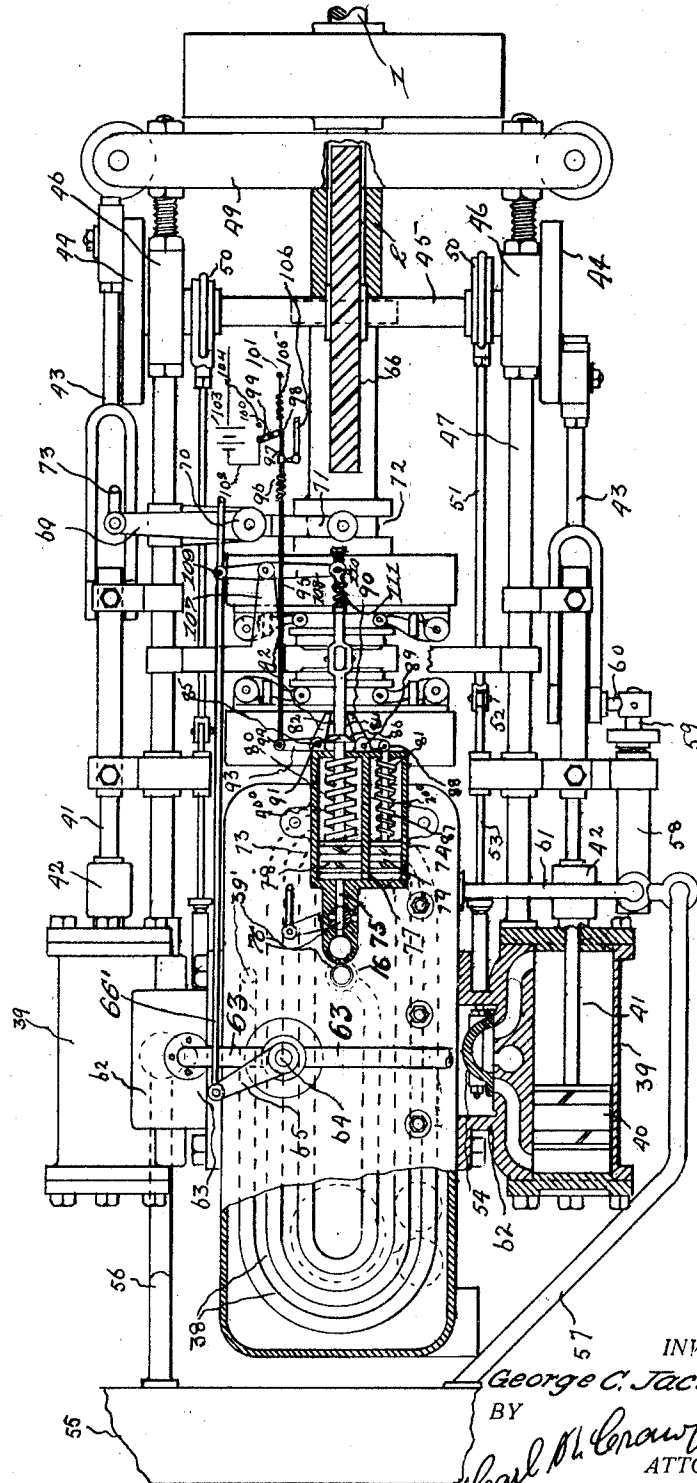


G. C. JACKMAN.
 COMBINED EXPLOSION AND STEAM ENGINE MECHANISM.
 APPLICATION FILED JUNE 18, 1917.

1,315,508.

Patented Sept. 9, 1919.
 2 SHEETS—SHEET 1.

FIG. 1

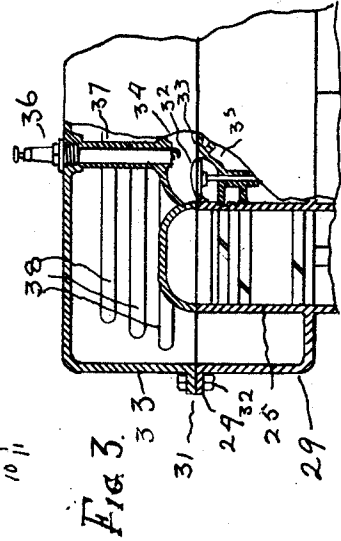
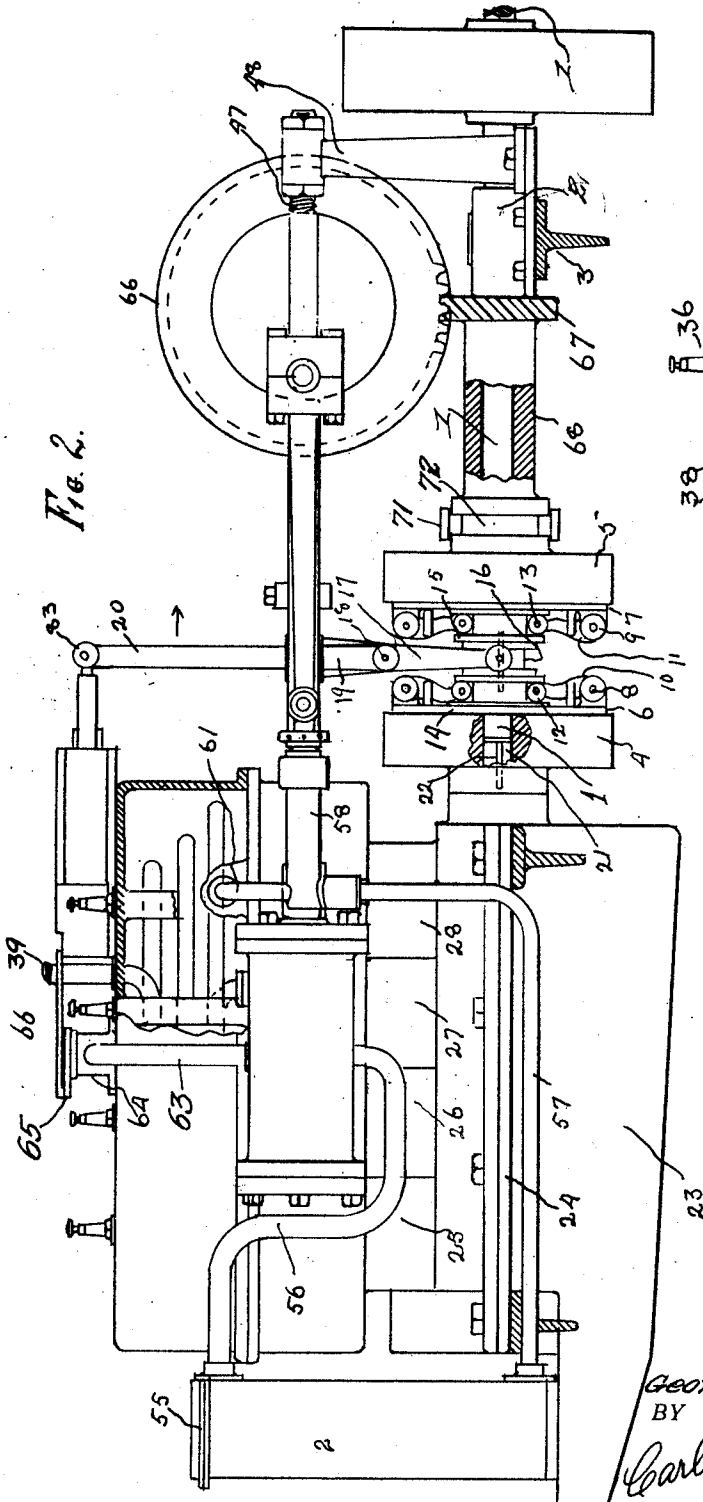


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UNITED STATES PATENT OFFICE.

GEORGE C. JACKMAN, OF SPOKANE, WASHINGTON, ASSIGNOR OF ONE-HALF TO
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COMBINED EXPLOSION AND STEAM ENGINE MECHANISM.

1,315,508.

Specification of Letters Patent.

Patented Sept. 9, 1919.

Application filed June 18, 1917. Serial No. 175,480.

To all whom it may concern:

Be it known that I, GEORGE C. JACKMAN, a citizen of the United States, residing at Spokane, in the county of Spokane and State of Washington, have invented new and useful Improvements in Combined Explosion and Steam Engine Mechanism, of which the following is a specification.

This invention relates to improvements in power plants and has to do with a combined steam and explosion engine mechanism, together with a boiler, the explosion engine being associated with the boiler in a manner to generate steam therein for use in the steam engine, and both of said engines being capable of being coupled up with a single drive shaft whereby either or both of said engines may be utilized for transmitting drive to said shaft.

My invention is more particularly adapted for use in connection with a motor vehicle or a boat but it will be understood that the invention is not limited to these particular utilities.

It is a feature of this invention to employ the explosion engine to start and run the boat, motor vehicle or other device and maintain such device in operation until the heat generated by the explosion engine has been sufficient to obtain a head of steam in the boiler sufficient to operate the steam engine. Thereafter, the steam engine will be employed to operate or run the device because the steam engine can be run more economically than the explosion engine.

The steam engine will be operated until the steam in the boiler decreases beyond a predetermined point of pressure, whereupon the explosion engine will again be employed. Under certain conditions, the explosion and steam engines may be simultaneously employed especially where the vehicle is running up grade or where the boat might be running against a swift current, this duplication of power being employed not only to keep up an effective head of steam but also to cause one engine to supplement the other, in the transmission of power. However, under all ordinary conditions, the steam engine will be capable of transmitting sufficient power to operate the device. Therefore, simultaneous operation of both engines would rarely be necessary

unless a continuous source of steam generation was desirable.

A feature of this invention which has a sequential and practically necessary existence, in view of this relation of the steam with the explosion engines, consists in means which is preferably automatic, and which functions to throw out of operation the explosion engine when the latter has generated a sufficient pressure of steam in the boiler to operate the steam engine, and conversely, the said automatic means also functions to cut out the steam engine and cut in the explosion engine when the steam in the boiler decreases beyond or below a predetermined pressure. In the most preferred embodiment of my invention, this automatic means is largely controlled by pressure in the boiler.

I preferably employ clutch mechanism of a novel form, in combination with the explosion and steam engines, such clutch mechanism being automatically operated to cut in one engine and cut out the other engine, or vice versa, whereby either engine will transmit drive to the drive shaft, a further feature being a manually operable device whereby when one of the engines has been clutched into drive and the other unclutched from drive, said unclutched engine may be clutched or thrown into drive to supplement the action of the running engine.

My invention has many other features and objects of novelty which will be more fully described in connection with the accompanying drawings and which will be more particularly pointed out in and by the appended claims.

In the drawings:—

Figure 1 is a plan view, with parts in elevation and parts in section showing one embodiment of my improved combined explosion and steam engine mechanism.

Fig. 2, is a view in side elevation thereof, with parts in section and parts in elevation.

Fig. 3 is sectional view showing projection of one of the explosion engine cylinders into the boiler for radiation of the heat from said explosion cylinder into the water of the boiler for the purposes of generating steam.

Like characters of reference designate

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similar parts throughout the different figures of the drawings.

As illustrated, 1 designates the main or explosion engine drive shaft from which drive is transmitted to the change gear mechanism and differential, to the rear axle sections, the change speed mechanism and the differential not being shown because these parts do not form a feature of my present invention. The said main drive shaft is shown journaled in a bearing, which may be mounted on any suitable frame structure 3. Said main drive shaft 1 extends through clutch mechanism, one entity being indicated at 4, and being termed the explosion engine clutch, and the other being indicated at 5, and being termed the steam engine clutch. The numerals 4 and 5 designate the female members of the clutch entities, the male members being designated at 6 and 7 and being connected to be movable in unison. To the male members are shown journaled at 8 and 9 suitable toggle levers 10 and 11, the remaining ends of which, as indicated at 12 and 13, are operatively associated with hub flanges 14 and 15, of a hub 16, the latter being splined or keyed, or otherwise non-rotatively connected but longitudinally movable in opposite directions upon the main drive shaft 1.

It will be noted that both of the female members 4 and 5, of the clutch entity, are loosely mounted upon shaft 1. An operating lever 17 is suitably connected with the hub 16 so as to shift the latter in opposite directions, and said lever 17 is pivotally mounted at 18 to a suitable bracket 19. The remaining end 20 of said lever is pivotally united with an automatically acting engine changing mechanism which will hereinafter be more fully described.

An explosion engine shaft 21 is disposed in co-axial or alined relation with the main shaft 1 and is keyed to the female clutch member 4, as indicated at 22.

The crank case of the explosion engine is indicated at 23, the same having a flange 24. The cylinders of the explosion engines are indicated at 25, 26, 27 and 28. It will be noted that the boiler extends downwardly about the cylinders, as illustrated in Fig. 3, thereby disposing the cylinders interiorly of the boiler. If desired, the crank case may be terminated at the bottoms of the cylinders and the cylinders may be jacketed as indicated at 29, the jacket 29 terminating in the flange 24. The boiler portion 30 terminates in a flange 31, which may be secured by bolts 32.

At this point, applicant desires to assert a very important feature of the invention, namely, that the cylinders of the explosion engine are sufficiently housed by the boiler so that all of the heat of the explosion engine cylinders will be absorbed by the water

in the boiler. Ordinarily, the explosion engine's cylinders of a motor vehicle are heated to such a high temperature that it is necessary to provide for some kind of cooling action. Otherwise, the cylinders of the explosion engine would be heated to such a temperature that the lubricant would fail to act. It has been estimated that no lubricant will be effective beyond 600 degrees F. Now in accordance with my invention, the cylinders of the explosion engine will be surrounded by the water in the boiler. Therefore, the heat from the cylinders of the explosion engine will be taken up by the water in the boiler. Therefore, applicant is practically assured that the temperature in the explosion engine cylinders will never reach a temperature beyond which the lubricant for pistons would be effective. It will be understood that the pre-determined steam pressure at which the steam engine will be automatically rendered operative, will be less than that temperature which would cause the lubricant in the explosion engine to become ineffective. It will also be seen that after the steam engine has been clutched in, and the explosion engine ceases to operate, there will be a considerable amount of residue heat transmitted from the explosion engine applied to the water in the boiler, which residue heat will tend to keep up steam pressure.

Thus it will be seen that even after the explosion engine has heated the water in the boiler to such an extent as to generate the pre-determined amount of steam for operation of the steam engine, the explosion engine will continue, for some considerable time, to deliver supplemental or additional heat to the water, which will be effective in the further generation of steam. It is not necessary that I should specifically set forth the steam pressure in the boiler at which a steam engine should be operative, this steam pressure, within a given pre-determined range, may vary with the kind of car to which my invention is applied. Furthermore, the range of pre-determined high pressure, at which the steam engine will be operative, and the range of pre-determined low pressure at which the steam engine will be thrown out of operation, is a matter of engineering skill which may be safely reserved for future practice. It is a well known fact that an explosion engine cylinder will heat to the extent of 2,000 degrees F. under continuous operation, in the absence of a cooling system of air or water. It is true, that in accordance with my invention the explosion engine cylinders can never reach 2,000 degrees F. because the heat generated by the explosion engine cylinders will be taken up by the water in the boiler substantially as rapidly as the heat is generated by said cylinder. Therefore, it will be clearly seen that

the maximum heat to which the explosion engine cylinders can be raised, will not be in substantially excess of heat of the water in the boiler. This heat will never be such as

5 will render the lubricant inefficient to lubricate the pistons in the cylinders. While this invention is not limited to the exact relation of the explosion engine cylinders in the boiler, it will be seen by reference to Fig. 3
10 that the major portion of the area of each cylinder of the explosion engine to which the greatest heat is generated, is immersed in the water of the boiler. Furthermore, during operation, the water in the boiler will al-
15 ways keep the explosion engine cylinders hot, when the explosion engine is not operating, and therefore, when the mechanism is shifted from steam to explosion engine operation, the explosion engine will be readily started be-
20 cause of the fact that its cylinders are hot.

With further reference to Fig. 3, it will be seen that I dispose the explosion cylinder valves 32' and 33 inside of the boiler, casings 34 and 35, housing said valves. In order to
25 render the spark plugs readily accessible, the latter are extended up through the top of the boiler, as indicated at 36, a housing 37 serving to inclose the plugs.

With a view of further conservation of
30 the explosion engine heat, I provide an exhaust pipe which is in the form of a coil 38, having an outlet at 39, and the convolutions of which coil are disposed in the boiler. There-
35 fore the water in the boiler will absorb practically all of the heat of the exhaust gases and the convoluted exhaust pipe will present a very extensive heating area to the water. As the exhaust gases traverse the winds of
40 the exhaust coil, the usual exhaust puffs will be muffled to such an extent as to render the exhaust practically noiseless.

Before completing the description of the shifting mechanism whereby the explosion engine is shifted or switched out of opera-
45 tion and the steam engine switched into operation, and prior to a complete description of the explosion engine portion of my improved mechanism, I will take up the steam engine portion thereof.

50 I have illustrated steam cylinders 39 as being horizontally disposed with their axes parallel with but somewhat elevated with respect to the aligned main shaft 1 and the explosion engine shaft 21. Each steam cylinder
55 has a piston 40, the piston rod 41 extending through suitable packing glands 42 and being provided with pitman rod 43. The pitman rod 43 is connected with crank disks 44 mounted upon a crank shaft 45. The
60 crank shaft 45 is journaled in suitable bearings 46, supported by longitudinal frame members 47. The front ends of said frame members 47 are supported in upright 48, the upright 48 terminating in a horizontal frame
65 member 49. On the crank shaft 45 are

mounted eccentrics 50 for operation of valve rods 51, pivotal connection being made at 52 with valve rods 53 which are directly connected with the valves 54 of the steam engine cylinders.

This much of the description pertaining
70 to the steam engine portion of the mechanism has been very briefly and generally made because I do not claim anything specifically new in the type of steam engine
75 shown, and so far described, the novel features of my invention resides more particularly in the interdependent relation of the steam and explosion engines with respect to each other.

I will next describe the novel means by
80 which the steam from the steam engine cylinders is condensed, and the manner in which the water of condensation is returned to the boiler.

A condensing radiator is generally indicated at 55 and the same will preferably be disposed in the front of the car, or in such a position as to be air cooled sufficiently to prevent steaming of the water of condensa-
90 tion. However, it will be understood that I deem it a novel feature of my invention to provide a condensing radiator wherein radiation to prevent over heating is not the
95 primary purpose but wherein radiation merely to maintain the water of condensation below the boiling point is the main desideratum.

Each steam cylinder will have an exhaust
100 56 leading therefrom and delivering steam to the upper portion of the condensing radiator. Leading from the lower portion of the condensing radiator is a return pipe 57 which opens to and terminates at a pump
105 58. Pump 58 has a pump piston rod 59 which is connected at 60 with one of the pitman rods whereby the pump will be continuously operated, during operation of the steam engine. Leading from the pump 58
110 is a pipe 61 which delivers to the boiler.

Now it will be clear that because of the return system shown, that the water will be re-used continuously and that the only loss
115 occurring will be through leakage and therefore it will not be necessary to re-fill with water as often as would be the case if the steam from the steam engine was exhausted into a non-return condenser.

I do not deem it necessary to go into the question of steam gages, safety valves and
120 the usual equipment of a steam engine which is now common, and such provision will in practice be made.

Admission of steam through the valve chests 62 will be made through pipes 63
125 which lead in opposite directions from a throttle valve 64 to said steam chests. A lever 65 is shown for controlling the throttle valve and a rod 66 may lead to the dash of the motor vehicle or to any other accep-
130

able point. By reference to Fig. 2, it will be seen that the throttle valve opens to the boiler at a high point therein, in the usual manner.

5 The throttle valve 64 will be opened and closed by the shifting mechanism which I am about to describe which functions automatically to throw the steam engine into and out of operation. Of course ingress of
10 steam to the steam engine will be throttled in a manner to use the steam expansively to as great an extent as possible, and adjustment of the throttle valve will, in fact, be effected only when the mechanism is initially started, and will thereafter probably
15 not require adjustment.

Reference will next be made to my novel shifting mechanism whereby either the steam or the explosion engines or both, may
20 be utilized for driving the vehicle, boat, or other device to which my invention may be applied.

On the crank shaft 45 is rigidly secured a skew-gear 66 which meshes with a skew-pinion 67. Pinion 67 is mounted on a clutch
25 sleeve 68, or it may be formed integral therewith, the clutch sleeve 68 being loose on main shaft 1. Clutch sleeve 68 is rigidly secured to the female clutch member 5. A shifting
30 lever 69 is pivotally mounted at 70 and is suitably forked, as indicated at 71, for engagement with the groove 72 in sleeve 68. Lever 69 is provided with a rod 73 which extends to the dash or other accessible points
35 of the vehicle.

From the foregoing, it will be seen that transmission is effected from the steam engine, through the crank shaft 45 and the
40 gears and sleeve 68, to the clutch member 5. If the male portion 16, of this clutch mechanism is shifted into clutch with member 5, then steam engine power will be transmitted, as just described, from clutch member 5, to clutch member 16, the latter being keyed on
45 main shaft 1. If however, the clutch member 16 is shifted into clutch with member 4, then steam transmission will be cut out and clutch member 4 will transmit the explosion engine drive from shaft 21, through key 22,
50 to clutch member 4, and from clutch member 4, to clutch member 16, and from the latter to shaft 1. For purposes of identification, clutch member 4 will be termed the explosion engine clutch member and clutch member
55 5 will be termed as a steam engine clutch member.

It will now be clear that either engine may be shifted into driving relation with shaft 1 and I will now describe how both engines
60 may be shifted into relation with said shaft.

Assuming that clutch member 16 was shifted into clutch with member 4, and therefore out of clutch with member 5, thereby throwing in the explosion engine,
65 and it was desired also to temporarily

utilize the steam engine, then lever 69 would be shifted to move sleeve 68 and clutch member 5 toward clutch member 4 and this would result in also throwing the steam engine into drive with shaft 1. This double
70 drive of both engines might possibly be desirable on the approach of a heavy upgrade of road, or in other emergencies, and whatever lack of synchronism of speed would be taken care of by the clutch mechanism.
75 Therefore, if the steam engine operated slightly slower than the explosion engine, no counter resistant action would result.

I will next describe the manner in which clutch lever 17 is automatically controlled
80 and operated by steam pressure.

Mounted upon the boiler are two cylinders, one of which is designated at 73 and the other of which is designated at 74. Cylinder 73 communicates with the boiler
85 through a passage 75 in which is interposed a bleed valve or three-way valve 76, the purpose of which will later appear. Cylinders 73 and 74 are in constant communication with each other through a passage 77
90 and it will be noted that cylinder 73 is larger than cylinder 74, in diameter. A clutch operating piston 78 is disposed in cylinder 73 and a retaining piston 79 is disposed in cylinder 74. A spring
95 80 normally acts to retain the piston 78 in the position shown, or in other words return it to the position shown. Likewise a spring 81 normally acts to return the retaining piston 79 to the position shown.
100 Spring 80 is more powerful than spring 81. The clutch operating piston 78 has a piston rod 82 which is pivoted to the clutch operating lever 17 at 83. Therefore when piston 78 moves to the right of Fig. 1, it will clutch
105 in the steam engine and when the piston 78 moves to the left of Fig. 1, it will clutch in the explosion engine. A locking and cam abutment 84 is mounted on said piston rod 82 and is provided with a cam portion
110 85 and a locking portion or retaining portion 86. Piston 79 has a piston rod 87 which is pivoted at 88 to one arm of a bell-crank lever, the latter being pivoted at 89. The remaining arm of said bell-crank lever,
115 as indicated at 90, is adapted for coaction with the locking portion 86 so that when said locking portion 86 is moved to the right of Fig. 1, sufficiently to enable the bell-crank arm 90 to get behind it, then said bell-crank
120 arm will lock the piston rod 82 in a position to hold the clutch mechanism in a steam drive adjustment

Thus it will be seen that steam pressure against piston 79 will serve to actuate the
125 bell-crank so as to lock the arm 90 behind the locking portion 86. It will also be seen that when steam pressure decreases behind piston 79, the spring 81 will force piston 79 to the left of Fig. 1 and this will release
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bell-crank arm 90 from engagement with the locking lugs 86 so that spring 80 can retract piston 78 from a right hand position to the left hand position shown in Fig. 1, thereby returning the clutch shaft from a steam engine drive adjustment to an explosion engine drive adjustment. It will be readily understood that this mechanism does not provide for any intermediate position of the clutch mechanism. The clutch mechanism must necessarily be either in a steam engine drive adjustment or in an explosion engine drive adjustment. Furthermore, reliance is placed upon steam pressure to effect the steam drive adjustment and reliance is placed upon spring action to maintain and effect explosion drive adjustment.

It would not be practical to merely throw the explosion engine out of drive with the vehicle and permit the explosion engine to continue operation, at least, normally. It is understood that in some few exigencies it might possibly be desirable to permit the explosion engine to continue operation even though it were not connected up in driven relation with the vehicle because such continued operation of the explosion engine, running idly, would serve to generate steam in the boiler. However, in addition to the means for throwing the explosion engine out of vehicle drive, I have provided means for arresting operation of the explosion engine, which means I will now describe in detail.

A bell-crank lever is designated at 91 and it has an arm 92 for coaction with the cam portion 85 so that when the cam portion 85 is moved to the right of Fig. 1 it will elevate arm 92 but arm 92 is of sufficient length so that the cam portion 85 cannot pass beyond it and so that arm 92 cannot descend behind said cam portion. Therefore the cam portion is merely a lifting element serving to actuate arm 92. The remaining arm of the bell-crank lever is indicated at 93 and the same is pivoted at 94 to a rod 95. Rod 95 is interrupted by a compression spring 96 and the remaining end 97 of said rod is connected at 98 with a switch 99 which is pivoted between its ends 100. The pivot 100 is connected with one limb 101 of the spark circuit of the explosion engine and one of the contacts of the switch is adapted for engagement with the other limb 102. A source of current 103 is interposed in said circuit and in Fig. 1, the circuit is shown closed, because the clutch mechanism is in an explosion engine adjustment. When the switch is in contact with terminal 104, then the circuit will be open. It is desirable to have the spark circuit opened when the explosion engine is shifted out of drive with the vehicle. A spring 105, which is a tension spring, normally acts to hold the switch in a circuit open position.

If for any reason it was desirable to cut out the explosion engine, without waiting for the explosion engine to be automatically cut out, then rod 106 can be pulled and the spring 96 will permit of this movement irrespective of the position of bell-crank 92.

I will next explain the function and purpose of the bleed or three-way valve 76.

Assuming that the piston 78 has been forced to the right of Fig. 1 so as to clutch in the steam engine, and thereby clutch out the explosion engine, and it was desired to temporarily employ the explosion engine to supplement the action of the steam engine, then in the absence of a bleed valve, pressure on the sleeve 68, by means of lever 69, would have to be exerted against the steam pressure on piston 78 in order to return the clutch mechanism to the position shown in Fig. 1. Therefore when the steam engine is in operation and it is desired to supplement the power of the steam engine by the explosion engine or to operate the explosion engine for generating steam, the bleed valve will be operated to release pressure from behind pistons 78 and 79 so that lever 69 can thrust the clutch mechanism into the coacting relation whereby both engines will be operated and driven. In this adjustment, the spark circuit would be automatically closed upon movement of piston 78 to the position shown in Fig. 1, as has been heretofore described.

I have described the means for rendering the explosion engine inoperative when the explosion engine is thrown out of drive with the drive shaft, and I will describe the manner in which the steam engine is rendered inoperative until the shifting mechanism acts to shift the drive and throw the steam engine either into or out of drive with the drive shaft.

On the bracket 107 is mounted a lever 108, one end of said lever being pivoted at 109 to said rod 66' and the other end of said lever being pivoted at 110 to the piston rod 82 of piston 78. Therefore, when piston 78 is actuated under steam pressure to throw the steam engine into coupling relation with the drive shaft, the throttle 64 will be automatically opened to start the steam engine. Otherwise, before steam pressure had reached the point where it would actuate piston 78, the steam engine would be running idly, and wasting steam.

I interpose a spring 111, in the piston rod 82, which spring is of a character that will resist contraction or elongation under normal pressure and will be sufficiently strong for the light work of actuating the throttle. The purpose of this spring is to permit of manual operation of the rod 66', to control the throttle, independently of the automatic mechanism, and a further function of the spring 111 is to permit of manual operation

of rod 66' to hold the throttle open when the bleed valve 76 is actuated to permit the piston 78 to be returned under action of lever 71, when it is desired to throw in the explosion engine to supplement the steam engine. Rod 106 will also be employed to maintain the spark circuit closed under this adjustment.

From the foregoing description, it is believed that the operation and structure of my invention will be clearly understood.

It will now be noted that instead of provision being made to radiate the heat off from the explosion engine so as to maintain the same in a sufficiently cold condition to operate, I utilize this heat for the purpose of generating steam. Therefore, one of the greatest losses incident to the operation of an explosion engine is totally obviated. I even conserve and utilize the heat which normally radiates off from the exhaust of the explosion engine, for the purpose of generating steam. Practically the only loss of heat incident to the operation of this combined engine mechanism will be in the radiator; wherein I merely radiate off enough heat to prevent the water of condensation from reaching a boiling point.

While I have herein shown and described one specific form of my invention, I do not wish to be limited thereto except for such limitations as the claims may import.

I claim:

1. In a combined explosion and steam engine mechanism for motor vehicles, a steam boiler, an explosion engine for generating steam in said boiler, a steam engine driven from said boiler, mechanism for transmitting vehicle drive either from said explosion or steam engines, and means controlled by steam pressure in said boiler for throwing the explosion engine out of vehicle drive and throwing said steam engine into vehicle drive, substantially as described.

2. In a combined explosion and steam engine mechanism for motor vehicles, a steam boiler, an explosion engine for generating steam in said boiler, a steam engine driven from said boiler, both of said engines having transmission means for driving the vehicle, and means controlled by steam pressure in said boiler for throwing said explosion engine out of vehicle drive and said steam engine into vehicle drive, substantially as described.

3. In a combined explosion and steam engine mechanism for motor vehicles, a steam boiler, an explosion engine for starting and running said vehicle and generating steam in said boiler, a steam engine operated by said boiler for driving said vehicle, and mechanism for cutting out said explosion engine and starting said steam engine when steam pressure has reached and while it is maintained at a range of pre-determined

pressure in said boiler and cutting said steam engine out when said boiler pressure decreases below such pre-determined range of pressure, substantially as described.

4. In a combined explosion and steam engine mechanism for motor vehicles, a steam boiler, an explosion engine for generating steam in said boiler, a steam engine driven from said boiler, mechanism for transmitting vehicle drive either from said explosion or steam engines, means controlled by steam pressure in said boiler for throwing the explosion engine out of vehicle drive and the steam engine into vehicle drive, and manual means for restoring said explosion engine into vehicle drive to supplement the driving power of the steam engine, substantially as described.

5. In a combined explosion and steam engine mechanism for motor vehicles, a steam boiler, an explosion engine for generating steam in said boiler, a steam engine driven from said boiler, mechanism for transmitting vehicle drive either from said explosion or steam engines, and automatically acting means for cutting either engine into drive and cutting the remaining engine out of drive, substantially as described.

6. In a combined explosion and steam engine mechanism, a steam boiler, an explosion engine for generating steam in said boiler, a steam engine operated by steam from said boiler, a drive shaft, mechanism for either coupling said steam or explosion engines to said shaft, and means for actuating said mechanism comprising a cylinder open to boiler pressure, a piston in said cylinder actuated by boiler pressure to make one character of adjustment of said mechanism, and means acting on said piston for making another character of adjustment of said mechanism, substantially as described.

7. In a combined explosion and steam engine mechanism, a steam boiler, an explosion engine for generating steam in said boiler, a steam engine operated by steam in said boiler, a drive shaft, mechanism for either coupling said steam or explosion engines to said shaft, means for actuating said mechanism comprising a cylinder open to boiler pressure, a piston in said cylinder actuated by boiler pressure to make one character of adjustment of said mechanism, means acting on said piston for making another character of adjustment of said mechanism, and a boiler pressure actuated device for locking said piston, substantially as described.

8. In a combined explosion and steam engine mechanism, a steam boiler, an explosion engine for generating steam in said boiler, a steam engine operated by steam from said boiler, a drive shaft, mechanism for either coupling said steam or explosion engine to said drive shaft, means for operating said mechanism comprising a cylinder

open to boiler pressure, a piston in said cylinder actuated by boiler pressure to make one adjustment of said mechanism, to couple the steam engine to said drive shaft and means acting on said piston for making another adjustment of said mechanism to couple said explosion engine to said drive shaft, a spark circuit for said explosion engine, and means actuated by said piston for closing said spark circuit when said explosion engine is coupled to said shaft and opening said spark circuit when said explosion engine is uncoupled from said shaft, substantially as described.

9. In a combined explosion and steam engine mechanism, a steam boiler, an explosion engine for generating steam in said boiler, a steam engine operated by steam from said boiler, a drive shaft, mechanism for either coupling said steam or explosion engines to said shaft, means for actuating said mechanism comprising a cylinder open to said boiler pressure, a piston in said cylinder actuated by boiler pressure to couple said steam engine to said shaft, means acting on said piston to couple said explosion engine to said shaft when steam pressure decreases, and means operated by said piston for rendering said explosion engine operative when coupled to said shaft and rendering said explosion engine inoperative when uncoupled from said shaft, substantially as described.

10. In a combined steam and explosion engine mechanism, a boiler, an explosion engine for generating steam in said boiler and having a crank shaft, a main drive shaft aligned with said crank shaft, a steam engine driven by steam from said boiler, and automatically acting clutch mechanism on said crank shaft and on said drive shaft for coupling either or both of said engines to said drive shaft irrespective of slight relative variation of speed of the engines, substantially as described.

11. In a combined explosion and steam engine mechanism for motor vehicles, a steam boiler, an explosion engine for generating steam in said boiler, a steam engine driven from said boiler, a vehicle shaft, mechanism for either coupling said explosion engine or said steam engine singly to said drive shaft or coupling both of said engines simultaneously to said drive shaft irrespective of slight relative variation of speed of the engines, and automatic means for rendering both engines operative when coupled to said drive shaft, substantially as described.

12. In a combined explosion and steam engine mechanism for vehicles, a steam boiler, an explosion engine for operating said boiler, a steam engine operated by said boiler, mechanism for coupling either engine into driving relation of said vehicle,

and means automatically rendering the explosion engine inoperative when the steam engine is operating, substantially as described.

13. In a combined explosion and steam engine mechanism for vehicles, a steam boiler, an explosion engine for operating said boiler and having a spark circuit, a steam engine operated by said boiler, mechanism for coupling either engine into driving relation with said vehicle, and means automatically opening the spark circuit of the explosion engine when said steam engine is operating, substantially as described.

14. In a combined explosion and steam engine mechanism for vehicles, a steam boiler, an explosion engine for operating said boiler, a steam engine operated by said boiler, mechanism for coupling either engine into driving relation with said vehicle, and means controlled by steam pressure in the boiler for starting said steam engine and rendering the explosion engine inoperative, substantially as described.

15. In a combined explosion and steam engine mechanism for vehicles, a steam boiler, an explosion engine for operating said boiler, a steam engine operated by said boiler, clutch mechanism for coupling either engine into driving relation with said vehicle, and means controlled by steam pressure in the boiler for actuating and locking said clutch mechanism in a position to couple the steam engine into vehicle drive, and spring mechanism for adjusting said clutch mechanism to couple said explosion engine into vehicle drive, substantially as described.

16. In a combined explosion and steam engine mechanism for vehicles, a steam boiler, an explosion engine for operating said boiler, a steam engine operated by said boiler, clutch mechanism for coupling either engine into driving relation with the vehicle, and means actuated by steam pressure in the boiler for adjusting and locking said clutch mechanism into a steam engine drive adjustment, and spring mechanism automatically operating upon decrease of boiler pressure for returning and holding said clutch mechanism in an explosion engine drive adjustment, substantially as described.

17. In a combined explosion and steam engine mechanism for vehicles, a steam boiler, an explosion engine for operating said boiler, a steam engine operated by said boiler, mechanism for coupling either engine into driving relation with said vehicle, and means actuated by steam pressure for adjusting said mechanism for a steam engine drive and locking said mechanism into such adjustment, substantially as described.

18. In a combined explosion and steam engine mechanism for vehicles, a steam

boiler, an explosion engine for operating said boiler, a steam engine operated by said boiler, clutch mechanism for coupling either engine into driving relation with said vehicle, an actuating cylinder including a clutch operating piston and communicating with said boiler for actuation of the piston by the boiler pressure, a retaining cylinder of reduced size with respect to said actuating cylinder and communicating with the latter, a retaining piston in said retaining cylinder, said operating piston having a piston rod connected with said clutch mechanism, means operated by said retaining piston for retaining said rod in a steam actuated adjustment, and a spring acting upon said retaining piston for operating the latter to release said rod on decrease of steam pressure, substantially as described.

19. In a combined explosion and steam engine mechanism for vehicles, a steam boiler, an explosion engine for operating said boiler, a steam engine operated by said boiler, clutch mechanism for coupling either engine into driving relation with said vehicle, an actuating cylinder including a clutch operating piston and communicating with said boiler for actuation of said piston by boiler pressure, a retaining cylinder communicating with said actuating cylinder, a retaining piston in said retaining cylinder, said operating piston having a piston rod connected in said clutch mechanism, means operated by said retaining piston for retaining said rod in a steam actuated adjustment, and a spring acting on said retaining piston for operating the latter to release said rod on decrease of boiler pressure, substantially as described.

20. In a combined explosion and steam engine mechanism for vehicles, a steam boiler, an explosion engine for operating said boiler and having a spark circuit, a steam engine operated by said boiler, clutch mechanism for coupling the engine into driving relation with the vehicle, an actuating cylinder communicating with said boiler, an actuating piston in said cylinder connected with said clutch mechanism, and means actuated by said piston for opening said spark circuit when said clutch mechanism is in a steam engine drive adjustment and closing said spark circuit when said clutch mechanism is in an explosion engine drive adjustment, substantially as described.

21. In a combined explosion and steam engine mechanism for vehicles, a steam boiler, an explosion engine for operating said boiler, a steam engine operated by said boiler, clutch mechanism for coupling either engine into driving relation with said vehicle, a relatively large actuating cylinder communicating with said boiler, an actuating piston in said cylinder having a rod operated in connection with said clutch mechanism

to throw the latter into a steam engine drive adjustment by steam actuating said piston, a retaining cylinder of smaller size than said actuating cylinder and having a piston, a positive locking device actuated by said retaining piston and coacting with said rod to lock the clutch mechanism in a steam engine drive adjustment, a relatively heavy spring for returning said actuated piston to a starting position and clutching in said explosion engine, and a spring acting on said retaining piston upon decrease of steam pressure to release said rod prior to actuation of the latter by said heavy spring and said retaining piston spring being lighter than the spring of said actuating piston, substantially as described.

22. In a combined explosion and steam engine mechanism for vehicles, a steam boiler, an explosion engine for operating said boiler, a steam engine operated by said boiler, clutch mechanism for coupling either engine into driving relation with said vehicle, an actuating cylinder communicating with said boiler, an actuating piston in said cylinder connected with said clutch mechanism and adapted to be actuated by steam from said boiler on one face of said piston to throw said clutch mechanism into a steam engine drive adjustment, and a spring for operation on the other face of said piston upon decrease of steam pressure to throw said clutch mechanism into an explosion engine drive adjustment, substantially as described.

23. In a combined explosion and steam engine mechanism for vehicles, a steam boiler, an explosion engine for operating said boiler, and having a spark circuit, a steam engine operated by said boiler, clutch mechanism for coupling either engine into driving relation with said vehicle, and means operated by steam pressure in the boiler for throwing said clutch mechanism into a steam engine drive adjustment and cutting out the explosion engine from vehicle drive and also opening the spark circuit of the said explosion engine to prevent operation of the latter, substantially as described.

24. In a combined explosion and steam engine mechanism for vehicles, a steam boiler, an explosion engine for operating said boiler, a steam engine operated by said boiler, clutch mechanism movable in one direction to connect said steam engine into vehicle drive and movable in an opposite direction to throw said explosion engine into vehicle drive, a cylinder open to said boiler and having a piston connected with said clutch mechanism and actuated by steam pressure to adjust said mechanism into steam engine drive upon pre-determined pressure in the boiler, and means for bleeding the pressure behind said piston to move said

clutch mechanism into an explosion engine drive adjustment while said steam engine is running, substantially as described.

25. In a combined explosion and steam engine mechanism for vehicles, a steam boiler, an explosion engine for operating said boiler, a steam engine operated by said boiler and including a throttle valve connection, clutch mechanism for coupling either engine into driving relation with said vehicle, and means operated by steam pressure for coupling said steam engine into driving connection with said vehicle and opening said throttle valve connection, substantially as described.

26. In a combined explosion and steam engine mechanism for vehicles, a steam boiler, an explosion engine for operating said boiler and having a spark circuit, a steam engine having a throttle valve connection with said boiler, mechanism for throwing either engine into vehicle drive, and an apparatus controlled by boiler pressure for operating said mechanism to couple either engine into vehicle drive and operate said throttle valve connection and open or close said spark circuit to render the explosion engine operative and the steam engine inoperative or vice versa, substantially as described.

27. In a combined explosion and steam engine mechanism for vehicles, a steam boiler, an explosion engine for operating said boiler, a steam engine operated by said boiler, mechanism for throwing either engine into vehicle drive, and an apparatus controlled by boiler pressure for operating said mechanism to couple either engine into vehicle drive and render such acting engine operative and render the non-acting engine inoperative, substantially as described.

28. In a combined explosion and steam engine mechanism for vehicles, a steam boiler, an explosion engine for generating steam in said boiler, a steam engine driven from said boiler, and automatically acting

mechanism for transmitting drive either from said explosion or steam engines irrespective of the running speeds of the engines, substantially as described.

29. In a combined explosion and steam engine mechanism for vehicles, an explosion engine, a steam engine, and automatically acting mechanism for transmitting drive either from said explosion or steam engines irrespective of the running speeds of the engine, substantially as described.

30. The combination with a vehicle or load to be driven, of steam and explosion engines for driving said vehicle or load, and automatically acting mechanism for rendering either of said engines operative irrespective of the running speeds of the engines, substantially as described.

31. The combination with a vehicle or load to be driven, of steam and explosion engines for driving said vehicle or load, and automatically acting mechanism for rendering either of said engines operative and rendering the remaining engine inoperative when the running engine is operating irrespective of the running speeds of the engine, substantially as described.

32. In a combined explosion and steam engine mechanism for vehicles, an explosion engine, a steam engine, and automatically acting mechanism for throwing either the steam or explosion engine into vehicle drive irrespective of the running speeds of the engines, substantially as described.

33. In a combined explosion and steam engine mechanism for vehicles, an explosion engine, a steam engine, and automatically acting mechanism for positively throwing either the steam engine or the explosion engine into vehicle drive and throwing one engine out of drive when the remaining engine is in drive, substantially as described.

In testimony, that I claim the foregoing as my own, I hereby affix my signature.

GEORGE C. JACKMAN.