S. ROSENZWEIG.

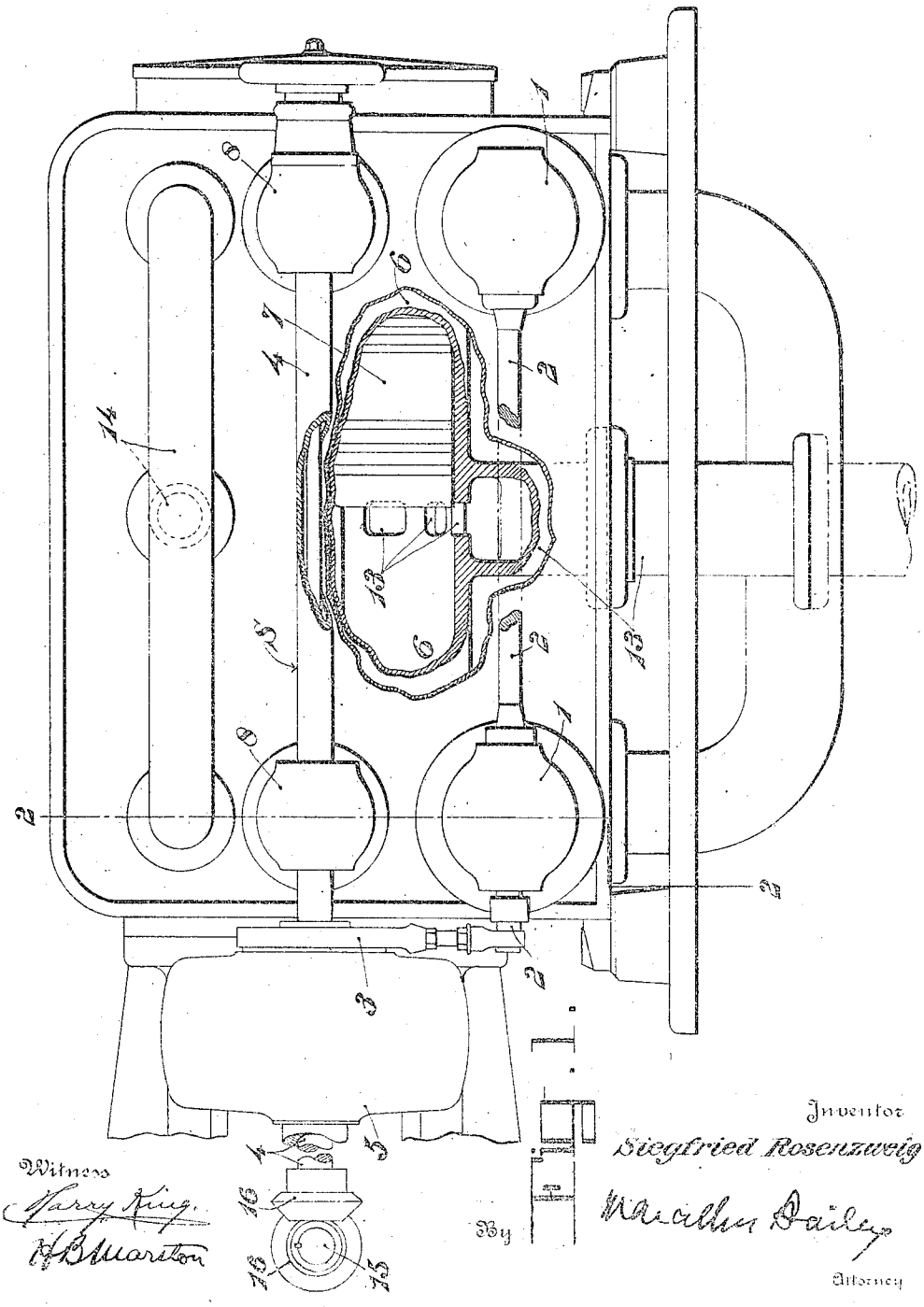
STEAM ENGINE.

APPLICATION FILED DEC. 5, 1916.

1,239,826.

Patented Sept. 11, 1917.

4 SHEETS—SHEET 1.



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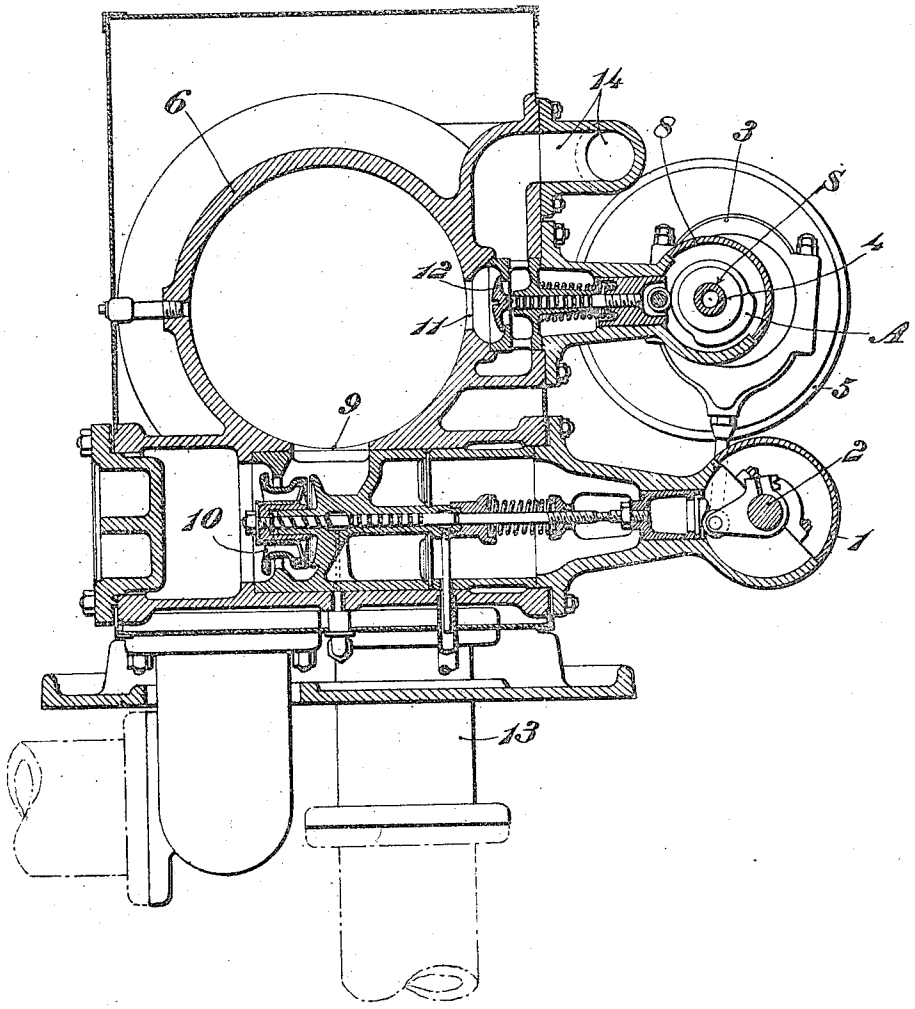
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4 SHEETS—SHEET 2.

Fig. 2.



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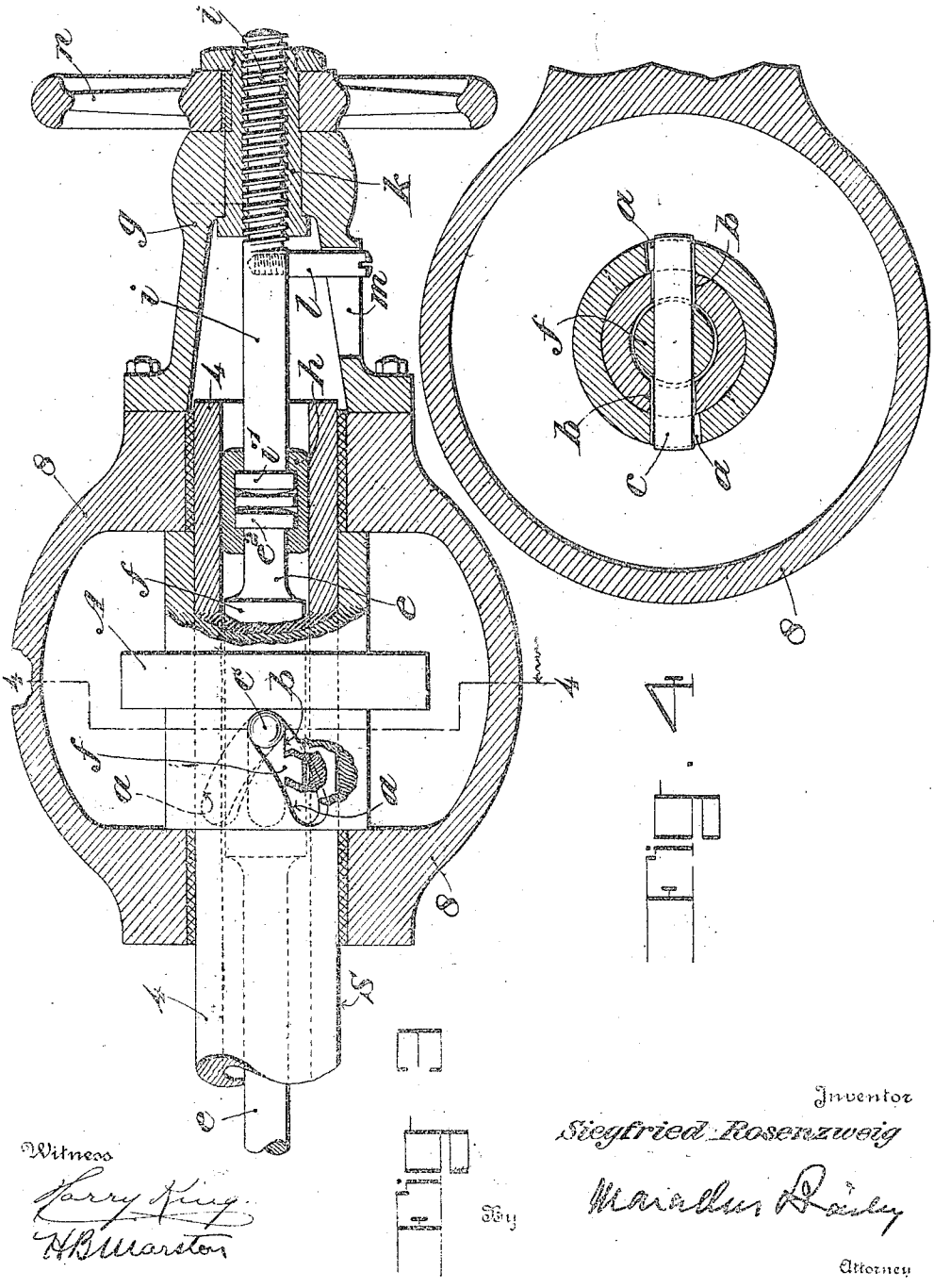
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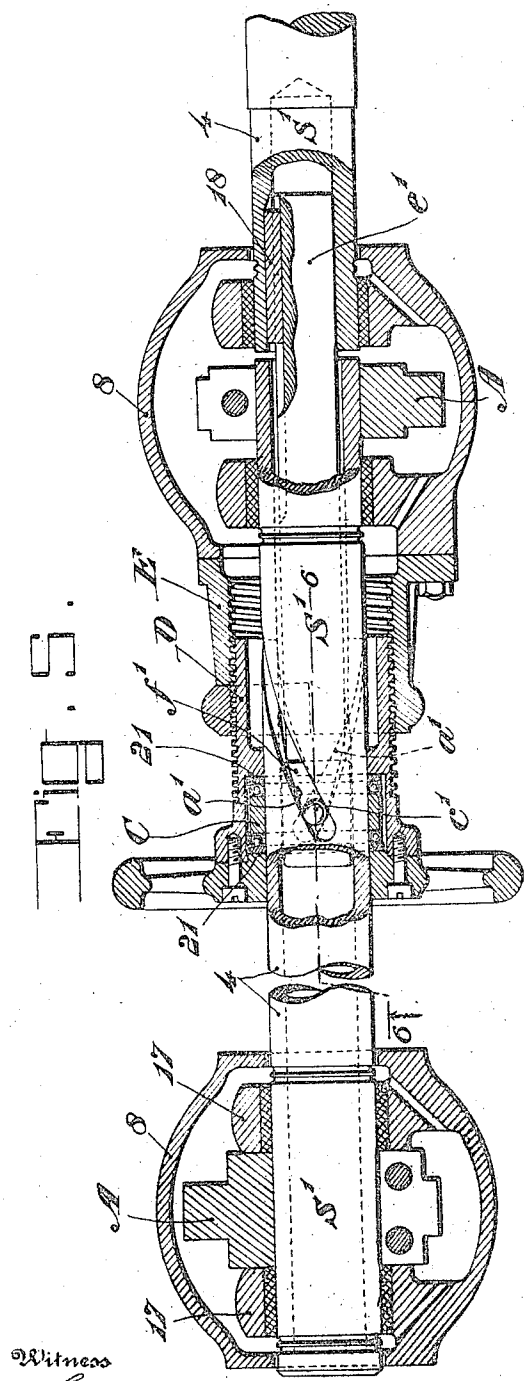


Fig. 5.

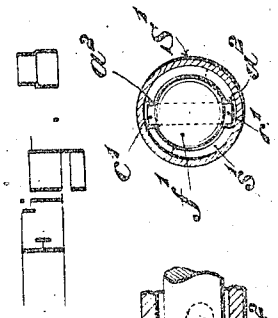
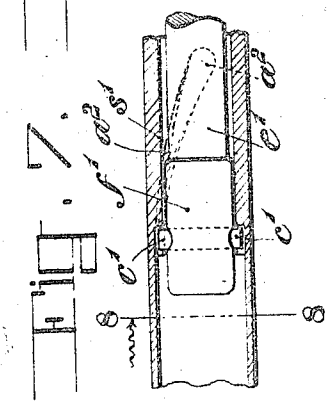


Fig. 7.



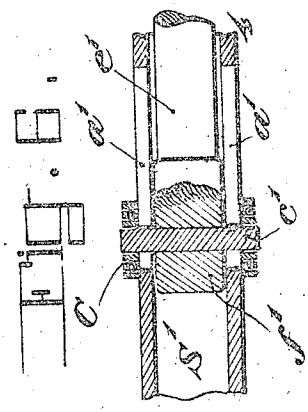


Fig. 6.

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UNITED STATES PATENT OFFICE.

SIEGFRIED ROSENZWEIG, OF NEW YORK, N. Y.

STEAM-ENGINE.

1,239,826. Specification of Letters Patent. Patented Sept. 11, 1917.

Application filed December 5, 1916. Serial No. 135,112.

To all whom it may concern:

Be it known that I, SIEGFRIED ROSENZWEIG, residing in New York city, in the county and State of New York, have invented a new and useful Improvement in Steam-Engines, of which the following is a specification.

My invention relates to uniflow engines having a central main exhaust port in the steam cylinder wall uncovered by the piston toward the end of the expansion stroke, and auxiliary exhaust ports and mechanically operated controlling valves therefor through which steam escapes, after the main exhaust has been closed by the piston, with a view to regulate and control the compression.

The object of my invention is to provide a simple and efficient means of adjusting the auxiliary exhaust valves to regulate and control the compression as desired, whether for condensing or non-condensing work. To this end I operate the auxiliary exhaust valves by means of cams driven from and revolving in unison with a rotating side shaft, preferably directly geared to and driven by the engine crank shaft as set forth in my Letters Patent No. 1,059,567 with reference to the exhaust valve cam-operating mechanism therein illustrated; these auxiliary-exhaust-valve operating-cams I make rotatably shiftable relatively to their operating shaft to the extreme limit in either direction required for condensing and non-condensing work respectively; and I combine with the thus-rotatably shiftable cams mechanical hand-operated means by which said cams may be adjusted, whether the engine be in motion or at rest, to any point between these limits in order to vary the compression as desired whether working condensing or non-condensing.

To enable others skilled in the art to make and use my invention, I will now proceed to describe the manner in which the same is, or may be, carried into practical effect by reference to the accompanying drawings forming part of this specification in which—

Figure 1 is a side elevation of so much of a uniflow engine as needed to explain my invention—the connections of the governor shaft 4 with the main engine or crank shaft being diagrammatically indicated, and the side of the steam cylinder being broken away to expose the steam piston therein.

Fig. 2 is a cross section on somewhat enlarged scale on line 2—2 Fig. 1. In this figure the steam inlet valve operating tappet and the auxiliary exhaust valve operating cam are shown in elevation; and the hand operated device for adjusting the auxiliary exhaust valve operating cam is omitted, as also is the steam piston.

Figs. 3 and 4 are on a larger scale, and are designed merely to exhibit the structural details of the means for adjusting the auxiliary exhaust valve operating cams.

Fig. 3 is an axial section, partly in elevation, of the end portion of the governor shaft 4 to which the adjusting means and operating handle are applied, together with one of the auxiliary exhaust cams, and the bonnet for said cam.

Fig. 4 is a cross section on line 4—4 Fig. 3.

Fig. 5 is a vertical axial section, partly in elevation, of the governor shaft and auxiliary exhaust valve operating cams, illustrative of a modification of the hand operated means for adjusting said cams.

Fig. 6 is a longitudinal section on line 6—6 Fig. 5, the spiral slots being diagrammatically represented as straight.

Fig. 7 is an axial section illustrative of a further modification.

Fig. 8 is a section on line 8—8 Fig. 7.

In the drawings 1 are the bonnets for the tappets on the rock shaft 2 for operating the two steam inlet valves 10 located at opposite ends of the steam cylinder 6 and controlling the steam inlet ports 9, said bonnets being on the outer ends of the housings for the inlet valve stems; 3 is the eccentric strap and its connecting rod through which motion is imparted from the eccentric on the governor shaft 4 to the rock shaft 2; 5 is a centrifugal governor mounted on the shaft 4 and connected in the usual way to the eccentric; 8 are the bonnets for the cams A for operating

the two auxiliary exhaust valves 12, which are located at opposite ends of the steam cylinder and control the auxiliary valve ports 11, said cams being mounted upon and revolving with a tubular extension S of the governor shaft 4, said shaft in practice extending back to the engine crank shaft 15 and being driven from the same by gearing 16, 16, as indicated diagrammatically in Fig. 1, and as shown and described in my Letters Patent No. 1,059,567 hereinbefore referred to; 13 are the main exhaust ports and passages located centrally between the ends of the steam cylinder and controlled by the reciprocating steam piston 7; 14 are the ducts leading from the auxiliary exhaust ports and passages to the main exhaust passages 13.

The governor shaft 4 is in a line parallel with the horizontal axis of the cylinder, and the auxiliary exhaust valves are located and move in the horizontal plane of that axis, as indicated in Figs. 1 and 2. The extended portion S of the governor shaft 4 on which the two auxiliary exhaust valve operating cams A are mounted passes through and takes its bearings in the bonnets 8, and each cam A is contained in its own bonnet, as in my aforesaid Letters Patent. Each cam A is restrained from movement lengthwise on its shaft by suitable means, in this instance by the cheeks of its bonnet 8 as seen in Fig. 3; but while compelled to rotate with said shaft, it is rotatably shiftable thereon to adjust its relation to the stroke of the engine, with a view to varying the compression as desired. To this end I form in the hub of the cam a slot *a*, or rather two symmetrically arranged and diametrically opposite slots *a*, which extend lengthwise of and at an inclination to the axis of the hub. Similarly, I form in the shaft 4, which is hollow at least for that portion S of its length devoted to the cams A, diametrically opposite straight slots *b* extending lengthwise of the shaft and in the plane of the axis thereof. The inclined slot *a* on the opposite side of the hub from the inclined slot *a* shown in full lines is represented in dotted lines in Fig. 3, it of course appearing, as thus located, inclined in the opposite direction from its fellow-inclined slot. Extending diametrically through the shaft 4 is a cross pin *c* which projects at its ends through the straight slots *b* in the shaft into the inclined slots *a* in the hub of the cam A. Manifestly, if the pin *c* by suitable means is pulled in one direction or the other in the shaft, the cam A will be correspondingly rotatably shifted thereon in one direction or the other according to the direction of movement of the pin, and for a distance determined by the extent of longitudinal travel of the pin in the slots *b* in the shaft and the degree of inclination of the slots *a* in the cam hub. The two slots *a* and *b* of each pair are so arranged and formed that when the pin brings up against either end of the one slot, it will have reached the corresponding end of the other slot also.

In order to thus operate the cross pin *c* various means may be employed. One convenient arrangement for this purpose is represented in the drawings. The extreme open end of the tubular extension S of shaft 4 passes through and beyond the auxiliary exhaust cam bonnet 8 farthest removed from the steam inlet valve operating eccentric and valve gear. An operating stem *e* enters the extension S from this end of it, and extends therethrough far enough to reach each one of the two cams. At each of these points the stem *e* is enlarged to form a cylindrical head *f* of such size and proportions as to fit the bore of the extension S and be slidable therein, the latter furnishing an accurate bearing and guide for the thus-movable stem. In each one of the heads *f* is secured a cross pin *c* like that already referred to, which extends crosswise of and diametrically through the head *f* and its ends engage the slots *a*, *b*, in the cam hub and shaft respectively as hereinbefore described.

To the end of the bonnet 8 through which the open end of tubular extension S projects, is secured a cap *g*. Within the open end of the same thus covered by the cap *g* is a cylindrical coupling box *h* which fits and is free to both rotate and slide lengthwise therein. The coupling box contains the abutting cylindrical heads e^2 and *i'* of the stem *e* and a screw spindle *i* respectively, which fit the cylindrical interior of the coupling box. The screw spindle *i* passes through and engages an internally screw threaded nut *k* extending through and supported in a bearing in the outer end of the cap *g* in which it is capable of rotary movement only as shown. On the screw spindle *i* is a radially projecting pin *l* which enters a guide slot *m* formed in and lengthwise of the cap, and on the nut *k* is mounted a hand wheel *n* for operating the same. When the nut *k* is rotated by the hand wheel *n*, the screw spindle will be moved lengthwise only without rotation, thus, through the coupling box *h*, imparting corresponding movement to the operating stem *e*. In this way, whether the engine be in motion or at rest, the auxiliary exhaust valve operating cams A—both of them—can at any time be readily and surely and simultaneously adjusted by hand to vary their position upon their shaft 4 as desired.

In the form of hand operated adjusting means just described, each cam A has its own individual connection with the operating stem *e*, viz: the cross pin *c*, the pair of

spiral inclined slots *a* in the hub of the cam and the pair of straight slots *b* in the tubular extension S of the governor shaft 4. In Figs. 5 and 6 is represented a modification wherein the tubular extension of the governor shaft 4 on which the cams A are mounted, designated S′ in said figures, is made separate from the governor shaft 4 for a purpose which will be presently described, although connected therewith in such manner that the two will always revolve in unison, just as the governor shaft 4 and its tubular extension S in the preceding figures.

The two cams A are mounted on and rigidly fastened to the governor shaft extension S′, which extends between and takes its bearings in the bonnets 8 of said cams, in which bearings said tubular extension S′ is free to revolve while restrained from longitudinal movement by the bearings 17 for said tubular extension S′ in the bonnet 8 at the far end of the steam cylinder, between the cheeks of which bearings fits the cam A contained in that bonnet. The main governor shaft 4 enters the bonnet 8 adjoining the near or stuffing-box end of the steam cylinder but stops short of its tubular extension S′. Connection between the main shaft 4 and its extension S′ is made through the intermediary of a stem *e′* which extends between and enters the extension S′ and also the shaft 4 whose end adjoining the extension S′ is made hollow for this purpose. The stem *e′* engages the shaft 4 by means of a feather key 18 in the tubular end of the shaft 4 which enters a corresponding longitudinal groove in the stem *e′*, thus forcing the stem to revolve with the main governor shaft 4 while permitting its lengthwise movement independently of said shaft, and said stem engages the tubular shaft extension S′ through the intermediary of a cross pin *c′* which extends diametrically through the head *f′* of the stem into and through spiral slots *a′* in the said tubular shaft extension S′, thus compelling the latter to revolve in unison with the stem *e′*, and consequently with the main governor shaft 4. The feather key and groove connection of the stem *e′* with the main shaft 4 is to allow the stem to be capable of a sliding lengthwise movement relatively to said shaft and its extension S′, and said feather key and groove connection is typical of any suitable connection between said stem and rotary shaft which will permit independent lengthwise sliding movement of the stem while compelling it to revolve with the shaft; and the engagement of the ends of the cross pin *c′* with the pair of spiral slots *a′* in the tubular shaft extension S′ is for the purpose of effecting partial rotation of the latter when the stem is moved lengthwise, in order to rotatably adjust the cams A as desired, precisely as in the preceding figures save that in Fig. 3 the spiral slots are formed in the hubs of the cams A which are loose on the shaft extension S, while in Fig. 4 the cams are fast on the shaft extension S′ and the spiral slots are formed in said extension.

In order to thus operate the stem *e′*, the ends of the cross pin *c′* in the head *f′* of said stem project through and beyond the spiral slots *a′*, and enter and are made fast to a coupling ring C which closely encircles the tubular extension S′, and has a slidable connection therewith both rotatably on and lengthwise of the same. Movement of the coupling ring lengthwise of the tubular extension S′ will produce corresponding movement of the stem, and thus through the intermediary of the cross pin *c′* and the spiral slots *a′* imparting to the said tubular extension S′ the movement of axial rotation requisite to adjust the cams A thereon to the desired position. Various means for thus operating the coupling ring C can be employed. In this instance I provide an adjusting sleeve D which encircles while not contacting with the extension S′ and is externally screw threaded as shown to engage the corresponding internally screw threaded housing E attached to the adjoining bonnet 8—the part E furnishing a support and bearing for the adjusting sleeve D in which said sleeve can be screwed back and forth. The outer end of the coupling sleeve is provided with a hand wheel for thus operating it; and at the point where the coupling sleeve passes around the coupling ring C it is provided with parallel annular shoulders 21 between which said coupling ring is received and by which it is compelled to follow the lengthwise movement of the screw threaded adjusting sleeve, as will be understood without further explanation. The general mode of operation of the two forms of hand operated adjusting device shown in Figs. 3, 4, and 5, 6, respectively, is the same. I prefer on the whole for practical purposes the modified form last referred to.

The spiral slots are typical of spiral channels which may extend entirely through the shell of the tubular part in which they are formed, or only part way through said shell from the inside thereof; and there may be more than two of said spiral channels, so numerous indeed as to form in effect an internally screw threaded tubular section of low pitch, engaged by corresponding peripheral pins or other suitable projections on the operating stem. Such a modification is represented in Figs. 7 and 8, where the channels are formed as interior spiral grooves a^2 of low pitch in an internally thickened portion *s′* of the tubular extension S′. The head *f′* of the stem e^2 which carries the cross pin *c′* whose ends enter and engage the spiral

groove a^2 is of a size to fit and take a sliding bearing in the internally thickened portion s'. The stem should have the same feather key and groove connection with the governor shaft 4 as in Fig. 5. Inasmuch, however, as the ends of the cross pins c' do not project to the outside, the hand operated means of Fig. 5 for moving the stem e' in and lengthwise of the tubular extension S' cannot be employed; and in lieu thereof the stem should extend through the tubular extension S' to the bonnet 8 (Fig. 5) through which the open end of said extension projects, and should there be coupled to a hand operated device such as represented in Fig. 3, as will be understood without further explanation.

The two cams A being at opposite ends of the steam cylinder, and designed to operate on correspondingly located valves, are of course set on the shaft 4 in a position diametrically opposite to one another so that each will operate its own auxiliary-exhaust-valve at the proper time, as will be understood without further explanation. It will also be understood that these auxiliary-exhaust-valve operating cams are not controlled in any manner by the action of the governor mechanism 5, but that they revolve always in their proper relation to the revolution of the crank shaft of the engine from which the shaft 4 takes its motion—said shaft making one revolution for each revolution of the engine crank shaft, or in other words, for each complete reciprocation of the steam piston.

Assume that the piston, as is the practice in uniflow engines, uncovers the central main exhaust ports in the cylinder near the end of its expansion stroke, say 10% before it reaches dead center; and assume that it be desired to obtain a range of compression variable between 70% and 15% approximately—70% for condensing work, 15% for non-condensing work—and that the spiral channels are of such length and pitch that when the cross pin c is at one end of the channels the cams will be so shifted as to open their valves say 8% before dead center, or after the piston on its expansion stroke has uncovered the central exhaust ports, and when the pin is at the opposite end of the channels the cams will be shifted around in the opposite direction to a position in which each will open its valve 8% after dead center or before the central exhaust ports are closed by the piston on its return stroke.

In these circumstances and under these conditions, let the cams for condensing work be rotatably shifted by the hand operated means to a position where each will operate to open the auxiliary valve controlled by it about 8% before dead center, or after the piston on its expansion stroke has uncovered the central exhaust ports, and let the cams be of such shape and dimensions that when thus positioned they will close their valves 30% after dead center. Under these conditions the engine will operate with 70% compression; a compression which on the whole is considered the most desirable in uniflow engines operating condensing.

Taking the other extreme, and operating non-condensing or with back pressure, the cams A should be shifted around so that the auxiliary-exhaust-valves will open at about 8% after dead center or at a time before the central exhaust ports are covered by the piston on its return stroke; under these conditions (the shape and dimensions of the cams of course remaining unchanged) the thus-opened auxiliary-exhaust-valve will close at about 15% before the piston reaches the other dead center.

The figures given are merely arbitrary and by way of illustration, and can be varied by changing the shape and dimensions of the cam. But I believe the values mentioned to be the most desirable for practical work.

Under this arrangement it will be noted that in all cases, and whether working condensing or non-condensing, the auxiliary exhaust valve is opened for the same fixed period of time, and in thus opening always has the same lift—the lift of the valve and the period of time during which it remains open being fixed and invariable, depending upon the form and dimensions of its operating cam. The opening movement of the auxiliary exhaust valve always takes place while the main exhaust is open, and it remains open until after the main exhaust has closed; and the period of the effective opening of said auxiliary exhaust valve—that is to say, the period, or length of time, it will remain open after the main exhaust closes—will vary with the time of opening of the auxiliary exhaust valve relatively to the closing of the main exhaust, increasing with the approach of the time of opening of the auxiliary exhaust valve to that of the closing of the main exhaust, and vice versa, this variation being dependent upon and governed by the rotary adjustment of the operating cam upon its driving shaft.

The result of this arrangement is that the beginning of the effective open period of the auxiliary exhaust valve is always coincident with the closing of the main exhaust, and therefore always takes place at substantially the same point in the return stroke of the steam piston, while the length of the period of said effective opening will vary with the rotary shifting of the operating cam upon, or with reference to, its driving shaft.

In this way, by the use of operating cams

rotating in unison with the engine crank shaft, and acting directly upon the auxiliary exhaust valves, I obtain the same advantageous result in the way of capacity to vary readily and at will the compression according to the cut-off of the engine in order to get the most economical operation and secure the best results, that I do by the use of an adjustable driving eccentric acting upon the auxiliary exhaust valves through the intermediary of suitable valve gear, as described and claimed in my application Serial No. 114,438 filed August 11, 1916, on which Letters Patent No. 1,232,093 were issued to me on July 3, 1917, with the added advantage of the wide range of rotary adjustment of the cams, which permits them to be readily set for either condensing or non-condensing work as desired, with the same capacity for variable adjustment within predetermined limits in each case.

Thus it will be seen that under my invention the compression can be varied between any predetermined limits—say from 70% as the one extreme to 15% as the other extreme—and naturally can be given any intermediate value desired between those two extremes; and that this result is simply and effectively obtained by the combination hereinbefore set forth of the rotating shaft and auxiliary-exhaust-valve operating cams driven from and revolving in unison with said shaft but rotatably shiftable relatively thereto, and hand operated mechanical means for thus shifting said cams within the predetermined limits of said shifting movement and holding them in their thus-adjusted position, whether the engine be in motion or at rest—and this I believe to be new with me beyond the particular structural embodiment of the same herein shown and described.

I therefore do not restrict myself narrowly to the structural details hereinbefore shown and described in illustration of the invention subject of my claim; but what I claim as new and desire to secure by Letters Patent, is as follows:

1. In a uniflow engine of the character described, the combination with the engine crank shaft, the steam cylinder and piston, and the steam admission, cut-off, and main exhaust instrumentalities, of auxiliary exhaust ports and controlling valves therefor; a rotary shaft independent of the steam admission and cut-off instrumentalities and driven from and revolving in unison with the engine crank shaft; auxiliary-exhaust-valve operating cams driven from and revolving in unison with said rotary shaft, acting to open the auxiliary-exhaust-valves always before the main exhaust closes, and to hold them open always for the same absolute period of time, said cams being rotatably shiftable with reference to their driving shaft to vary the time of opening of the auxiliary-exhaust-valves relatively to that of closing of the main exhaust, whereby while the beginning of the effective open period of the auxiliary exhaust is always coincident with the closing of the main exhaust and therefore takes place always at substantially the same point in the return stroke of the steam piston, the length of said effective open period will vary with and depend upon the rotary adjustment of said operating cams with reference to their driving shaft; and means for thus-adjusting said cams.

2. In a uniflow engine of the character described, the combination with the engine crank shaft, the steam cylinder and piston, and the steam admission, cut-off and main exhaust instrumentalities, of auxiliary exhaust ports and controlling valves therefor; a rotary shaft, independent of the steam admission and cut-off instrumentalities and driven from and revolving in unison with the engine crank shaft; auxiliary-exhaust-valve operating cams, driven from and revolving in unison with said rotary shaft, acting to open the auxiliary-exhaust-valves always before the main exhaust closes and to hold them open always for the same absolute period of time, said cams being rotatably shiftable with reference to their driving shaft within predetermined limits for condensing work on the one hand and non-condensing work on the other hand to vary the time of opening of the auxiliary exhaust valves relatively to that of the closing of the main exhaust; and hand operated mechanical means for thus-shifting said cams, whether the engine be in motion or at rest, to any desired point within the predetermined limits of said rotary shifting movement, and holding them in their thus-adjusted position, substantially as and for the purposes hereinbefore set forth.

3. In a uniflow engine of the character described, the combination with the auxiliary exhaust valves, of a rotary side shaft driven from and in unison with the engine crank shaft; a tubular extension of said rotary shaft, separate from but arranged on the axial prolongation of said shaft, mounted in bearings in which it is capable of rotary movement only, and formed with symmetrically arranged spiral channels; operating cams, one for each auxiliary exhaust valve, mounted on and fast to said tubular extension; an operating stem housed in and extending between and into the opposed tubular ends of said rotary shaft and tubular extension; a feather key and groove connection between the operating stem and the rotary shaft to permit lengthwise movement of the stem relatively to the shaft,

while compelling the two to revolve in unison; projections on the stem engaging the spiral channels in the tubular extension, and hand operated mechanical means for moving the stem lengthwise of the rotary shaft and its tubular extension as desired, whether the engine be in motion or at rest, and holding it in its thus-adjusted position, substantially as and for the purposes hereinbefore set forth.

In testimony whereof I affix my signature.

SIEGFRIED ROSENZWEIG.