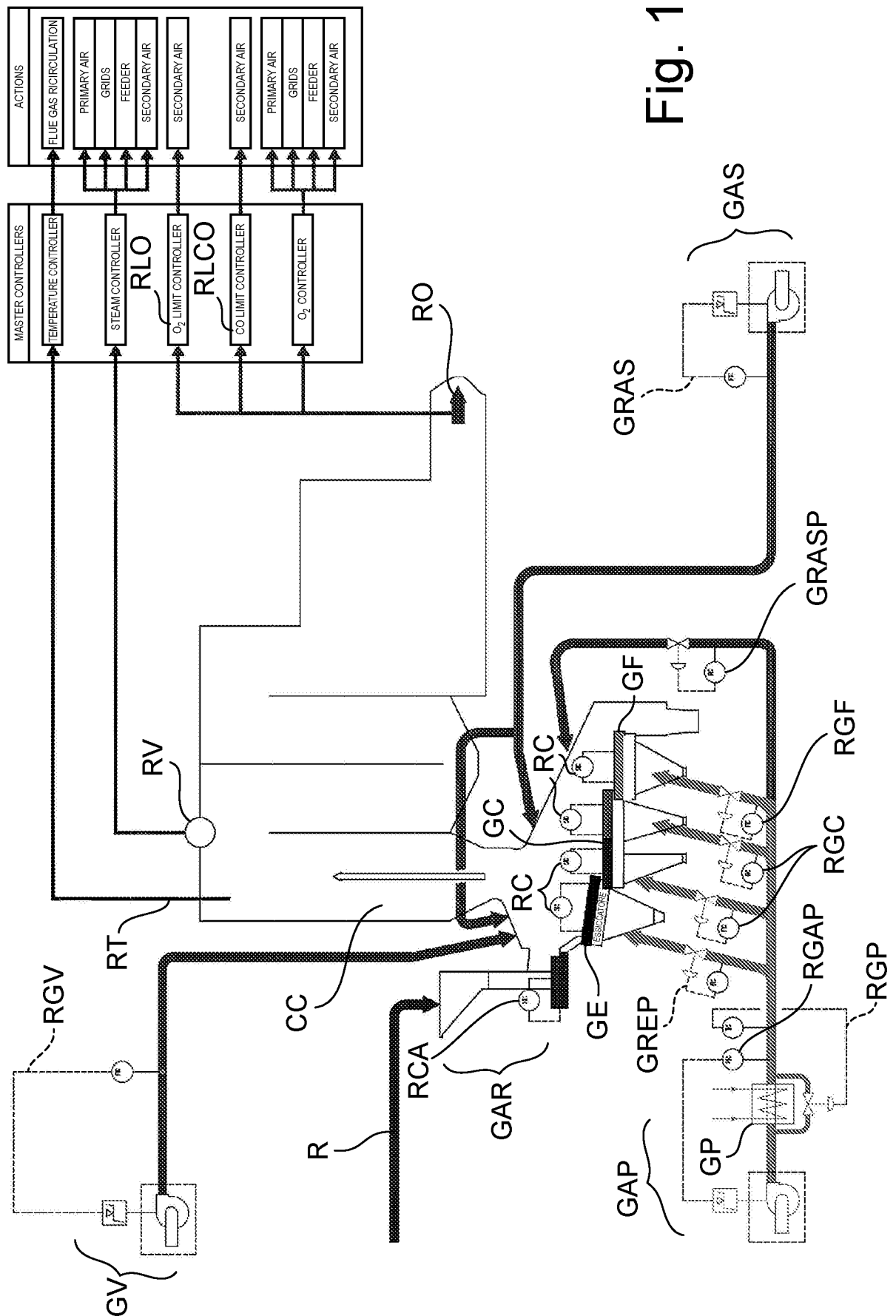
9. Control system according to claim 7, wherein an adjustment block (R02) adjusts the quantity of wet oxygen in the fumes and controls the primary and secondary air adjustment assemblies, the motion of the grids and the feeding of waste to the plant.

10. Control system according to claim 7, comprising the calculation of the combustion chamber temperature

setpoint (C16) and an adjustment block (R03) that adjusts the fume temperature and controls the fume recirculation flow adjustment assembly (RGV) so as to minimize NO_x formation.

11. System according to claim 7, wherein, according to the detections carried out, the adjustment assemblies are controlled on the basis of the continuous hourly steam production, the wet oxygen content in the fumes exiting the boiler, and the CO and O₂ contents exiting the boiler.

12. Control system according to claim 1, wherein the total secondary air flow rate is corrected by CO and O₂ limit controllers (L01-01,L01-02), through which, if the theoretical value of the total secondary air reaches the minimum limit, any further increase of under-grid primary air will be prevented.



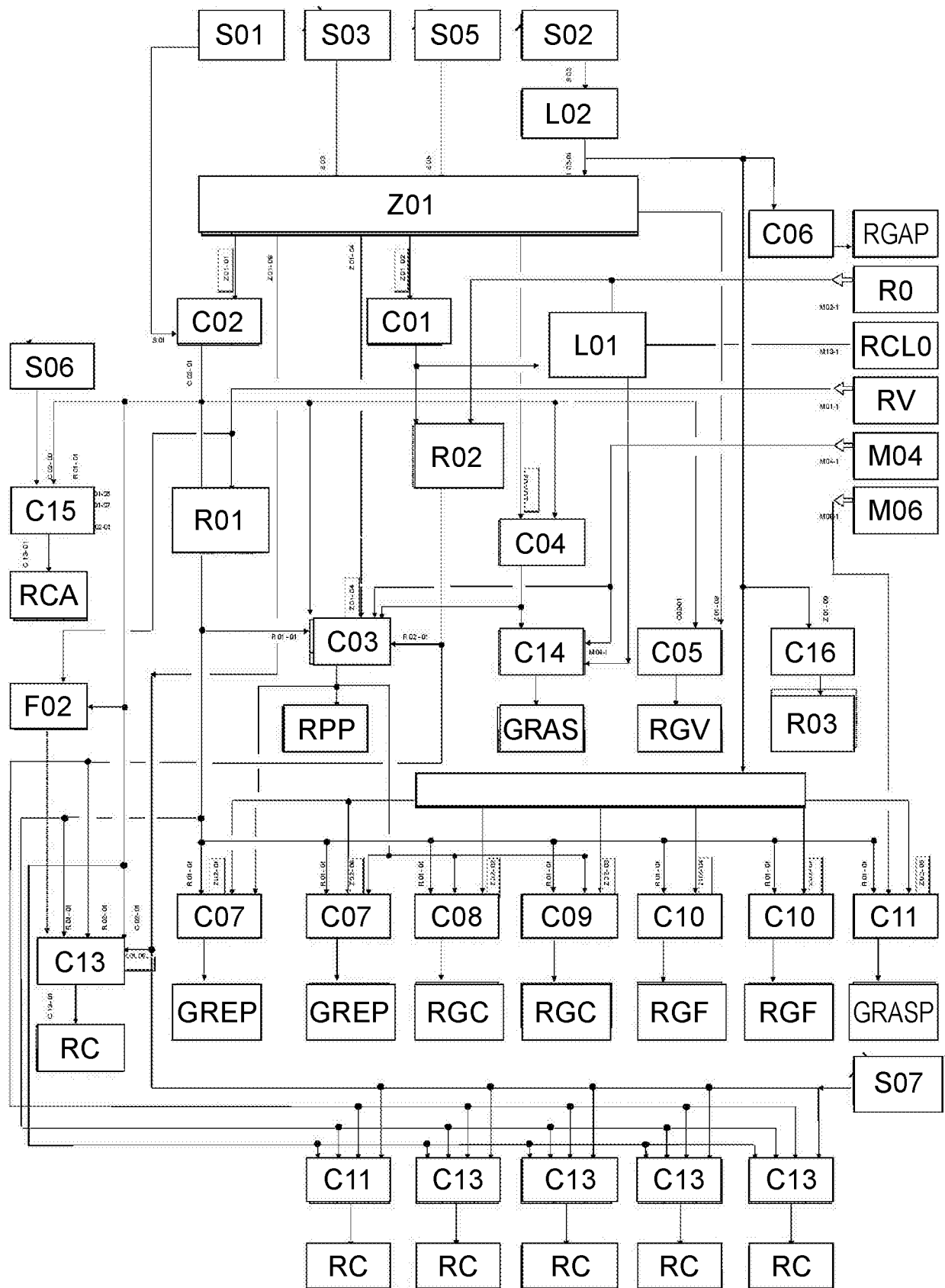


Fig. 2

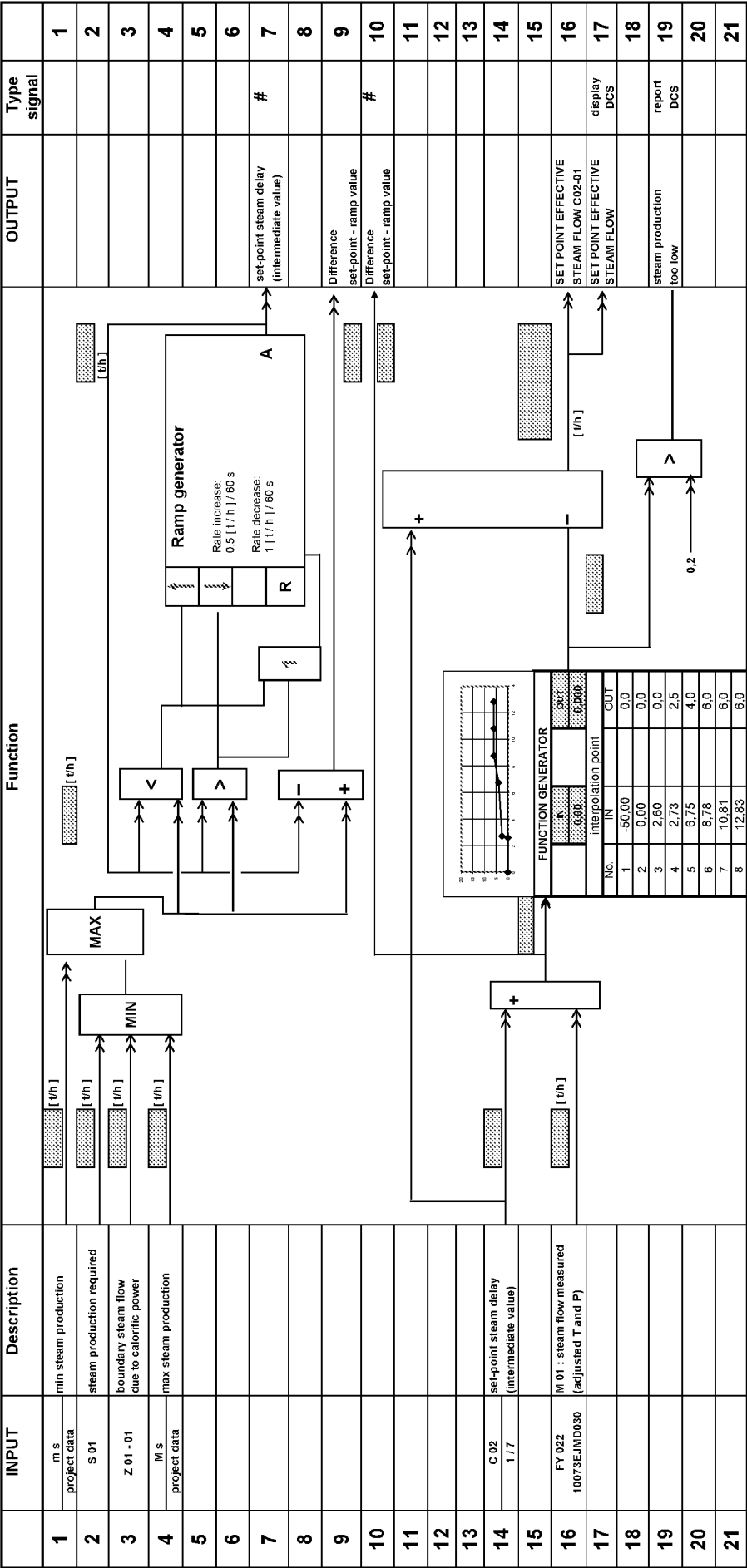


Fig. 3a

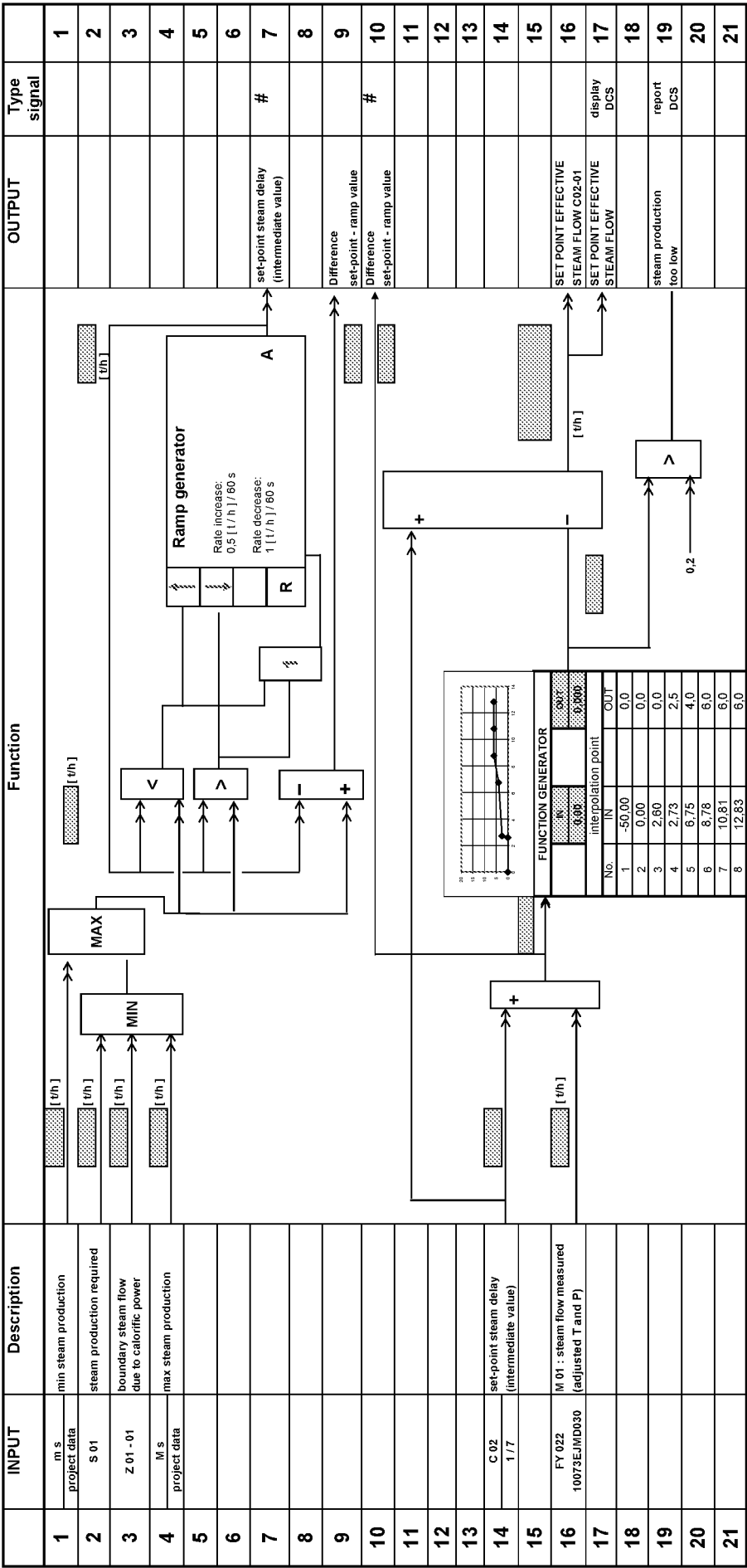


Fig. 3b

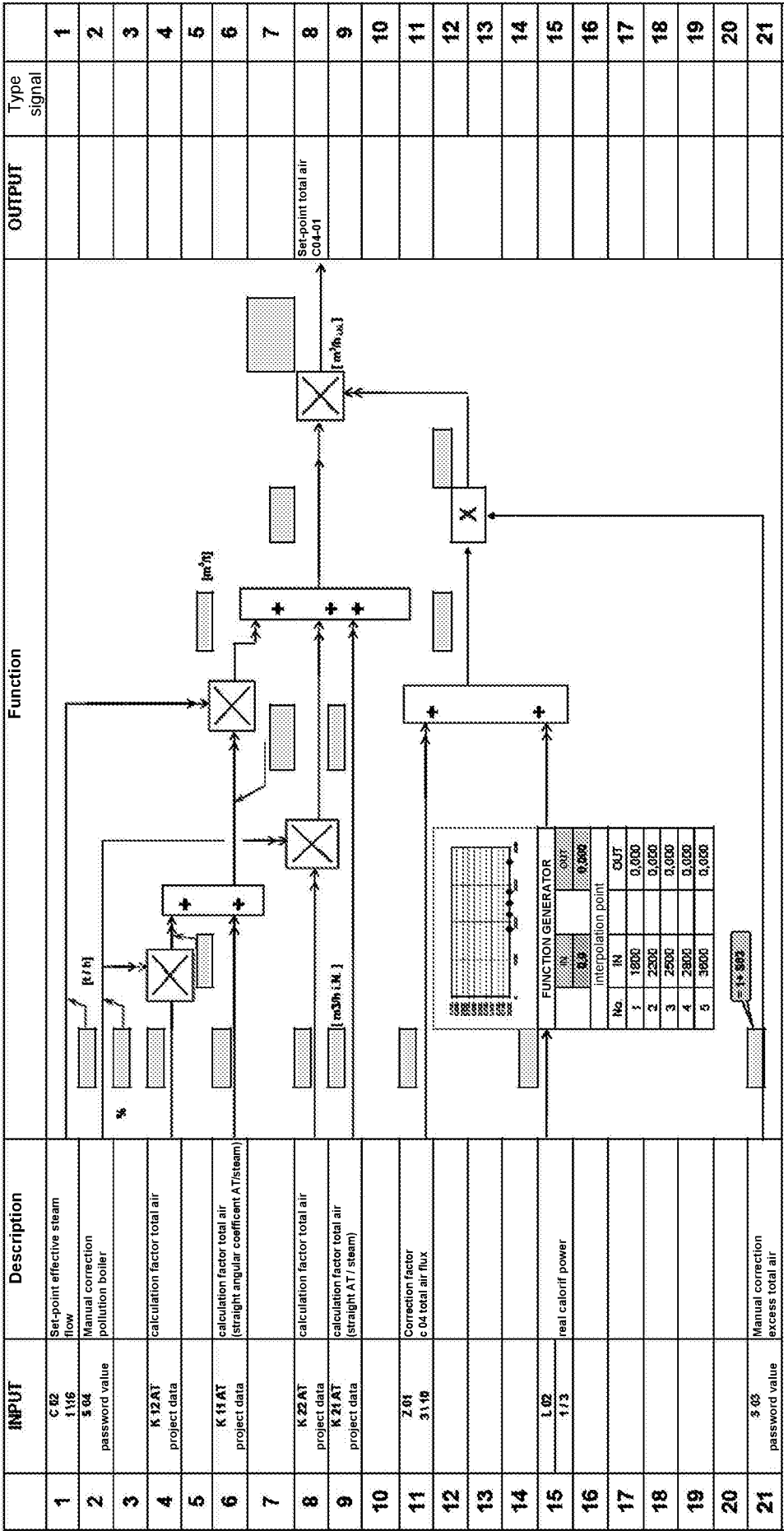


Fig. 4

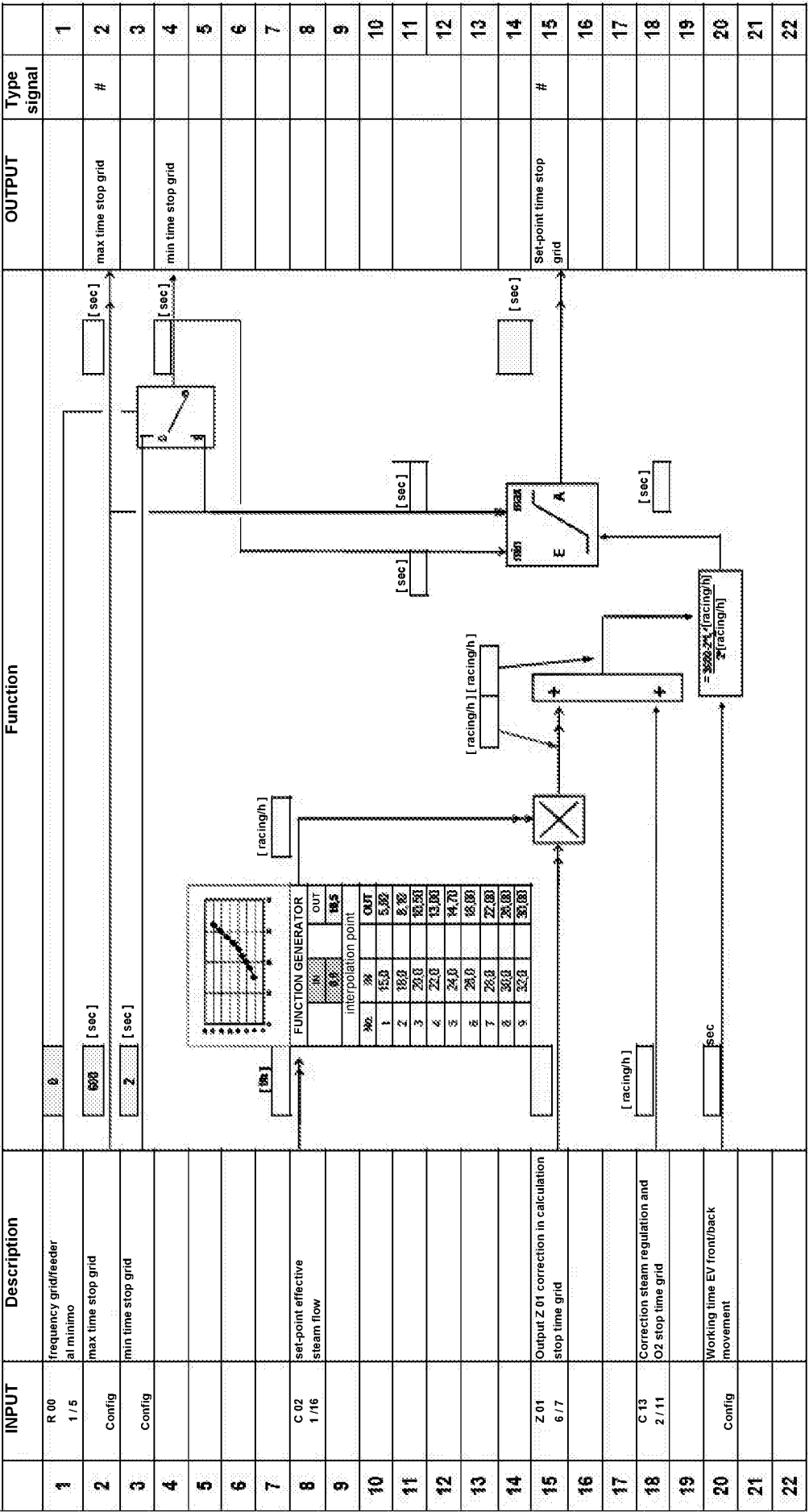


Fig. 5a

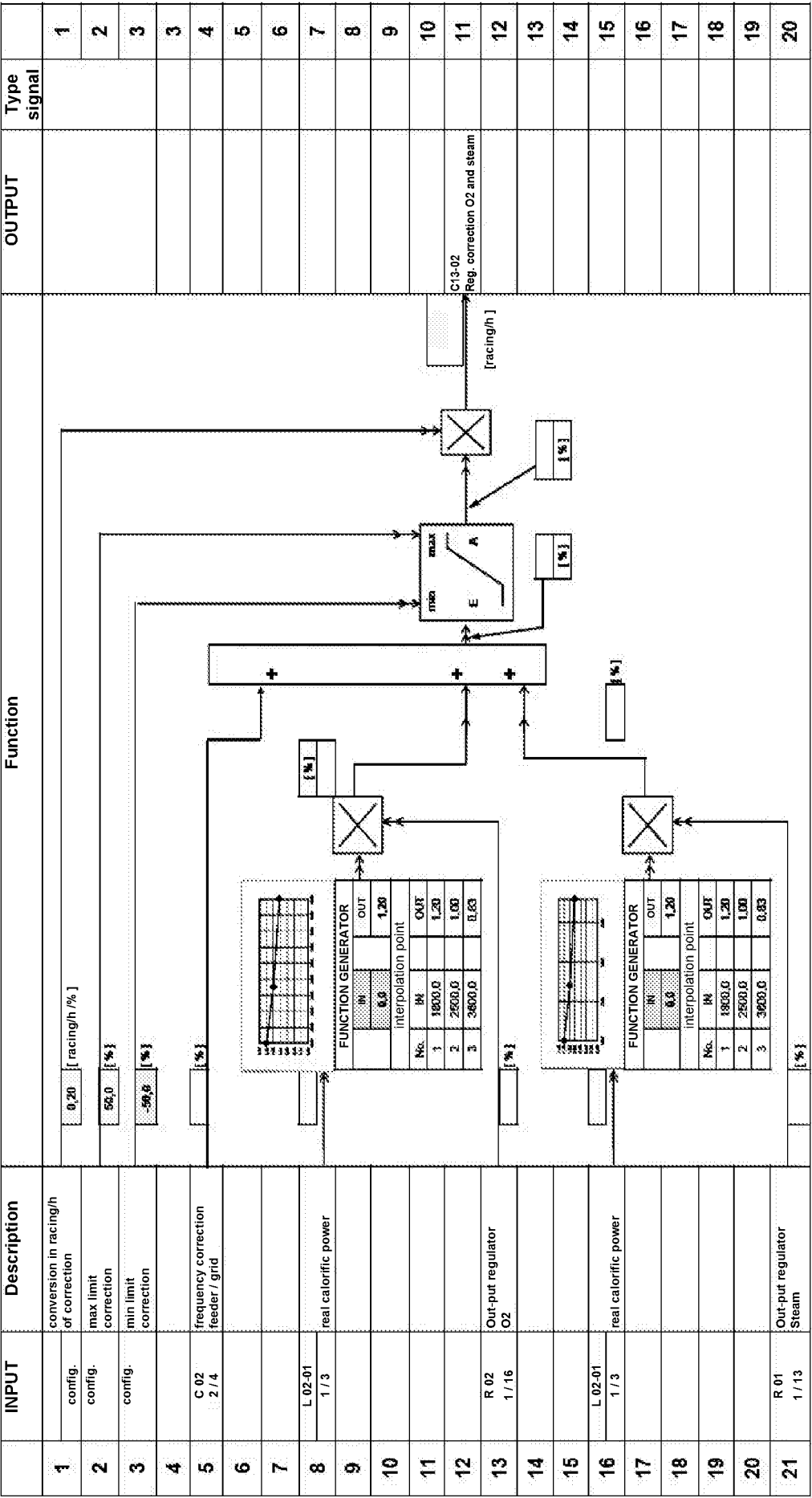


Fig. 5b

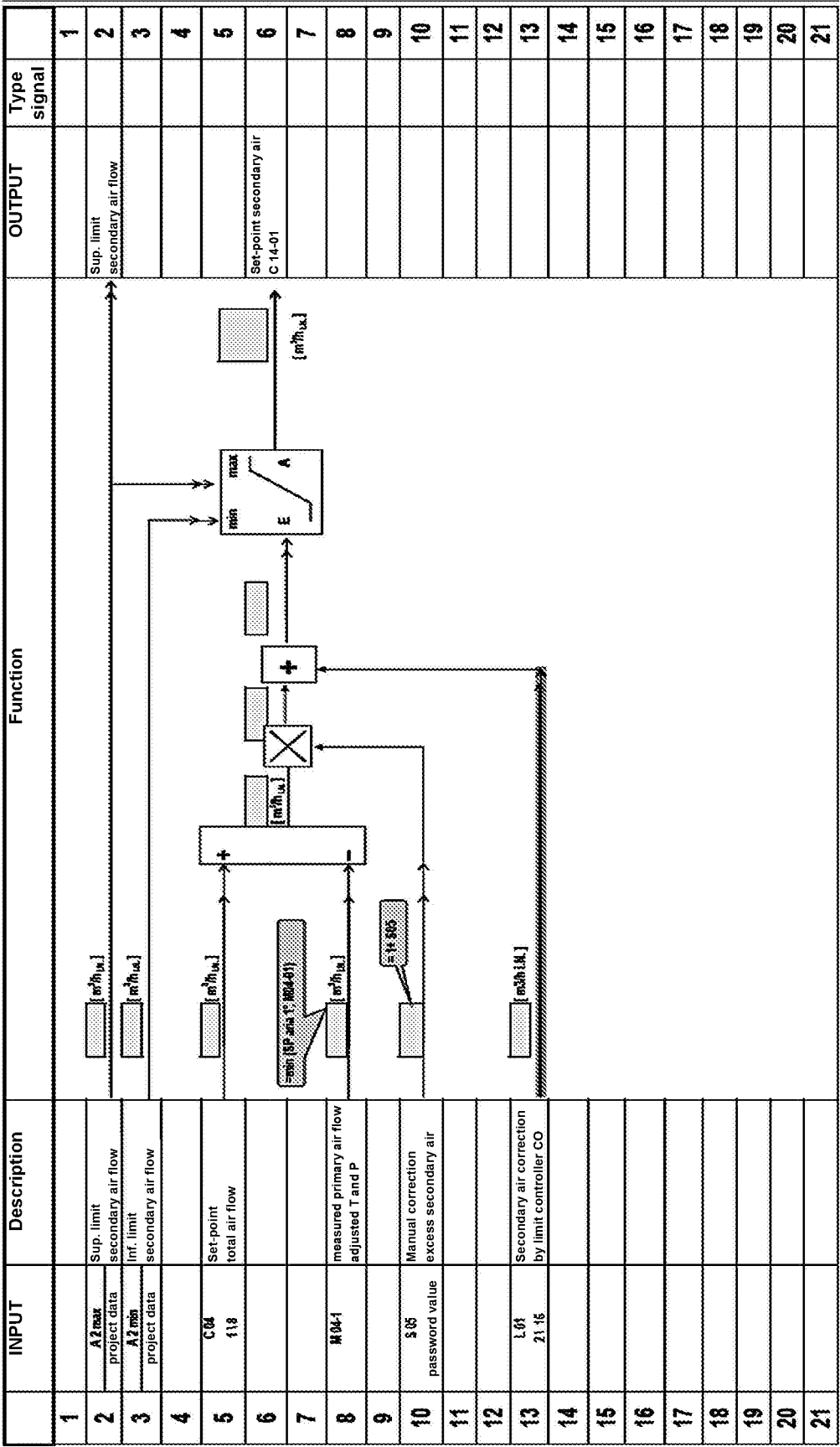


Fig. 6

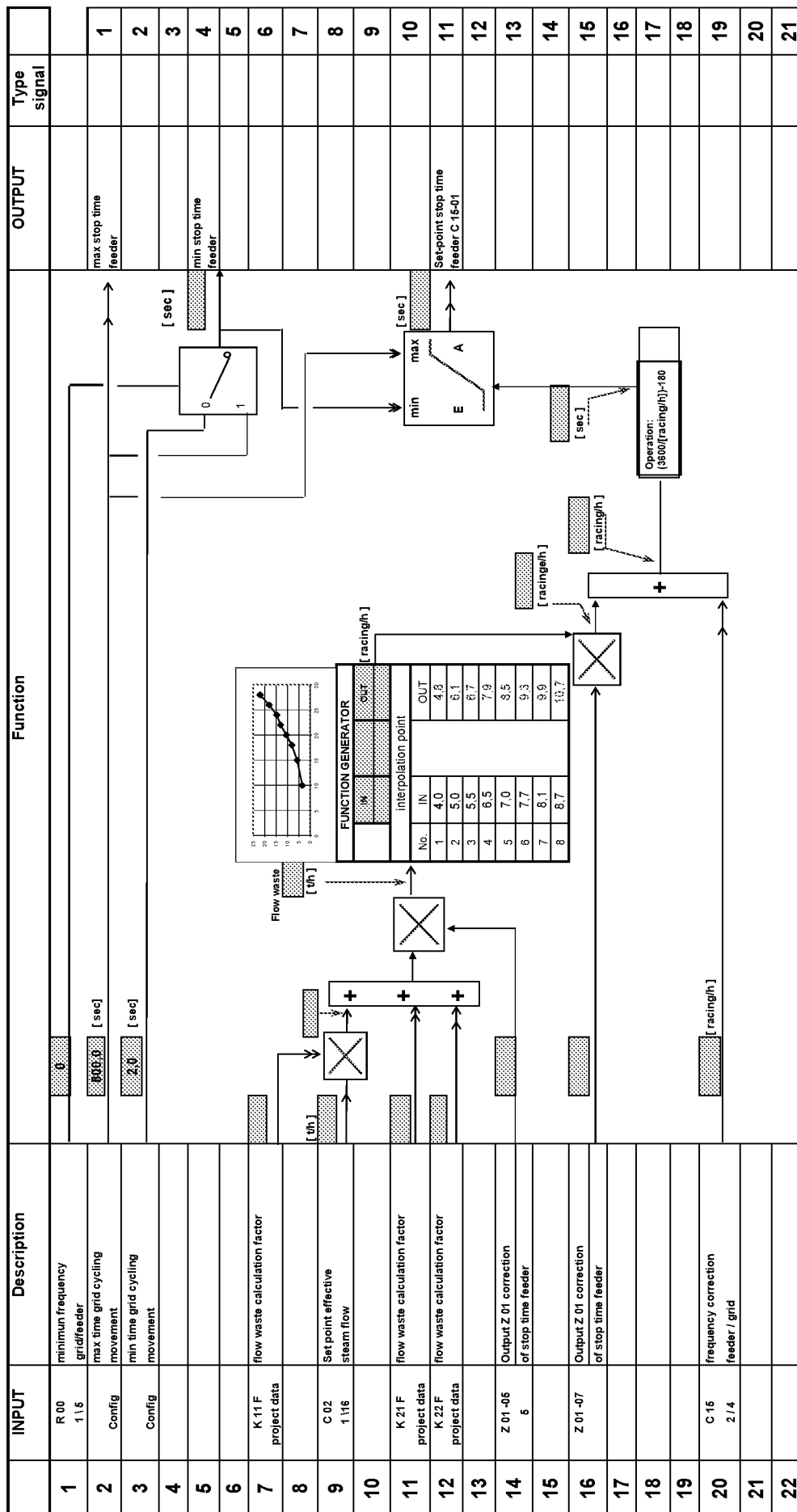


Fig. 7a

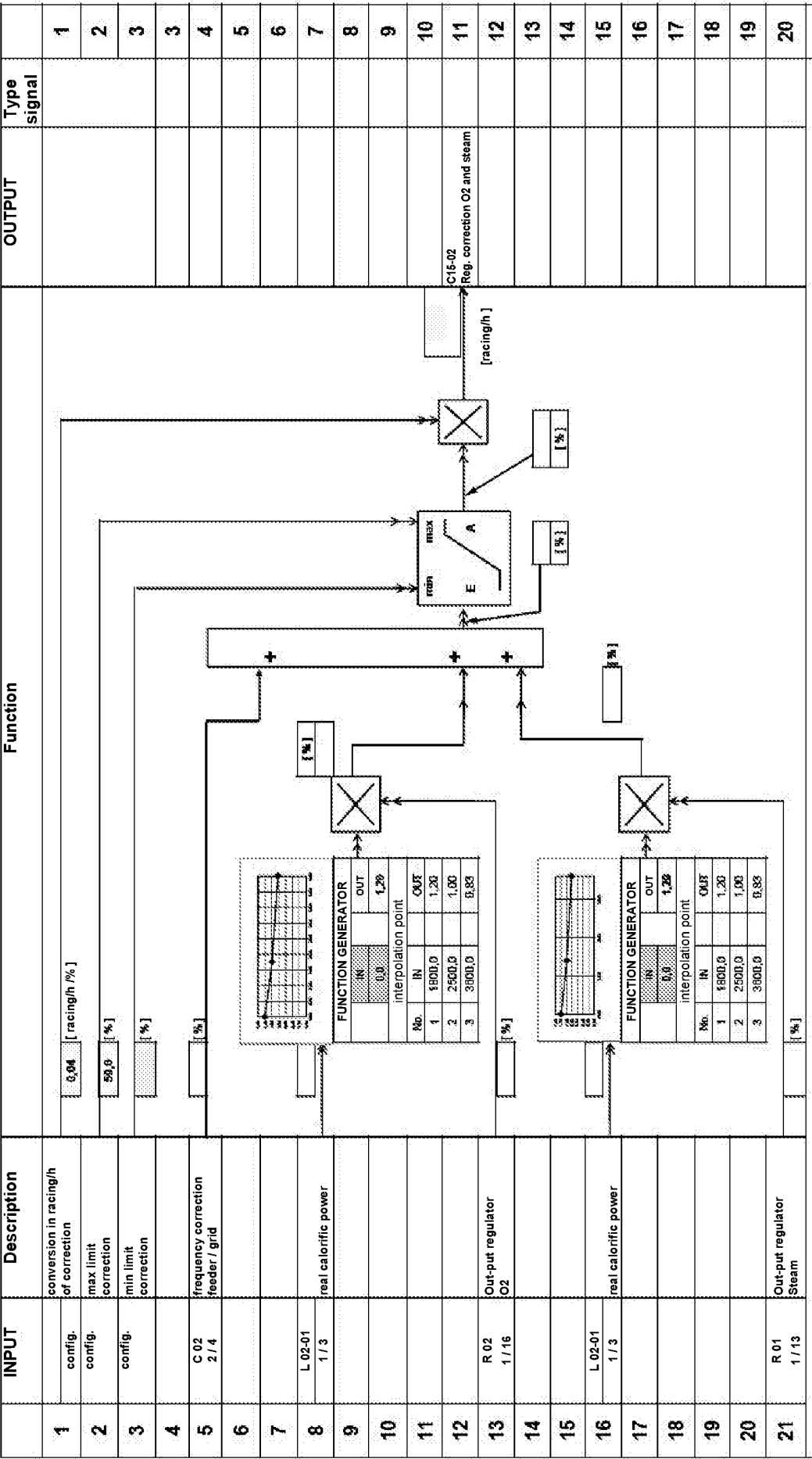


Fig. 7b

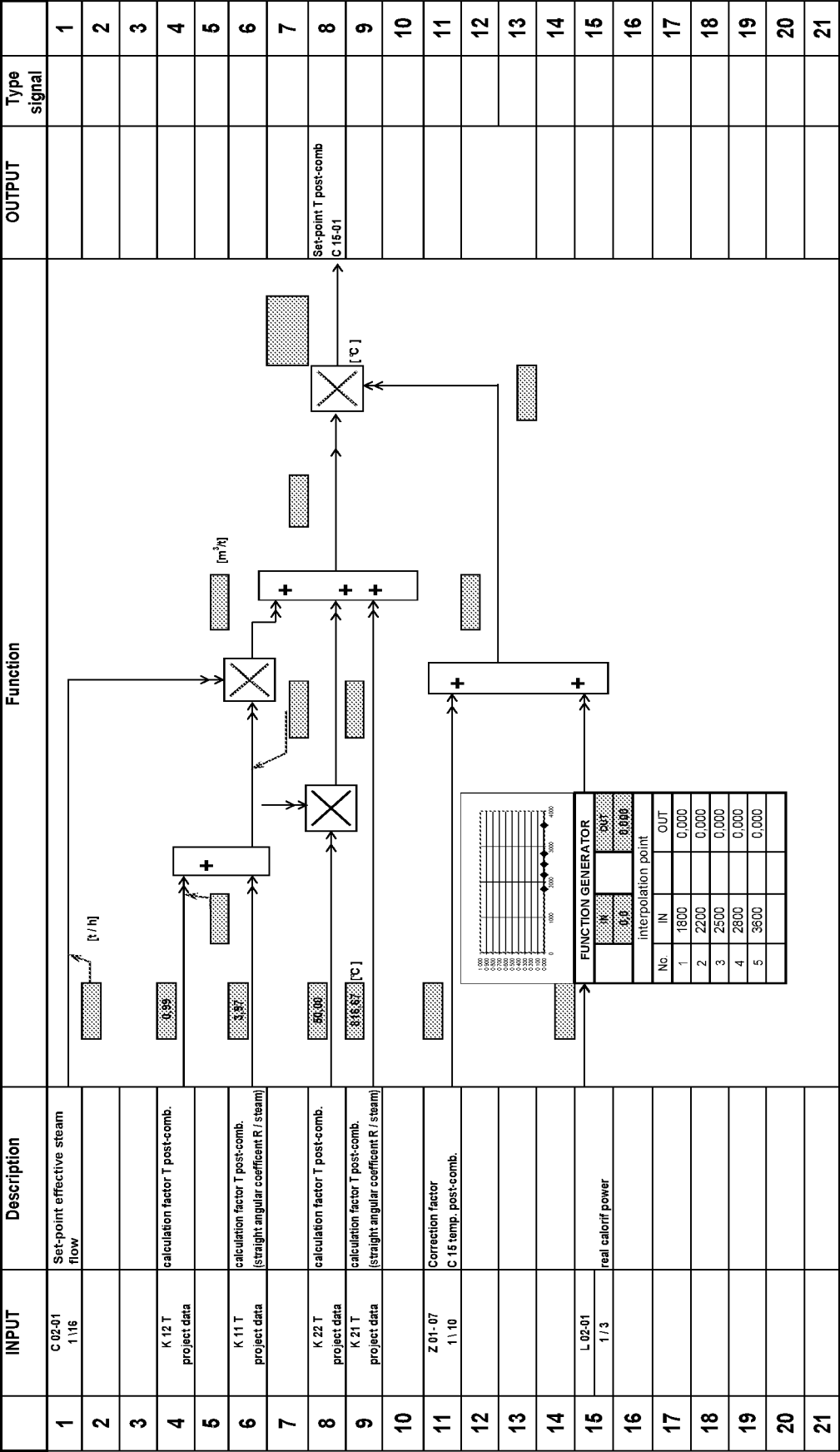


Fig. 8

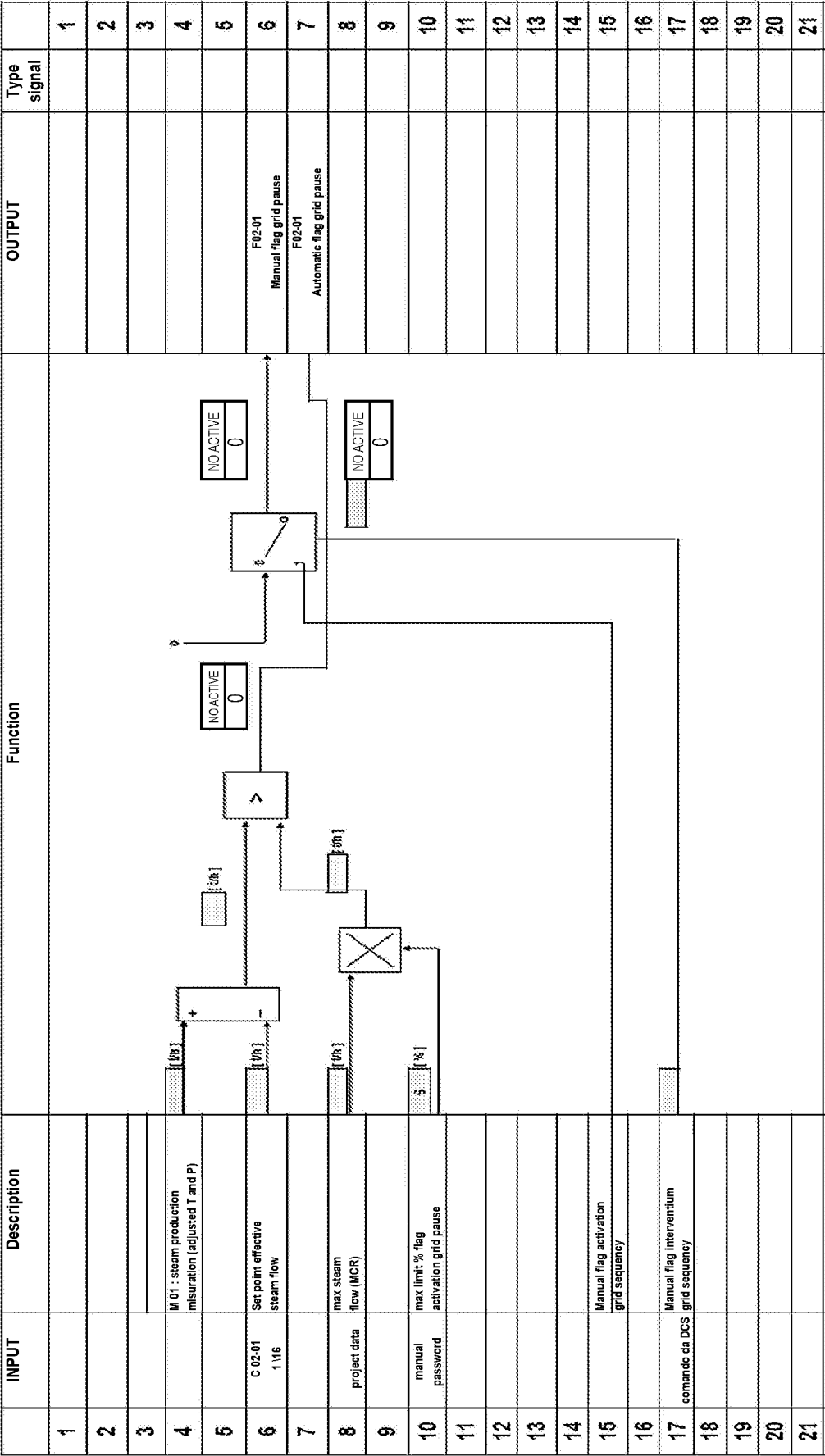


Fig. 9

INPUT		Description	Function	OUTPUT	Type signal
1	Config.	Delimitation regulation (scope (-1,5...+1,5))			

Fig. 10a

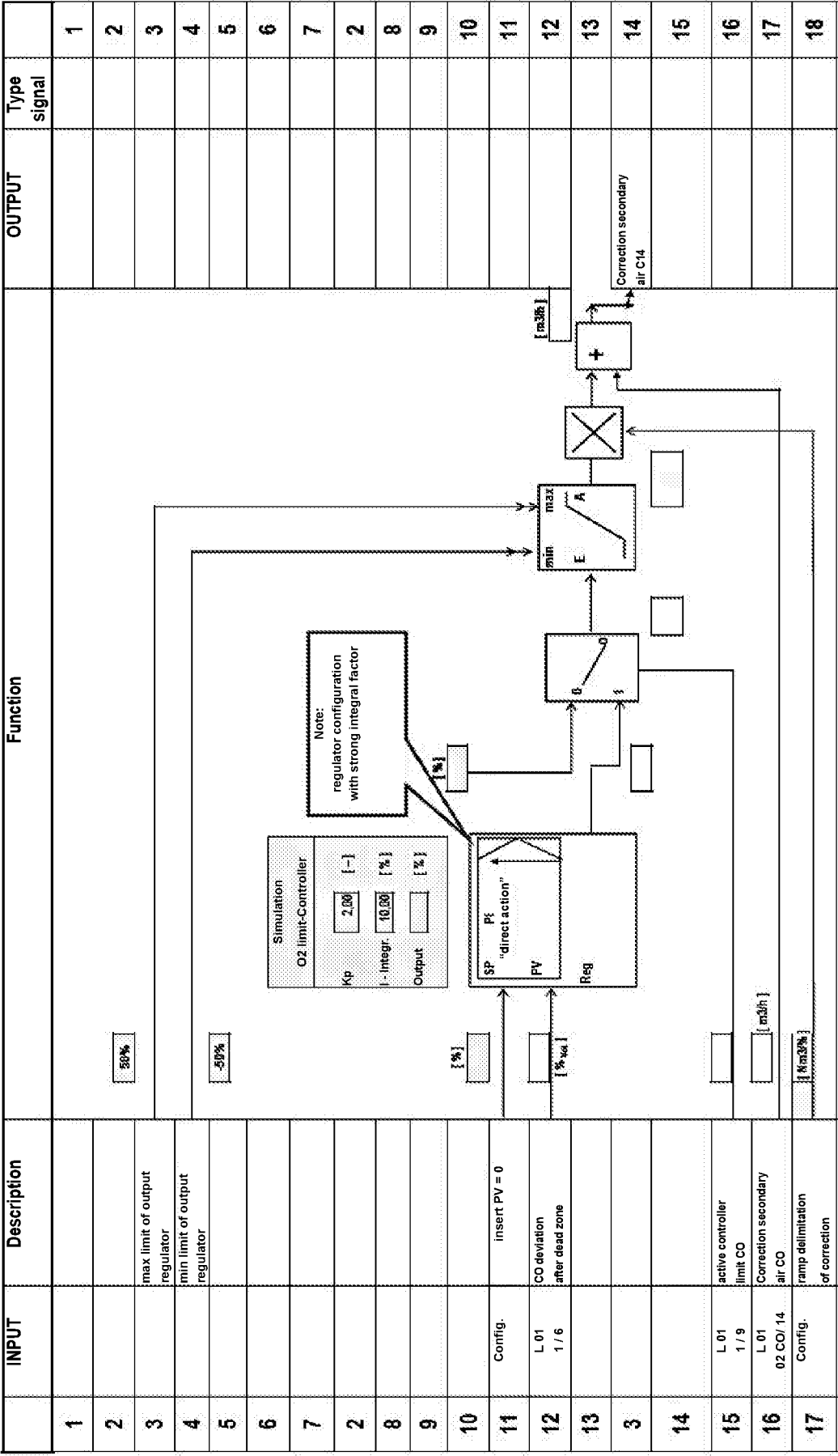


Fig. 10b

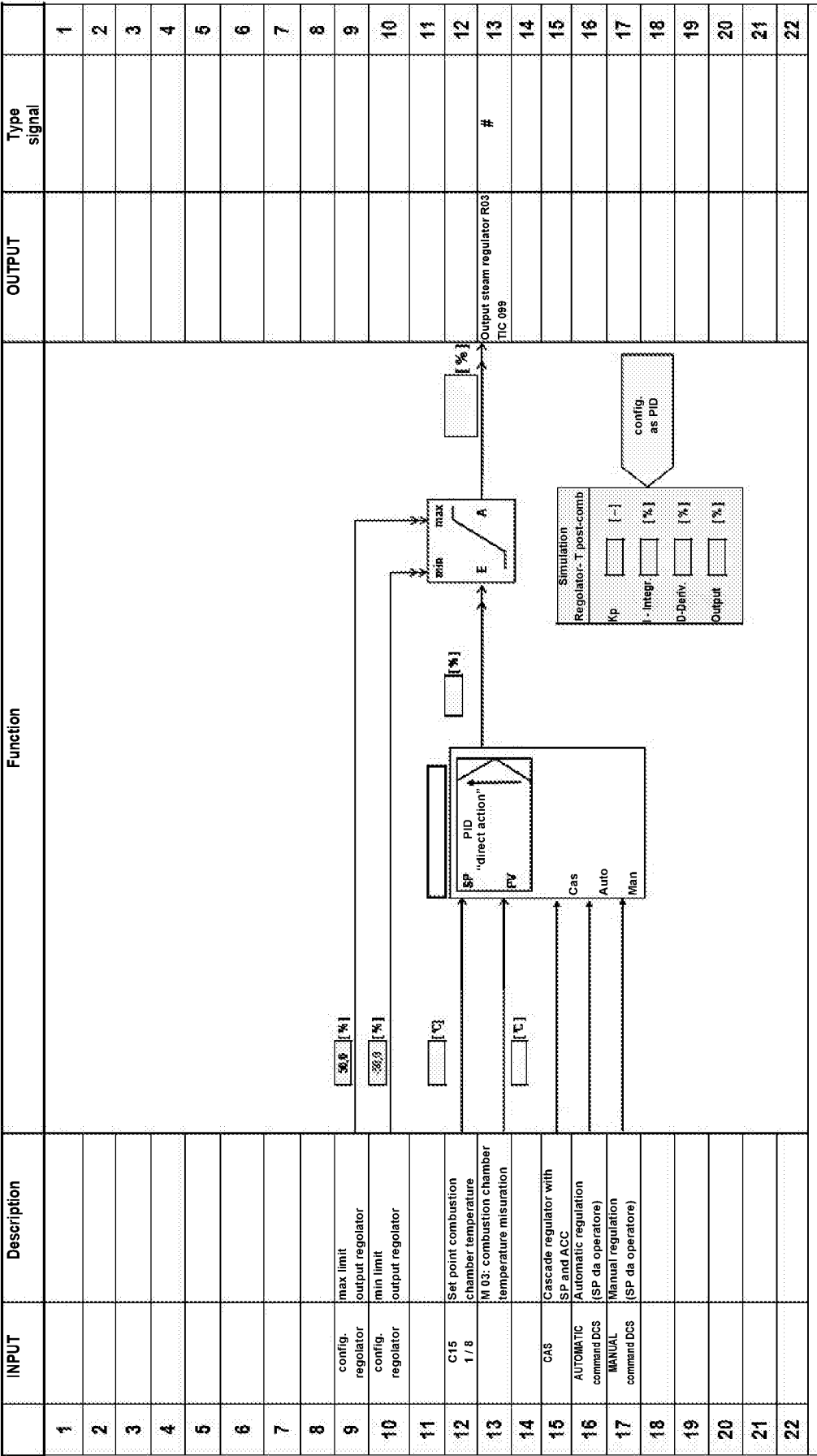


Fig. 11

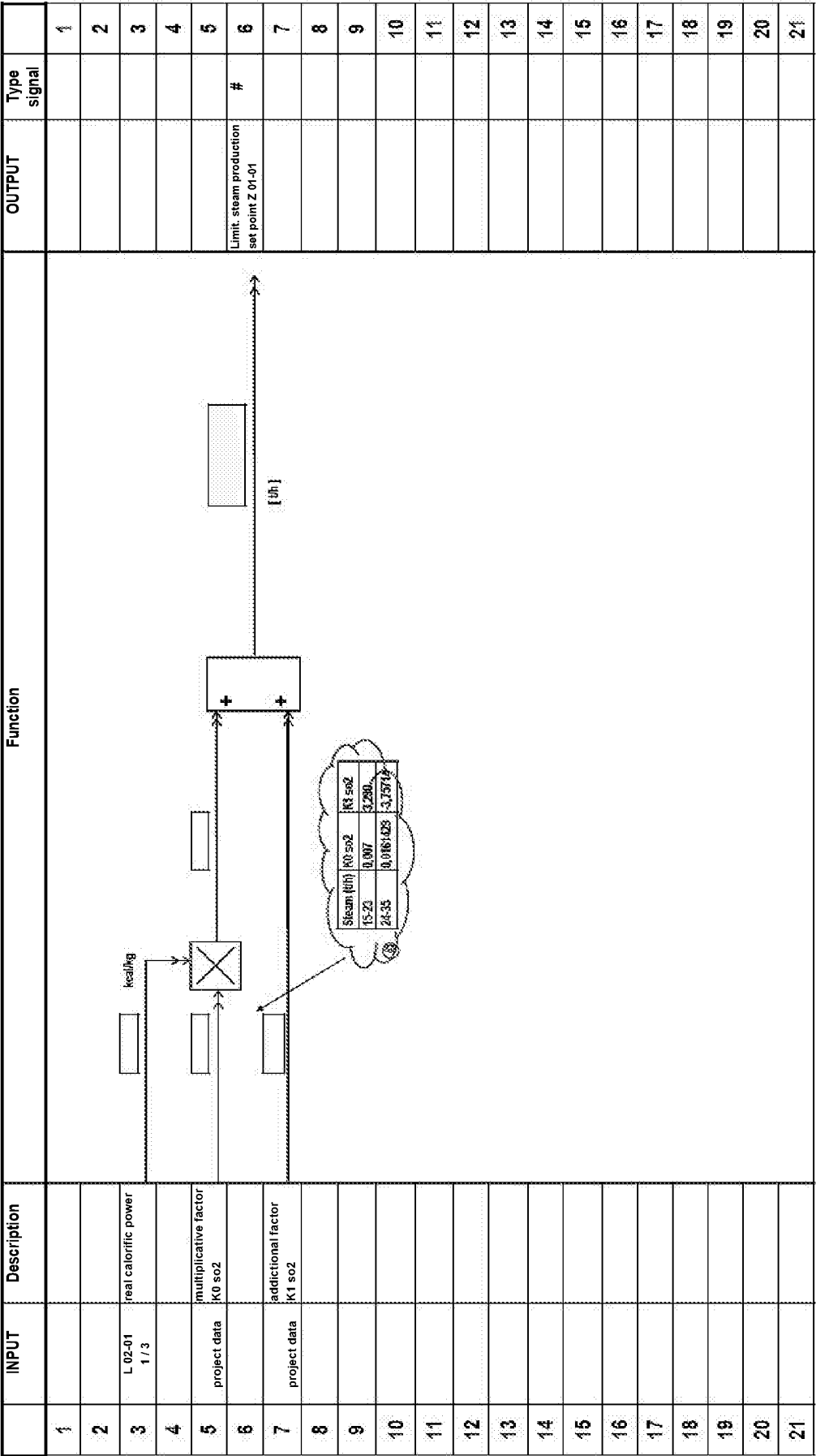


Fig. 12a

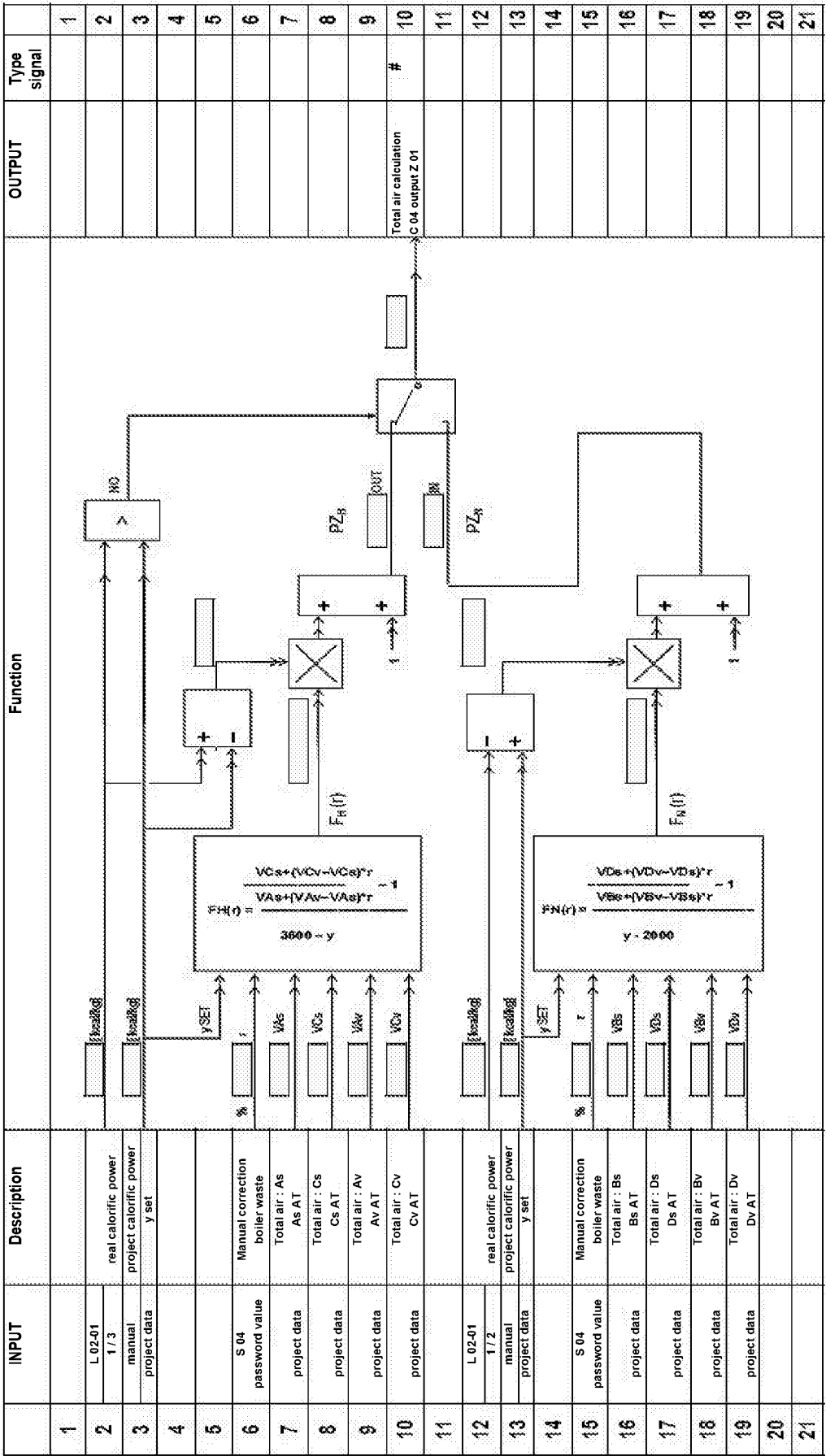


Fig. 12b

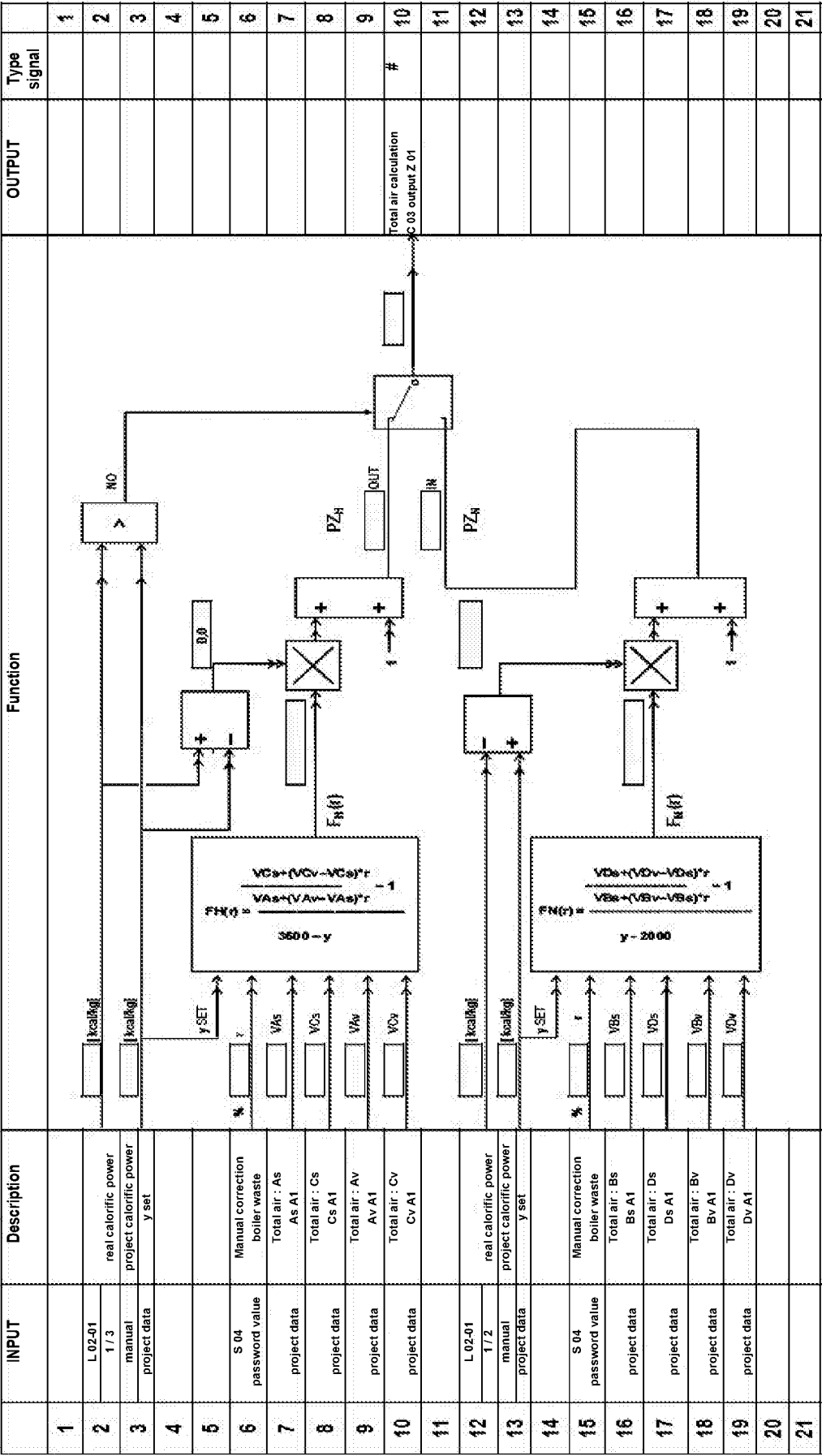
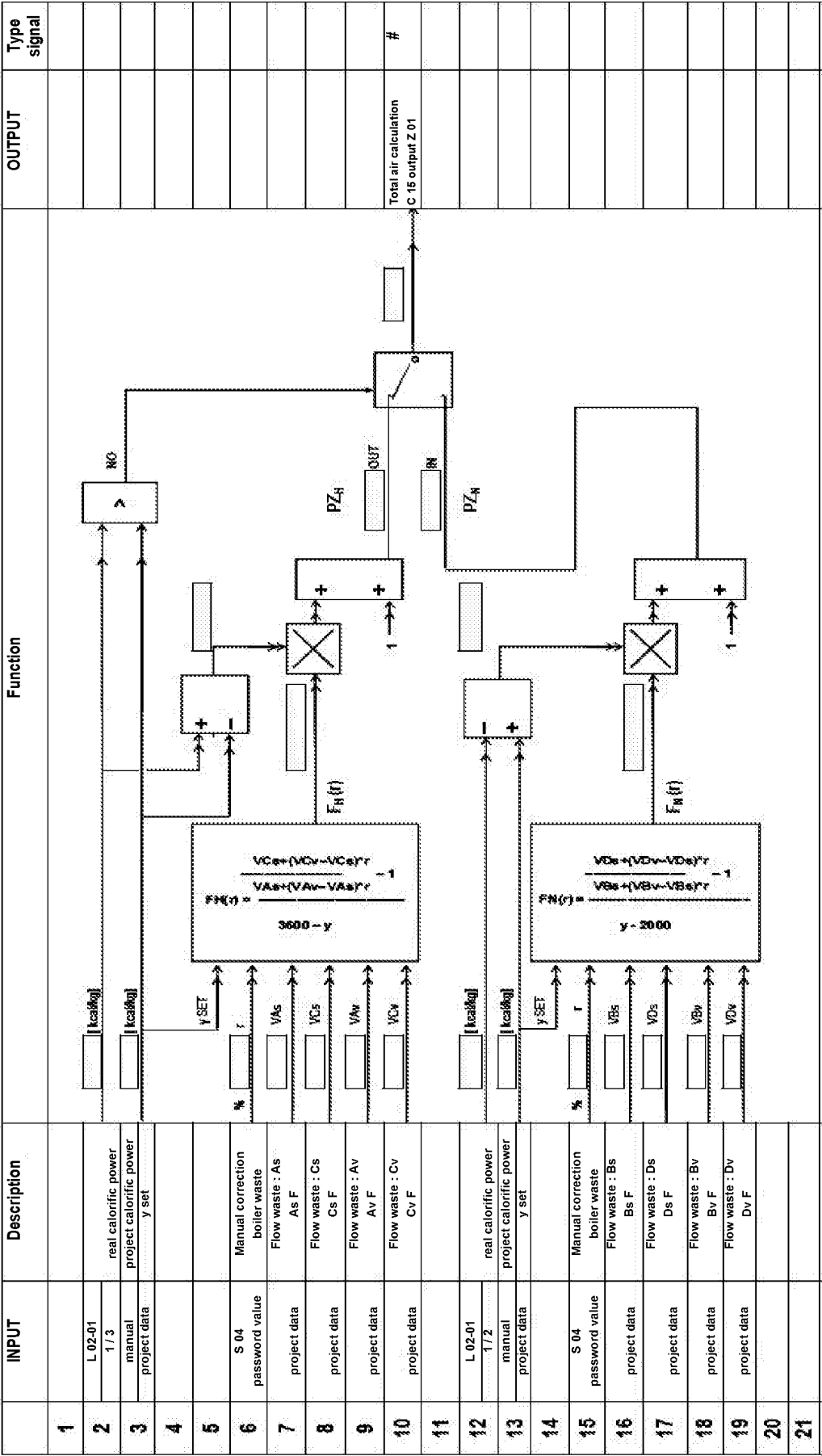


Fig. 12c



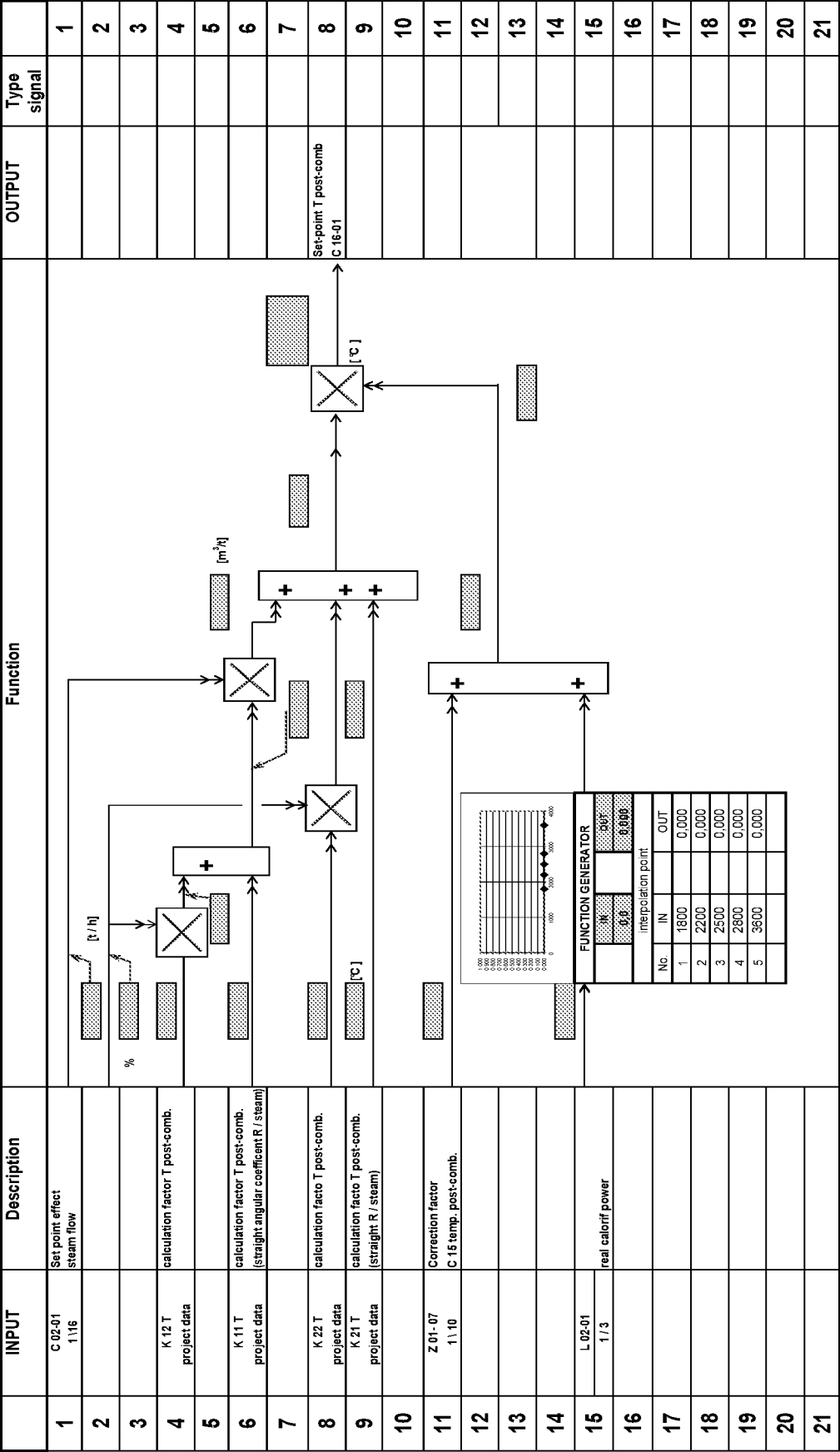


Fig. 12e

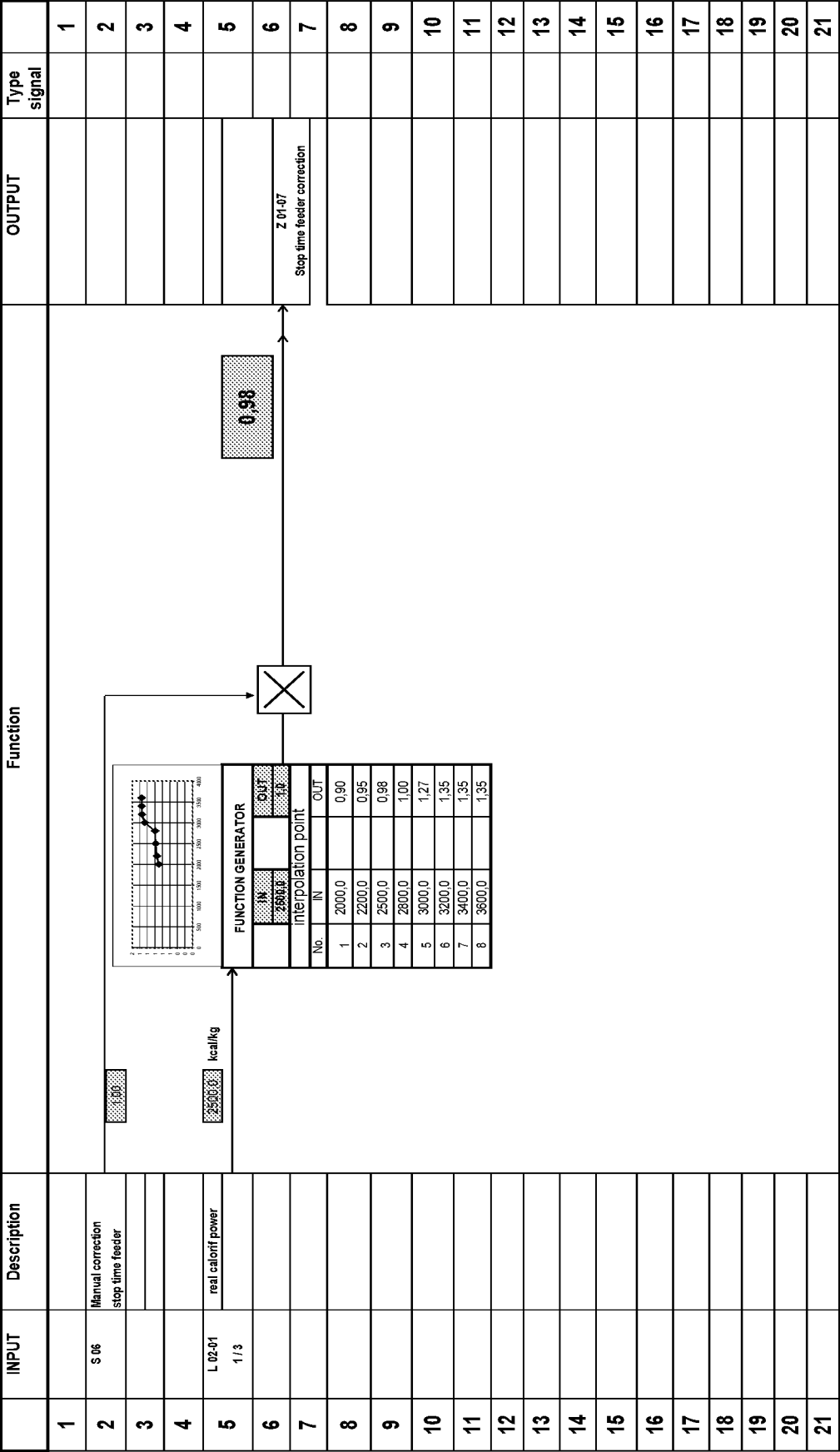


Fig. 12f

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2014/061495

A. CLASSIFICATION OF SUBJECT MATTER

INV. F23G5/50 F23G5/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F23G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EP0-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 1 726 876 A1 (TAKUMA KK [JP]) 29 November 2006 (2006-11-29) paragraphs [0018], [0019], [0021], [0023], [0031], [0033], [0034], [0037], [0038], [0062]; claims 4,9; figures 1,3,4	1-12
Y	EP 0 312 818 A2 (KUPAT AG [CH]) 26 April 1989 (1989-04-26) column 3, line 28 - line 54; figures 1,2	1-12
Y	US 2003/010269 A1 (SCHIRMER ALFONS [CH] ET AL) 16 January 2003 (2003-01-16) paragraphs [0009], [0010], [0029], [0030]	5
	----- -/-	



Further documents are listed in the continuation of Box C.



See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"&" document member of the same patent family

Date of the actual completion of the international search

9 October 2014

Date of mailing of the international search report

16/10/2014

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Authorized officer

Mougey, Maurice

INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2014/061495

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	JP H04 324015 A (KUBOTA KK) 13 November 1992 (1992-11-13) abstract; figure 1 -----	1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2014/061495

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