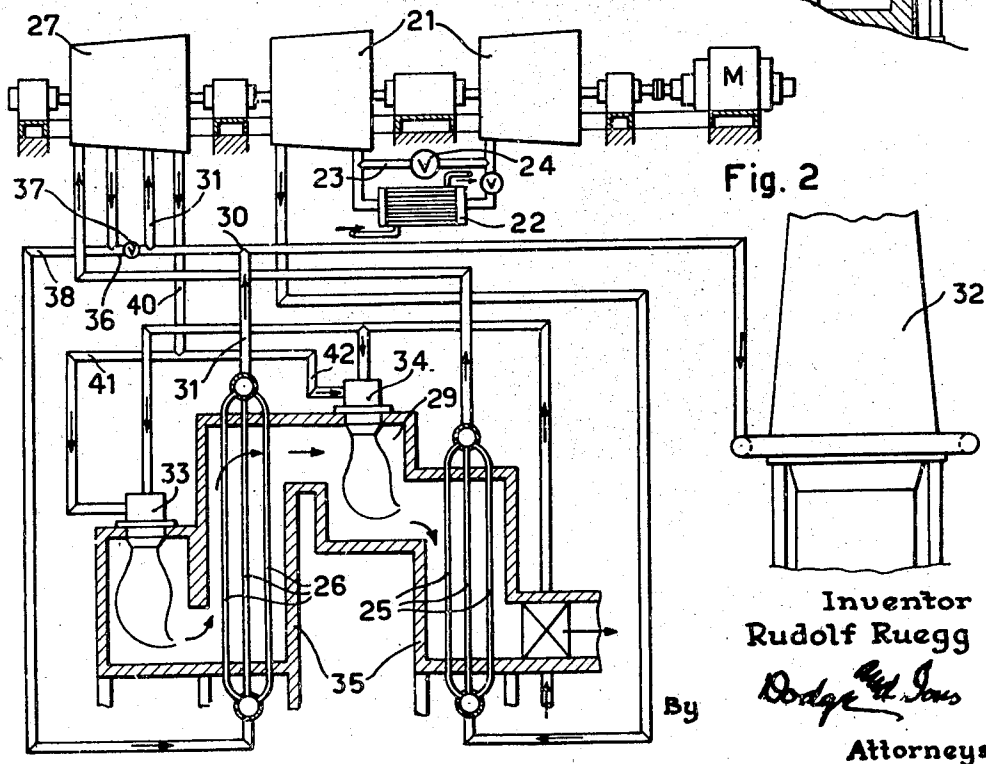
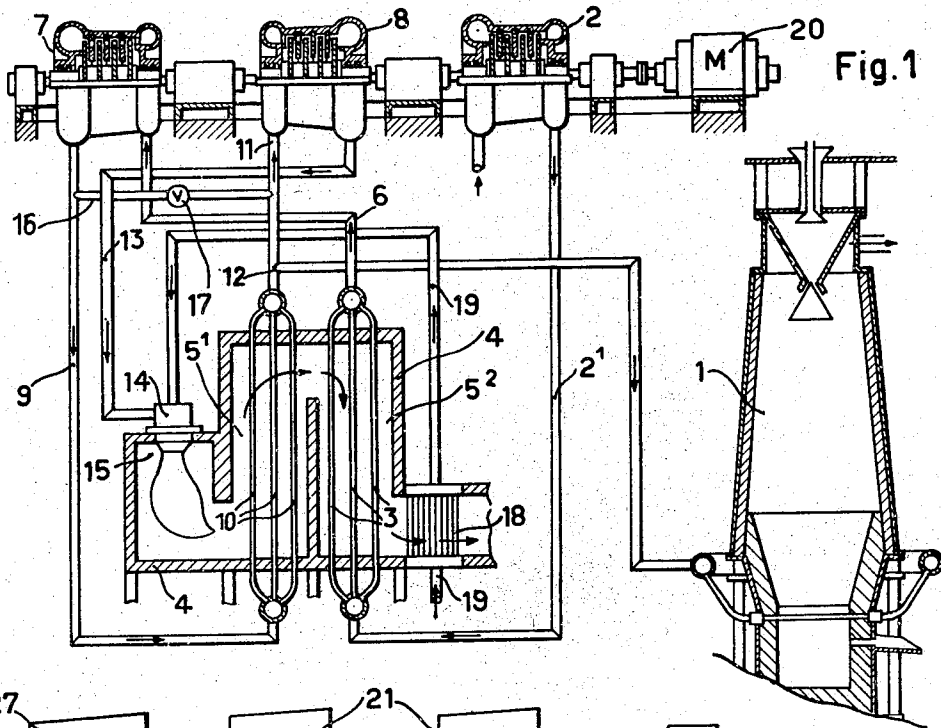


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PLANT FOR THE PRODUCTION AND
HEATING OF COMPRESSED AIR
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PLANT FOR THE PRODUCTION AND
HEATING OF COMPRESSED AIR

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2 Claims. (Cl. 263—19)

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This invention relates to a plant for the production of compressed air, e. g. blast furnace air, in which air is brought in at least one compressor to a higher pressure than the pressure required in the compressed air consumer, then heated in a heater by a supply of heat derived from an external source, and afterwards expanded (whilst giving up energy) in at least one turbine which drives the compressor.

In such plants if it is at all possible, an operation without supply of external power is aimed at, that is to say endeavour is made to produce in the turbine just so much energy as the compressor requires. It is however important that even under altered working conditions, e. g. partial loads, an operation without supply of external power shall be still ensured. In order to attain this, it is already known to adapt the consumption of energy by the compressor to the particular working conditions of the moment by varying the degree of intermediate cooling during the process of compression, or to vary the amount of air compressed in the compressor to the final pressure or the amount of air expanded in the turbine to the final pressure.

The object of the present invention is to provide further means which will render an operation without supply of external work possible under different working conditions, and this in a manner involving a small consumption of heat and allowing of a rapid adaptation to the working conditions at any particular moment. For this purpose according to the present invention, a quantity of air which is greater than the quantity required by the compressed air consumer is withdrawn from the turbine at least before the last stage thereof and passed again into the heater. The part which is to be passed to the consumer is then branched off from this quantity of air heated for the second time, and the remainder together with the quantity which has not been passed for the second time through the heater, expanded still further in the turbine, after which this remainder serves, at least in part, as air to support combustion in the heater.

Two simplified constructional forms of the subject matter of the invention are shown in the accompanying drawing in which:

Fig. 1 represents a plant for the production and heating of blast furnace air, in which the compression of the air takes place without intermediate cooling and

Fig. 2 represents a plant for the production of blast furnace air in which the air is immediately cooled once during the compression

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thereof, and in which also a part of the fuel is introduced into a combustion chamber placed between two systems of pipes.

In Fig. 1 of the drawing 1 denotes a blast furnace. The compressed air required in this latter is supplied by a compressor 2, which draws air in from the atmosphere. This compressor 2 not only draws in the quantity of air required in the blast furnace 1 but also the additional quantity which it requires to be able to drive the compressor 2 in the way to be hereinafter described. The compressor 2 compresses the whole of the quantity of air drawn in to a pressure which is higher than that which corresponds to the consumption pressure at the blast furnace 1 increased by the normal additional losses of pressure in the pipes and apparatus. The compressor 2 forces the compressed air through a pipe 2¹ into a system of pipes 3, which, for the greater part, are accommodated in a second flue 5² of a heater 4. This system of pipes 3 is traversed by the air to be heated from below upwards, i. e. in the opposite direction to that in which the flue gases pass. The air heated therein passes through a pipe 6 into the high pressure part 7 of a two casing turbine the low pressure part of which is denoted by 8. In the high pressure part 7 of the turbine the air expands, giving up energy, as it does so, to the compressor 2 and after having passed through all the stages of this part 7 it passes into a pipe 9 which is connected to a second system of pipes 10 of the heater 4. This system of pipes 10 is accommodated in a first flue 5¹ of the heater 4 and the air therein which is to be heated flows through them likewise from the bottom upwards, but in the same direction as the heating gases. The air heated for the second time in the system of tubes 10 passes into a pipe 11, which is connected to the inlet to the low pressure part 8 of the turbine. At the point 12 on the pipe 11 the quantity of compressed air required in the blast furnace 1 is branched off from the current of air which has been heated for the second time. The remainder of this current of air is expanded still further in the low pressure part 8 of the turbine giving up energy as it does so to the compressor 2 and passes finally through the pipe 13 into the burner 14 of the heater 4 there to serve as air for the support of combustion. 15 denotes the combustion chamber of the heater. From the pipe 9 there branches off a by-pass pipe 16, which is connected to the pipe 11 and in which an adjustable regulating device 17 is inserted. A quantity of the air expanded in the high pressure part 7 of the turbine

and adjustable at any time, can pass over directly into the low pressure part 8 of the turbine without going through the system of tubes 10. With the help of the quantity of air passing through the pipe 16 the temperature at the inlet to the low pressure part 8 can be controlled. This enables firstly the energy produced in the low pressure part 8 to be controlled and secondly if a higher temperature is desired for the air to be supplied to the blast furnace, correspondingly highly heated air can be prevented from passing into the low pressure part 8, it being always possible to allow such a quantity of colder air to pass through the pipe 16 into the pipe 11 that the air passing into the low pressure part 8 shall have approximately the temperature for which this part is designed. For the sake of completeness it should also be stated that 18 denotes a pre-heater for the fuel which flows to the burner 14 through a pipe 19. 20 is an auxiliary motor, which serves to start up the plant.

The constructional form shown in Fig. 2 differs in the main from that just described only by the fact that the compressor 21 in which the whole of the quantity of air drawn in is compressed, is built with two casings and that the air is cooled intermediately during the process of compression in a cooler 22. In consequence of the provision of a short-circuit pipe 23 with a regulating device 24 the quantity of air which is subjected to intermediate cooling, can be regulated and therefore also the energy absorbed by the compressor 21. In other respects the second constructional form of the plant differs from the one previously described also by the fact that a further combustion chamber 29 is provided between the system of pipes 25 in which the whole of the quantity of air drawn in is heated, and the system of pipes 26 in which at least part of the air expanded in the high pressure stages of the turbine 27 is heated for the second time.

The quantity of air required in the blast furnace 32 is likewise branched off from the quantity of air heated for the second time in the system of pipes 26 at the point 30 on the pipe 31, which leads from the system of pipes 26 to the low pressure section of the turbine 27. The remainder of this quantity of air is expanded still further in said low pressure section of the turbine 27 giving up, as it does so, energy to the compressor 21. The air escaping from the turbine 27 is supplied through pipes 40, 41, 42 as air to support combustion to the burners 33 and 34 of the heater 35. A short-circuit pipe 36 with an adjustable regulating device 37 permits of an adjustable quantity of the air escaping from the high pressure part of the turbine 27 into pipe 38 to pass directly into the pipe 31 without passing through the system of pipes 26, so that any desired temperature may be adjusted at the inlet to the low pressure section of the turbine 27. According to the adjustment therefore of the regulating device 37 the whole or only a portion of the air expanded in the high pressure part of the turbine 27 flows through the system of pipes 26 in which air is heated for the second time.

The air escaping from the low pressure part of the turbine need not be wholly used as air for the support of combustion. Part of it may be used for preheating purposes for example.

The above described possibility of being able to influence the temperature of a quantity of air withdrawn from the turbine and heated a second time in the heater prior to its entry into

the turbine again so as to regulate the energy supplied by the compressor, can be used simultaneously with one or more other means for influencing the amount of energy consumed by the compressor or produced by the turbine. Such further known means are for example varying the amount of air serving as an excess in the heater, and varying the amount of air compressed in the compressor to the final pressure or that expanded in the turbine to the final pressure.

What is claimed is:

1. A plant for compressing and heating air and delivering the heated compressed air at a desired rate at desired temperature and pressure, comprising in combination at least one compressor arranged to draw air from the atmosphere at a rate greater than said desired rate and compress it to a pressure greater than said desired pressure; a heater structure enclosing a combustion space and an offtake passage leading therefrom; combustion means in said space; a primary heat exchanger and a secondary heat exchanger mounted in said offtake passage so as to derive heat from products of combustion flowing therethrough from said combustion means; a staged turbine connected to drive said compressor and subdivided into two units in the first of which air can be expanded from the pressure to which it is compressed by the compressor approximately to said desired pressure and in the second of which air can be expanded from said desired pressure to a pressure suited to said combustion means; connections for leading air from the compressor outlet to the inlet of the primary exchanger and from the outlet of said exchanger to the inlet of the first turbine unit; connections from the outlet of the first turbine to the inlet of the secondary heat exchanger and from the outlet of said exchanger to the inlet of the second turbine unit; a final discharge connection for heated compressed air leading from the outlet of said secondary exchanger; a connection from the outlet of the second turbine unit to said combustion means; a flow connection from the outlet of the first turbine unit to the inlet of the second turbine unit; and a regulating device controlling flow through the last named connection.

2. The combination defined in claim 1 in which the compressor comprises two staged units connected in series with an interposed intercooler; and means are provided to regulate the cooling action of said intercooler.

RUDOLF RUEGG.

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Certificate of Correction

August 9, 1949

Patent No. 2,478,504

RUDOLF RUEGG

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows:

Column 4, line 39, claim 1, after the word "turbine" insert *unit*;
and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 13th day of December, A. D. 1949.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.