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(54) A CONTROLLING METHOD OF A GENERATOR SET PROVIDED WITH A BYPASS SYSTEM

STEUERVERFAHREN FÜR EINEN MIT EINEM BYPASSSYSTEM VERSEHENEN
GENERATORSATZ

PROCÉDÉ DE COMMANDE D'UN ENSEMBLE GÉNÉRATEUR PRÉSENTANT UN SYSTÈME DE
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(56) References cited:

WO-A1-91/06807 **CN-A- 101 096 918**
CN-B- 87 101 723 **GB-A- 1 309 145**
JP-A- 03 037 304 **JP-A- 59 170 410**
JP-A- 60 228 710 **JP-A- 2002 115 805**
JP-A- 2002 277 192 **US-A- 2 132 732**
US-A- 4 471 446 **US-A- 4 598 551**

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- **FENG W.:** 'Comprehensive prevention of steam oxidation and solid particle erosion for the ultra-supercritical unit' **ELECTRIC POWER** vol. 40, no. 1, January 2007, pages 69 - 73, **XP008133537**
- **FENG W.:** 'Functions and configuration of the bypass system for 1000 MW' **ELECTRIC POWER** vol. 38, no. 8, August 2005, pages 53 - 56, **XP008133777**
- **ZHAO W.:** 'Some measures for alleviating solid particle erosion in steam turbines' **TURBINE TECHNOLOGY** vol. 33, no. 4, August 1991, pages 38 - 40, **XP008171693**
- **ZHAO W.:** 'Some measures for alleviating solid particle erosion in steam turbines' **JOURNAL OF ENGINEERING FOR THERMAL ENERGY AND POWER** vol. 7, no. 1, January 1992, pages 14 - 17, **XP008171692**

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Description

Field of the Invention

[0001] The present invention relates to the field of electric power thermal automation, and particularly to a control method for alternately opening the bypass valves of a steam turbine.

Background of the invention

[0002] With continuous improvement in the parameters of steam turbogenerator units, steam oxidation of metal as well as retention of fallen oxide skins in the boiler pipes is increasingly threatening the safe operation of the units. The retention and accumulation of oxide skins may easily happen in the boiler header. As shown in Figure 1, the main reason for the accumulation of oxide skins lies in the fact that: after the inlets of coiled pipes 1 distributed throughout the header have gathered steam 3 into a header 2, the gathered steam 3 is in turn discharged from steam pipes A and B that are connected with both sides of the header 2. The steam flow rate varies from place to place in the header when the steam is passing therethrough. The steam flow rate is maximum on both sides of A/B, and at the O-point in the header, the steam flow rate approximately approaches zero, forming a position of the lowest flow rate where the steam flow rate is the lowest, the impulse is minimum, and it is easy for foreign matters such as oxide skins to accumulate.

[0003] With the same principle, as in other implementations, if the O-point of the header is the steam outlet connected with the steam pipe, the steam flow rate at the corresponding point A or point B of the header approximately approaches zero, forming a region of the lowest flow rate (not shown).

[0004] The foreign matters (such as oxide skins) discharged from the coil pipe will stay in the region of low flow rate after entering the header. The foreign matters which have entered the header will gradually deposit and accumulate in the region of smaller steam impulse. Only under special operating conditions, for example, when the main steam door is unilaterally closed, these foreign matters can be blown out of the header. Large quantities of granular foreign matters such as oxide skins deposited in the region of low flow rate will endanger the safety of the pipelines connected with this region as well as the safety of the whole unit.

[0005] Therefore, it is necessary to develop a technology to reach the goal of removing the foreign matters such as oxide skins in the header, reducing the erosion rate of solid particles in the turbine and thus improving the safety of the unit.

[0006] A method using water to discharge sludge in a lower branch pipe at a lower portion of a steam boiler and difficult to be discharged with only a total blow is known from JP 2002115805A. However, this method is

unrelated to the goal of removing the foreign matters such as oxide skins in a header.

Summary of the Invention

[0007] In view of aforesaid deficiency in the prior art, an issue to be addressed by the present invention is to provide a low-cost but high-efficient control method so as to reach the goal of reducing the foreign matters such as oxide skins in the header, reducing the erosion rate of solid particles in the turbine and thus improving safety of the unit.

[0008] To achieve the aforesaid object, the present invention provides a bypass control method, comprising the following steps:

Step 1: during the starting period of the generating unit provided with a bypass system, said boiler is firstly started in a conventional mode by means of said bypass system, and its steam parameters have basically met the conditions for impulse starting the turbine; said bypass system comprises a first-side bypass valve group and a second-side bypass valve group that are respectively set on the main steam pipe and the reheat steam pipe which are connected with both sides of said outlet header of the superheater or reheater of the boiler:

Step 2: closing said second-side bypass valve group and at the same time forcing said first bypass valve group to a wide open position, so that said steam that passes through said header is unilaterally discharged only from said first-side bypass valve group in the open state;

Step 3: after maintaining said first-side bypass valve group in the open state for a required time period, closing said first-side bypass valve group and at the same time opening said second-side bypass valve group, so that said steam that passes through said header is discharged only from said second-side bypass valve group in the open state via the other side; Step 4: after maintaining said second-side bypass valve group in the turning-up state for a required time period, restoring the conventional control state of said bypass system and being prepared to impulse start the turbine.

[0009] Preferably in said step 1, said boiler shall have completed the starting and be prepared to impulse start the turbine.

[0010] Preferably, after said step 3, said steps 2 and 3 can be repeated, until it is sure that the foreign matters in said header are removed and that the quality of said steam reaches an acceptance value.

[0011] Preferably, said first-side bypass valve group and/or said second-side bypass valve group are alternately opened /closed in a program-controlled mode.

[0012] Preferably after said step 4, the conventional control mode of said bypass system can be immediately

restored and it is prepared to impulse start the turbine.

[0013] Preferably, said bypass system is a high-pressure bypass or a low-pressure bypass. The control strategy of this method is also applicable to a low pressure bypass to reduce the accumulation of foreign matters (such as oxide skins) in the outlet header of the reheater.

[0014] Preferably, said first-side bypass valve group and said second-side bypass valve group respectively comprise at least one bypass valve.

[0015] Preferably, the greater the capacity of said bypass valve group is, the better the sweeping effect on the header is.

[0016] The bypass control method provided by the present invention realizes alternate changing of the steam flow direction in the header by controlling the alternate opening of the two sides of the bypass valves, without need of adding any hardware facility or extra expenditure. Due to the alternate changing of the steam flow direction in the header, the region of the lowest flow rate in the header is alternately shifted along with the alternate changing of the steam flow direction, so that there is no fixed position of the lowest flow rate in the header, i.e., no existence of dead point of flow rate, and all regions in the header are swept in an all-side way, so as to reach the goal of removing such foreign matters as oxide skin in the header, reducing the erosion rate of solid particles in the turbine and thus improving safety of the unit.

[0017] The concept, the specific configuration and the resulted technical effects of the present invention will be further described hereinafter in conjunction with the attached drawings, in order to adequately understand the objects, features and effects of the present invention.

Brief Description of the Drawings

[0018]

Figure 1 is a schematic diagram of the steam flow directions in a unit header according to the conventional bypass control method of prior art.

Figure 2 is a schematic diagram of the arrangement of the unit provided with a bypass system.

Figure 3 is a schematic diagram of the stream flow rate in the header at a stage of alternately opening of the unit according to the bypass control method of the present invention.

Figure 4 is a flow chart of the control method according to the present invention.

Detailed Description of the Preferred Embodiments

[0019] Figure 2 is a schematic diagram showing the arrangement of a one-reheating unit provided with a bypass system. At least two main machines are provided in the thermoelectric generating unit: a turbine 10 and a boiler 1, and the bypass system is the main component to adjust and coordinate the two main machines. In the

operating process of the unit, the steam transmitted from the boiler 1 passes through a superheater 2 and enters a superheater outlet header 5, then, after passing through a main steam pipe 11, the steam enters an HP cylinder of the turbine 10 via a main intake door and an adjusting door (not shown) of the turbine to do work, and the discharged steam enters a reheater 3 in the boiler after passing a cold section 4 of the reheater. The high-pressure bypass is located between the outlet header 5 of the boiler and the cold section 4 of the reheater, and the low-pressure bypass is located between the outlet header of the reheater and the condenser (not shown), and the embodiment described herein is also applicable to a low pressure bypass. The bypass system to which the present invention is applied comprises a first-side bypass valve group and a second-side bypass valve group or a low-pressure bypass (not shown) that are respectively provided on the main steam pipe and the reheat steam pipe, which are connected with both sides of the outlet header of the superheater or reheater of the boiler. In this embodiment, the first-side bypass valve group comprises bypass valves 6 and 7, and the second-side bypass group comprises bypass valves 8 and 9.

[0020] Under normal operating conditions, the steam enters the HP cylinder of the turbine 10 via a main steam pipe 11 for doing work. However, under abnormal operating conditions such as in the starting stage, an embodiment of the bypass control method according to present invention comprises the following steps (the control method for a low pressure bypass is the same):

Step 1: at the starting stage of the unit provided with a bypass system, the steam transmitted from the superheater 2 of the boiler 1 passes through the bypass system via an outlet header 5, and then enters the reheater of the boiler via the cold section 4. The bypass system comprises bypass valves 6 and 7 of the first-side bypass valve group and bypass valves 8 and 9 of the second-side bypass valve group that are respectively provided on the main steam pipe and the reheat steam pipe, which are connected with both sides of the outlet header of the superheater 2 or the reheater 3 of boiler 1.

Step 2: at the starting stage, when the steam parameter has basically met the conditions for impulse starting the turbine (by this time, both bypass valve groups shall be in the open state), firstly closing the bypass valves 8 and 9 mounted on the outlet pipeline on one side of the outlet header 5, and at the same time turning up the bypass valves 6 and 7, so that the steam that has passed through the outlet header 5 is discharged only via the bypass valves 6 and 7 in the open state. As shown in Figure 3, since the bypass valves 6 and 7 are opened while the bypass valves 8 and 9 remain in the closed state, the steam in the outlet header 5 is discharged from the pipeline on the same side with the bypass valves 6 and 7 via Point A, and by this time, Point B is a point of zero

flow rate, and such foreign matters as oxide skins that are deposited in the regions, excluding the neighboring regions of Point B, are blown out of the outlet header 5 along with the steam, and the farther the distance from Point B is, the greater the scouring momentum of the steam is.

Step 3: maintaining the bypass valves 6 and 7 in a wide open state, after the steam pressure in the pipeline has become stable and remains the same for a required time period, closing the bypass valves 6 and 7 and at the same time starting the bypass valves 8 and 9, so that the steam that passes through the outlet header 5 is discharged from the bypass valves 8 and 9 on the other side; since the bypass valves 8 and 9 are open, the steam that has passed through the outlet header 5 is discharged from the pipeline located on the same side with bypass valves 8 and 9 via Point B, and by this time, Point A is a point of zero flow rate, and such foreign matters as oxide skins that are deposited in the regions, excluding the neighboring regions of Point A, are blown out of the outlet header 5 along with the steam, and the farther the distance from Point A is, the greater the scouring momentum of the steam is.

Step 4: maintaining the bypass valves 8 and 9 in the wide open state, after the steam pressure in the pipeline has become stable and remains the same for a required time period, restoring the conventional control state of the bypass system and being prepared to impulse start the turbine.

[0021] The steps described above are shown in Figure 4.

[0022] According to the bypass control method of the present invention, the alternate changing of the steam flow direction in the header is changed by controlling the alternate opening of the two sides of the bypass valves, without need of adding any hardware facility or extra expenditure. Due to the alternate changing of the steam flow direction in the header, the region of the lowest flow rate in the header alternately changes in position along with the alternate changing of the steam flow direction, so that there is no fixed position of the lowest flow rate in the header, i.e., there is no dead point of the flow rate, and all regions in the header are swept in an all-side way, so as to reach the goal of removing foreign matters such as oxide skins in the header, reducing the erosion rate of the solid particles in the turbine and thus improving the safety of the unit.

[0023] The method of the present invention is not limited to aforesaid embodiment.

[0024] Preferably, in other embodiments of the present invention, a full program-controlled mode can be adopted and all the control systems of the present invention can be included in the unit starting program control, so as to automatically shift and realize the operations of opening/closing the first-side bypass valve group and/or the second-side bypass valve group, without the need of

manual participation or intervention. Meanwhile, this control method can be designed into the starting mode of the bypass itself, without affecting starting time and operation safety of the unit.

[0025] Further, the control method of the present invention is not limited to a single opening/closing alternate operation in said embodiment. According to actual requirements, after said step 3, the process of repeating the step 2 and step 3 can be added for one or many times, i.e., it includes unilaterally alternate opening/closing operations for many times, until it is for sure that the foreign matters in said header have been removed and that the quality of said steam reaches the acceptance value.

[0026] After the step 4, when the unit has completed the starting process, the conventional control state of the bypass system is to be restored and it is prepared to impulse start the turbine.

[0027] Said first-side bypass valve group and the second-side bypass valve group in the present invention have no limitation on the quantity of the valves. In aforesaid embodiments, the first-side bypass valve group and the second-side bypass valve group respectively comprise two bypass valves in each group. In other embodiments of the present invention, each bypass group may also comprise either one bypass valve or a plurality of bypass valves, and the selection of the quantity of the bypass valves mainly depends on the steam flow rate and the bypass capacity.

[0028] The method of the present invention can also be used in combination with other control methods for bypass systems.

[0029] In summary, only several preferred embodiments of the present invention have been described.

Claims

1. A bypass control method for a generating unit, comprising the following steps:

step 1: during the starting period of a generating unit provided with a bypass system, a boiler (1) being firstly started by means of said bypass system in normal mode; wherein said bypass system comprises a first-side bypass valve group and a second-side bypass valve group that are respectively provided on the main steam pipe and/or the reheat steam pipe, which are connected with both sides of an outlet header (5) of a super heater (12) and/or reheater (3) of said boiler (1);

step 2: closing said second-side by-pass valve group and at the same time forcing said first by-pass valve group to a wide open position, so that said steam that passes through said header (5) is unilaterally discharged only from said first-side bypass valve group in an open state;

step 3: after maintaining said first-side bypass

valve group in an open state for a required time period, closing said first-side bypass valve group and at the same time opening said second-side bypass valve group, so that said steam that passes through said header (5) is discharged only from said second-side bypass valve group in the open state;

step 4: after maintaining said second-side bypass valve group in a starting state for a required time period, restoring a normal control state of said bypass system and being prepared to impulse start a turbine.

2. The bypass control method of Claim 1, wherein in said step 1 should be carried out prior to impulse starting said turbine.
3. The bypass control method of Claim 1, wherein after said step 3, said steps 2 and 3 can be repeated, until foreign matters in said header (5) have been removed and that a quality of said steam reaches, an acceptance value.
4. The bypass control method of Claim 1, wherein said first-side valve group and/or said second-side bypass valve group are alternately opened/closed in a program-controlled mode.
5. The bypass control method of Claim 1, wherein after said step 4, the normal control mode of said bypass system can be immediately restored and it is prepared to impulse start the turbine.
6. The bypass control method of Claim 1, wherein said bypass system is a high-pressure bypass or a low-pressure bypass.
7. The bypass control method of Claim 1, wherein said first-side bypass valve group and said second-side bypass valve group respectively comprise at least one bypass valve.

Patentansprüche

1. Bypass-Steuerverfahren für eine Kraftwerkseinheit, das die folgenden Schritte umfasst:

Schritt 1: während des Startzeitraums einer Kraftwerkseinheit, die mit einem Bypass-System versehen ist, wird zuerst ein Kessel (1) mittels des Bypass-Systems in einem Normalbetrieb gestartet; wobei das Bypass-System eine Bypass-Ventilgruppe der ersten Seite und eine Bypass-Ventilgruppe der zweiten Seite, die jeweils bei der Hauptdampfleitung und/oder bei der Zwischendampfleitung vorgesehen sind, die mit beiden Seiten eines Austrittssammlers (5)

eines Überhitzers (12) und/oder eines Nachbrenners (3) des Kessels (1) verbunden sind, umfasst;

Schritt 2: Schließen der Bypass-Ventilgruppe der zweiten Seite und gleichzeitig Bringen der ersten Bypass-Ventilgruppe in eine weit offene Position, so dass der Dampf, der durch den Sammler (5) läuft, nur von der Bypass-Ventilgruppe der ersten Seite in einem offenen Zustand einseitig abgeführt wird;

Schritt 3: nach dem Halten der Bypass-Ventilgruppe der ersten Seite in einem offenen Zustand für einen erforderlichen Zeitraum, Schließen der Bypass-Ventilgruppe der ersten Seite und gleichzeitig Öffnen der Bypass-Ventilgruppe der zweiten Seite, so dass der Dampf, der durch den Sammler (5) läuft, nur von der Bypass-Ventilgruppe der zweiten Seite in dem offenen Zustand abgeführt wird;

Schritt 4: nach dem Halten der Bypass-Ventilgruppe der zweiten Seite in einem Startzustand für einen erforderlichen Zeitraum, Wiederherstellen eines Normalsteuerungszustands des Bypass-Systems und Schaffen der Bereitschaft für einen Impulsstart einer Turbine.

2. Bypass-Steuerverfahren nach Anspruch 1, wobei Schritt 1 vor einem Impulsstart der Turbine ausgeführt werden sollte.
3. Bypass-Steuerverfahren nach Anspruch 1, wobei nach dem Schritt 3 die Schritte 2 und 3 wiederholt werden können, bis Fremdstoffe in dem Sammler (5) entfernt worden sind und bis eine Qualität des Dampfes einen Akzeptanzwert erreicht.
4. Bypass-Steuerverfahren nach Anspruch 1, wobei die Ventilgruppe der ersten Seite und/oder die Bypass-Ventilgruppe der zweiten Seite in einer programmgesteuerten Betriebsart abwechselnd geöffnet bzw. geschlossen werden.
5. Bypass-Steuerverfahren nach Anspruch 1, wobei nach Schritt 4, die Normalsteuerungsbetriebsart des Bypass-Systems unmittelbar wiederhergestellt werden kann und für einen Impulsstart der Turbine bereit ist.
6. Bypass-Steuerverfahren nach Anspruch 1, wobei das Bypass-System ein Hochdruck-Bypass oder ein Niederdruck-Bypass ist.
7. Bypass-Steuerverfahren nach Anspruch 1, wobei die Bypass-Ventilgruppe der ersten Seite und die Bypass-Ventilgruppe der zweiten Seite jeweils wenigstens ein Bypass-Ventil umfassen.

Revendications

1. Procédé de commande en dérivation pour une unité de génération, comportant les étapes suivantes :

étape 1 : pendant la période de démarrage d'une unité de génération munie d'un système de dérivation, une chaudière (1) est d'abord démarrée au moyen dudit système de dérivation en mode normal ; ledit système de dérivation comportant un groupe de vannes de dérivation de premier côté et un groupe de vannes de dérivation de deuxième côté qui sont respectivement placés sur la conduite principale de vapeur et/ou la conduite de vapeur resurchauffée, qui sont raccordées avec les deux côtés d'un collecteur (5) de sortie d'un surchauffeur (12) et/ou réchauffeur (3) de ladite chaudière (1) ;

étape 2 : fermer ledit groupe de vannes de dérivation de deuxième côté et imposer en même temps audit premier groupe de vannes de dérivation une position grande ouverte, de telle sorte que ladite vapeur qui traverse ledit collecteur (5) soit unilatéralement refoulée uniquement à partir dudit groupe de vannes de dérivation de premier côté à l'état ouvert ;

étape 3 : après avoir maintenu ledit groupe de vannes de dérivation de premier côté à l'état ouvert pendant un laps de temps requis, fermer ledit groupe de vannes de dérivation de premier côté et ouvrir en même temps ledit groupe de vannes de dérivation de deuxième côté, de telle sorte que ladite vapeur qui traverse ledit collecteur (5) soit refoulée uniquement à partir dudit groupe de vannes de dérivation de deuxième côté à l'état ouvert ;

étape 4 : après avoir maintenu ledit groupe de vannes de dérivation de deuxième côté dans un état de démarrage pendant un laps de temps requis, rétablir un état de commande normale dudit système de dérivation et se préparer au démarrage par impulsion d'une turbine.

2. Procédé de commande en dérivation selon la revendication 1, ladite étape 1 devant être réalisée préalablement au démarrage par impulsion de ladite turbine.
3. Procédé de commande en dérivation selon la revendication 1, lesdites étapes 2 et 3 pouvant être répétées, après ladite étape 3, jusqu'à ce que des corps étrangers présents dans ledit collecteur (5) aient été éliminés et qu'une qualité de ladite vapeur atteigne une valeur d'acceptation.
4. Procédé de commande en dérivation selon la revendication 1, ledit groupe de vannes de premier côté et/ou ledit groupe de vannes de dérivation de deuxième

me côté étant ouverts/fermés en alternance dans un mode commandé par programme.

5. Procédé de commande en dérivation selon la revendication 1, après ladite étape 4, le mode de commande normale dudit système de dérivation pouvant être immédiatement rétabli et les préparatifs étant effectués pour le démarrage par impulsion de la turbine.
6. Procédé de commande en dérivation selon la revendication 1, ledit système de dérivation étant une dérivation à haute pression ou une dérivation à basse pression.
7. Procédé de commande en dérivation selon la revendication 1, ledit groupe de vannes de dérivation de premier côté et ledit groupe de vannes de dérivation de deuxième côté comportant respectivement au moins une vanne de dérivation.

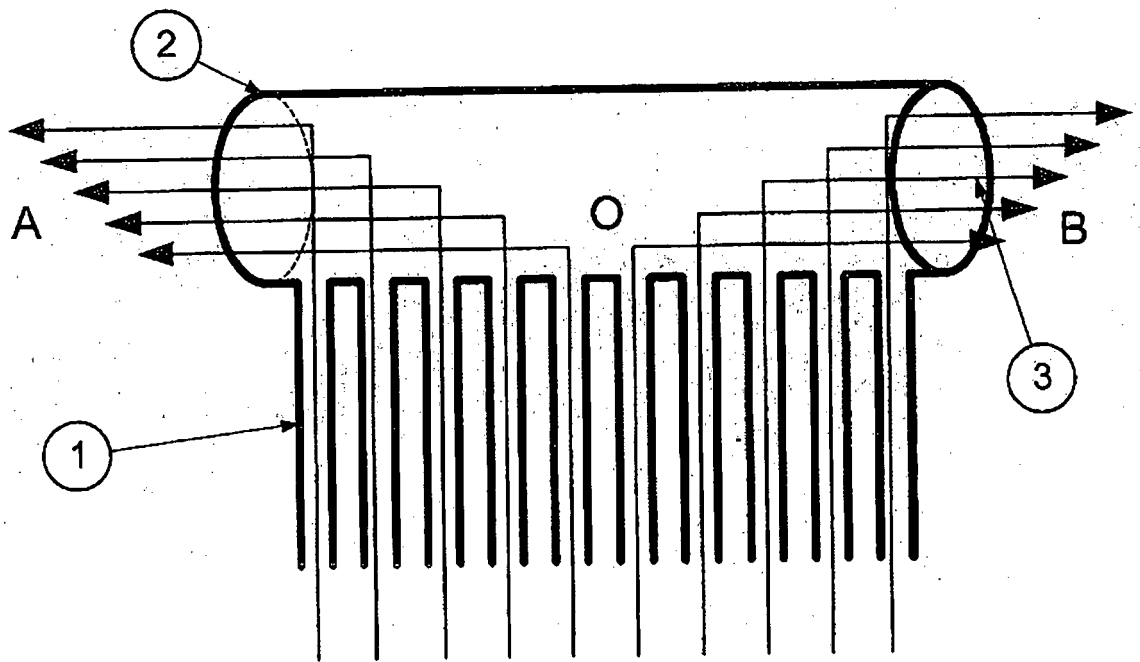


FIG. 1

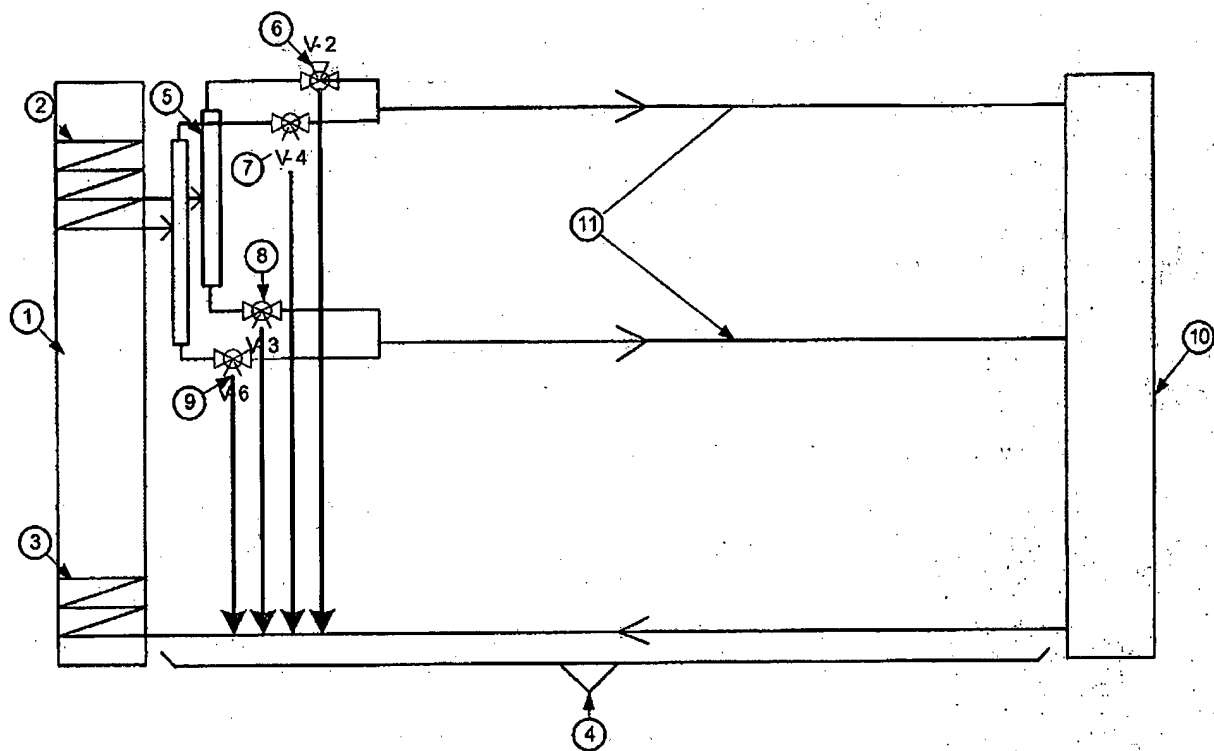


FIG. 2

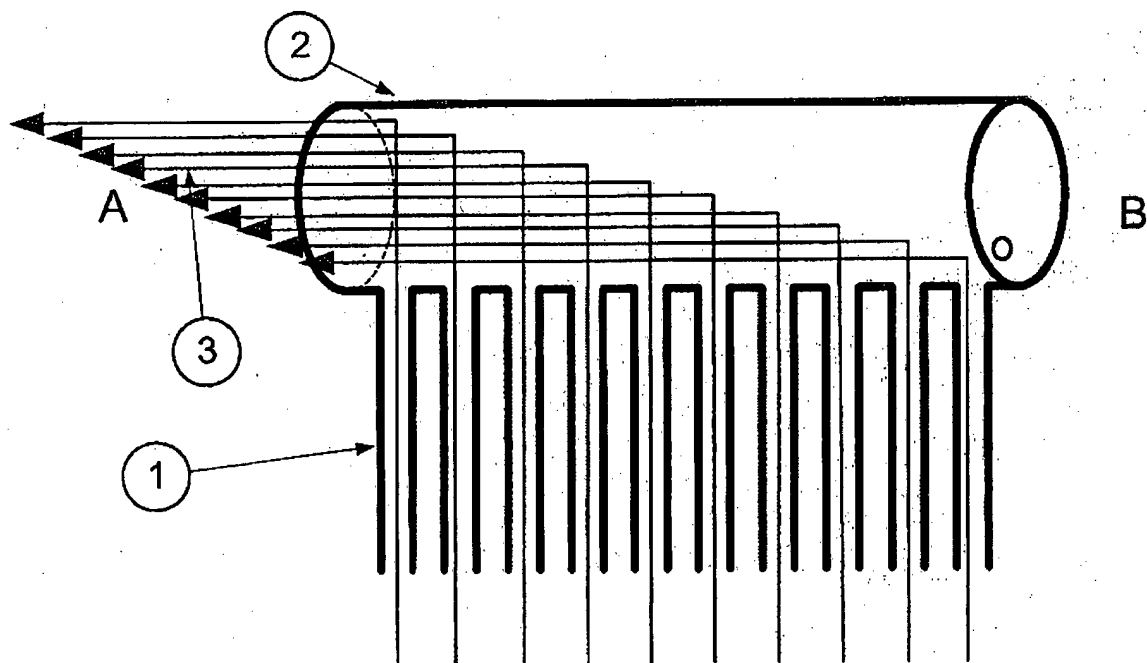


FIG. 3

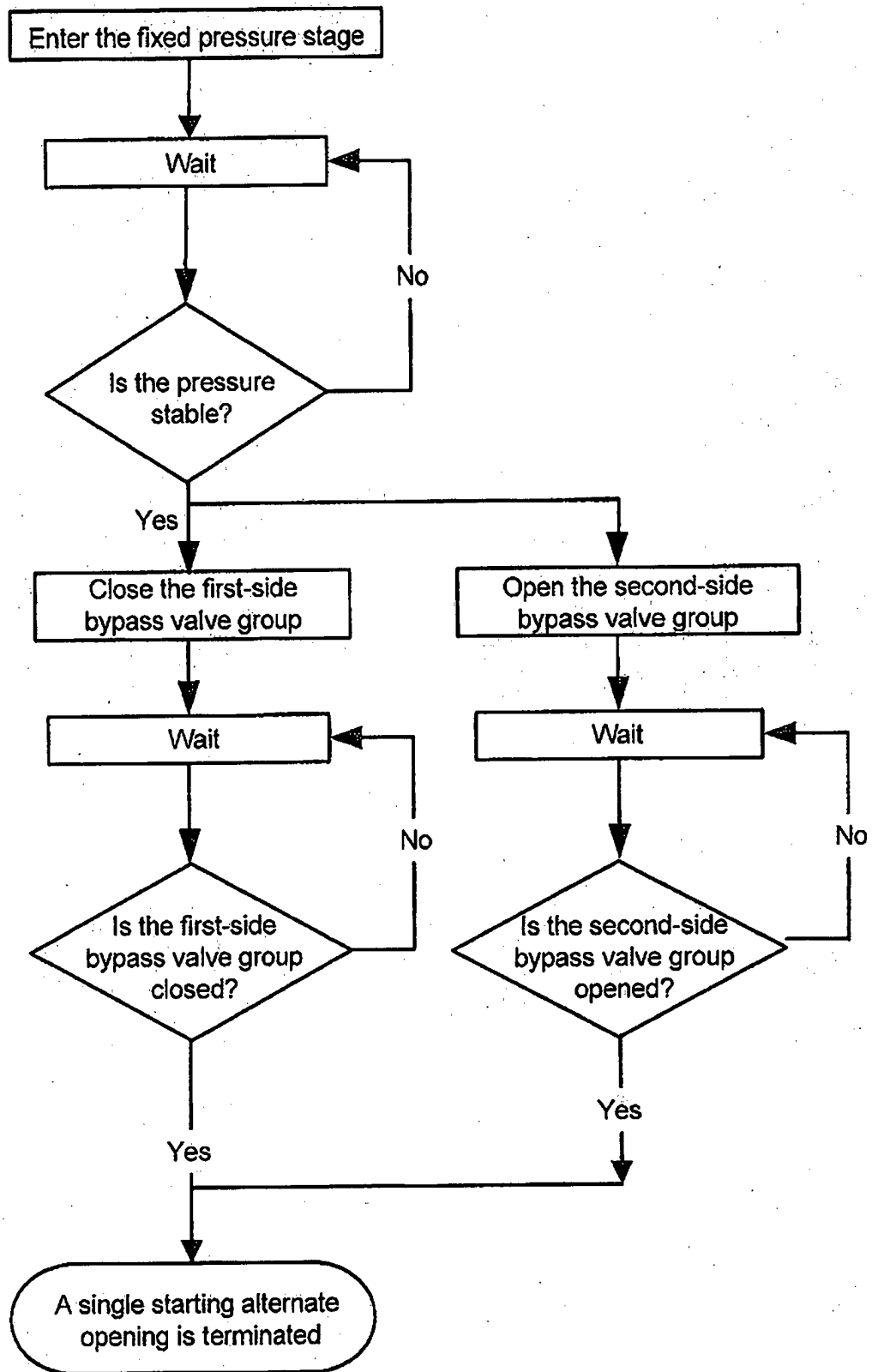


FIG. 4

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2002115805 A [0006]