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(54) **Heat engine for a vehicle with related control method**

Brennkraftmaschine für Fahrzeuge und Steuerungsverfahren

Moteur à combustion interne pour véhicule et méthode de commande

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Description

[0001] The present invention relates to a heat engine for a vehicle, in particular a commercial vehicle, and to a method of controlling the engine itself.

[0002] Engines provided with a decompression braking device are known, which device is adapted to discharge from the cylinders the gas compressed during the compression stroke and, at the same time, to prevent the injection of fuel into the cylinders. In this way, the work carried out during the compression stroke is converted into braking torque on the drive shaft and substantially no useful work is produced during the subsequent expansion stroke.

[0003] The discharge of the gas compressed at the end of the compression stroke can take place either through the conventional exhaust valves, as described for example in European Patent Application EP-A-0 543 210, in which case the device comprises means for the auxiliary opening of said valves, or through dedicated valves, as described for example in Italian Patent Application No. T092A 000974 of 30th November 1992.

[0004] In any case, in a four-stroke engine the decompression of the cylinders takes place every fourth stroke and the braking action resulting therefrom is basically limited.

[0005] DE-C-577 588 discloses a heat engine having means for varying the timing from a four stroke conventional cycle into a two stroke compressor cycle, in order to improve engine braking power.

[0006] The object of the present invention is to devise an engine for a vehicle provided with an improved decompression braking device which makes it possible to obtain greater braking torque than in the above-described known engines.

[0007] This object is achieved by a heat engine for a vehicle as claimed in claim 1, and by a method of controlling a heat engine according to claim 2.

[0008] With a view to a better understanding of the present invention two preferred embodiments will be described non-restrictively by way of example below, with reference to the accompanying drawings, in which:

Figure 1 is schematic, partial view of an engine designed in accordance with the present invention;
Figure 2 is an operating diagram of a vacuum braking device of the engine in Figure 1, and
Figure 3 is comparative diagram illustrating various timing sequences of the engine in Figure 1.

[0009] Referring now to Figure 1, the reference numeral 1 generally denotes a heat engine 1 for a commercial vehicle.

[0010] The engine 1 comprises a plurality of cylinders 2, each of which is provided with a pair of inlet valves 3 communicating with an inlet manifold 3a and a pair of main exhaust valves 4 communicating with an exhaust manifold 4a.

[0011] The engine 1 is also provided with a decompression braking device 5 illustrate schematically in Figure 2. Said device substantially comprises one auxiliary exhaust valve 6 per cylinder, which valve communicates with a bleed manifold 7 for compressed air, which is connected in known manner, for example as illustrated in Italian Patent Application No. TO92A 000974, to a pneumatic installation of the vehicle (not shown).

[0012] The valves 3, 4 and 6 are of the so-called active type and are operated by an electronic control unit 8. In particular, as illustrated in Figure 2 with reference to an auxiliary valve 6, each of the valves 3, 4 and 6 is associated with a double-acting hydraulic actuator 9 having a piston 10 rigidly connected to a stem 11 of the respective valve. The actuator 9 is controlled by a respective servo-valve 14, for example of four-way, three-position, closed centre type, which is adapted to connect selectively the chambers of the actuator itself with a delivery duct 15 and with a return duct 16 of a hydraulic unit 17. The control unit 8 is connected to each of the servo-valves 14 and generates control signals designated s1, s2 and s3 respectively for the valves 3, 4 and 6 of the engine 1.

[0013] The actuators 9 are provided with respective position sensors 12 which are connected to the control unit 8 and transmit signals s4 correlated with the position of the respective valves.

[0014] The unit 8 also receives, in known manner, a plurality of further input signals correlated with operative variables of the engine and of the vehicle, which include an input signal s5 for identifying the timing of the cylinders, and a signal s6 for activating engine braking, which is generated for example by a potentiometer (not shown) connected to the brake pedal of the vehicle (also not shown).

[0015] Finally, the control unit 8 is connected to the injectors 15 of the engine 1 and is adapted to generate signals s7 for controlling the injectors themselves.

[0016] The control unit 8 is adapted to control the valves 3, 4 and 6 in accordance with a first four-stroke timing sequence of normal type, when the signal s6 is inactive (i.e. the brake pedal is released). This first sequence is illustrated in the diagram a) in Figure 3, with reference to a given cylinder, as a function of the angle of rotation of the drive shaft; the angular intervals at which the valves are opened are indicated by a thickened line.

[0017] In particular, the inlet valve is opened in advance with respect to the top dead centre preceding the induction stroke, is held open during the entire stroke itself and reclosed after the bottom dead centre (bdc). Analogously, the exhaust valve is opened in advance with respect to the bottom dead centre preceding the exhaust stroke, is held open during the entire stroke itself and reclosed with delay after the subsequent top dead centre (tdc).

[0018] The injectors are controlled in a conventional manner in accordance with control maps stored in the

control unit 8, on the basis of input signals received from the unit itself.

[0019] When the signal s6 is active, or assumes a value above a predetermined threshold level, the control unit 8 controls the valves 3, 4 and 6 in accordance with a different timing sequence which is illustrated graphically in Figure 3, diagram b).

[0020] In particular, the main exhaust valves 4 are held closed; the inlet valves 3 are opened for a short time around each bottom dead centre and the auxiliary valves 6 are opened for a short time around each top dead centre in accordance with a two-stroke cycle. Additionally, the unit 8 prevents the injection of fuel into the cylinders 2.

[0021] According to the new timing sequence, therefore, the engine 1 acts as a two-stroke compressor. In fact, in accordance with each bottom dead centre air is drawn from the inlet manifold 3a through the inlet valves 3; the air drawn in is compressed during the subsequent upstroke of the piston and is expelled into the bleed manifold 7 through the auxiliary valves 6 in the vicinity of the top dead centre.

[0022] Therefore, during each upstroke of the piston compression work is carried out which is converted into braking torque on the drive shaft; the decompression at top dead centre prevents a considerable proportion of the work carried out from being recovered as useful work during the subsequent downstroke of the piston.

[0023] Figure 3, diagram c), illustrates an alternative timing sequence to that in the above-mentioned diagram b). In this case the behaviour of the inlet valves 3 and outlet valves 4 is substantially identical. However, with regard to the auxiliary valves 6 the control unit 8 effects their opening both in the vicinity of each top dead centre and after each bottom dead centre, according to a cycle which can be termed "single-stroke", thus increasing the braking power.

[0024] The subsequent opening of the auxiliary valves 6, which commences in the final phase of the opening period of the inlet valves 3, has the purpose of improving the filling of the cylinder, thus allowing the admission of compressed air from the bleed manifold which is at a higher pressure than the inlet manifold. This has the result that the initial compression pressure is higher and, therefore, the compression work and thus the braking torque are increased.

[0025] The advantages achieved with the present invention are apparent from a study of the features of the engine and the associated control method in accordance therewith. Above all, the decompression braking takes place according to a two-stoke cycle; therefore, the decompression work is dissipated with each revolution of the drive shaft, rather than every two revolutions as happens with conventional devices. The braking torque on the drive shaft is thus increased.

[0026] Furthermore, in the solution illustrated with reference to diagram c) in Figure 3 the braking effect is further increased owing to the fact that the internal pressure of the cylinder at the start of compression and thus the compression work are increased by the inflow of compressed air into the cylinder from the bleed manifold.

[0027] Finally, it is evident that the engine 1 and the associated control method described can be subject to modifications and variants which do not depart from the protection afforded by the claims.

[0028] In particular, the actuators for controlling the valves may be of single-acting type, with spring return; alternatively, the engine can be provided with a timing system of mechanical type, with a suitably designed camshaft and hydraulically acting tappets interposed between the cams and the associated valves and designed to transmit or absorb selectively the actuating forces of the valves; the variation of the timing sequence may be achieved by cyclically switching respective solenoid valves for controlling hydraulic tappets by means of an electronic control unit.

Claims

1. A heat engine (1) for a vehicle, comprising:

a plurality of cylinders (2), each of which is provided with at least one inlet valve (3) and at least one exhaust valve (4, 6);
control means (8) for said valves (3, 4, 6) establishing a first four-stroke timing sequence;
a decompression braking device (5) which can be actuated so as to dissipate the compression energy in said cylinders (2);
said decompression braking device (5) comprising means (8) for varying the timing establishing, in response to actuation of said device (5), a second two-stroke timing sequence in which said inlet valve (3) and an exhaust valve (6) are opened alternately in the vicinity of with each of the respective dead centres (bdc, tdc) of the associated cylinder (2),

characterised in that said cylinders (2) have at least one main exhaust valve (4) and an auxiliary exhaust valve (6) communicating with a bleed conduit (7) for compressed air, said second timing sequence of said means (8) for varying the timing being adapted to keep said main exhaust valve (4) closed, and to open said auxiliary exhaust valve (6) in the vicinity of each top dead centre (tdc) as well as after each bottom dead centre (bdc) of the associated cylinder (2) so as to increase air filling of said cylinder (2)

2. A method of controlling a heat engine (1) for a vehicle, the engine (1) comprising a plurality of cylinders (2), each of which is provided with at least one inlet valve (3), and at least one main exhaust valve

(4) and an auxiliary exhaust valve (6) communicating with a bleed conduit (7) for compressed air, and a decompression braking device (5) which can be actuated so as to dissipate the compression energy in said cylinders (2), said valves (3, 4) being controlled according to a first four-stroke timing sequence when said decompression braking device (5) is inoperative;

said method including the step of varying the timing, in response to actuation of said decompression braking device (5), so as to establish a second two-stroke timing sequence in which said main exhaust valve (4) is kept closed, said inlet valve (3) is opened in the vicinity of each bottom dead centre (bdc), and said auxiliary exhaust valve (6) is opened in the vicinity of each top dead centre (tdc) as well as after each bottom dead centre (bdc) of the associated cylinder (2) so as to increase air filling of said cylinder (2).

Patentansprüche

1. Brennkraftmaschine (1) für ein Fahrzeug, umfassend:

eine Vielzahl von Zylindern (2), von denen jeder mit zumindest einem Einlassventil (3) und mindestens einem Auslassventil (4, 6) versehen ist;

Steuermittel (8) für die Ventile (3, 4, 6), die eine erste Viertaktzeitgebungssequenz errichten;

eine Dekompressionsbremseinrichtung (5), die so betätigt werden kann, dass die Kompressionsenergie in den Zylindern (2) dissipiert wird;

wobei die Dekompressions-Bremseinrichtung (5) Mittel (8) zur Variation der Zeitgebung umfasst, die als Antwort auf die Betätigung der Einrichtung (5) eine zweite Zweitaktzeitgebungssequenz errichten, bei der das Einlassventil (3) und ein Auslassventil (6) wechselweise in der Nähe von jedem der jeweiligen Totpunkte (bdc, tdc) des zugehörigen Zylinders (2) geöffnet sind,

dadurch gekennzeichnet, dass die Zylinder (2) mindestens ein Hauptauslassventil (4) und ein Hilfsauslassventil (6) haben, das mit einer Entlüftungsleitung (7) für Druckluft in Verbindung steht, wobei die zweite Zeitgebungssequenz der Mittel (8) zum Variieren der Zeitgebung geeignet ist, das Hauptauslassventil (4) geschlossen zu halten und das Hilfsauslassventil (6) in der Nähe jedes oberen Totpunkts (tdc) zu öffnen, ebenso wie nach dem unteren Totpunkt (bdc) des zugehörigen Zylinders (2), so dass das Befüllen des Zylinders (2) mit Luft beschleunigt wird.

2. Verfahren zum Steuern einer Brennkraftmaschine (1) für ein Fahrzeug, wobei die Maschine (1) eine Vielzahl von Zylindern (2) umfasst, von denen jeder mit zumindest einem Einlassventil (3) und mindestens einem Hauptauslassventil (4) versehen ist, und einem Hilfsauslassventil (6), das mit einer Entlüftungsleitung (7) für Druckluft in Verbindung steht, und einer Dekompressionsbremseinrichtung (5), die so betätigt werden kann, dass sie die Kompressionsenergie in den Zylindern (2) dissipiert, wobei die Ventile (3, 4) gemäß einer ersten Viertakt-Zeitgebungssequenz gesteuert werden, wenn die Dekompressionsbremseinrichtung (5) nicht in Betrieb ist;
wobei das Verfahren den Schritt des Variierens der Zeitgebung als Antwort auf die Betätigung der Dekompressionsbremseinrichtung (5) umfasst, so dass eine zweite Zweitakt-Zeitgebungssequenz errichtet wird, in der das Hauptauslassventil (4) geschlossen gehalten wird, das Einlassventil (3) in der Nähe jedes unteren Totpunts (bdc) geöffnet wird und das Hilfsauslassventil (6) in der Nähe jedes oberen Totpunkts (tdc) geöffnet wird ebenso wie nach jedem unteren Totpunkt (bdc) des zugehörigen Zylinders (2), so dass das Befüllen des Zylinders (2) mit Luft beschleunigt wird.

Revendications

1. Moteur thermique (1) pour un véhicule, comprenant :

une pluralité de cylindres (2), dont chacun comporte au moins une soupape d'admission (3) et au moins une soupape d'échappement (4,6);
des moyens de commande (8) pour lesdites soupapes (3,4,6) établissant un premier ordre d'allumage à quatre temps;
un dispositif de freinage à décompression (5), qui peut être actionné de manière à dissiper l'énergie de compression dans lesdits cylindres (2);
ledit dispositif de freinage à décompression (5) comprenant des moyens (8) pour modifier l'établissement de synchronisation, en réponse à l'actionnement dudit dispositif (5), un second ordre d'allumage à deux temps, dans lequel ladite soupape d'admission (3) et ladite soupape d'échappement (6) sont ouvertes alternativement au voisinage de chacun des points morts respectifs (bdc, tdc) du cylindre associé (2),

caractérisé en ce que lesdits cylindres (2) possèdent au moins une soupape d'échappement

principale (4) et une soupape d'échappement auxiliaire (6) communiquant avec un conduit de purge (7) pour air comprimé, ledit second ordre d'allumage desdits moyens (8) pour modifier la synchronisation étant adapté pour maintenir ladite soupape d'échappement principale (4) fermée, et pour ouvrir ladite soupape d'échappement auxiliaire (6) au voisinage du point mort haut (tdc) ainsi qu'après chaque point mort bas (bdc) du cylindre associé (2) pour augmenter le remplissage d'air dudit cylindre (2).

2. Procédé pour commander un moteur thermique (1) pour un véhicule, le moteur (1) comprenant une pluralité de cylindres (2), dont chacun est équipé d'au moins une soupape d'admission (3) et d'au moins une soupape d'échappement principale (4), et une soupape d'échappement auxiliaire (6) communiquant avec un conduit de purge (7) pour air comprimé, et un dispositif de freinage à décompression (5) qui peut être actionné de manière à dissiper l'énergie de compression dans lesdits cylindres (2), lesdites soupapes (3,4) étant commandées conformément à un premier ordre d'allumage à quatre temps, lorsque ledit dispositif de freinage à décompression (5) est inactif;

ledit procédé incluant l'étape consistant à modifier la synchronisation, en réponse à l'actionnement dudit dispositif de freinage à décompression (5), pour établir un second ordre d'allumage à deux temps, dans lequel ladite soupape d'échappement principale (4) est maintenue fermée, ladite soupape d'admission (3) est ouverte au voisinage de chaque point mort bas (bdc) et ladite soupape d'échappement auxiliaire (6) est ouverte au voisinage de chaque point mort haut (tdc) ainsi qu'après chaque point mort bas (bdc) du cylindre associé (2) de manière à accroître le remplissage d'air dudit cylindre (2).

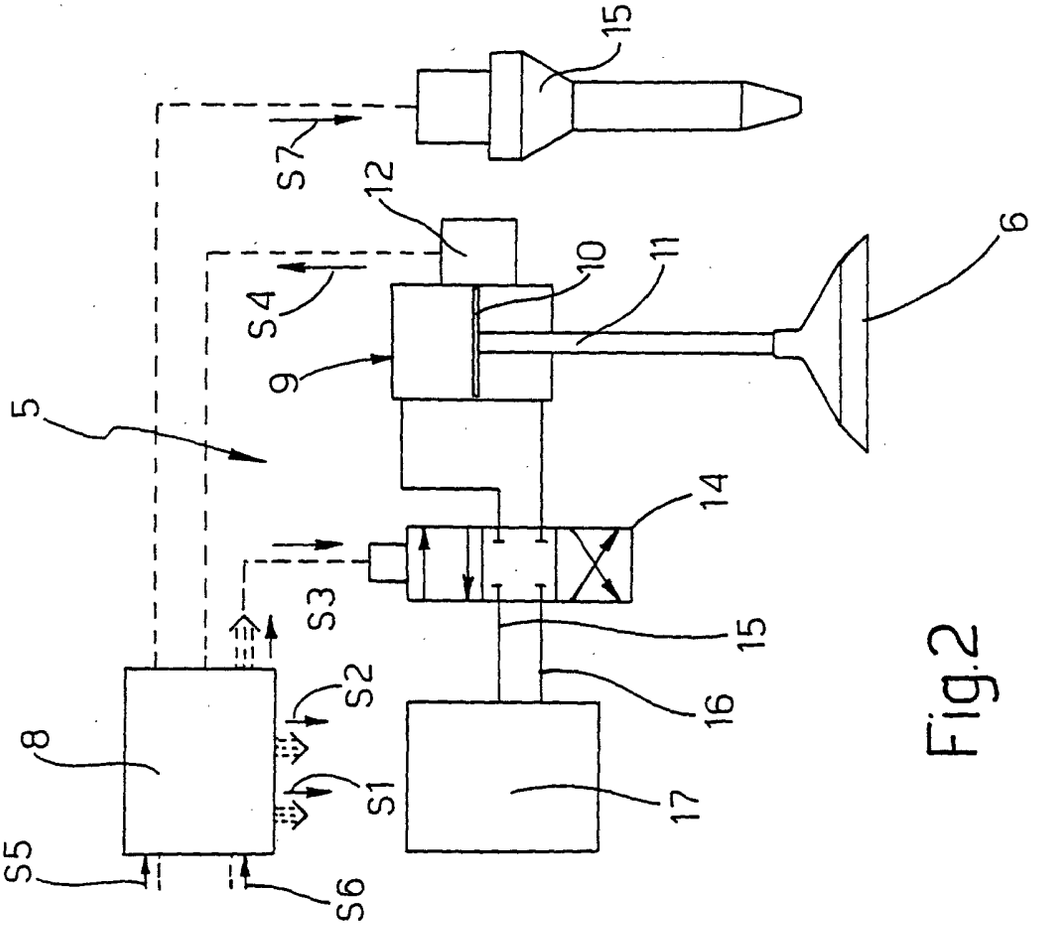
15
S7
12
6
S4
10
11
9
5
14
S3
15
S2
16
8
S1
17
S5
S6

Fig.2

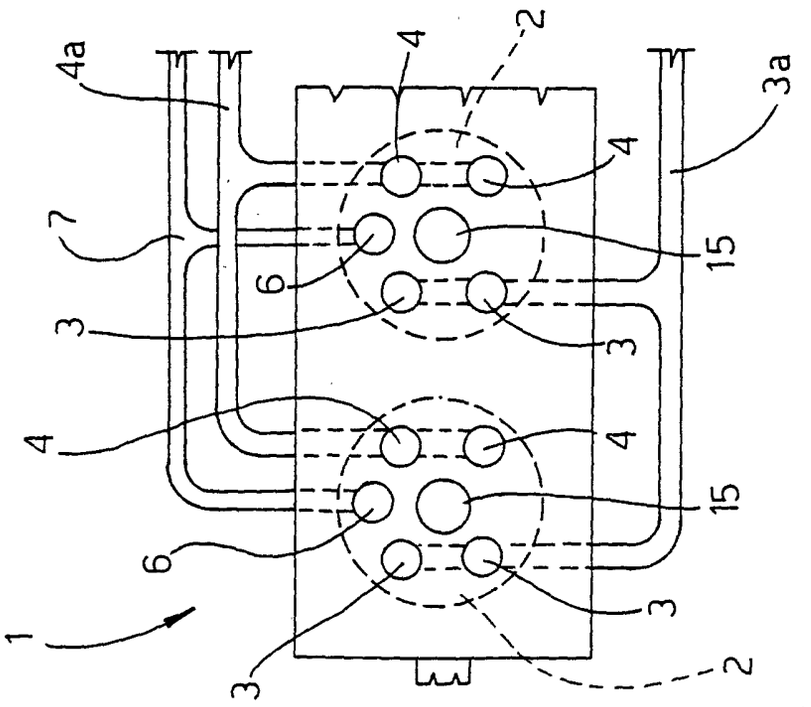
4a
4
2
3a
4
7
15
6
3
3
4
4
15
6
3
1
3
2

Fig.1

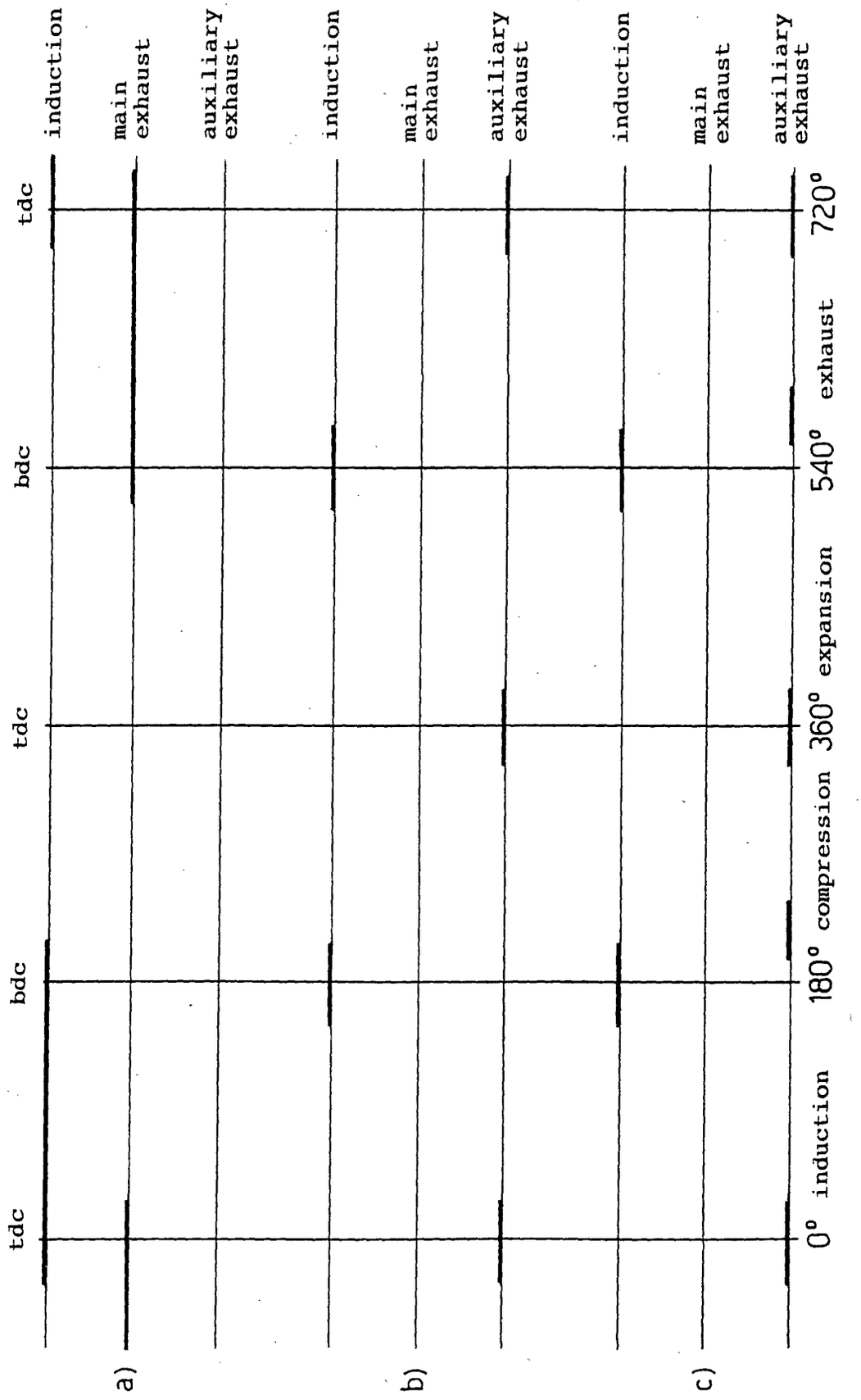
a)
b)
c)
tdc
bdc
tdc
bdc
tdc
induction
main exhaust
auxiliary exhaust
induction
main exhaust
auxiliary exhaust
induction
main exhaust
auxiliary exhaust
0° induction
180° compression
360° expansion
540° exhaust
720°

Fig. 3