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Method and apparatus for controlling the level of molten slag in a slagging coal gasifier and use thereof in operating a slagging coal gasifier

This invention relates to coal gasification plant, and in particular to a method of and apparatus for controlling the level of molten slag in the hearth of slagging coal gasifiers.

It is known to gasify coal or other carbonaceous fuel in slagging coal gasifiers of the kind (hereinafter referred to as the kind specified) in which coal or other carbonaceous fuel is introduced into the top of a column-like gasifying vessel and is gasified under high pressure and temperature by means of oxygen and steam introduced near the fuel bed through tuyeres. The residual ash collects as a molten slag and iron in the hearth of the gasifier vessel from which it is periodically discharged (commonly known as slag-tapping) downwardly through a slag tap outlet or orifice in the hearth into water contained in a quenching chamber. Usually, the pool of molten slag and iron is maintained in the hearth by directing hot combustion products from a burner located beneath the slag top orifice up the tap orifice to retain the slag and iron in the hearth by maintaining a positive differential pressure between the quench chamber and the gasifying vessel, that is, a higher pressure in the quench chamber. The tapping of the molten slag and iron being initiated and controlled by stopping or reducing the burner output and reducing the pressure in the quenching chamber by controlled venting to atmosphere through a venting system so as to reduce the differential pressure between the quenching chamber and the gasifier vessel.

Examples of such slagging gasifier plant are those disclosed in United Kingdom Patent Specification No. 977,122, the Gas Council Research Communication No. GC 50 and GC 112.

The problems which the present Invention seeks to overcome are those experienced with known methods of slag level control in a vessel with continuous liquid flow at varying rate and intermittent outflow. The particular difficulties which the system overcomes are:—

1. The lack of a consistent measurement of slag pool level.

2. The need to keep below the maximum permissible negative differential during taps. Above this differential, spraying occurs and the tap tends to block.

3. The need for rapid sensing and response to tap blockages to give quick clearance.

4. The need to avoid emptying the hearth, as this can cause a blocked tap.

5. The need for rapid system control if an irredeemably blocked tap is experienced.

According to the one aspect of the Invention, there is provided a method of controlling the level of molten slag in a slagging coal gasifier of the kind specified comprising the steps of, periodically tapping the slag from the hearth of the gasifier vessel through the slag tap orifice into the quench chamber using a system of timing means which set a maximum and a minimum predetermined period of time between slag tapping operations and which set the duration time of actual slag tapping, measuring the differential pressure between the gasifier vessel and the quench chamber whereby to given an indication of the level of slag in the hearth of the vessel and to cause initiation of a slag tapping operation when the slag reaches a predetermined level or when any deviations from the expected differential pressure measurements caused by malfunctions being detected and used to override the timer system until the malfunctions have been corrected.

According to another aspect of the Invention, there is provided an apparatus for carrying out the method described above comprising a system of timing means for setting said maximum and minimum periods and for setting the said slag tapping duration time, means for measuring said differential pressure and for producing a signal representative of said measurement, and means responsive to said signal for initiating a slag tapping operation when the slag reaches said predetermined level or when any said deviations from the expected differential pressure measurement is detected.

To enable the Invention to be more clearly understood, and solely by way of example, one embodiment of the Invention will now be described with reference to the accompanying drawings, in which:—

Figure 1 is a schematic flow diagram of the slag level control arrangement of timers and differential pressure trips,

Figure 2 is a schematic diagram showing an arrangement for measuring the differential pressure (and hence the slag level before tapping) and controlling the differential pressure, (and hence the slag flow rate) during a slag tapping operation in a slagging coal gasifier of the kind specified, and

Figure 3 is a schematic diagram showing how a burner rate is controlled.

Referring to the drawings, the invention relates to a system for controlling the level of molten slag in the hearth of a slagging coal gasifier of the kind specified, and for removing the slag at a fixed rate for a fixed period at intervals determined by the rate of slag build-up. The characteristics of the differential pressure between the gasifier vessel (30) (Figure 2) and the quench chamber 31 are used as an indication of the molten slag level existing in the hearth. Hot burner gases from the burner 21 bubble up through the slag tap orifice 32 and through the head of molten slag in the hearth of the vessel 30, creating a differential pressure which is indicative of the slag level. The differential pressure is said to be positive when the

quench chamber is at a higher pressure than the gasifier vessel.

Although the differential pressure can be used as a form of slag level measurement, it is envisaged that it is within the scope of the invention that any method of level measurement could be used, for example a radio active source.

During a slag-tapping operation the burner 21 located below the slag-tap orifice 32 is turned down to avoid any splattering or diffusion of the slag stream, and to avoid high temperature build-up in the quench chamber 31.

A slag-tapping operation is achieved in the gasifier by reducing the differential pressure between the quench chamber and the gasifier vessel. When this happens the quantity of slag, which previously had been held in the hearth and slag tap above the quench chamber by the positive differential pressure, runs through the slag tap orifice 32 into the quench chamber water (not shown) and is quenched and removed as frit through a removal means (not shown). The quench chamber pressure is lowered by a venting system, as described in UK Patent Specification No. 1,562,790. As explained earlier, the burner is turned down to a required burning rate to avoid any slag being diffused around the quench chamber and to avoid high temperature in the chamber.

With particular reference to Figure 1, the system for obtaining an automatic slag-tapping operation to control the slag level in the hearth comprises three automatic timers, an enable period timer T1, a tap period timer T2 and a run period timer T3. The enable period timer T1 has a differential pressure override trip 5 which can over-ride the enable period timer period and start the tap period timer T2 to commence a slag tapping operation. The system is versatile and can be run in a number of ways according to the level of the slag in the hearth.

In a normal operation for a slag tap to take place the run timer T3, which is set to a minimum predetermined time between taps dependent upon the rate of slag production, is allowed to run out which then starts the enable timer T1 to begin its time period. The run period timer T3 re-sets to the pre-determined time. The end of the enable timer T1 period, or upon the operation of its high differential pressure trip 5, then starts the tap timer T2. The tap timer mechanism initiates the actuation of the valving means of the quench chamber venting system and a tap is completed at the end of the tap timer T2 period or upon the operation of its low differential pressure trip 6. The run timer T3 is then triggered so that the cycle can be repeated.

Referring also to Figure 2 the low differential pressure trip 6 is activated during the tap period on the occurrence of a blocked tap orifice to terminate the tapping operation. This would ensure a rise in quench chamber pressure due to re-establishment of the burner rate and closure of the venting valve means, with consequential clearing of the blocked orifice.

If the orifice becomes blocked during a run period, it will cause a rapid rise in pressure in the quench chamber and this high pressure is detected by a blocked-tap-orifice-detector 7. This automatically turns down the burner rate and initiates the actuation of the quench chamber venting valve means 27 to reduce the differential pressure to a safe level to enable an operator to take remedial action.

Referring also to Figure 3, in a normal slag tapping cycle, the slag level in the hearth is rising during the run period controlled by the run timer T3. When the T3 timer period runs out, the enable time T1 is started and if at any time during its timing period the high level differential pressure trip 5 is tripped, the timer T1 enables the trip 5 to initiate a tapping period, i.e. it starts timer T2. Should the high level differential pressure trip 5 not be tripped during the enable period, the tapping operation will begin at the end of the enable period. At the start of the tap period, in order to enable a tapping of the slag to take place, the burner rate is turned down and the quench chamber is vented to atmosphere in order to reduce the differential pressure for this purpose.

The rate of the burner 21 is turned down by reducing the gas and oxygen flows. The gas flow 19 through control valve 14 is closed by an automatic valve 15, but a sufficient amount of gas is fed to the burner via a needle valve 16 so as to maintain a small flame for relighting the burner. The oxygen flow 26 through the control valve 17 is cut off by an automatic valve 28. The set points of gas and oxygen flow controllers 8 and 9 respectively are switched from a burner-rate-manual-control 11 to manual slag tapping-rate-set-point-controls 12 and 13 which may be set to zero. The air flow through a control valve 18 remains constant and is controlled by controller 10, and its set point is derived from the manual control 11.

The differential pressure is measured by a detector 22 whose output signal is fed to the high and low differential pressure trips 5 and 6, the blocked tap detector 7 and the differential pressure controller 25. The output signal from controller 25 operates the valve 27 to achieve the differential pressure required by the controller's set point. During a slag tapping operation this set point is set by a pneumatic signal generator 23. During the run period this set point is set by a pneumatic signal generator 24 which is always set to a high differential to ensure that the valve 27 is closed.

If during a slag tapping operation a blocked slag orifice occurs giving rise to a momentary drop in differential pressure, this will be detected by trip 6 and the tapping will be terminated and the run period recommenced. This rapid re-establishment of the run condition will tend to blow the obstruction clear of the orifice.

If there is no interruption of tapping, the run period recommences after the tapping period is completed.

Claims

1. A method of controlling the level of molten slag in a slagging coal gasifier of the kind comprising a vertical gasifier vessel (30) with a gasifier hearth, a slag tap orifice (32), a burner (21) and a slag quench chamber (31), and in which the differential pressure between the gasifier vessel (30) and the slag quench chamber (31) is used for indicating the slag level in the hearth (30), characterised in that the method comprises the steps of, periodically tapping the slag from the hearth of the gasifier vessel (30) through the slag tap orifice (32) into the quench chamber (31) using a system of timing means (T1, T2, T3) which is arranged to set a maximum and a minimum predetermined period of time between slag tapping operations and to set the duration time of actual slag tapping, measuring said differential pressure by means (22) which is arranged to produce a signal representative of said measurement, and causing initiation of a slag tapping operation by means (5—7, 14—18, 22—28) in response to said signal when the slag reaches a predetermined level or when any deviations from the expected differential pressure measurements caused by malfunctions being detected and used to override the timer system until the malfunctions have been corrected.

2. Apparatus for carrying out the method according to Claim 1 comprising a system of timing means (T1, T2, T3) for setting said maximum and minimum periods and for setting the said slag tapping duration time, means (22) for measuring said differential pressure and for producing a signal representative of said measurement, and means (5—7, 14—18, 22—28) responsive to said signal for initiating a slag tapping operation when the slag reaches said predetermined level or when any said deviations from the expected differential pressure measurement is detected.

3. Apparatus according to Claim 2, characterised in that said system of timing means consists of, a first timing means (T3) for setting the gasifying run time during which slag is being produced, a second timing means (T1) for setting the period of time for enabling a slag-tapping operation to take place, and a third timing means (T2) for setting the duration time of a slag tapping period.

4. A method of operating a slagging coal gasifier of the kind comprising a vertical gasifier vessel (30) with a gasifier hearth, a slag tap orifice (32), a burner (21) and a slag quench chamber (31), and in which the differential pressure between the gasifier vessel (30) and the slag quench chamber (31) is used for indicating the slag level in the hearth (30), incorporating a method according to Claim 1.

5. A slagging coal gasifier of the kind comprising a vertical gasifier vessel (30) with a gasifier hearth, a slag tap orifice (32), a burner (21) and a slag quench chamber (31), and in which the differential pressure between the gasifier vessel (30) and the slag quench chamber (31) is used for indicating the slag level in the hearth (30), incorporating apparatus according to Claim 2 or Claim 3.

Revendications

1. Procédé de contrôle du niveau de scories liquides dans un gazogène à fusion de cendres du type comprenant une cuve verticale (30) de gazogène équipée d'un foyer de gazogène, un orifice (32) de soutirage de scories, un brûleur (21) et une chambre (31) de refroidissement des scories, et dans lequel la différence de pression entre la cuve (30) du gazogène et la chambre (31) de refroidissement des scories est utilisée pour indiquer le niveau de scories dans le foyer (30), caractérisé en ce que le procédé comprend les étapes qui consistent à soutirer périodiquement les scories du foyer de la cuve (30) du gazogène par l'orifice (32) de soutirage de scories, pour les faire passer dans la chambre (31) de refroidissement à l'aide d'un système de moyens de minutage (T1, T2, T3) qui sont agencés pour établir des périodes de temps prédéterminées maximale et minimale entre des opérations de soutirage de scories et pour établir la durée du soutirage réel de scories, à mesurer ladite différence de pression par des moyens (22) qui sont agencés pour produire un signal représentatif de ladite mesure, et à provoquer le déclenchement d'une opération de soutirage de scories par des moyens (5—7, 14—18, 22—28) en réponse audit signal lorsque les scories atteignent un niveau prédéterminé ou lorsque tous écarts, par rapport aux mesures prévues de différence de pression, dus à des défauts de fonctionnement, sont détectés et utilisés pour agir prioritairement au système de minutage jusqu'à ce que les défauts de fonctionnement aient été corrigés.

2. Appareil pour la mise en oeuvre du procédé selon la revendication 1, comprenant un système de moyens de minutage (T1, T2, T3) pour établir lesdites périodes maximale et minimale et pour établir ladite durée de soutirage de scories, des moyens (22) pour mesurer ladite différence de pression et pour produire un signal représentatif de ladite mesure, et des moyens (5—7, 14—18, 22—28) qui réagissent audit signal pour déclencher une opération de soutirage de scories lorsque les scories atteignent ledit niveau prédéterminé ou lors de la détection desdits écarts par rapport à la mesure prévue de différence de pression.

3. Appareil selon la revendication 2, caractérisé en ce que ledit système de moyens de minutage comprend un premier moyen de minutage (T3) destiné à établir le temps de marche en gazéification pendant lequel des

scories sont produites, un deuxième moyen de minutage (T1) destiné à établir la période de temps permettant à une opération de soutirage de scories d'avoir lieu, et un troisième moyen de minutage (T2) destiné à établir la durée d'une période de soutirage de scories.

4. Procédé pour faire fonctionner un gazogène à fusion de cendres du type comprenant une cuve verticale (30) de gazogène ayant un foyer de gazogène, un orifice (32) de soutirage de scories, un brûleur (21) et une chambre (31) de refroidissement de scories, et dans lequel la différence de pression entre la cuve (30) du gazogène et la chambre (31) de refroidissement des scories est utilisée pour indiquer le niveau de scories dans le foyer (30), en utilisant un procédé selon la revendication 1.

5. Gazogène à fusion de cendres du type comprenant une cuve verticale (30) de gazogène ayant un foyer de gazogène, un orifice (32) de soutirage de scories, un brûleur (21) et une chambre (31) de refroidissement de scories, et dans lequel la différence de pression entre la cuve (30) du gazogène et la chambre (31) de refroidissement de scories est utilisée pour indiquer le niveau de scories dans le foyer (30), en utilisant l'appareil selon la revendication 2 ou la revendication 3.

Patentansprüche

1. Verfahren zum Überwachen des Schlackenstandes in einem Abstickgaserzeuger mit vertikalem Vergasungsbehälter (30) mit einem Vergasungs-Brennraum, einer Schlackenabstichöffnung (32), einem Brenner (21) und einer Schlackenabkühlkammer (31), wobei der Differenzdruck zwischen dem Vergasungsbehälter (30) und der Schlackenabkühlkammer (31) für die Anzeige des Schlackenstandes im Brennraum (30) verwendet wird, gekennzeichnet durch folgende Verfahrensschritte:

a) Periodisches Abstechen der Schlacke aus dem Brennraum des Vergasungsbehälters (30) über die Schlackenabstichöffnung (32) in die Schlackenabkühlkammer (31) unter Verwendung eines Systems von Zeitsteuereinrichtungen (T1, T2, T3) zur Festlegung einer maximalen und einer minimalen Zeitspanne zwischen Schlackenabstichvorgängen und zur Festlegung der Dauer des eigentlichen Schlackenabstiches;
b) Messen des Differenzdruckes durch eine Einrichtung (22), die ein die Messung wiedergebendes Signal erzeugt, und
c) Einleitung des Schlackenabstichvorganges durch eine Einrichtung (5—7, 14—18, 22—28), die auf das Signal anspricht, wenn die Schlacke einen vorbestimmten Pegel erreicht oder wenn irgendwelche Abweichungen von den zu erwartenden Differenzdruckmessungen aufgrund von Fehlfunktionen ermittelt und dazu verwendet werden, das Zeitsteuersystem zu übergehen, bis die Fehlfunktionen korrigiert worden sind.

2. Vorrichtung zur Ausübung des Verfahrens nach Anspruch 1, gekennzeichnet, durch ein System von Zeitsteuereinrichtungen (T1, T2, T3) zur Festlegung der maximalen und minimalen Zeitspannen und zur Festlegung der Schlackenabstichdauer, durch eine Einrichtung (22) zum Messen des Differenzdruckes und zum Erzeugen eines die Messung widergebenden Signals, sowie durch eine Einrichtung (5—7, 14—18, 22—28), die auf das Signal anspricht, um einen Schlackenabstichvorgang einzuleiten, wenn die Schlacke den vorbestimmten Pegel erreicht oder wenn irgendwelche Abweichungen von der zu erwartenden Differenzdruckmessung ermittelt werden.

3. Vorrichtung nach Anspruch 2, dadurch gekennzeichnet, daß das System von Zeitsteuereinrichtungen sich zusammensetzt aus einer ersten Zeitsteuereinrichtung (T3) zum Festlegen der Vergasungszeit, während welcher Schlacke erzeugt wird, einer zweiten Zeitsteuereinrichtung (T1) zum Festlegen der Zeitdauer, während welcher der Schlackenabstich stattfinden kann, und einer dritten Zeitsteuereinrichtung (T2) zum Festlegen der Dauer des Schlackenabstiches.

4. Verfahren zum Betrieb eines Abstich-Kohlevergasers mit einem vertikalen Vergasungsbehälter (30) mit einem Vergasungs-Brennraum, einer Schlackenabstichöffnung (32), einem Brenner (21) und einer Schlackenabkühlkammer (31), dadurch gekennzeichnet, daß der Differenzdruck zwischen dem Vergasungsbehälter (30) und der Schlackenabkühlkammer (31) unter Einsatz des Verfahrens nach Anspruch 1 zum Anzeigen des Schlackenstandes im Brennraum (30) verwendet wird.

5. Abstich-Kohlevergasser mit einem vertikalen Vergasungsbehälter (30) mit einem Vergasungs-Brennraum, einer Schlackenabstichöffnung (32), einem Brenner (21) und einer Schlackenabkühlkammer (31), dadurch gekennzeichnet, daß der Differenzdruck zwischen dem Vergasungsbehälter (30) und der Schlackenabkühlkammer (31) unter Einsatz der Vorrichtung nach Anspruch 2 oder 3 zum Anzeigen des Schlackenstandes im Brennraum (30) verwendet wird.

Fig. 1.

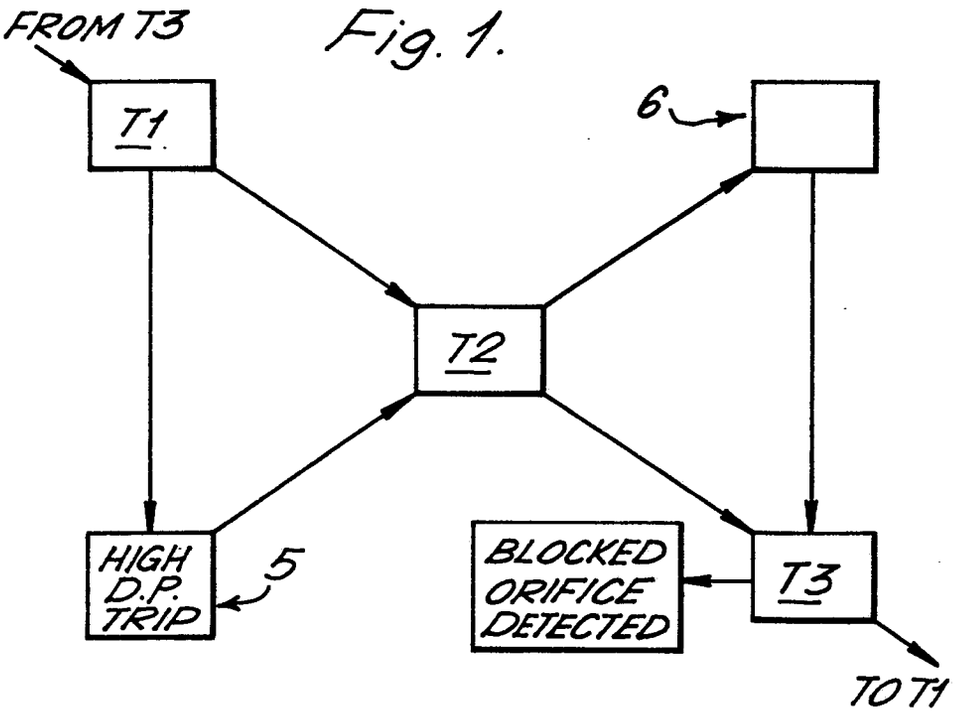
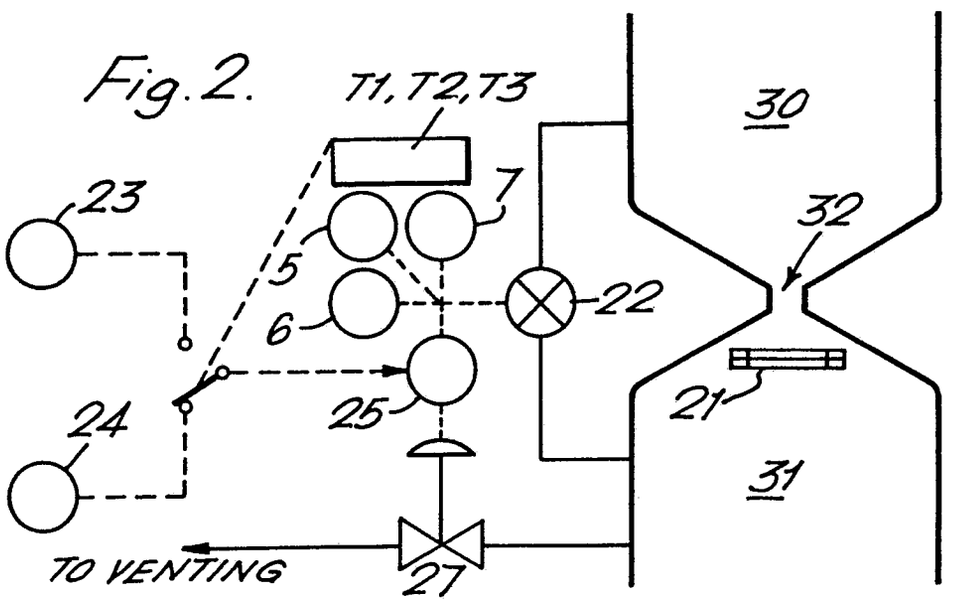

FROM T3
T1
6
T2
HIGH D.P. TRIP
5
BLOCKED ORIFICE DETECTED
T3
TO T1

Fig. 2.


T1, T2, T3
30
23
7
32
5
22
6
21
24
25
31
TO VENTING
27

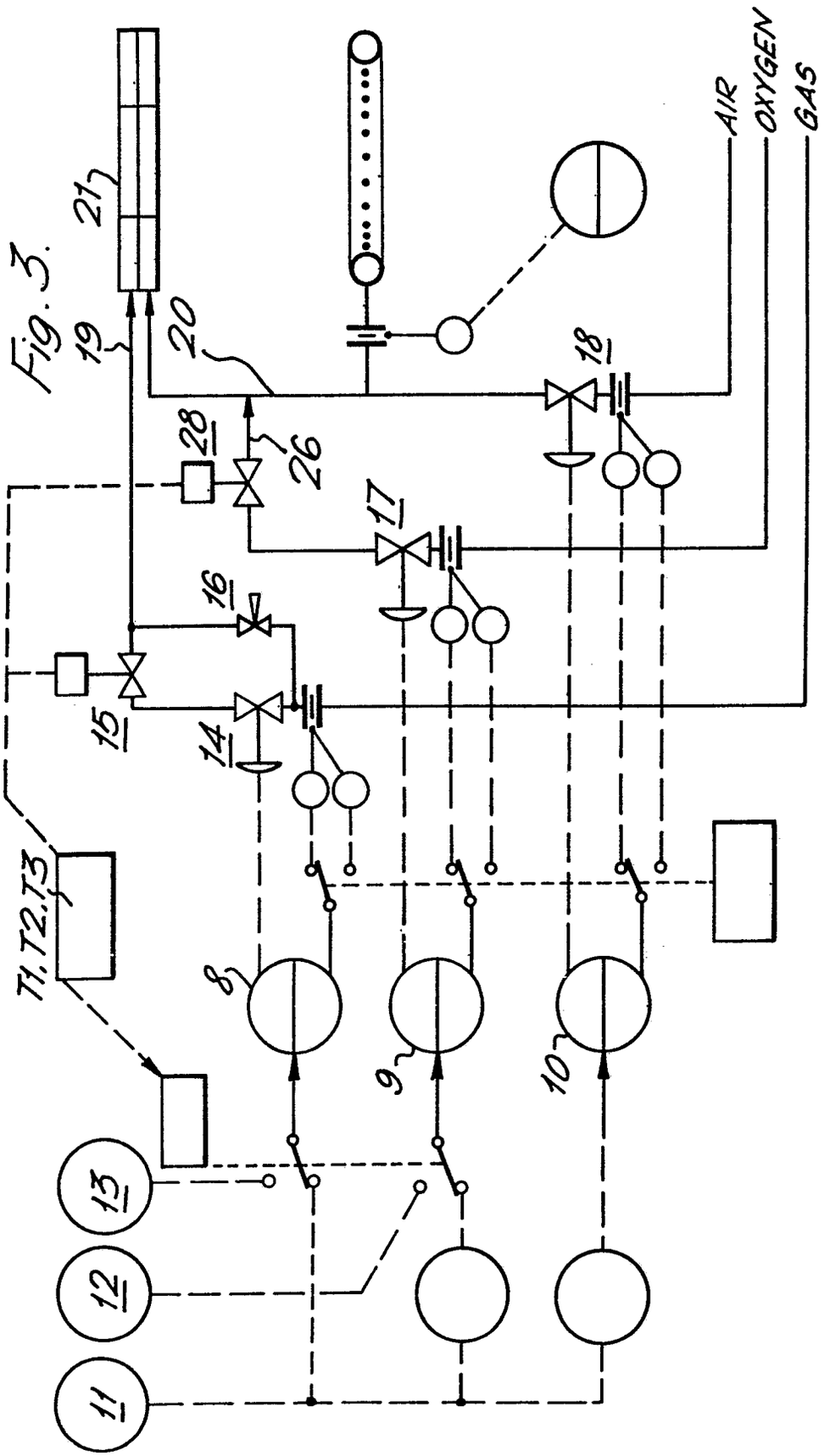



Fig. 3.