(No Model.)

4 Sheets—Sheet 1.

E. TINCKNELL.

VALVE GEAR.

No. 358,996. Patented Mar. 8, 1887.

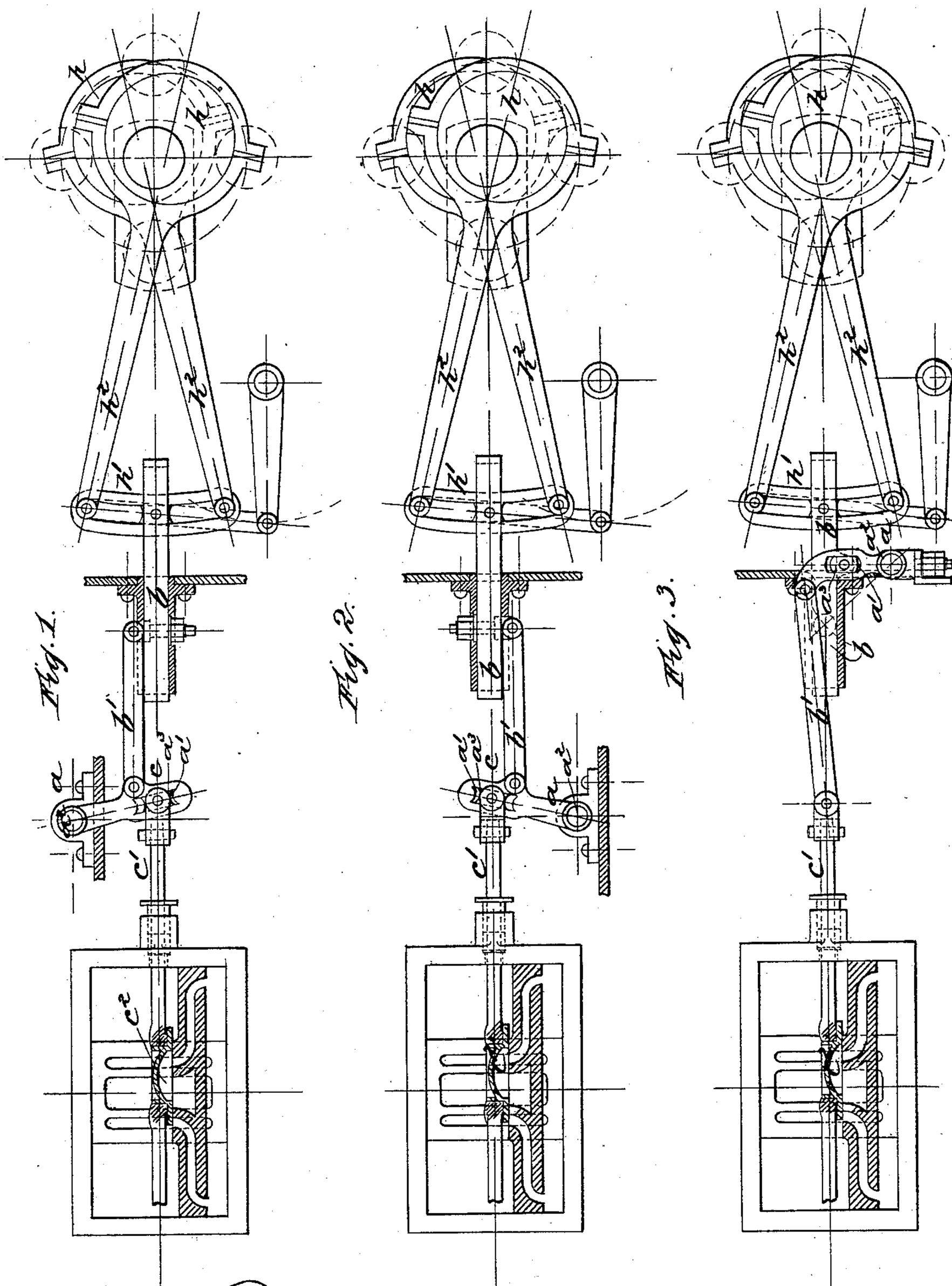

Fig. 1.

Fig. 2.

Fig. 3.

Witnesses.
Will. C. Norton.
H. C. Kennedy.

Inventor.
Edward Tinckenell.
By John J. Halsted & Son
His Attys

N. PETERS, Photo-Lithographer, Washington, D. C.

(No Model.) 4 Sheets—Sheet 2.

E. TINCKNELL.

VALVE GEAR.

No. 358,996. Patented Mar. 8, 1887.

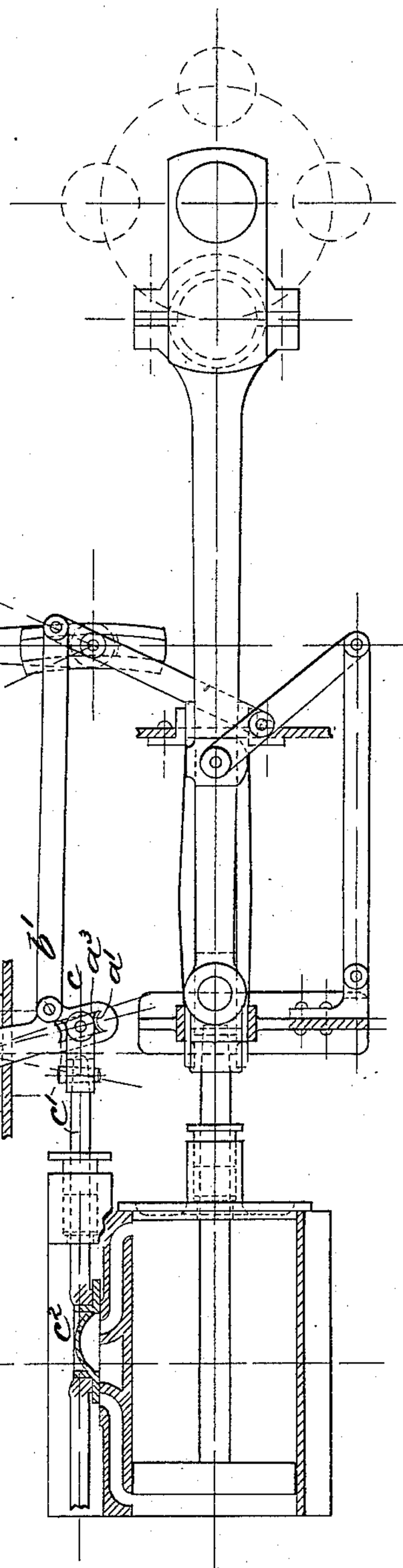

Fig. 4.

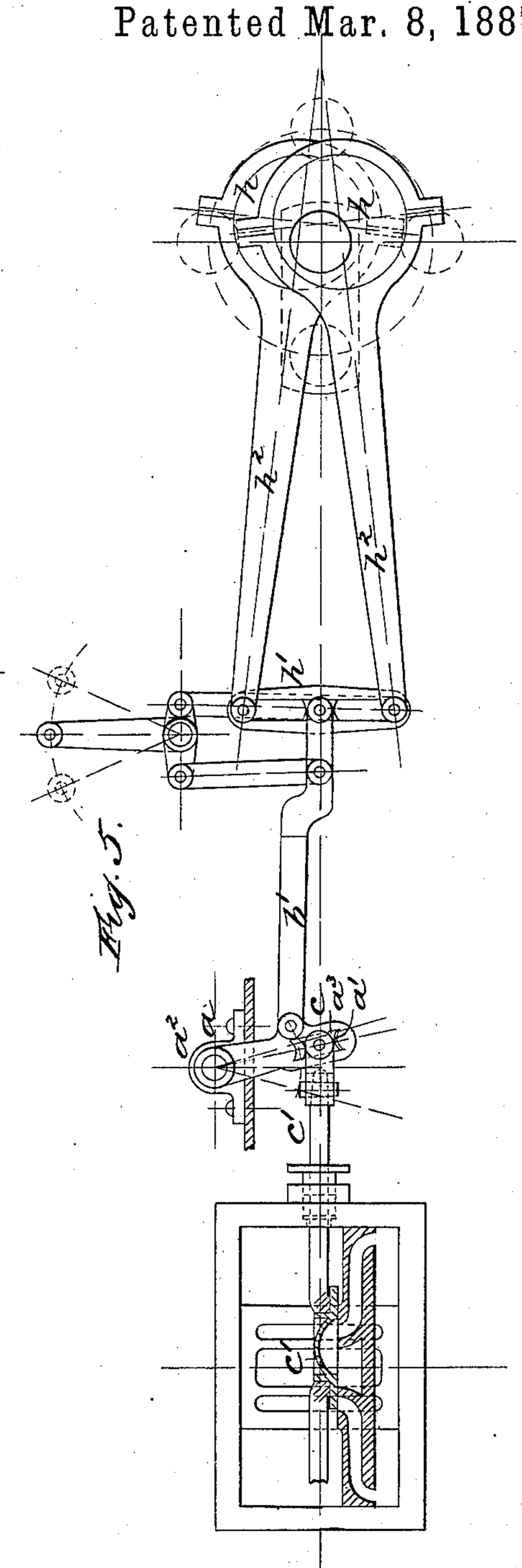

Fig. 5.

Witnesses.
Will. I. Norton.
H. C. Kennedy.

Inventor.
Edward Tincknell,
By John J. Halsted & Son
his Attys

(No Model.)

4 Sheets—Sheet 3.

E. TINCKNELL.

VALVE GEAR.

No. 358,996. Patented Mar. 8, 1887.

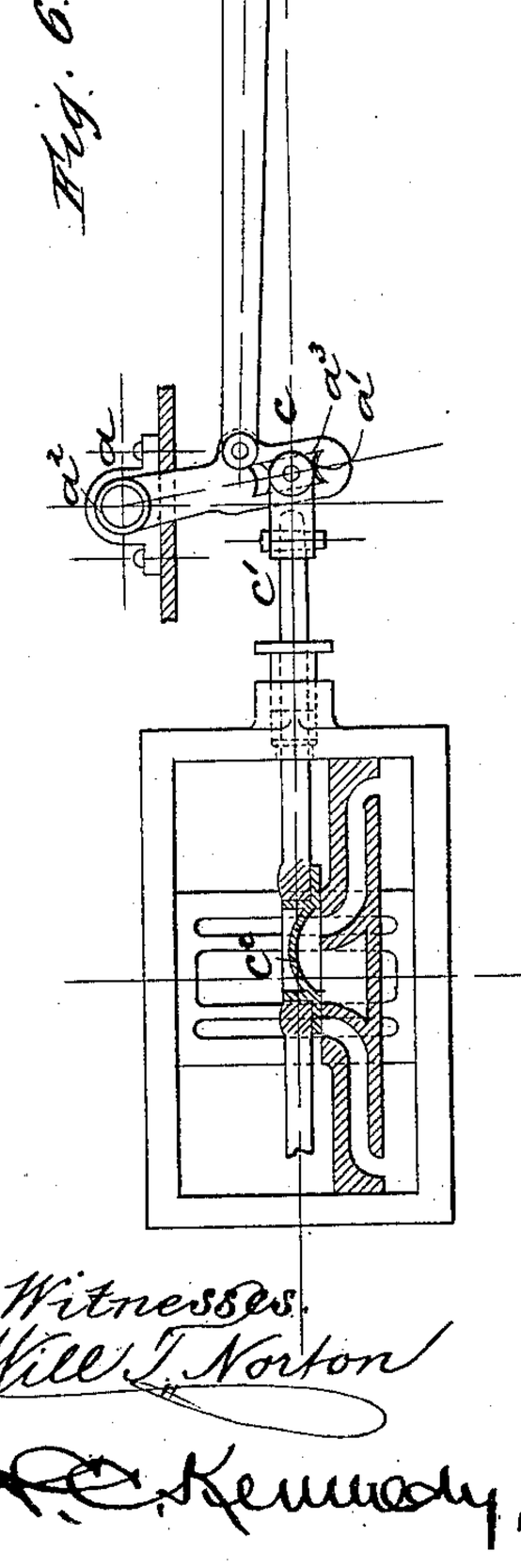

Fig. 6.

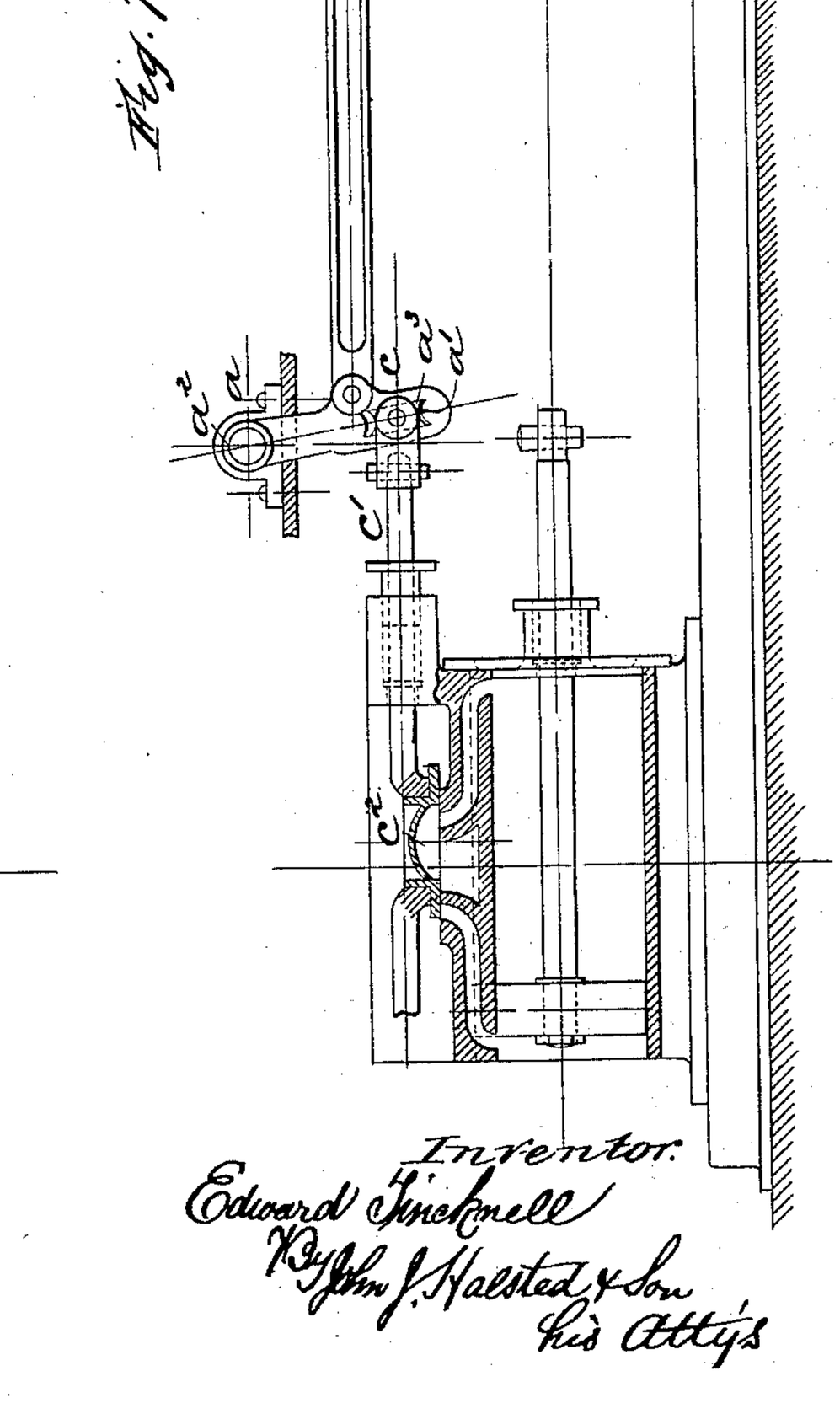

Fig. 7.

Witnesses.
Will J. Norton
H. C. Kennedy.

Inventor.
Edward Tincknell
By John J. Halsted & Son
His Att'ys

(No Model.) 4 Sheets—Sheet 4.

E. TINCKNELL.

VALVE GEAR.

No. 358,996. Patented Mar. 8, 1887.

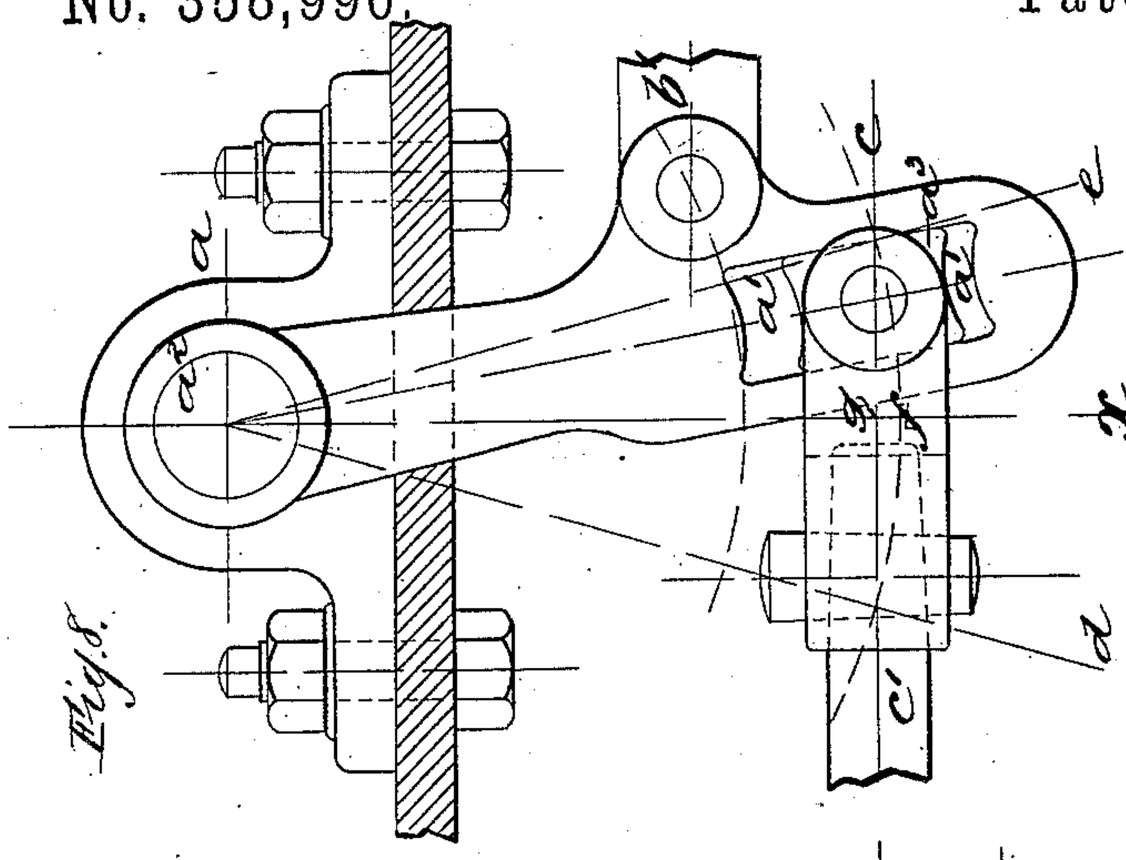

Fig. 8.

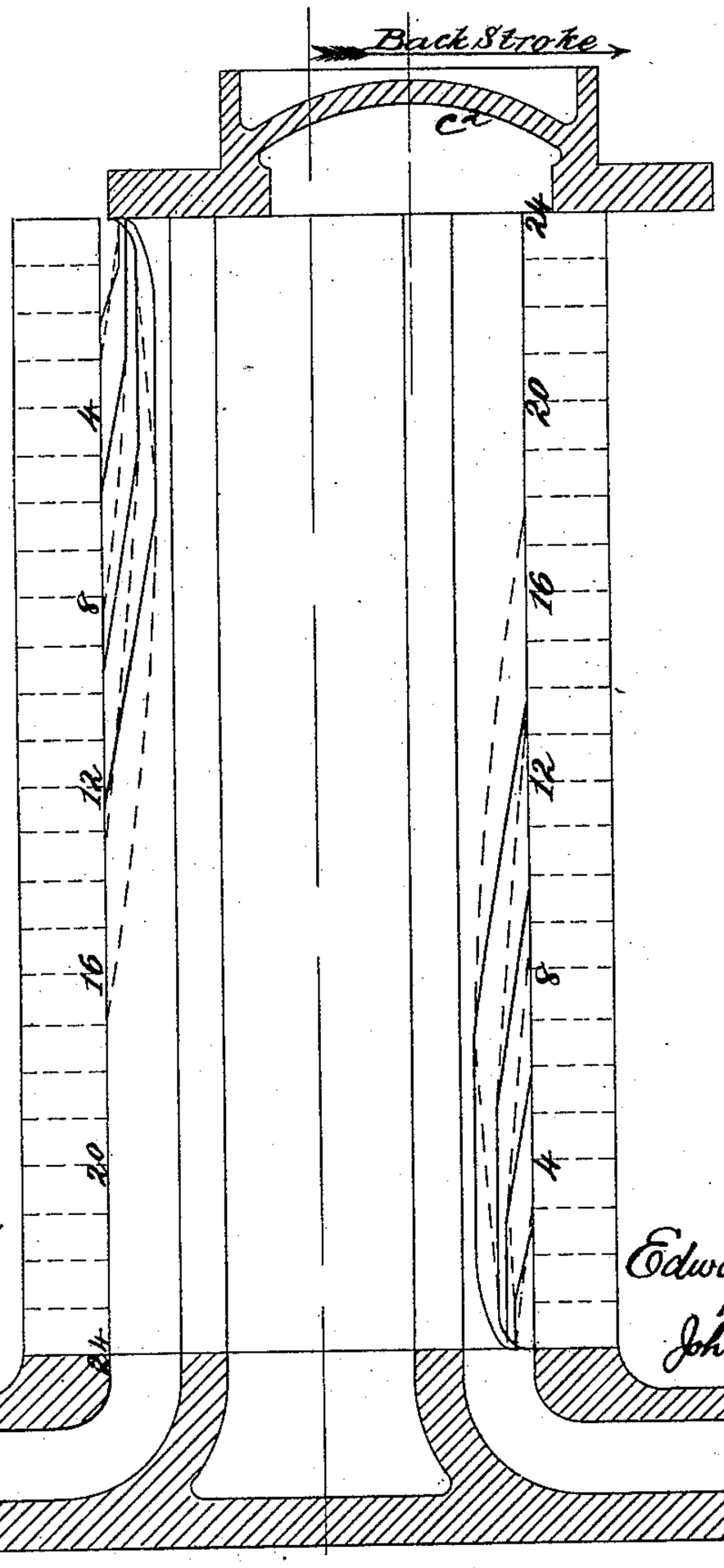

Fig. 9.

Witnesses.
Will L. Norton
H. C. Kennedy.

Inventor.
Edward Tincknell.
By
John J. Halsted & Son
His Atty's

UNITED STATES PATENT OFFICE.

EDWARD TINCKNELL, OF NEW SWINDON, COUNTY OF WILTS, ENGLAND.

VALVE-GEAR.

SPECIFICATION forming part of Letters Patent No. 358,996, dated March 8, 1887.

Application filed October 19, 1886. Serial No. 216,656. (No model.) Patented in England January 7, 1886, No. 293.

To all whom it may concern:

Be it known that I, EDWARD TINCKNELL, a subject of the Queen of Great Britain, residing at New Swindon, in the county of Wilts, England, have invented new and useful Improvements in or applicable to Steam-Engine Valve-Gears, (for which I have obtained a patent in the following country, viz: Great Britain, by Letters Patent No. 293, dated January 7, 1886,) of which the following is a specification.

My invention relates to the construction of what I term a "valve-gear corrector," consisting of an oscillating link and sliding block worked from a fixed point, and is applicable, where one eccentric is used, for one-way-working engines, and also to stationary, marine, and locomotive engines fitted with any kind of valve-gear.

In order to enable my invention to be fully understood, I will describe the same by reference to the accompanying drawings, in which—

Figures 1 to 7 are sectional elevations showing my improvements applied to the link-motion of the valve or valves of steam-engines having a reversing motion. Fig. 8 is an elevation of the corrector, and Fig. 9 is a diagram illustrating the results of the use of my valve-gear corrector. Figs. 1 to 7 are drawn to a scale of about one-sixteenth full size, and Figs. 8 and 9 about one-quarter full size.

Similar letters in Figs. 1 to 8 represent similar parts.

In Fig. 1 my corrector takes the place of and serves the purpose of a valve-spindle guide, and the said figure represents the most advantageous mode of its application, as, the link being suspended, the motion will work to the best advantage.

Referring to the said Fig. 1 and to Fig. 8, a is the corrector or oscillating link, having a slot, a', the said link being attached at a^2 to the motion-plate, framing, guide-bar, cylinder, or bed-plate of the locomotive or other engine to which it is desired to apply my invention, the corrector being applicable to all kinds of valve-gear motion. Working within the slot a' is a block, a^3, loosely attached to the valve-spindle c' of the slide-valve c^2. h h are the usual eccentrics, attached to the usual reversing-link, h', by the eccentric-rods h^2 h^2, the slide-block working in the said link being connected to the corrector a by means of the slide-rod b and link b'. The link b' is attached to the oscillating link a at a shorter distance from its pivot a^2 than the valve-spindle c', thereby giving the slide-valve a longer travel than if the link b' were connected directly to the valve-spindle c', in the usual manner, or to the eccentric only, as in a non-reversing engine.

The dotted lines shown in Fig. 8 at d and e indicate the extreme extent of travel of the valve-spindle c' when working with the reversing-link h' in full gear, and the radius at f to the center line, c, of the valve-spindle c' at g shows the extent to which the corrector a moves over the block during its forward and backward motion, consequently lengthening or shortening (as the case may be) the distance from a to c, thereby giving a motion to the valve which varies in speed. As will be seen by reference to the diagrams shown in Fig. 9, in which the full lines indicate the gear corrected and the dotted lines the gear uncorrected, and to the explanation hereinafter given, I obtain a quick opening and retain the maximum port-opening during a great portion of the stroke of the piston—that is to say, the valve arrives at a point of rest which equals the length of the straight portion of the slide-valve diagram-lines, resulting in a very quick cut-off. At the same time I obtain eighty per cent. additional expansion-space.

The diagrams illustrated in Fig. 9 were taken from a full-sized model in the first, third, fifth, and eighth notches. The said figure shows the cylinder-face upon which the slide-valve works in section, and the measurements of which—videlicet, the width of exhaust-port, width of bar, width of steam-ports, and width of metal outside the steam-ports—are drawn extended, so as to represent the length of stroke. The said extended part is divided into the number of inches equaling the piston travel—viz., twenty-four inches—and the spaces on which the full and dotted diagram-lines are drawn are intended to illustrate the steam-ports on both sides of the exhaust-port. From these lines or slide-valve diagrams the conditions of the valve movement can be seen, or the true position of the valve in relation to all points of the piston travel—videlicet, the point of lead, port-opening, duration of full port—to the point of cut-off.

The proportion of measurements shown in Fig. 8 will be found suitable for one inch and seven-eighths outside lap, giving one inch and

one-eighth port-opening and three-sixteenths of an inch lead. In this case the eccentric sheaves would be moved forward, increasing the angular advance in order to overcome the additional lap and equal the desired lead.

It will be seen from the valve diagram, Fig. 9, that the cut-off is later at the forward stroke than at the back stroke, the corrector being adjusted for this purpose, so as to render the beat of the engine more uniform.

In Fig. 2 the same results are obtained by means of the corrector as by the arrangement shown in Fig. 1; but the link is not shown suspended, as in Fig. 1.

In Fig. 3, where the corrector is attached to the motion-plate, it will be seen that the corrector does not act as a valve-spindle guide. Nevertheless the results are practically the same in the movement on the valve or valves as those obtained from Figs. 1 and 2. The valve or valves may be either cylindrical or the ordinary D shape.

Figs. 4, 5, 6, and 7 represent four different valve-gears, showing the adaptability of the corrector to each motion. These four illustrations will be sufficient to show that the corrector is equally applicable to any kind of valve-gear motion.

	Number of notch.	Travel of valve.	Forward gear.									
			Lead of valve.		Slide opens.		Steam cut off.		Exhaust opens.		Exhaust closes.	
			Front stroke.	Back stroke.	Front stroke.	Back stroke.	Front stroke.	Back stroke.	Front stroke.	Back stroke.	Front stroke.	Back stroke.
		Inches.			B							
A....	1	$4\frac{9}{16}$	$\frac{3}{16}$	$\frac{3}{16}$	$1\frac{1}{8}$	$1\frac{3}{16}$	$17\frac{11}{16}$	$16\frac{3}{4}$	$22\frac{1}{16}$	$21\frac{9}{16}$	$22\frac{1}{16}$	$21\frac{9}{16}$
B....	1	$6\frac{3}{8}$	$\frac{3}{16}$	$\frac{3}{16}$	F $1\frac{1}{8}$	F $1\frac{1}{8}$	$13\frac{1}{2}$	$12\frac{5}{8}$	$20\frac{11}{16}$	$20\frac{1}{16}$	$20\frac{11}{16}$	$20\frac{1}{16}$
A....	3	$3\frac{13}{16}$	F $\frac{9}{32}$	$\frac{9}{32}$	B $\frac{3}{4}$	B $\frac{13}{16}$	$13\frac{1}{2}$	13	$20\frac{5}{16}$	$19\frac{13}{16}$	$20\frac{5}{16}$	$19\frac{13}{16}$
B....	3	F $5\frac{5}{8}$	B $\frac{5}{16}$	F $\frac{1}{4}$	F $\frac{3}{4}$	F $\frac{3}{4}$	$9\frac{7}{8}$	$9\frac{3}{8}$	19	$18\frac{5}{16}$	19	$18\frac{5}{16}$
A....	5	$3\frac{1}{4}$	$\frac{11}{32}$	B $\frac{11}{32}$	$\frac{1}{2}$	F $\frac{1}{2}$	$8\frac{15}{16}$	$8\frac{7}{8}$	$17\frac{5}{8}$	$17\frac{1}{2}$	$17\frac{5}{8}$	$17\frac{1}{2}$
B....	5	$5\frac{3}{16}$	B $\frac{3}{8}$	F $\frac{5}{16}$	$\frac{9}{16}$	$\frac{9}{16}$	$6\frac{1}{4}$	$6\frac{3}{16}$	$16\frac{1}{2}$	$16\frac{1}{4}$	$16\frac{1}{2}$	$16\frac{1}{4}$
A....	8	B 3	$\frac{3}{8}$	B $\frac{3}{8}$	$\frac{3}{8}$	B $\frac{3}{8}$	$3\frac{1}{8}$	$2\frac{7}{8}$	$11\frac{5}{8}$	$11\frac{15}{16}$	$11\frac{5}{8}$	$11\frac{15}{16}$
B....	8	B $4\frac{7}{8}$	F $\frac{3}{8}$	B $\frac{3}{8}$	F $\frac{3}{8}$	B $\frac{3}{8}$	$2\frac{11}{16}$	$2\frac{5}{16}$	12	B 12	12	B 12

	Number of notch.	Travel of valve.	Backward gear.									
			Lead of valve.		Slide opens.		Steam cut off.		Exhaust opens.		Exhaust closes.	
			Front stroke.	Back stroke.	Front stroke.	Back stroke.	Front stroke.	Back stroke.	Front stroke.	Back stroke.	Front stroke.	Back stroke.
		Inches.			B							
A....	1	$4\frac{1}{4}$	$\frac{3}{16}$	$\frac{3}{16}$	$\frac{7}{8}$	$1\frac{1}{8}$	$16\frac{7}{8}$	$16\frac{3}{4}$	$21\frac{3}{4}$	$21\frac{1}{8}$	$21\frac{3}{4}$	$21\frac{1}{8}$
B....	1	$6\frac{3}{16}$	$\frac{3}{16}$	$\frac{3}{16}$	1	$1\frac{1}{16}$	$12\frac{1}{2}$	13	$20\frac{1}{2}$	$19\frac{7}{8}$	$20\frac{1}{2}$	$19\frac{7}{8}$
A....	3	$3\frac{11}{16}$	$\frac{9}{32}$	F $\frac{1}{4}$	F $\frac{5}{8}$	B $\frac{13}{16}$	$13\frac{1}{8}$	$14\frac{1}{8}$	$20\frac{3}{8}$	$20\frac{3}{16}$	$20\frac{3}{8}$	$20\frac{3}{16}$
B....	3	F $5\frac{5}{8}$	B $\frac{5}{16}$	F $\frac{1}{4}$	$\frac{3}{4}$	B $\frac{13}{16}$	$9\frac{3}{4}$	$10\frac{5}{8}$	$19\frac{1}{4}$	$18\frac{13}{16}$	$19\frac{1}{4}$	$18\frac{13}{16}$
A....	5	$3\frac{1}{4}$	$\frac{5}{16}$	$\frac{5}{16}$	B $\frac{1}{2}$	$\frac{1}{2}$	$8\frac{3}{4}$	$10\frac{3}{8}$	$18\frac{1}{16}$	18	$18\frac{1}{16}$	18
B....	5	F $5\frac{1}{16}$	$\frac{5}{16}$	$\frac{5}{16}$	F $\frac{1}{2}$	F $\frac{1}{2}$	$6\frac{3}{8}$	$7\frac{1}{8}$	$17\frac{3}{8}$	$17\frac{3}{16}$	$17\frac{3}{8}$	$17\frac{3}{16}$
A....	8	B 3	$\frac{3}{8}$	B $\frac{3}{8}$	$\frac{3}{8}$	B $\frac{3}{8}$	$3\frac{3}{4}$	4	$12\frac{13}{16}$	$13\frac{9}{16}$	$12\frac{13}{16}$	$13\frac{9}{16}$
B....	8	F $4\frac{13}{16}$	F $\frac{3}{8}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{3}{8}$	$2\frac{9}{16}$	2	F $12\frac{3}{4}$	$12\frac{3}{4}$	F $12\frac{3}{4}$	$12\frac{3}{4}$

The above table, showing the working of the slide-valve, was taken from the link-motion illustrated in Fig. 1, equaling twenty-four inches stroke or piston travel. The figures on the lines marked A indicate the gear working in the usual manner without the corrector applied, while those on the lines marked B indicate the gear as shown on the drawings with the corrector applied. The letter B against the figures denotes the bare measurement, while the letter F denotes the full measurement. It will be seen from the table

that the same was taken with the reversing-handle in four different positions—videlicet, in the first, third, fifth, and eighth notches, the first notch being full-gear and the eighth mid-gear, or, in other words, out of gear, so that the difference between the two conditions of working shown by the figures on lines A and B can be clearly seen. A supplies steam for nearly seventy-five per cent. and B for fifty-five per cent. of piston travel. Both A and B give the same amount of port-opening; but B cuts off the supply more quickly than A, owing to the valve or valves opening and closing the cylinder-ports more quickly with B than with A. B's action upon the valve or valves is almost equivalent to the "Corliss gear," and the table shows that in the first notch, or at full-gear working, the space for expansion is increased eighty per cent., whereby the steam is utilized to a much greater advantage, and in the eighth notch, or at mid-gear working, it will be seen that B is working more expansively than A. Consequently the cut-off is rendered quicker or shorter, retaining approximately the same points of exhaust as at present

The valve which gave the figures on lines A had one and one-eighth inch outside lap. That which gave those on lines B had two and one-sixteenth inches outside lap. The valves for both A and B had no inside lap. It must be understood that any extent of outside lap may be adopted, the valve-gear corrector being adjusted accordingly, allowing the eccentric sheaves to retain their original amount of throw.

The advantages to be derived from the employment of my invention over the present system of working are numerous, as will be seen from the following results: It gives equal port-openings in backward and forward gear, as well as back and front stroke on each gear, and also retains equal leads. It can be adjusted to give equal cut-off at any desired point of the piston travel, giving at the same time the required amount of port-opening. Eighty per cent. more space for expansion is obtained than can now be procured by any valve-gear, excluding the Corliss gear. I am enabled to open the exhaust at an earlier part of the stroke than hitherto, thereby insuring a much more perfect exhaust before the return-stroke of the piston, consequently dispensing with a large amount of back-pressure. The steam is regulated so as to utilize the same to the best advantage in the one cylinder. A saving of over twenty-five per cent. in fuel and water will be effected.

The application of the corrector does not necessitate any alteration to whatever valve-gear it may be attached, as the same throw and position of eccentric sheave or sheaves, length of eccentric-rods, and position of weigh-shaft can be employed as at present, in addition to which the corrector will allow of any desired alteration in lead, port-opening, or cut-off being made without interfering with any conditions that may be required to remain. Being able to obtain the maximum port-opening at an earlier part of the stroke and to retain the same for a large portion of the travel of the piston, in addition to obtaining a quick cut-off, which prevents wire-drawing the steam, the expansion commencing at, say, half-stroke is more than sufficient for the further propelling of the crank, (which is known from the fact that the pressure of exhaust is, in most cases, seventy-five and eighty pounds per square inch,) which has practically done its work, being, as it were, built up with the power previously applied to it.

Comparing the results given by the Corliss gear with the present system of working, I find that the pressure which is brought to bear (during the rotary action of the crank) on the crank-pin at such points of crank angle—say seventy-five per cent. of stroke where the cut-off now takes place—is converted into friction on the axle bearings, boxes, &c., whereby much power or turning force is lost. This loss would be prevented by adopting the early and quick cut-off, and the engine would be at liberty to work more freely, and consequently get up speed more easily.

By the use of my invention the travel of the valve will equal approximately six inches, whereas under the present system it only equals four and a half inches at full-gear working. Consequently the six inches travel effects a more perfect lubrication on the faces.

My corrector, when applied to Hackworth's gear, Fig. 7, will correct the defects of that gear, rendering it adjustable for any desired range of cut-off, whereas the required port-opening can only be obtained now by adopting a very late cut-off, which necessitates the notching of the link to a point of very acute angle, whereby the gear is rendered almost impracticable.

The arrangement of the corrector is so simple and effective that very little additional expense is incurred in applying it to any existing valve-gear.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that I do not claim the oscillating link worked or actuated by the guide-bar or eccentric rod or rods; but

What I claim is—

1. In a valve-gear, the combination of the valve-spindle with a guide-bar, the connecting-link, the oscillating link, and the sliding link-block, and means for operating the guide-bar, substantially as shown and described.

2. The valve-gear corrector described, consisting of the combination, with the valve-spindle, of the slotted oscillating link a a', block a^3, eccentrics h h, eccentric-rods h^2 h^2, reversing-link h', and slide-rod b, all substantially as and for the purposes set forth.

Witnesses:
F. SAUNDERS,
WM. TURNER.

E. TINCKNELL.