3 Sheets—Sheet 1.

H. & A. SULZER & J. R. ERNST.

VALVE-GEAR FOR MOTIVE POWER ENGINES.

No. 178,201. Patented May 30, 1876.

Fig. 1.

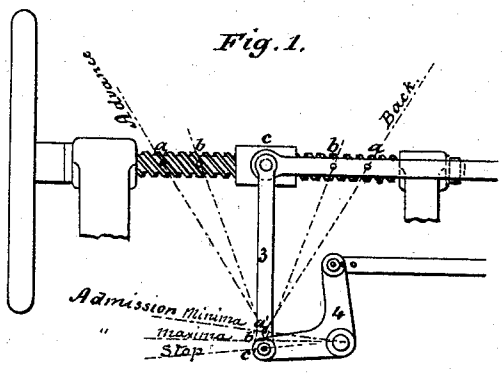


Fig. 2.

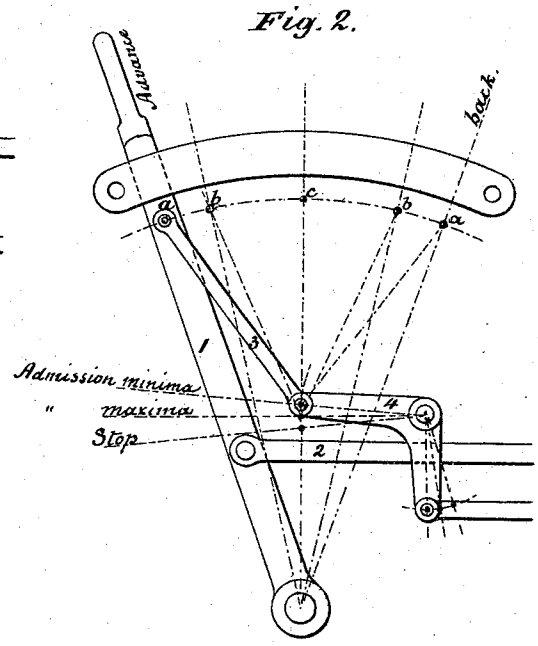


Fig. Y

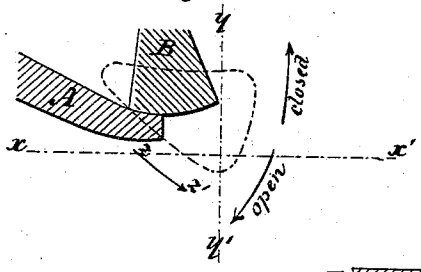


Fig. Z

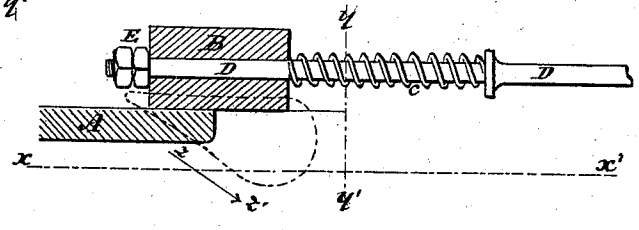


Fig. x'.

A — Admission minima forward and backward.

Full admission.

B — Stop.

Fig. X.

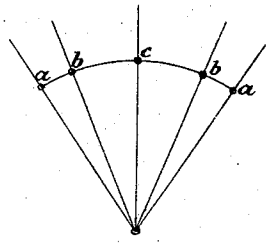


Fig x²

A — Admission minima forward.

Full admission forward.

Stop.

Full admission backward.

B — Minima admission backward.

Witnesses:

E. E. Masson

Ewell a. Rock.

Inventors:

Henri Sulzer

Albert Sulzer

J. R. Ernst

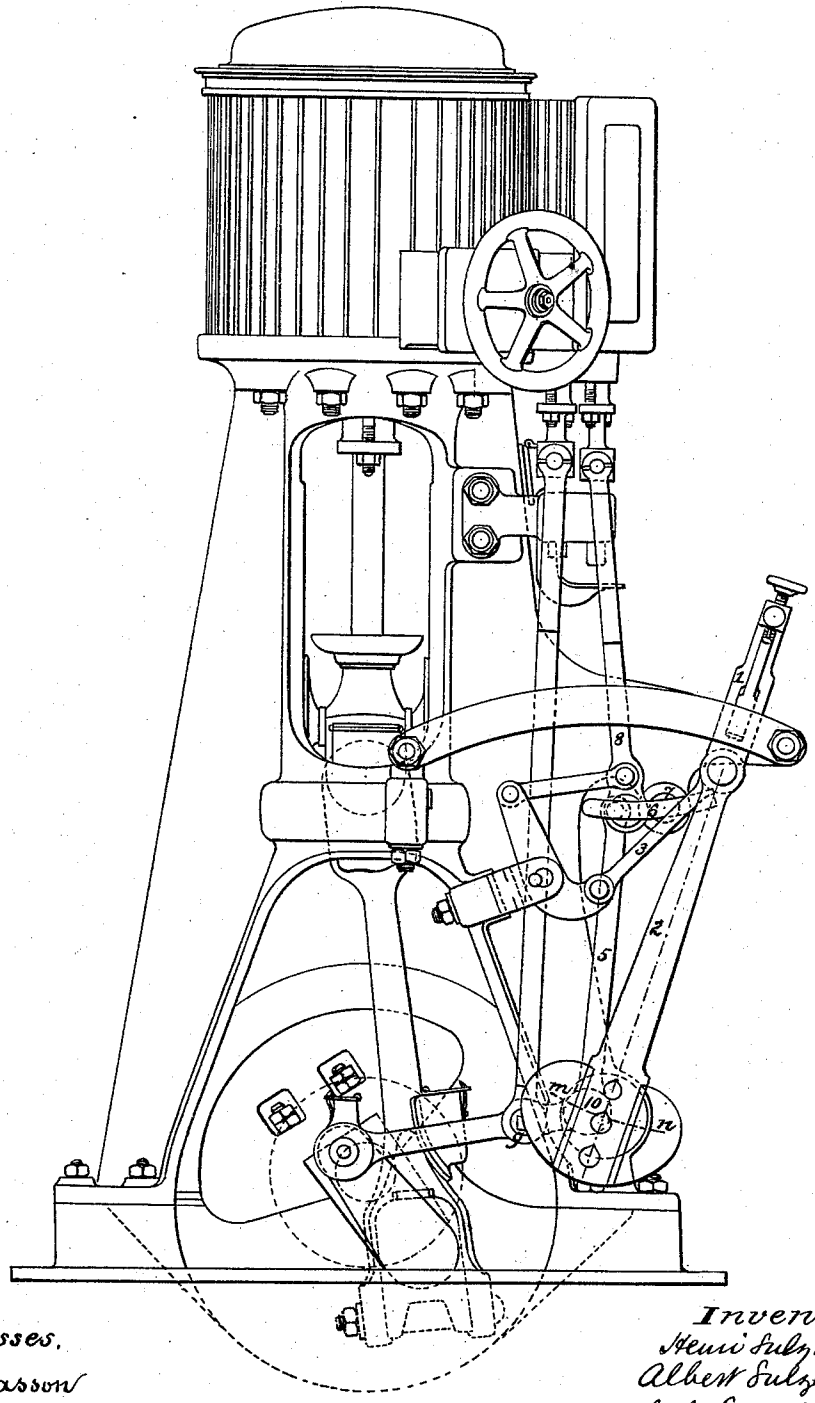
by attys Pollok & Bailey.

3 Sheets—Sheet 2.

H. & A. SULZER & J. R. ERNST.

VALVE-GEAR FOR MOTIVE POWER ENGINES.

No. 178,201. Patented May 30, 1876.



Witnesses.
E. E. Masson
Ewell A. Brick

Inventors.
Henri Sulzer
Albert Sulzer
J. R. Ernst
by Walter Pollock & Bailey

3 Sheets—Sheet 3.

H. & A. SULZER & J. R. ERNST.

VALVE-GEAR FOR MOTIVE POWER ENGINES.

No. 178,201. Patented May 30, 1876.

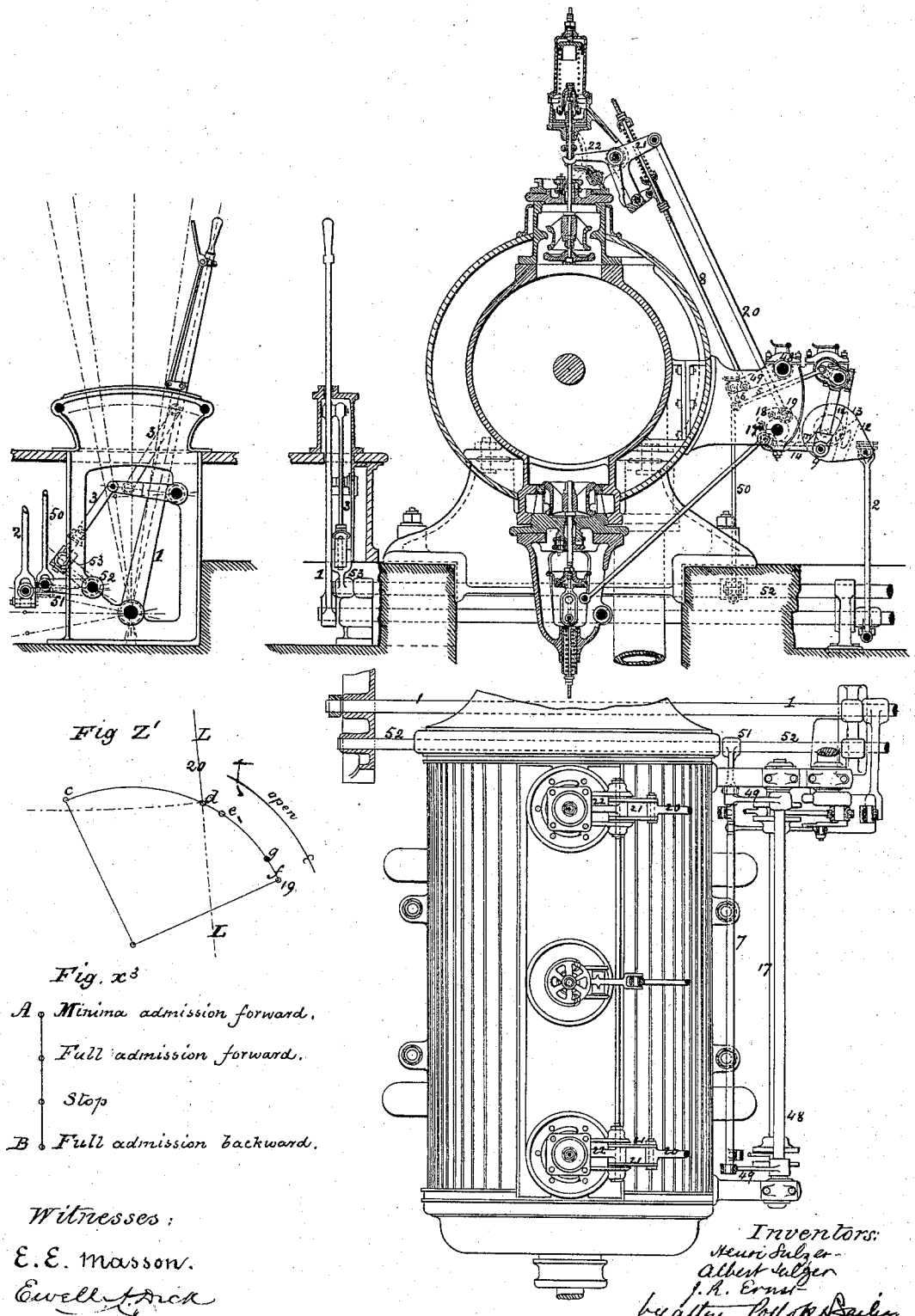


Fig Z'

Fig. x³

A Minima admission forward.

Full admission forward.

Stop

B Full admission backward.

Witnesses:

E. E. Masson.

Ewell & Brick

Inventors:

Henri Sulzer

Albert Sulzer

J. R. Ernst

by Atty's Pollock & Bailey

UNITED STATES PATENT OFFICE.

HENRI SULZER, ALBERT SULZER, AND JEAN RODOLPHE ERNST, OF WINTERTHUR, SWITZERLAND.

IMPROVEMENT IN VALVE-GEARS FOR MOTIVE-POWER ENGINES.

Specification forming part of Letters Patent No. **178,201**, dated May 30, 1876; application filed March 21, 1876.

To all whom it may concern:

Be it known that we, HENRI SULZER, ALBERT SULZER, and JEAN RODOLPHE ERNST, engineers, of Winterthur, Switzerland, have invented certain new and useful Improvements in Motive-Power Engines, of which the following is a full, clear, and exact description:

The fundamental principle which underlies our invention may be stated as follows: Suppose the hand-lever or screw which, by means of intermediary pieces, acts upon a mechanism to change or reverse the movement of a motor, (but especially a steam-engine with valves of the kind hereinafter referred to,) in such a way that its position to the right corresponds to progressive movement, its position to the left to a retrograde movement, and its middle position to a stop. Suppose, again, such lever or screw to be connected with a variable cut-off mechanism, and that the extreme positions shown at *a*, Figure *x*, Sheet 1, of the drawings—either for the forward or backward movement—correspond to the minimum admission and the positions *b b*, which are somewhat nearer to the center, and are identical and correspond to the maximum admissions. In such case it will be understood that the engine can be operated to advance or to back without regard to the cut-off mechanism; and, to cut off, it is only necessary to push the lever beyond the positions *b b* toward *a*. Between the positions *b* and *b* there is no action of the cut-off upon the distribution of steam, while between the points *a b* the action takes place when the engine is provided with an automatic regulator, in which case the regulator must be arranged between the first element of connection of the lever with the cut-off and the cut-off itself.

The connection of the reversing-lever with the mechanism which effects changes of the cut-off may be effected in accordance with our invention in different ways; but, according to the necessary displacement of the connecting-rod, which serves to effect the variation of the cut-off 4, Figs. 1 and 2, Sheet 1, we may distinguish three different kinds of arrangements, which we would indicate as follows, (A B being the entire course of 4:) First, minimum admissions forward and backward are situated on the same side. (See diagram x^1.) The cut-off can be effected forward and backward without the necessity of the same points on the side A corresponding with the same degrees of admission. The movement of 4 is in a direction perpendicular to the movement of the lever relatively to the screw. (See Figs. 1 and 2, Sheet 1.) Second, the minimum admissions for the forward movement are situated at one extremity of A B, while those of the backward movement are situated upon the other extremity. (See diagram x^2.) The cut-off may be effected both forward and backward, as in the preceding instance, and in this case the movement of 4 is in a direction parallel to the movement of the lever relatively to the screw. And, third, the cut-off is effected in but one direction—for instance, when going forward, while to back no cut-off is employed. (See diagram x^3.) In this case the movement of 4 is in a direction oblique to the movement of the lever relatively to the screw. The first mode hereinbefore indicated will be employed most frequently, if it be desired to make the connection between the reversing-lever and 4 in the simplest manner—that is to say, by a simple connecting-rod, 3.

In the two examples, Figs. 1 and 2, Sheet 1, *a'* corresponds to the minimum admission, both for the forward and backward movement; *b'*, to the full admission, and *c'* to the stop. Connection is effected by means of a connecting-rod, 3, for which mechanical equivalents may be substituted—such as cams, eccentrics, tappets with springs, &c.

Sheet 2 of the drawings represents an illustration of the application of this apparatus arranged with reference to small, vertical, one-cylinder engines, particularly adapted for screw-propellers — an arrangement which is convenient and safe when the engineer has to work two such engines as are generally used for twin propellers.

The two valves in the steam-chest are operated by a single eccentric or crank, and the connecting-link 11 is united with the connecting-rod 2 by means of a bolt, 10, which describes an arc of a circle, *m n*, inclined on one

side for the forward motion, and on the other side for the backward motion, according to the position of the reversing lever.

The distributing slide-valve in the steam-chest receives its movement from the bolt or pin 9, and the cut-off valve from the bolt or pin 10 by means of a link, 5, and the slide 6, (which turns around the fixed point 7,) and the connecting-rod 8, as shown in Fig. 2, Sheet 1. The elbow-lever 4 is operated by the connecting-rod 3. It is the same with the connecting-rod 8 in the slide just referred to, the result of which is, that the course of the cut-off valve is variable and can be reduced to zero. Thus, for either going forward or backward, the minimum admission corresponds to the maximum course of the cut-off valve, and also to the extreme positions of the reversing-lever 1. It is immaterial if the position of the distributing-valve is changed a little in moving the lever from *a* to *b*, Fig. 2, Sheet 1, as generally maximum admissions are only used in changing the action of the engine when smaller openings are even desirable.

This simple apparatus, that can be applied to every kind of distributing-valve, offers the same conveniences to the engineer, requiring no other attention than that which is necessary for an ordinary change of direction with a simple slide-valve in steamboat-engines, locomotives, &c.

In regard to locomotives, we may say that by means of our mechanism any kind of special apparatus can be used for the expansion of steam.

The combination will always be very simple, although the form may change according to the movement used to operate the cut-off.

Movement of distribution for engines with lifting or slide valve, with or without reversing movement.—This movement of distribution is supposed to be applied only to steam-engines having lifting-valves; but it can as conveniently be applied to flat or round slide-valves, if the opening of the admission apparatus is operated by the mechanism of distribution, and is closed automatically.

To be brief we will, however, confine our explanation to lifting-valves having double seats.

In Fig. Y, Sheet 1, A represents a slide, forming a part of a lever or rod connected directly or indirectly with the lifting-valve of admission, and B represents a sliding sector, which we call a "carrier," the motion of which is always directed by the motion of the distributing-valve, and the path of which is in the form of endless curves of different forms. The valve is opened in the direction shown in the drawings, and it is closed automatically in the opposite direction when the carrier B has left A. It has been customary for the carrier B to describe ellipses by means of a single eccentric, the rod of which is guided in a straight line at its upper part. The regulator causes the slide A to advance more or less in the direction $x\,x^1$, and in this manner changes the admission.

The principles of our new movement, by means of which a change of direction can be produced, are as follows:

First, the path of the carrier B produces endless curves, heart-shaped, resulting from two different movements, of which one is the opening movement, in the direction $y\,y'$, and the other a displacing movement, in the direction $x\,x^1$.

Second, in reversing the engine, the opening movement will always be reversed relatively to the direction of rotation of the machine, while the direction of the displacing movement does not change. For example, if the engine is advancing and the lever used to change the direction is in the corresponding position, the carrier B will advance in the direction $z\,z'$. It is the same when the engine is backing and the lever is in the position "back." But in giving the counter-pressure—that is to say, in reversing rapidly the lever while the engine is yet progressing—the movement of the carrier is in the direction $z'\,z$.

Third, in changing the cut-off, either with or without regulator, the entire curve described by the carrier will be changed in the direction $x\,x^1$—viz., $x\,x^1$ in diminishing, and $x^1\,x$ in augmenting the admission, while A does not move in that direction.

Fourth, the form of the curve $z\,z'$ will always be chosen so that the velocity of B while touching A will not be too great; but from that point the velocity of B must increase very rapidly. Having this quality, our new distributer can be applied at a high velocity, and thus diminish the inevitable shocks produced by the sudden admission of steam, without risking any losses of pressure.

Fifth, the part $z\,z'$ of the curve must always be of such length that, even for the minimum admissions, the carrier B will be in contact with a great portion of the surface of A, so that small variations in the displacement of the curve will correspond with small variations in the admission, and this is necessary, particularly in working with feeble admissions.

Sixth, the carrier B touches A, not only as a cam, but the contact of the surfaces is always absolutely exact, so as to obviate entirely the wear of the sliding surfaces.

Seventh, when using a regulator, the resistance to be overcome will be reduced to the minimum.

Eighth, the lifting-valves are closed by means of springs, and the shocks produced by their coming in contact with their seats are reduced by an air-compressing piston.

Ninth, when operating on engines that are to be worked in either direction, we always use the mechanism described in the first part of our specification.

From what we have said above, it will be understood that no escape will take place between the positions *b b*, Figs. 1 and 2, Sheet

1, and the engineer will be able to start, reverse rapidly, increase the power, &c., without the risk of a shock of B against A, even when B is describing the curve *z z* in the opposite direction; but yet, in machines that are to be reversed, we apply the safety-springs *c*, Fig. Z, Sheet 1, to press the carrier B against the extremity E of the rod D, and operate upon it in the direction *x' x*, so that the connection will be permanent enough to sustain in any case the result of the friction of B upon A. If B should produce a shock against A, the spring would be useful; but such a shock could happen only if the engineer should pass rapidly beyond the position opposite *b*, Figs. 1 and 2 of Sheet 1, and operate on the cut-off, which would be against all reason when a sudden reversal is desired.

From the above it will be understood that our system of lever or of screw can be combined in all manners, so as to be applied, for example, to horizontal mining-engines with regulator and change of movement, to marine engines, to vertical, mining, or marine engines, to inclined engines, to slide-valves of horizontal engines without regulator and without change of movement, and, moreover, with a sector to the valves of horizontal engines with a regulator, but without change of movement.

In Sheet 3 is shown the combination of the distributing-valves of horizontal mining-engines with regulator and change of movement.

Distribution with change of movement.—To operate this engine an eccentric, 12, is keyed to the main shaft, or to a shaft used specially for the movement of the distributing-valves. The pin 10 on the extension of the eccentric (or on its rod) operates in a slide, 13, movable around its axis. The arc *m n* is inclined to the one side to move forward, and to the other side to move backward, and when near the center of the shaft it is in position for stop. Starting from *g*, the rod 14 oscillates a shaft, 17, and taking advantage of the arcs described by the journals 19 (upon the levers 18) we act upon the opening valves.

In Fig. Z', Sheet 3, if L L indicate the direction of the rod 20 in its middle position, the extremity of 20 advances from *d* to *c* and returns, while the admission-valve remains closed—viz., during the return of the piston. The rod 20, having arrived close to *d*, begins to open the admission-valve. At *e* it passes the dead-center, and at *g* the valve must be open to attain full admission, while the journal 19 is moving to *f*, and resumes its return. When the parts are of proper relative dimensions this opening movement will fulfill all necessary conditions. This movement can be reversed by means of the slide—viz., to move forward (the lever being in forward position) the journal 19 advances from the dead-center *e* toward *f* and returns, and to back (also, the lever being in the back position.) When counter-pressure is given the journal 19 advances in the same manner to the dead-center *e* in the direction of *c*. For this reason the curve *z z'* will then be reversed, as shown in Fig. Y, Sheet 1; but we will state here that many other systems of reversing can be used, as well as the one we have described above.

The rod 20 is united to the lever 21, which regulates the opening of the valve, by means of the carrier B and the lever 22. If the carrier does not escape between the positions *b* and *b* of the reversing-lever, Figs. 1 and 2, Sheet 1, the cut-off will operate only according to the dead-center *e* of the point *d*, and according to the proportions of the rod of the eccentric, and it will be found to correspond ordinarily to an admission of from seventy-five to ninety per cent.

The displacing movement can be taken from the eccentric 12 in a direction perpendicular to a line passing through the center of the axle, the eccentric, and the middle of the slide 13. (In Plate 3 we have employed a separate crank for the displacing movement.) We transmit this movement to the carrier B by means of the rod 5 and lever 6, the latter being often angular. Generally the position of the lever 6 will not be stationary; but it will be regulated either by the reversing mechanism (rod 3) or by the regulator. It is clear that this lever 6 can be in the form of an axle, as shown in Plate 3, and have levers keyed or soldered on either side, and then, if the movement of the four valves is produced by a single eccentric, the rod 8 for the first valve will be attached on one side, and the rod for the second on the opposite side, of the axle 6, as is done with the lever 6. The collar of the shaft 17 will operate in the same manner. The oscillation on one side will regulate the opening of the valve forward, and the oscillation on the other will regulate the opening of the valve back. In the same manner the shaft 17 can be used to open the exhaust-valves, either directly or by means of cams.

We have only to explain that in the Sheet 3 the eccentric is replaced by a crank attached to the extremity of the shaft of distribution, making as many revolutions as the engine.

The displacing-shaft 7 is mounted upon two levers, 49, keyed to the axle 48, and it will be raised or lowered according to the degree of the admission. In this special case that we have supposed to be a twin engine the two axles 48 are connected by the rods 50, the levers 51, and an axle, 52. The regulator acts upon this last axle so long as the position of the reversing-lever and the rod 3 allows it.

As the connection of 3 with 53 is not stationary, but movable, as indicated in Sheet 3, a full admission can be given when the regulator requires it, even in the farthest positions of the reversing-lever. If, besides this, the connection of regulator to the shaft is not entirely stationary, but slightly elastic, it will be possible to suppress, if need be, at any moment, the influence of the regulator, and even

reverse rapidly the direction of the motion of the engine. This advantage is very important in mining-engines, thus giving them an entire security of action.

Having described our invention, what we claim, and desire to secure by Letters Patent, is—

In combination with the distributing-valve and the cut-off mechanism, the hand-lever or screw connected with the same, and arranged and operating substantially in the manner set forth, both to start, stop, or change the movement of the engine, and to regulate the cut-off, substantially as described.

In testimony whereof we have signed our names to this specification before two subscribing witnesses.

HENRI SULZER.
ALBERT SULZER.
JEAN RODOLPHE ERNST.

Witnesses:
S. H. M. BYERS,
FRD. G. VETTERS.