

## ON DIRECT-ACTING WINDING ENGINES FOR MINES.

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In treating of this important subject the writer will refer to the principal types of Direct-Acting Winding Engines at present in work in the different coal-mining districts of this country. He is indebted to many friends for the data supplied, which he trusts may prove useful by furnishing the means of comparing the various usages and results in the different districts.

In Figs. 1 and 2, Plates 28 and 29, is shown a Single-Cylinder Vertical Winding Engine, having double-beat gunmetal valves and seats, with parallel motion and tappet valve-motion. A number of winding engines have been constructed of this type, of which one of the earliest has been at work over twenty-six years, having a cylinder 34 in. diameter and 5 ft. stroke, and a pair of flat winding drums DD, 9 ft. diameter. This engine winds coal from a shaft 10 ft. diameter and a depth of 450 yards in 55 seconds, or at the rate of 16 miles per hour; the time of banking is 30 seconds. The ropes used are flat, made of steel, and last about eighteen months. The engine winds four tubs at a time, each weighing  $1\frac{3}{4}$  cwt., and containing  $6\frac{1}{4}$  cwt. of coal, making 32 cwt. for the four. The cage and chains, which are of iron, weigh together 30 cwt. and the flat rope weighs 50 cwt. The total quantity of coal raised in 10 hours work is 250 tons, being at the rate of 25 tons per hour from the depth of 450 yards, or 112 tons per hour per 100 yards depth. The conductors are of iron. The boiler pressure is 45 lb. per sq. in. The repairs to this engine have been very few indeed, a new piston and a crank-pin having been the only renewals since the engine was started; and it has worked night and day since its erection in 1848. Another similar engine has been at work between twenty and thirty years, and in the shape of repairs has had only a new piston and crank-pin.

A Single-Cylinder Vertical High-pressure Winding Engine of similar construction, which has been at work about seventeen years, has a cylinder 30 in. diameter and 5 ft. stroke, with parallel motion, and double-beat gunmetal valves worked by two tappet-rods T T, Fig. 2, one for each direction of winding. The boiler pressure is 50 lb. per sq. in.; and a cast-iron feed-water heater H is attached to the engine. The winding drums are flat, 9 ft. diameter. The pit shaft is 11 ft. diameter and 212 yards depth. The time of winding is about 35 seconds, and of banking 20 seconds, the average speed in the shaft being about 12 miles per hour. The rope is flat and of steel, weighing about 28 cwt., and it lasts from ten to fourteen months. The tubs are of wood, and four of them are raised at each winding; each weighs 4 cwt. and contains 8 cwt. of coal, making 32 cwt. of coal at each winding. The cage and chains weigh about 20 cwt. The engine winds about 520 tons of coal in 10 hours time, being at the rate of 52 tons per hour, or 110 tons per hour per 100 yards depth. The conductors are of iron. In consequence of the boilers driving this engine being pretty well worn out, it has been considered advisable to reduce the steam pressure upon them to 40 lb. per sq. in.; and this has been effected by putting in a new steam cylinder of 32 in. diameter, so as keep about the same power of the engine.

In Fig. 3, Plate 30, is shown a Coupled pair of Vertical Winding Engines erected some twelve years ago, having cylinders 24 in. diameter and 5 ft. stroke, and working with a boiler pressure of 40 lb. per sq. in.; the valves are slide-valves with Bristol's antifriction rollers, and are worked by a link motion. The winding drum is of internal conical form,  $11\frac{1}{2}$  to 13 ft. diameter. The depth of the pit is 260 yards, and the winding is done in 35 seconds, or at the rate of 15 miles per hour. The ropes are round and of charcoal iron, and last twelve months in the wet pit, and eighteen months in the dry pit. The weight of the cage and chain is 20 cwt. The tubs, four in number, each weigh 3 cwt. and hold 7 cwt. of coal, making 28 cwt. of coal at each load; and the number of windings in 10 hours is 480, equal to 672 tons of coal, or at the rate of 67 tons per hour, or 174 tons per hour per 100 yards depth.

Up to 1850 the direct-acting steam winding engines used in Lancashire or the neighbourhood of St. Helen's were principally beam engines or vertical engines. About 1851 the Horizontal Single-Cylinder High-pressure Winding Engine was introduced by the writer's firm, and several such engines were put to work at different collieries. At that time great prejudice existed against the horizontal engines, in consequence of the prevailing idea that the cylinders would become oval by the weight of the piston; and this must be considered the reason why the piston-rods were carried through the back cover of the cylinders, and a slide or shoe attached to them for taking the weight of the piston off the bottom of the cylinder.

Amongst a number of engines of this class may be mentioned one that is shown in Figs. 4 and 5, Plates 31 and 32, having a cylinder 36 in. diameter and 5 ft. stroke, with double-beat gunmetal valves worked by a loose eccentric; in Fig. 6 is shown a transverse section of the cylinder and valves. The drum D is flat, 10 ft. diameter, and on the drum shaft is a flywheel 20 ft. diameter, which is used for the break, Fig. 4. The back piston-rod was originally used for a feed pump P, but for the last five years the engine has had no back piston-rod. This engine has been at work night and day for the last twenty-two years at the Rose Bridge Colliery near Wigan, and has required very slight repairs indeed; the writer believes it was the first winding engine of the horizontal type, and the largest size of its class when first erected. The pressure of steam in the boilers is 40 lb. per sq. in. The pit shaft is 11 ft. diameter and 290 yards deep, fitted with iron conductors. The winding takes 35 to 40 seconds, giving a speed of from 17 to 15 miles per hour in the shaft. The rope is flat and of iron, weighing about 35 cwt., and it requires renewing about every twenty-four months. The number of tubs raised at each winding is four, each weighing 3 cwt. and containing 8 cwt. of coal, or 32 cwt. gross load of coal. The weight of the cage, which is of steel, is 28 cwt., with the chains. The total weight of coal raised in 10 hours is 800 tons, being at the rate of 80 tons per hour, or 232 tons per hour per 100 yards depth.

A Coupled pair of Horizontal High-pressure Winding Engines similar to that shown in Figs. 4 and 5 was erected in 1860 at the

Rose Bridge Colliery, having cylinders 36 in. diameter and 6 ft. stroke, with double-beat gunmetal valves. Steam was supplied by eight egg-ended boilers,  $5\frac{1}{2}$  ft. diameter and 36 ft. long, working at 45 to 50 lb. pressure per sq. in. Up to 1870 these engines wound from a shaft 16 ft. diameter and 605 yards deep. The ropes were made of steel, and were flat and taper, each weighing 57 cwt. total, and 48 cwt. in the pit; they had to be renewed about every eighteen months. The number of tubs raised at a winding was four; they were of wood, weighing 12 cwt. each, and containing  $8\frac{1}{2}$  cwt. of coal, making 34 cwt. of coal raised at each winding; the cage and chains weighed 30 cwt. The number of windings in 10 hours was 500, raising 850 tons of coal per day, or at the rate of 85 tons per hour, or 514 tons per hour per 100 yards depth. The time occupied in each winding was 48 seconds, giving an average speed of 26 miles per hour in the shaft; the time of banking was 27 seconds. The winding drum was flat, 20 ft. diameter at starting, and  $23\frac{1}{2}$  ft. diameter with all the rope on. The conductors in the pit were iron wire ropes with a steel stranded core.

In consequence of the seams at this colliery being worked out in 1870 at the shallower depth of 605 yards, these engines were then called upon to wind from a depth of 806 yards; and it was accordingly found requisite by Mr. John Bryham, the engineer and manager of the colliery, to increase the winding drum to 24 ft. 4 in. diameter, and 28 ft. diameter with all the rope on. The ropes now in use are flat and taper, made of steel, and each weighs 65 cwt. total, and 57 cwt. in the pit, and lasts eighteen months. Four tubs are brought up at each winding, each weighing  $3\frac{1}{4}$  cwt. and containing  $7\frac{1}{2}$  cwt. of coal, or 30 cwt. of coal altogether; the cage and chains weigh 30 cwt. The number of windings in 10 hours is 450, equal to 675 tons of coal, or 67 tons per hour, or at the rate of 544 tons per hour per 100 yards depth. The time taken in each winding is 55 seconds, giving an average speed of 30 miles per hour in the shaft; the time of banking is 27 seconds. The conductors are iron wire ropes  $1\frac{7}{8}$  in. diameter with steel stranded core.

As it was considered advisable not to subject the present boilers to a higher pressure than 60 to 65 lb. per sq. in.,

the back piston-rods were taken away, and the result has been that 4 to 5 lb. per sq. in. pressure of steam has been saved, while the piston rings, which are of cast iron, have been found to last eighteen months. The cylinders have never been bored or otherwise touched since they were erected, and it is considered the repairs have been less since the back piston-rods were taken away. Looking at the fact that these engines are now running at the maximum rate of 60 miles per hour in the pit, and with a maximum piston speed of 700 ft. per min., the writer considers this severe test sufficient to answer all objections to the abandonment of the back piston-rods and slides, and he consequently recommends that no slides should be used.

In Fig. 7, Plate 33, is shown a Coupled pair of Horizontal Winding Engines with 30 in. cylinders and 5 ft. stroke, fitted with an internal conical winding drum of 16 to 24 ft. diameter.

In Figs. 8 and 9, Plates 34 and 35, is shown one of the most modern style of Coupled Horizontal Winding Engines, having cylinders 36 in. diameter and 6 ft. stroke, and fitted with an external conical winding drum of 19 to 30½ ft. diameter, which is shown in section in Fig. 10, Plate 36. These engines are working at the Pemberton Colliery near Wigan, and wind from a depth of 638 yards in 55 seconds, giving an average speed of 24 miles per hour; the time of banking is 35 seconds. The cage is of steel, and with the chains weighs 29 cwt. It holds six steel tubs, weighing together 18¾ cwt. and raising 46 cwt. of coal at each winding. The winding is done at the rate of 92 tons of coal per hour, or 587 tons per hour per 100 yards depth. The ropes are of steel, tapering from 1½ to 1¼ in. diameter and each weighing 59 cwt.; they have now been in work from September 1871, and are not much worn. The pit is 16 ft. diameter, and the conductors are iron T rails weighing 42 lb. per yard. The drum makes 22 revolutions in each winding, and the steam is shut off from the engines at 2½ to 3 revolutions before stopping, or 80 to 90 yards from the top of the pit. The pressure of steam at the engines is 53 lb. per sq. in. The several handles for controlling the working of the engines are all brought together to the same place within convenient reach of the engineman, as shown

in the plan, Fig. 9: S is the handle controlling the steam stop-valves V; and R is the reversing lever of the link motion; F is the foot lever for applying the break, which acts upon the centre portion D of the winding drum; and B is the handle for applying the steam gear A to work the break. The whole of the head-gear framing and heapstead is of iron, and the roofing over the stage is of galvanized iron. The arrangements enable twelve railway trucks to be loaded at a time, namely six with best coal, two with nuts, and four with slack; the level of the truck rails is  $23\frac{1}{2}$  ft. above the pit mouth. The head-gear pulleys are 18 ft. diameter and centered 45 ft. above the pit mouth.

Consumption of fuel seems in the writer's experience not to have been taken account of in colliery engines, and he has never yet been able to arrive at the quantity of coal consumed by a colliery winding engine, the general excuse being that the coal used at collieries was unfit for sale, and therefore it did not matter what quantity was burned.

From the Tables appended it will be seen that the condensing engine has very seldom been applied to the winding of coal; but with the greatly extended scale of mining operations at the present day it is worth consideration whether the more general adoption of the condensing principle would not be beneficial, where a sufficient supply of pure water can be obtained. Where this is the case, the existing high-pressure winding engines should have a separate condensing apparatus attached, with air-pumps worked by a donkey engine independent of the main engines, and under the control of the engineman, who would thus be able at all times to have the vacuum available for immediate use.

*Counterbalancing.*—In winding with drums of equal diameters up vertical coal-pit shafts, the actual working strain upon the engines is much greater at the commencement of the winding than at the finishing, in consequence of the weight of the rope in the shaft. For example, in the case of a shaft 806 yards deep, with a flat rope weighing 57 cwt., and cage and tubs weighing 43 cwt. and

raising 30 cwt. of coal, the load at the commencement of the winding is 130 cwt., less 43 cwt. on the descending rope, giving 87 cwt. net load upon the engine; and by the time the ascending load reaches the bank the respective weights will be 73 cwt. at the top of the pit and 100 cwt. at the bottom, or 27 cwt. acting to drag the engine forwards. Thus the power that has to be exerted during the winding of the first portion of each lift greatly exceeds that required to raise the coal alone; and at the end of the winding the engine has actually to exert a certain amount of power to retard the machinery, inasmuch as the weight of the empty descending cage with its long and heavy rope then exceeds that of the ascending loaded cage with its short length of rope. The different modes of counterbalancing such engines consist in the use of conical drums, levers, and chains.

*Conical Drum.*—The spiral or conical winding drum the writer believes was first introduced and adopted in Wales. In the Wigan district the first conical drum was started and set to work some fourteen years ago, and worked until 1872, when in consequence of an accident with a winding drum at another pit belonging to the same proprietors, this conical drum was altered, and a flat drum substituted for it. Whilst in use the conical drum was worked by a pair of 24 in. horizontal engines with 5 ft. stroke and 45 lb. steam in the boilers. The drum was of the shape shown in the diagram, Fig. 11, Plate 36, having a lagging of wood; it was 13 ft. diameter in the smallest diameter of the conical portion, and 20 ft. in the largest diameter and in the flat portion; it made 22 revolutions in winding, 11 laps being on the cone and 11 on the flat. It wound from a depth of 414 yards in 60 seconds, giving an average speed of 14 miles per hour. The ropes were of steel, 1 in. diameter, each weighing 20 cwt., and lasted two years. The cage with chains weighed 25 cwt., and held four tubs weighing  $2\frac{1}{2}$  cwt. each and containing  $6\frac{1}{2}$  cwt. of coal, 26 cwt. of coal being raised at each winding; the pit was 12 ft. diameter. The winding was done at the rate of 62 tons of coal per hour, or 257 tons per hour per 100 yards depth.

The conical drum shown in the diagram, Fig. 12, Plate 36, of 19 ft. and 30 ft. diameter, was erected in 1863, and had a lagging of wood, in which the grooves for the rope were cut by means of a self-acting screw-cutting lathe designed expressly for the work. It was driven off the crank-shaft of the engines by means of an intermediate shaft and gearing. This drum had to wind from the respective depths of 390 and 450 yards; but it was contemplated winding eventually from the greater depth with both ropes. The drum worked well for some time, but in consequence of one rope having slipped out of the groove, this principle of drum was abandoned, and the ordinary flat drum substituted. The slip was owing in a great measure to the peculiar arrangement of head-gear, whereby the rope that slipped had to pass over two pulleys before descending the pit, thus causing an amount of slack rope between the pulleys, which no doubt was the only cause of the slipping.

In the diagram, Fig. 13, Plate 36, is shown an external conical winding drum made of wrought and cast iron, and having angle-iron for the grooves, the diameters being  $17\frac{1}{2}$  ft. and  $31\frac{1}{2}$  ft. It is driven by two cylinders, 36 in. diameter with 6 ft. stroke, and winds with 14 revolutions from a depth of 390 yards in 50 seconds, giving an average speed of 16 miles per hour; the quantity of coal raised is 85 tons per hour, being at the rate of 331 tons per hour per 100 yards depth. This drum has been in work since 1864, and no accident has to the writer's knowledge occurred.

In Fig. 14 is shown an external conical winding drum with wood lagging, of 16 and 27 ft. diameter.

In Fig. 15 is shown an external conical winding drum, with wood lagging having angle-iron bolted on it to form the grooves, the diameters being  $20\frac{1}{2}$  ft. and 30 ft. This drum winds from a depth of 406 yards, and raises 120 tons of coal per hour, being at the rate of 487 tons per hour per 100 yards depth. The great advantage in its use is the saving of ropes, one pair of iron wire ropes having been in use for nearly four years, and having wound 1,000,000 tons of coal. The drum is driven by a pair of engines with 36 in. cylinders and 6 ft. stroke, and makes 14 revolutions; the time of



winding is 45 seconds, giving 18 miles per hour as the average speed in the shaft.

In Fig. 16 is shown an internal conical winding drum made of iron, and having wood lagging with the grooves cut in it by means of a special lathe; the diameters are 18 ft. and 25 ft. This has been at work about eight years, and has given entire satisfaction. It is driven by two cylinders of 30 in. diameter and 5 ft. stroke, and winds with  $22\frac{1}{2}$  revolutions from a depth of 510 yards in 52 seconds, giving an average speed of 20 miles per hour; the quantity of coal raised is 56 tons per hour, being at the rate of 286 tons per hour per 100 yards depth. The ropes are of steel,  $1\frac{1}{4}$  in. diameter, and last about three years.

The external conical winding drum at the Pemberton Colliery, shown in section in Fig. 10, Plate 36, and in the plan, Fig. 9, is believed by the writer to be the largest that has yet been erected. It weighs about 40 tons and is composed entirely of wrought and cast iron; the groove iron was specially rolled for it, and is so shaped that it is quite impossible for the rope to get out of the grooves.

*Other modes of Counterbalancing.*—In the North of England several kinds of counterbalance are used for winding engines; and for the particulars of these the writer is indebted to a paper read some years ago at another Institution by Mr. John Daglish.

The Pendulum counterbalance, shown in Fig. 18, Plate 37, consists of a weighted pendulum, which is raised by a chain attached to a drum on the shaft of the winding engine. At the commencement of the winding the pendulum is in a horizontal position, and the full weight of the counterbalance is acting to aid the engine against the load; as the winding proceeds up to the half-way point, an increasing portion of the weight is supported by the pendulum rod, which is then in a perpendicular position; and from this point until the load is brought to the surface the pendulum is gradually raised again to its horizontal position by the winding up of the chain, the counterbalance weight acting against the engine with gradually increasing force. In consequence however of the short travel of the pendulum, even with the smallest practicable chain-

drum, this system can only be applied to shallow pits; and as it is not these for which counterbalancing is of so much importance, the application of this plan may be considered as almost obsolete.

Another form of counterbalance, shown in Fig. 17, consists of a Lever or Crank of great strength, 20 ft. long, from the end of which a weight of 30 tons is suspended; and by means of intermediate gearing connected with the main shaft E of the winding engine the lever is made to describe a single semicircle during the whole of the winding, the action being thus the same as that of the pendulum. This counterbalance works a pit 336 yards deep.

In Fig. 19 is shown another form of counterbalance, called the Inclined-Plane counterbalance, in which a weight of 2 tons runs down a curved incline, and is then drawn up it again.

The system of counterbalance in general use in the northern collieries is the Chain counterbalance, shown in Fig. 20, and consisting of a long bunch of chain A, which at the commencement of winding hangs suspended in the top of a staple or shallow pit. The winding drum making 24 revolutions at each winding, B shows the position at the end of the third revolution, when the bunch of chain touches the bottom of the staple. C shows the position at the end of the sixth revolution, when the whole of the bunch lies at the bottom of the staple. At the meeting point, where the ascending and descending cages pass each other in the shaft, the whole of the large suspending chain, as well as the bunch, lies at the bottom of the staple, as shown at D. During the latter half of the winding the converse action taken place, the chain being drawn up out of the staple, and thereby producing a gradually increasing retardation upon the engine.

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TABLES.

*Particulars of Colliery Winding Engines.*

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Reference No.	District.	Style of Engine.  * Counterbalanced.	Cylinders.				Piston Speed. Ft. per min.	
			Number.	Diameter.	Stroke.	Effective Area of both cyla.	Mean.	Maximum.
1	Cheshire	Vertical Condensing	No. 1	36	6	...	261	360
2		Do. do.	1	60	7	...	340	350
3		Horizontal Non-cond.	2	26	5	...	266	400
4	Derbyshire	Vertical Non-cond.	1	36	6	...	456	600
5		Horizontal do.	2	30	5	...	330	600
6		Do. do.	2	26	4½	...	548	650
7		Do. do.	2	20	4	...	280	560
8	Durham	* Vertical Condensing	1	65	7	3300	176	250
9		* Do. do.	1	68	7	3613	224	300
10		Do. do.	1	68½	7	...	...	...
11		Horizontal Non-cond.	2	40	6	2460	253	410
12		Do. do.	2	34	6	1780	291	522
13		* Do. do.	1	48	6	1776	232	320
14		Do. do.	2	36	6	...	...	...
15		Do. do.	2	26	5	...	...	...
16		Do. do.	2	34	6	...	...	...
17	F. of Dean	Beam	1	24½	8	...	180	360
18	Glo'ster-shire	Horizontal Non-cond.	2	30	5	...	111	200
19		Do. do.	2	24	5	...	113	220
20	Lanca-shire	Horizontal Non-cond.	2	30	5	1400	260	462
21		Do. do.	2	36	6	2000	288	432
22		Do. do.	2	36	6	2000	376	720
23		Do. do.	2	36	6	2000	...	...
24		Do. do.	2	24	5	...	...	...
25		Do. do.	2	30	6	...	...	...
26	Notting-hamshire	Vertical Non-cond.	2	32	6	...	465	600
27		Do. do.	2	32	6	...	420	540
28		Do. do.	1	40	5	1230	300	...
29		Horizontal do.	2	36	6	2000	376	...
30	Scotland	Beam Non-cond.	1	20	4½	...	...	...
31		Do. do.	1	16½	2½	...	...	...
32		Horizontal do.	2	20	1½	...	...	...
33	South Wales	Vertical Condensing	1	42	8	...	318	592
34		Horizontal Non-cond.	1	24	6	...	390	870
35	Stafford-shire	Horizontal Non-cond.	2	26	6	...	280	420
36		Do. do.	2	20	3½	...	294	380
37	Yorkshire	Horizontal Non-cond.	2	42	6	2720	360	700
38		Do. do.	2	36	6	2000	228	...

*Particulars of Colliery Winding Engines.*

Reference No.	Valves.	Pressure.			Power.	Duty.		Load at starting in percentage of Pressure on Piston.	Maximum Indicated Horse Power of Engine.
	Double-beat, Equilibrium, Slide, or Throttle.	Boiler Pressure. Lb. per sq. in.	Steam Pressure in Cylinders. Lb. per sq. in.	Vacuum in Cylinders. Lb. per sq. in.		Weight of Coals raised through Height of shaft.	Percentage of Power.		
1	E	11	11	...	Ft.-lbs.	Ft.-lbs.	ψ cent.	ψ cent.	I. H. P.
2	E	25	10	11	...	...	...	...	376
3	S	31	...	...	...	...	...	...	...
4	D	45	20	...	...	...	...	...	...
5	E S	45	37	...	...	...	...	...	...
6	E S	70	25	...	...	...	...	...	...
7	D	50	30	...	...	...	...	...	...
8	D	19	16	9½	10,342,350	7,729,344	75	50	...
9	D	20	19-20	10½	15,403,000	9,744,000	63	42	422
10	D	15	...	...	...	...	...	...	...
11	D	...	35	...	7,470,000	4,077,000	55	36	470
12	S	40	30-40	...	4,375,596	2,700,000	62	43	497
13	S	...	36	...	5,281,107	3,956,178	75	37	344
14	D	50	...	...	...	...	...	...	...
15	S	25	...	...	...	...	...	...	...
16	S	30	...	...	...	...	...	...	...
17	Lift	...	...	...	...	...	...	...	...
18	D	60	40	...	...	...	...	...	...
19	D	50	45	...	...	...	...	...	...
20	D	49	45	...	6,851,700	4,131,000	60	37	461
21	D	...	53	...	...	...	...	...	...
22	D	60-65	53	...	19,196,400	8,114,400	42	80	900
23	D	45-50	...	...	12,957,570	6,911,520	53	...	...
24	S	45	45	...	...	...	...	...	...
25	D	40	35-40	...	...	...	...	...	...
26	D	40	30	...	...	...	...	...	...
27	S	...	30	...	...	...	...	...	...
28	D	...	40-42	...	3,363,568	2,460,000	73	...	...
29	D	...	48	...	10,542,411	6,265,023	59	58	...
30	T	50	...	...	...	...	...	...	...
31	T	40	...	...	...	...	...	...	...
32	Cock	40	...	...	...	...	...	...	...
33	D	35	25	11	...	...	...	...	...
34	S	45	25	...	...	...	...	...	...
35	D	45	37	...	...	...	...	...	...
36	S	60	42	...	...	...	...	...	...
37	D	...	42	...	12,120,000	6,300,000	52	48	950
38	D	...	48	...	7,955,782	5,999,948	76	29	...

*Particulars of Colliery Winding Engines.*

Reference No.	District.	Winding Drums.			Ropes.			
		Flat or Conical.	Diameter.			Size.	Weight per yard. (*Gross weight.)	Duration. Those marked + are still at work.
			Minimum.	Maximum.	Mean.			
1	Cheshire	Flat	Ft. ...	Ft. 12	Ft. ...	I R	In. ...	Months. 28
2		Flat	...	24	...	I F T	4½ to 3¾	18
3		Flat	...	14	...	I R	...	25
4	Derbyshire	Flat	...	15	...	I R	...	9
5		Flat	...	15	...	S R	...	11½
6		Flat	...	11	...	S R	...	... +
7		Flat	...	11	...	I R	...	6
8	Durham	Flat	25	27	26	I F	6½ × ⅞	18 to 24
9		Flat	22	25	23½	I F	6 × ⅞	12½
10		Flat	...	21	...	I F	...	14
11		Conical	16	26	21	S R	1⅝ diam.	14 to 24
12		Conical	16¾	18½	17½	I R	1⅝ diam.	14
13		Flat	20¾	22¼	21½	I F	...	16
14		Flat	...	18½	...	I R	...	...
15		Flat	...	12	...	I R	...	...
16		Conical	16	24	20	S R	1⅝ diam.	... +
17	F. of Dean	Flat	9	11	10	I F	...	36
18	Glo'ster-shire	Flat	...	16½	...	S R	...	*40 cwt. 12
19		Flat	...	15	...	S R	...	*40 cwt. 18
20	Lanca-shire	Conical	18	25½	21¾	S R	1½ diam.	5½ 36
21		Conical	19	30½	24¾	S R T	1½ to 1¼	9 47 +
22		Flat	24	28	26	S F T	...	11 18
23		Flat	20	23½	21½	S F T	...	... 18
24		Conical	13	20	16½	S R	1 diam.	3¾ 24
25		Conical	16	27	21½	S R	1⅝ diam.	7½ 36
26	Notting-hamshire	Flat	15	17	16	F	...	8½ 10
27		...	16	19	17½	R	...	9 24
28		Flat	13½	15½	14½	I F	...	16½ ...
29		Flat	15½	18½	16¾	I F	...	14½ ...
30	Scotland	Flat	5½	8	6¾	H F	...	*9 cwt. 12
31		Flat	...	...	...	H F	...	*4 cwt. 15
32		...	...	...	...	I R	...	*3 cwt. 48
33	South Wales	Flat	21	22	21½	I F	6 × ⅞	*70 cwt. 15
34		Flat	11	13½	12¼	I F	4½ × ⅞	*27½ cwt. 24
35	Stafford-shire	Flat	...	14	...	I R	1½ diam.	... 20 +
36		Flat	...	9½	...	I R	1½ diam.	... 14 +
37	York-shire	Flat	...	18	...	I & S, R	...	14½ & 11½ ...
38		Conical	20½	30	27½	I R	...	9 47 +

*Particulars of Colliery Winding Engines.*

Reference No.	Pit Shaft.		Weight of Cage with Chais.		Total Weight of Tubs empty.		Weight of Coal raised.		Time of Winding.	Time of Banking.	Speed of Cage in Shaft.			Conductors.
	Diameter.	Depth.					Tonnage per hour.	Tonnage per 100 yards depth.			Mean	Maximum.		
												Feet per min.	Feet per min.	
		Ft.	Yds.	Cwt.	Cwt.	Cwt.	Tons.	Tons.	Sec.	Sec.	Ft.	Ft.	Miles	In.
1	13½ × 9½	240	18	5½	12½	35½	84	50	10	506	1131	12·8	Wood	
2	12	686	21½	4½	32	44½	307	65	50	1630	2037	23·1	Wood	
3	10	270	18½	5½	12½	50	135	33	7	1170	1760	20·0	Wood	
4	9 × 8½	200	30	...	18	18½	37½	20	10	1800	...	...	Wood	
5	12½	305	40	...	32	26½	82	35	50	1740	...	...	W	
6	14	175	40	...	27	16½	29	15	15	2100	...	...	W	
7	13	135	35	...	18	30	40	20	10	1200	...	...	Wood	
8	14	426	50	30	54	91	388	75	30	1020	1431	16·2	Wood 5 × 3	
9	11½	580	35	33	50	72½	420	89	35	1180	1630	18·5	...	
10	15½	591	...	24	45	31½	186	90	...	...	...	...	...	
11	12	516	40	15½	24½	80	413	55	37	1689	2788	31·7	Wood 5 × 3	
12	14	246	18	22	35½	110	271	34	25	1302	2436	27·7	W	
13	10½	322	22½	16	36	65	209	45	50	1300	1706	19·4	Wood	
14	14½	240	...	20	33	...	...	...	...	...	...	...	...	
15	12	108	...	10	16½	...	...	25	15	...	...	...	...	
16	16	348	40½	20	32	...	...	52	...	...	...	...	...	
17	13 × 11	180	10	4½	13	34½	62	48	20	720	1421	16·1	I	
18	10	444	30	12	42	63	280	60	40	1003	1890	21·3	Wood 4 × 4	
19	9	488	20	7	24	30	146	75	35	1194	2319	26·4	Wood 5 × 5	
20	16	510	20	12	24	56	286	52	25	1765	3100	35·2	I W	
21	16	638	29	18½	46	92	587	55	35	2088	3450	39·2	I, T rails	
22	16	806	30	13	30	67½	544	55	27	2590	5100	57·9	I & S W 1½	
23	16	600	30	13	34	85	510	48	25	2166	4302	48·9	I & S W 1½	
24	12	414	25	10	26	62	257	60	15	...	...	...	Wood	
25	14	280	22	10	28	71	199	55	15	...	...	...	Wood	
26	12	515	32	12	30	50	257	45	50	2040	2280	25·9	Wood	
27	...	...	36½	18	50	60	...	50	60	1860	2340	26·6	W	
28	...	222	25½	15	33	91	202	30	30	1320	...	...	...	
29	...	413	30	25	45	128	529	45	25	1652	...	...	...	
30	10 × 6½	100	8½	3	8	10	10	18	...	...	...	...	...	
31	9 × 5½	30	6	2½	6½	7½	2½	16	...	...	...	...	...	
32	10	80	6	2½	7	8½	7	18	...	...	...	...	...	
33	22 × 18	300	40	20	60	135	405	40	20	1350	1590	18·1	W 1½	
34	18 × 9	120	22	8½	22	45	54	40	42	617	870	9·9	...	
35	12½	240	28	14	20	62½	150	24	90	1100	1525	17·3	S W 1½	
36	7	225	12	4½	12	24	54	20	90	1200	1675	19·0	Wood	
37	...	450	48	19	40	102	459	47	21	1691	3080	35·0	...	
38	...	406	48	22	44	120	487	45	25	1624	...	...	...	





Mr. JEREMIAH HEAD, referring to the abandonment of the back piston-rod in horizontal steam cylinders, mentioned that he had some large engines at work with back piston-rods, and thought the plan was worse than useless. If the back slide was packed up sufficiently to carry any part of the weight of the piston, the rod was inevitably sprung upwards out of line; and the effect of the tail piston-rod was to work an oval in the back stuffing-box. If, as was generally the case on that account, the back slide was omitted, the overhanging piston-rod produced a similar result by the leverage of its weight. As a means of obviating the tendency of the cylinder to wear oval, one plan that had occurred to him was to measure the exact deflection of the piston-rod with the piston upon it, before introducing it into the cylinder, and then, after carefully warming it, to give it by means of screws a set of an equal amount in an upward direction, so that it should become truly horizontal in working; if that could be done, he thought it would make a perfect job. Another plan he had thought of was to set the bottom of the cylinder, and the slides of the front and back piston-rods, approximately parallel to the catenary which the piston-rod and piston would assume when transversely supported on the slide-blocks. It was obvious that the piston-rod would thus be always working with its particles so strained as to carry the piston and relieve the bottom of the cylinder. In this way the oval wear of the cylinder and of the glands might be reduced to a minimum.

Mr. E. REYNOLDS agreed in considering that it was altogether undesirable to have the piston-rod prolonged through the back end of the cylinder in a horizontal engine, though this was found necessary in many modern foreign locomotives, probably owing to the use of wrought-iron or steel pistons, which being proportioned with reference only to the theoretical requirements of strength had very narrow bearing surfaces and therefore cut the cylinders. The simple remedy for wear of the piston was to have plenty of bearing surface, which would remove all necessity for back rods, except where steam-jackets or superheated steam

were used: in these cases back rods or very strong single piston-rods had sometimes been found necessary to resist the jarring action arising from the dryness of the sides of the cylinder.

One thing worth calling attention to was the modern fashion of making winding engines excessively large in proportion to their work: the cylinders were made large enough to command three or four times the load actually raised, the object being to enable them to start very quickly. This quick starting involved a strain on the rope much greater than the simple amount of load attached, and thereby shortened the life of the rope. It had been mentioned that with certain of the drums described in the paper the ropes had lasted four or five years; but those drums were described as being 30 ft. diameter and 40 tons weight, and the inertia of this large mass would absorb a large proportion of the surplus power of the engines at the commencement of the winding, and so relieve the ropes from undue strain. The large diameter of the drum and pulleys would also very much prolong the life of the ropes, particularly of the one which wound on under the drum, reversing the direction of the bend over the pulley at the pit head. Where the usual size of these pulleys was from 8 to 10 ft. diameter, the lower rope did not last on the average more than half as long as the upper one; whereas this difference rapidly decreased as the size of the pulleys was increased, so that it was not very conspicuous where such large sizes as those described in the paper were used. In a particular case where the pit-head pulleys were 15 ft. diameter and the drum 16 ft. diameter, the wire ropes being  $1\frac{1}{4}$  in. diameter, no difference had been traced in the wear of the two ropes.

Mr. BENJAMIN WALKER considered the great weight of the drum in modern winding engines, which caused it to act as a large flywheel, was a decided advantage, and in conjunction with the long stroke adopted must prove an important source of economy in the working of the engines. He suggested that if a few indicator diagrams could be obtained from some of the winding engines described in the paper they would be of much interest for comparison with those obtained

from other engines, and he had no doubt would show favourably in connection with the consumption of coal for the work done. The vertical engine was the one he preferred for winding purposes, rather than the horizontal; it was an excellent type of engine, and gave capital results in economy of working. The guide for the back piston-rod in horizontal cylinders he had for many years abandoned, considering it to be only a make-shift and of no practical benefit. He had made the piston-rod flat at the bottom, working through a gland with a corresponding flat side, which had been found to work very successfully; there was no difficulty in fitting the rod and gland so correctly that they would work just as well as in the case of an ordinary round piston-rod, while the flat bearing surface had the advantage of being more durable.

Mr. W. RYE was satisfied it was an advantage as regarded the durability of the cylinder to do away with the back piston-rod altogether. He had had very little occasion to rebore horizontal cylinders on account of their wearing oval, and had known horizontal engines work for twenty years without the cylinders being rebored; where however engines had a large amount of work to do, it was likely the cylinders might want boring again in only ten years' time. He should be glad to hear what had been the experience of others as to how far and under what circumstances the cylinders really did wear oval in horizontal engines; or if it was not better to ignore the back piston-rod altogether as a useless appendage.

Mr. H. DAVEY enquired to what extent expansive working was now carried in winding engines. This was one of the most important subjects connected with winding engines, and one that had occupied the attention of engineers for many years; but he was not aware that any great success had yet been attained in that direction. Various constructions of expansion gear had been proposed for winding engines, and he should be glad to know how far any of them had been successful in practice.

He quite agreed in the desirability of providing winding engines with a condenser worked by an independent engine, which was a

most important point. Winding engines had previously been made with condensers attached, but a condenser so applied could not keep the vacuum perfect during the time the engine was stopped.

With reference to the question of horizontal cylinders wearing oval, he thought there was no difficulty from that cause with good metal, and with the supporting surface of the pistons large enough in proportion to their weight. Pistons were often made with a very narrow supporting surface and of great weight, and in such cases there must inevitably be great wear. Instead of this, the piston should be made as light as was compatible with its required strength, and of sufficient length to give very wide bearing surfaces in the rims of the piston; for the spring packing-rings had no supporting power, the whole weight being carried by the rims of the piston itself. The back piston-rod he agreed in considering might well be dispensed with as worse than useless.

In the section shown in Fig. 6 (Plate 32) of the double-beat steam and exhaust valves used in one of the horizontal winding engines, he noticed that the double seating of the steam valve was not made all in one piece, but consisted of two distinct seats fixed in separate parts of the nozzle. Having put similar valves in an engine some years ago, he had not succeeded in getting them to keep steam-tight, and had had to replace them by the ordinary form of Cornish double-beat valve. The difficulty arose from the unequal expansion of the two metals, the seats being fixed in the cast-iron nozzle, while the valve was made of gunmetal; when heated the two seats separated less than the increase in length of the valve, so that the valve became longer than the seating, and there was consequently a leakage at the upper seat. He enquired whether this difficulty had been experienced with the valves shown in the drawing.

Mr. H. LAWRENCE mentioned that he had seen double-beat valves like those shown in the drawing (Fig. 6, Plate 32) in extensive use on American river steamboats, and had not heard of their giving any trouble. He had himself overcome the difficulty of unequal expansion in valves of that description by using a

special mixture of metal for the cast-iron nozzle carrying the two seats; and also by introducing a sliding joint in the valve-spindle between the upper and lower beats, and leaving a little vertical play between them, so that both of them were able to close steam-tight under all circumstances.

One thing which had struck him most of all in connection with the present paper was the great difference in the durability of the ropes, many not having lasted more than eighteen months, while those working upon the conical drum shown in Figs. 8 and 9 had already continued in use nearly four years to the present time. At the collieries in the North of England it had gradually become the practice to make the head-gear pulleys as nearly as possible the same diameter as the flat winding drums, so that the ropes might not receive any greater amount of bending in passing over these pulleys. It appeared to him however that the long duration of the ropes on the conical winding drum could not be attributed to that circumstance, because the diameter of the conical drum itself varied from 20 to 30 ft. in the portion on which the ropes wound, and the bend of the ropes was thus continually altering; notwithstanding which there was the fact that the ropes on the conical drum had already lasted since 1871, while those on the flat drums lasted only about eighteen months. This difference in duration must be a serious matter to colliery proprietors, and it was important to ascertain to what cause it was to be attributed. In ropes winding on flat drums, the successive coils of the rope had a grating and wearing action against each other; whereas in the conical drum each turn of the rope had its own separate groove, and instead of wearing at the sides it was not in contact with anything but the correctly shaped surface of the groove. This he thought might account for the saving in the wear, even to the extent of the great difference between eighteen months and four years.

In reference to the small use of condensing engines for colliery winding, he mentioned that in the county of Durham there were many condensing engines in use for that purpose, which were working in a most efficient manner.

Mr. W. S. HALL observed, in regard to the size of the pit-head pulleys and the wear of the ropes, that if the pulley was made too large in diameter it acted as a flywheel, and would then overrun the rope in stopping or starting quickly, and wear a flat place in the rope at that part. He had frequently noticed this occur in a very marked manner when stopping quickly, and that would account for the wear of the rope.

Mr. C. COCHRANE, referring to the question asked respecting the wear of horizontal cylinders, mentioned that in the case of some of Mr. Slate's horizontal blowing engines, having blowing cylinders 4 ft. diameter and 2 ft. stroke and running at 60 or 70 rev. per min., a serious wear took place, owing to the weight of the wrought-iron piston having no back support; and after the lapse of a few years it became necessary to take the cylinders out and rebore them, the wear being chiefly at the back end. To prevent a recurrence of this wear, the piston-rod of  $5\frac{1}{2}$  in. diameter was prolonged, and carried through the back cover of the cylinder, and worked through a stuffing-box 18 in. long attached to the cylinder cover, so as to afford a larger total extent of bearing surface, which proved a great advantage. The brasses carrying the piston-rods were in halves, the lower halves having vertical adjustments so as to take up the wear; and the exact adjustment of the piston-rods to the particular level desired was tested at regular intervals by careful gauging. This alteration had been attended with considerable success in preventing unequal wear of the cylinder. The result showed the importance of relieving the cylinder as far as possible from the duty of bearing any of the weight of the piston; and in all cases the weight of the piston was made as small as possible.

Mr. D. ADAMSON thought the wear of a horizontal blowing cylinder could not well be compared with that of the steam cylinder of a horizontal winding engine, because the interior of a blowing cylinder was exposed to the gritty atmosphere usual in an ironworks, while the inside of a steam cylinder was clean and free from grit, receiving only steam; and this consideration

seemed sufficient to explain why in some engines it was found there was no necessity at all for reborring the cylinders, while in others reboring was required. He agreed in preferring that the back piston-rod should not be used; it not only occasioned friction and loss of power, but it could not be got to work well for any length of time, as a series of bearing surfaces in the same straight line were always difficult to maintain. Cylinders that had come under his own notice had had a much shorter life in work where the piston-rod had gone through the back end. It had been recommended that care should be taken to have a good class of metal; but that was a very indefinite mode of expression, as there were various notions of what constituted a good class of metal. In his own experience he had found that, to obtain a metal possessing the utmost slipperiness of surface, manganiferous iron must be used. For heavy castings where great tensile strength was required, spiegeleisen should not be employed; but if an iron was wanted that would be good for turning and boring, as in the case of steam-engine cylinders, a manganiferous iron must be used in such proportions as would render it most suitable for undergoing those operations. Spiegeleisen alone did not give a metal such as was required, because it contained from 8 to 10 per cent. of manganese, which was too large a proportion; but 2 or 3 per cent. of manganese was the best for giving a good slippery surface, which would continue in the best possible order in working, and was consequently adapted for horizontal stationary and locomotive cylinders, and for other sliding surfaces. He had for some years adopted a mixture of North Lincolnshire manganiferous iron with hæmatite and a little Scotch pig, in order to get fluidity in melting; such a mixture gave a close metal, which while difficult to file could be turned and bored with great facility. Where certain definite results were desired, it was important that care should be taken to have iron of the exact character necessary; and this could be obtained with the simple ingredient manganese, used in the proper proportion for the quality of iron required, as for steam cylinders, slide valves, or motion bars.

Mr. W. HOWE mentioned that one of the first horizontal winding engines had been put down at the Clay Cross Colliery about 36 years ago by Mr. George Stephenson, and after it had been working for ten years there was a good deal of leakage past the piston, which was accordingly taken out for reboring the cylinder. He had then found that the cylinder was worn barrel-shaped, the wear being quite as much at the top as at the bottom, and it was not worn oval transversely. That engine was still working satisfactorily, without having had anything further done to it in the way of reboring; it had a back piston-rod, as had also all the other horizontal engines at Clay Cross, but that was the only one which had had the cylinder rebored.

Another winding engine at the Clay Cross Colliery was a vertical engine somewhat similar to that shown in Figs. 1 and 2 (Plates 28 and 29); and after working for some years with the ordinary cast-iron packing rings, it had suddenly stopped working, though it had been examined not long before. On taking the cover off, it was found that the packing rings were broken into a great number of pieces. As it was a matter of the greatest importance that this should be remedied as speedily as possible, and there was not time to fit in new cast-iron packing rings, an ordinary ring was cast, thick enough to fill up the space occupied by the previous packing, and was fitted with a couple of Ramsbottom rings made of brass. This plan had worked excellently; the rings were changed every two or three years, but the cost of renewal was so exceedingly small and the efficiency so great that the plan was still adhered to.

With regard to the double-beat steam valves shown in the drawing (Fig. 6, Plate 32), he had had an engine working at Clay Cross for 21 years with similar valves, and had had no leakage from unequal expansion. In that case the top seating of the valve was made so slightly conical as to be almost cylindrical, the bottom seating alone being the usual cone, so that expansion did not affect the fit at all; and he had never noticed any leakage going on through these valves.



Mr. T. CLARIDGE said he had overcome the difficulty of unequal expansion in double-beat valves of the construction shown in the drawing by making the valve itself of cast iron as well as the nozzle. It was simply necessary to make the valves of good tough iron, with a little greater thickness of metal than in gunmetal valves, and when so made they were stronger than gunmetal valves and would wear very much longer; he had known them work for 25 years. The cast-iron valves were cheaper not only in first cost but also in total expense.

Mr. W. J. L. WATKIN mentioned that in the particulars he had furnished for the paper as to the winding engines at the Pemberton Colliery, which had been visited by the members at the Liverpool meeting of the Institution three years ago, the duty of the engines had been understated, and the quantity of coal that would eventually be raised by the same engines in regular working would be considerably greater than the amount given in the paper. At present there was not a satisfactory arrangement for changing the tubs quickly; with conical drums there was always a difficulty in this respect, unless some special means were adopted. The drum in this instance had a minimum diameter of 19 ft. and a maximum of 30 ft. 6 in.; consequently when the cage arrived at the top landing the tubs were being changed with a drum of larger diameter by 11 ft. 6 in. than was the case with the tubs which were being removed at the bottom of the shaft at the same time. At present one deck was thus lost in changing, and the engine had to be moved once more than would be necessary when suitable apparatus was erected for acting upon the cage at the bottom of the shaft in such a manner as to dispense with any additional movement of the engine. The time occupied in changing six tubs in each cage was now 35 seconds; but when the alteration was made a saving of 7 seconds would be effected, which would enable the engines to raise 150 tons of coal per day more than at present.

With regard to the wear and tear of the ropes at that colliery, he attributed their long duration to the careful manner in which the grooves on the winding drum had been prepared by the author of

the paper. There was not the slightest grating of the ropes in the grooves during the whole course of the winding, and there was scarcely any noise whatever. The ropes, which were made by Messrs. Haggie of Gateshead, had now been at work since September 1871, and he could not yet find the slightest defect in them.

The PRESIDENT enquired whether any difference was found in the durability of the two ropes, in consequence of the reverse bending given to the one which passed underneath the winding drum.

Mr. W. J. L. WATKIN replied that the rope which passed under the winding drum used generally to wear out sooner on that account than the one which passed over it; and with the drum at Pemberton Colliery he thought three months' shorter duration a fair allowance to make for the under rope.

Mr. W. BRYHAM considered the conical winding drum at Pemberton Colliery was the best that had yet been made; the ropes used with it were exceedingly strong round ropes. At Rose Bridge Colliery, with a flat winding drum and flat taper ropes, the wear and tear of the ropes was apparently greater; but in proportion to the weight drawn the flat ropes at that colliery were lighter, being as light as could possibly be used, and no stronger than sufficient to do the work for a certain length of time with safety, as there was not engine power enough to allow of using heavier ropes.

The PRESIDENT enquired whether there was any saving of wear in consequence of letting each convolution of the rope bed in its own separate groove, instead of heaping itself on the preceding turn.

Mr. W. BRYHAM replied that he had had one of the internal double-cone winding drums at work at another pit for eight years, and had not taken the ropes off till they had been working four

years. They were then changed, lest the wire might be getting bad inside; not that it was seriously worn, but lest it might have lost its tensile strength from constant concussion. The long wear of the ropes in that case proved the advantage of the drum being made with grooves properly fitting the ropes; moreover the drum being covered with a wood lagging, the grooves were of wood, not of iron, which was also a great advantage.

The PRESIDENT enquired in what distance the cage could be brought to rest when moving at the maximum speed of 60 miles per hour in the shaft.

Mr. W. BRYHAM replied that the engineman shut off the steam and began to reverse the engine about seven revolutions before stopping, the ascending cage being then about 180 to 200 yards from the top; and the steam had to be admitted against the engine in the last two or three revolutions. Up to the time of shutting off steam the engine was running at its full speed, and he understood from the author of the paper that the speed in the shaft was then 60 miles an hour.

Mr. G. H. DAGLISH said he was indebted to Mr. G. Fowler for kindly measuring the speed in that and other instances, by means of a special instrument for the purpose; and he believed the maximum speed was not overstated at 60 miles an hour in the shaft.

Mr. W. BRYHAM said he had been a little surprised at hearing the rate stated so high; the speed depended however upon the man driving the engine, and it was possible for the engine to be driven so fast as to give a speed of 60 miles an hour in the shaft.\*

With regard to the abandonment of the back piston-rod in horizontal winding engines, the engine referred to by the author of the paper (shown in Fig. 5, Plate 32) was one that he had had to

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\* The actual velocity of the cage in the pit at the point of greatest speed has been subsequently ascertained to be 57 to 58 miles per hour in regular working.

do with for a long time, and it had been originally made with the piston-rod carried through the back end of the cylinder, not with the intention of supporting the weight of the piston, but for working a small feed pump, which however had not been used as a pump except for a very short period. Finding that the back piston-rod was no advantage and was only occasioning a waste of packing, he had had it cut off a few years ago both in that engine and in the rest of the horizontal engines under his charge, all of which had previously had back rods; since then he had found less waste in packing. The cylinder of that engine, which had been at work for 22 years, was 36 in. diameter and 5 ft. stroke, and he had not found there was any wear upon it whatever; it was just as true in its circumference now as it had been at first.

Mr. J. R. WADDLE remarked that a good deal more importance seemed to be attached to the back piston-rod than he thought it merited, for in his own experience he had found it neither did much good nor much harm. Where a slide-block had been applied at the end of the back piston-rod for carrying the weight of the piston, it had been efficient enough for that purpose; but it was remarkable that the only horizontal cylinders which he had rebored had been worn at the top, while the bottom of the cylinder had been quite uninjured.

Mr. G. H. DAGLISH, in reply to the enquiry about expansion valves, said he was not aware of any having been tried for winding engines, none having come under his notice.

With regard to the back piston-rod, a horizontal winding engine which had been put up in 1860, and had been constantly at work ever since, had worked with a back slide till 1870, when the rod was removed; and the cylinder on being gauged recently was found perfectly true in shape, not worn at all oval during the five years' work since the removal of the rod.

The double-beat steam valves shown in the drawing had been found to give very little trouble, which he thought was due to the fact that both the valves and the seats were cast of the same metal, all of them being of gunmetal.

The particulars given respecting the time of winding with the different engines referred to in the paper had been kindly supplied to him from different districts, and he hoped the comparison thereby afforded would be useful.

The PRESIDENT considered the subject of the paper was a most important one, because upon the efficiency of the winding machinery depended the safety of the men who were lowered into the mine and raised from it by that means, as well as the power of turning out a sufficient amount of coal per day to yield a profit on the working.

The suggestion had been made in the paper that it would be well to have condensing engines introduced for winding, and to employ with them a separate engine for working the air-pumps. At the time when the Blackwall Railway was worked by ropes, the stationary engines used for the purpose, which were of the marine type, had their air-pumps separate and worked by an independent pair of beam engines of 12 H. P., and thus the large engines were always ready to start when the signal was given. The suggestion might be practicable for colliery winding engines; but he thought one of Morton's ejector condensers would be particularly applicable to these engines. Although it did not give the very best vacuum, yet a sufficiently good vacuum would be obtained by that means; and it went to work immediately upon the engine starting, the first stroke putting the whole into operation.

In reference to the utility of the back piston-rod, the discussion upon this point had borne out the opinion that it did harm rather than good, and did harm even when an additional slide was provided to carry the back end of the rod. The best plan seemed to be to make the piston as light as possible, with a large amount of bearing surface, and the cylinder of a good quality of metal, and to do away with the back piston-rod altogether. He was glad Mr. Adamson had explained how this good quality of metal could be obtained, the phrase being a very ambiguous one; and they were much indebted to him for the practical information he had given.

No allusion had been made in the paper to the means taken for ensuring safety in stopping, for the prevention of overwinding. He should have been glad to hear remarks on this subject, because accidents had arisen from overwinding, notwithstanding that the usual breaks were employed; and it would have been well that what was known upon this point should be discussed. This might perhaps be done on a subsequent occasion.

He moved a vote of thanks to Mr. Daglish for his paper, which was passed.

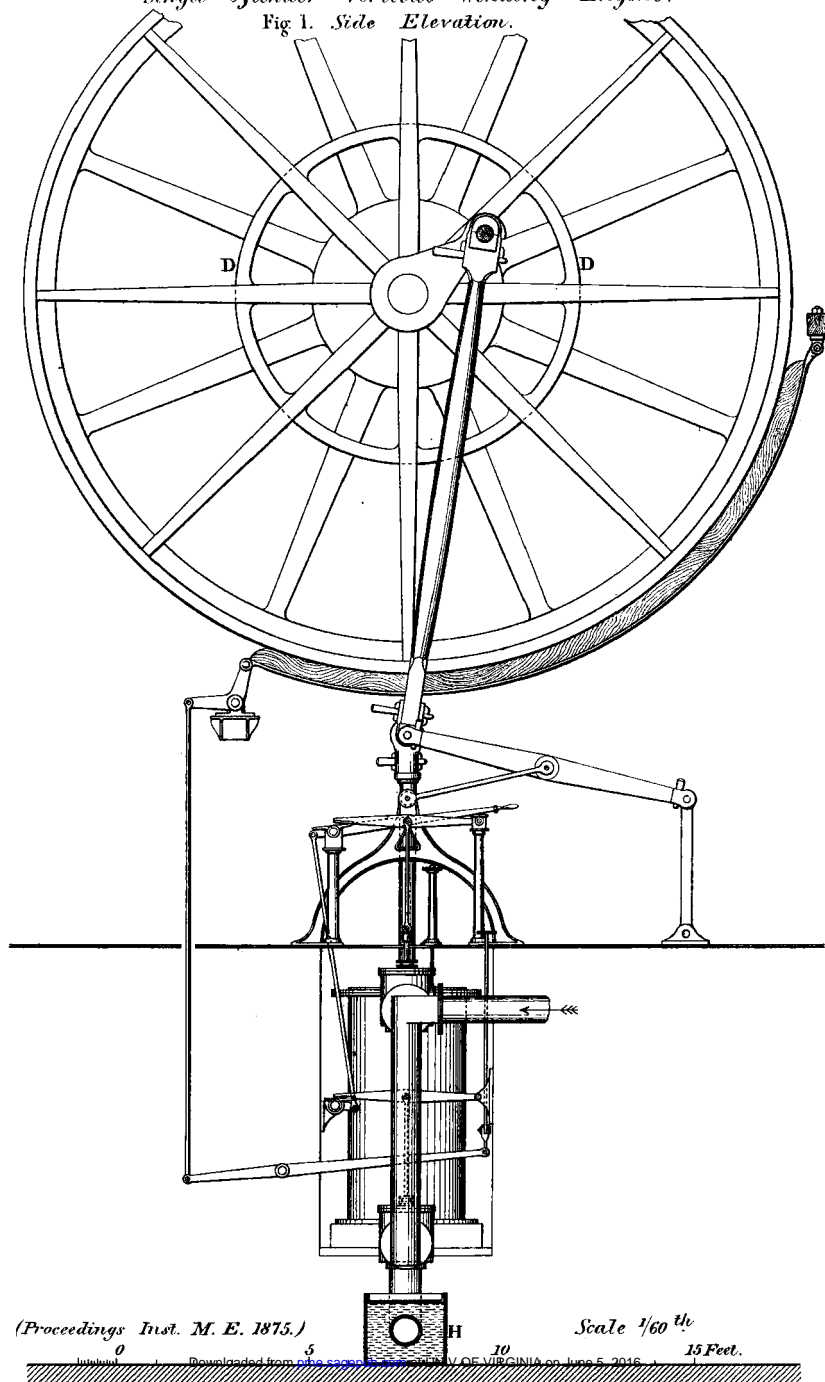
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# DIRECT-ACTING WINDING ENGINES.

Plate 28.

*Single - Cylinder Vertical Winding Engine.*

Fig 1. *Side Elevation.*



(Proceedings Inst. M. E. 1875.)

Scale  $\frac{1}{60}^{th}$

15 Feet.

0

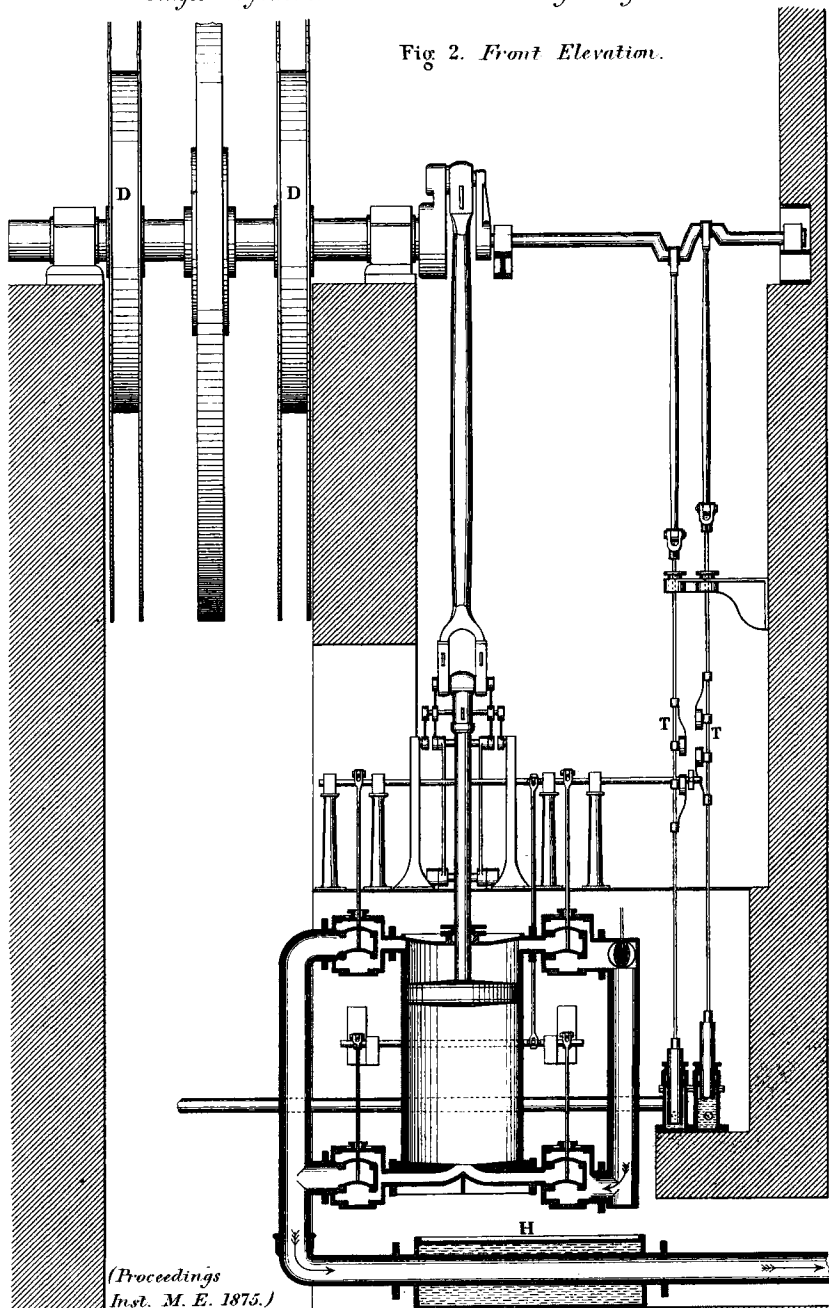
5

10

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*Single - Cylinder Vertical Winding Engine.*

Fig 2. *Front Elevation.*



(Proceedings  
Inst. M. E. 1875.)

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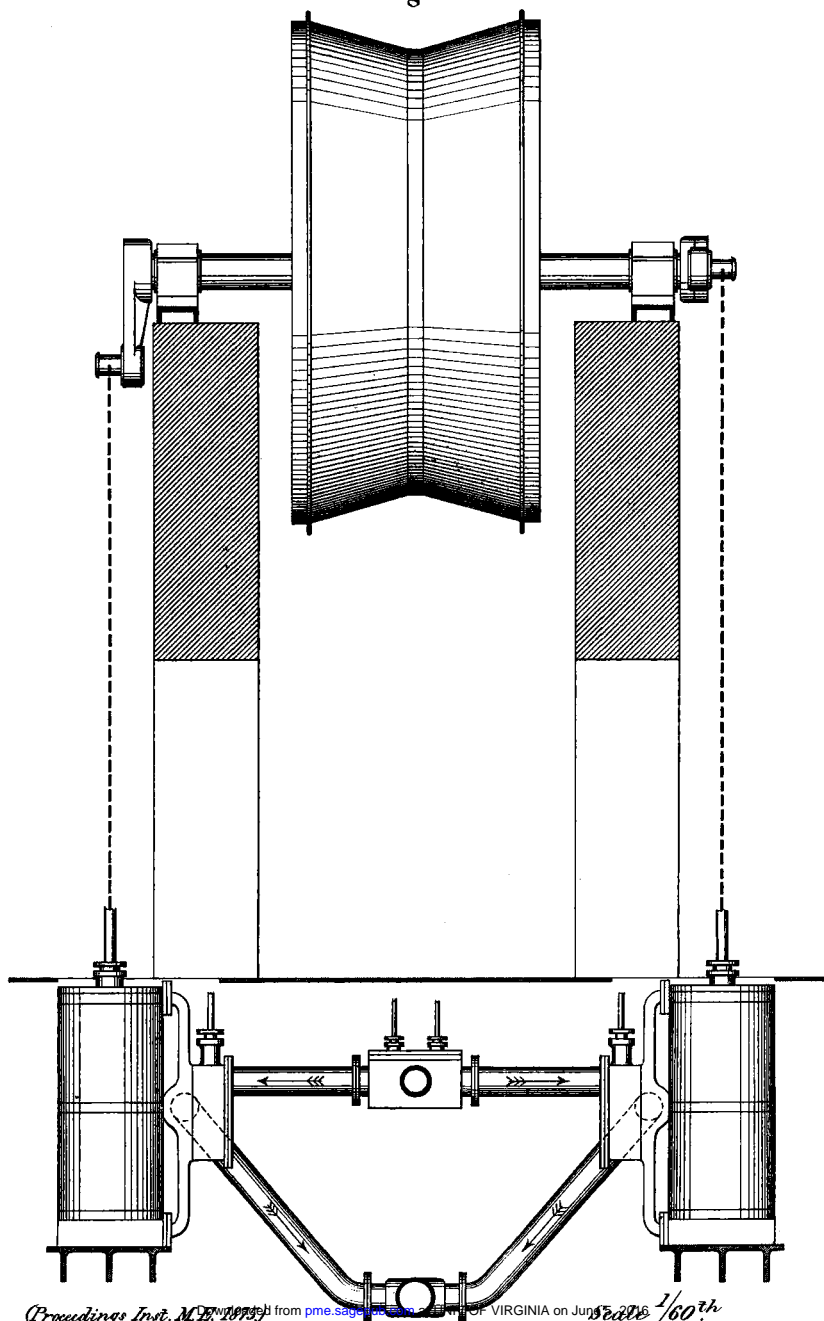
Scale  $\frac{1}{60}^{\text{th}}$

0 5 10 Feet 15



DIRECT-ACTING WINDING ENGINES. *Plate 30.*  
*Coupled Pair of Vertical Winding Engines.*

Fig. 3.

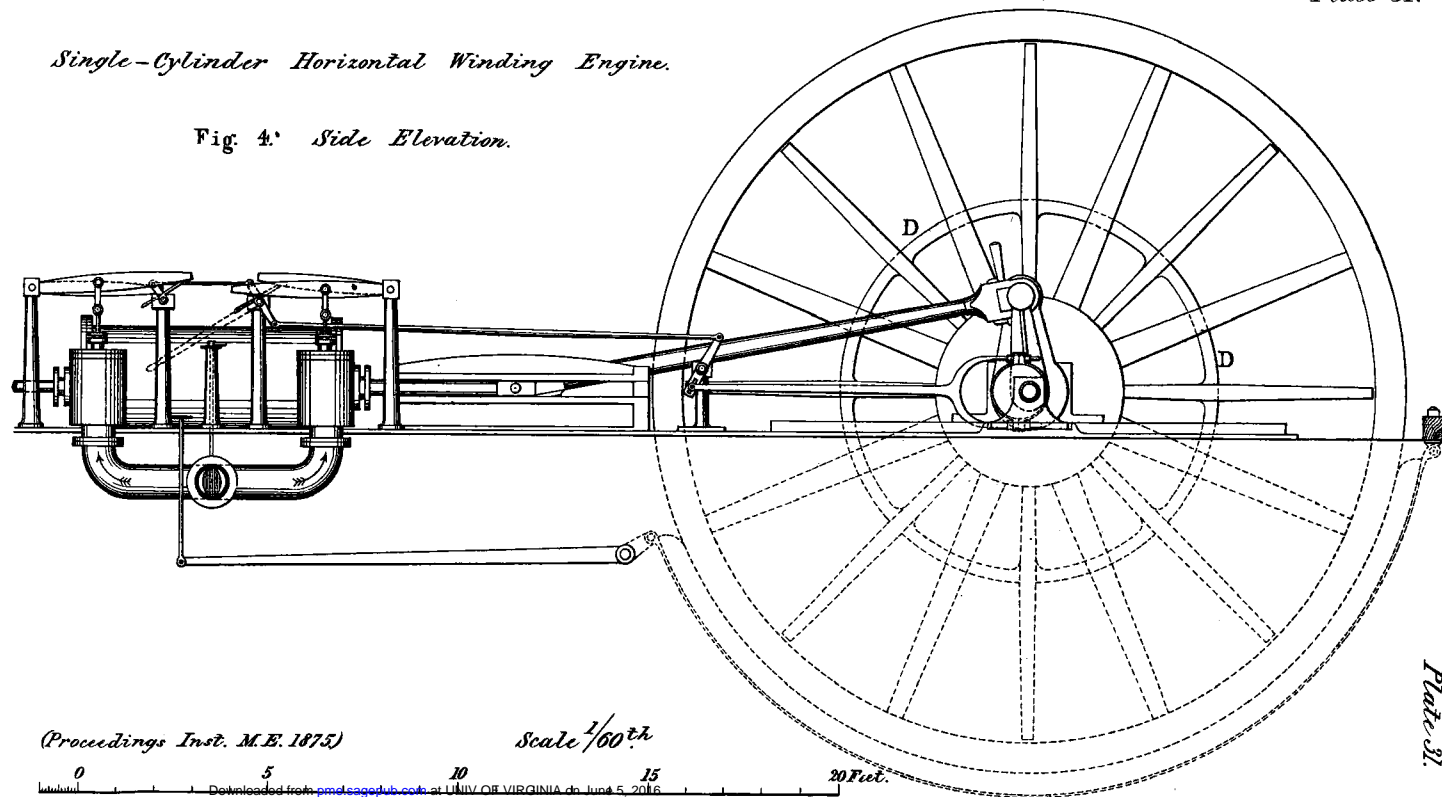


# DIRECT-ACTING WINDING ENGINES.

Plate 31.

*Single-Cylinder Horizontal Winding Engine.*

Fig. 4. *Side Elevation.*



(Proceedings Inst. M.E. 1875)

Scale  $\frac{1}{60}$  in.

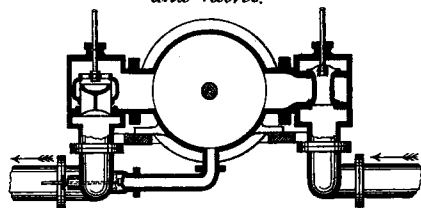
0 5 10 15 20 Feet.

Plate 31.

# DIRECT-ACTING WINDING ENGINES.

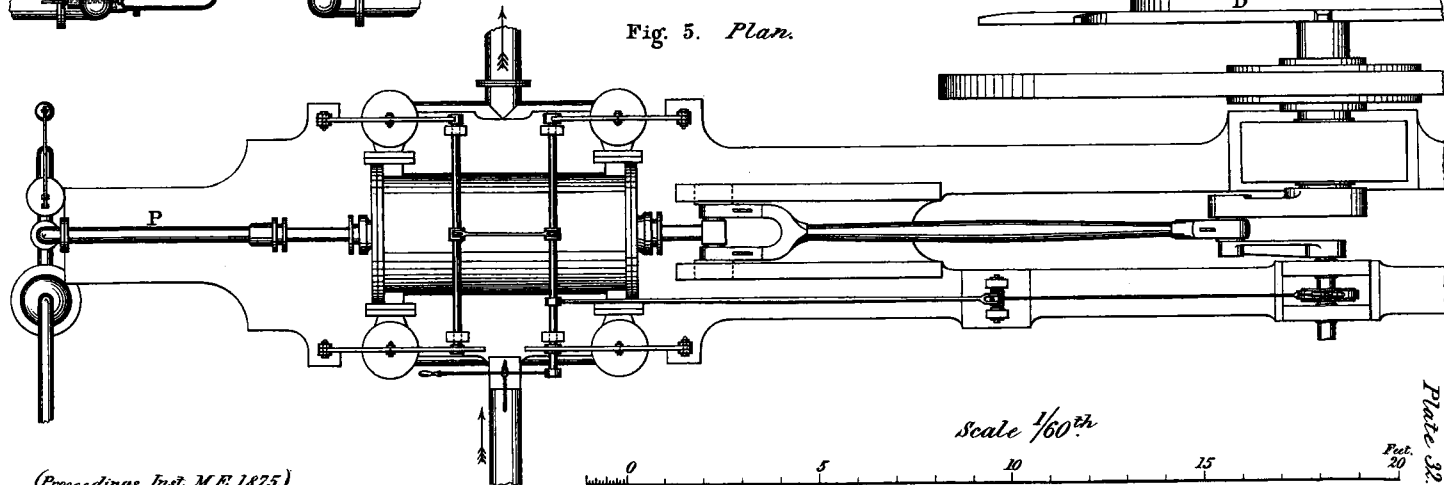
Plate 32

Fig. 6. *Transverse Section  
of Cylinder  
and Valves.*



*Single - Cylinder Horizontal Winding Engine.*

Fig. 5. *Plan.*



(Proceedings Inst. M.E. 1875.)

Plate 32.

# DIRECT - ACTING WINDING ENGINES.

Plate 33.

*Coupled Pair of Horizontal Winding Engines with internal conical drum.*

Fig 7. Plan.

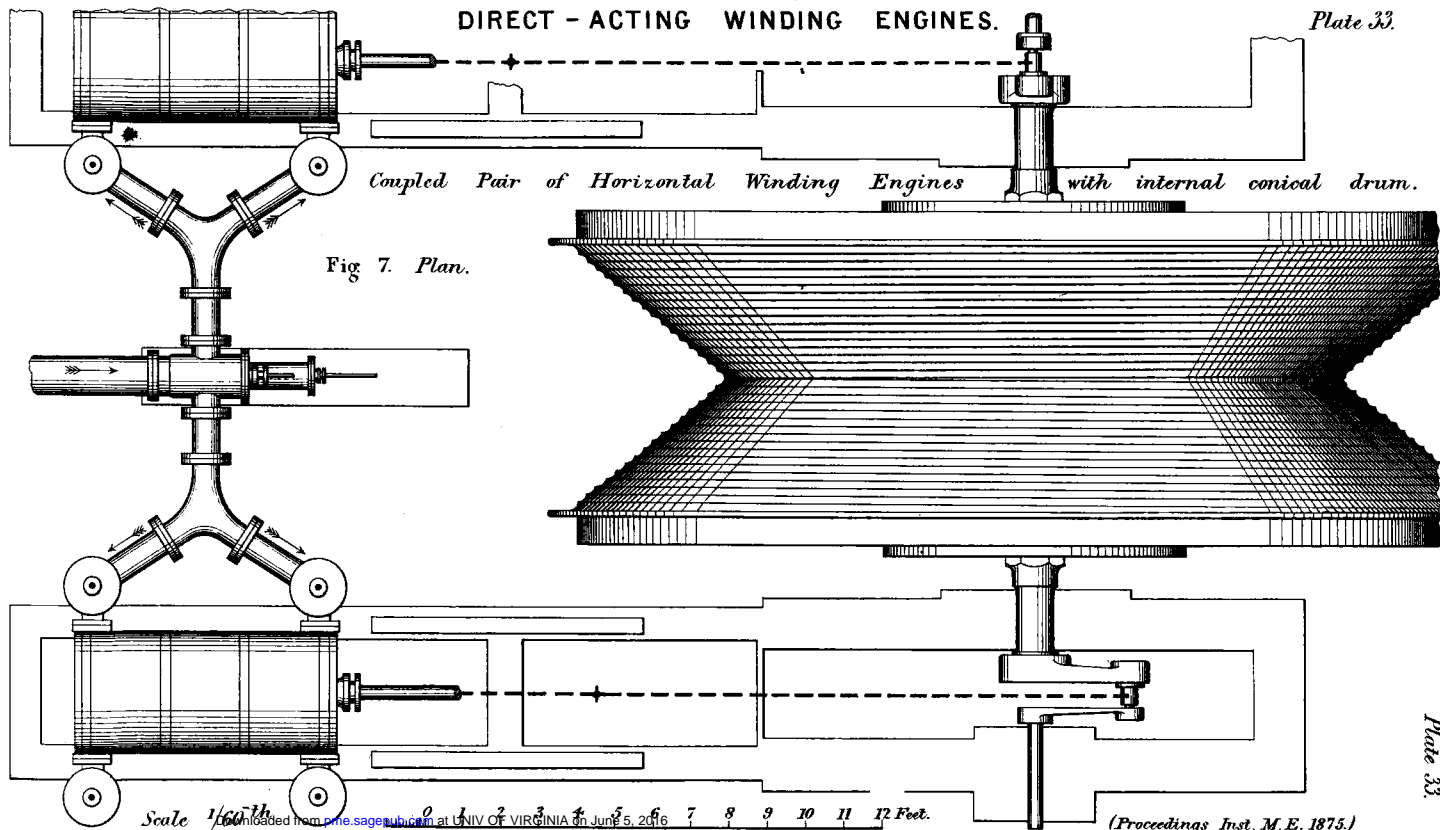


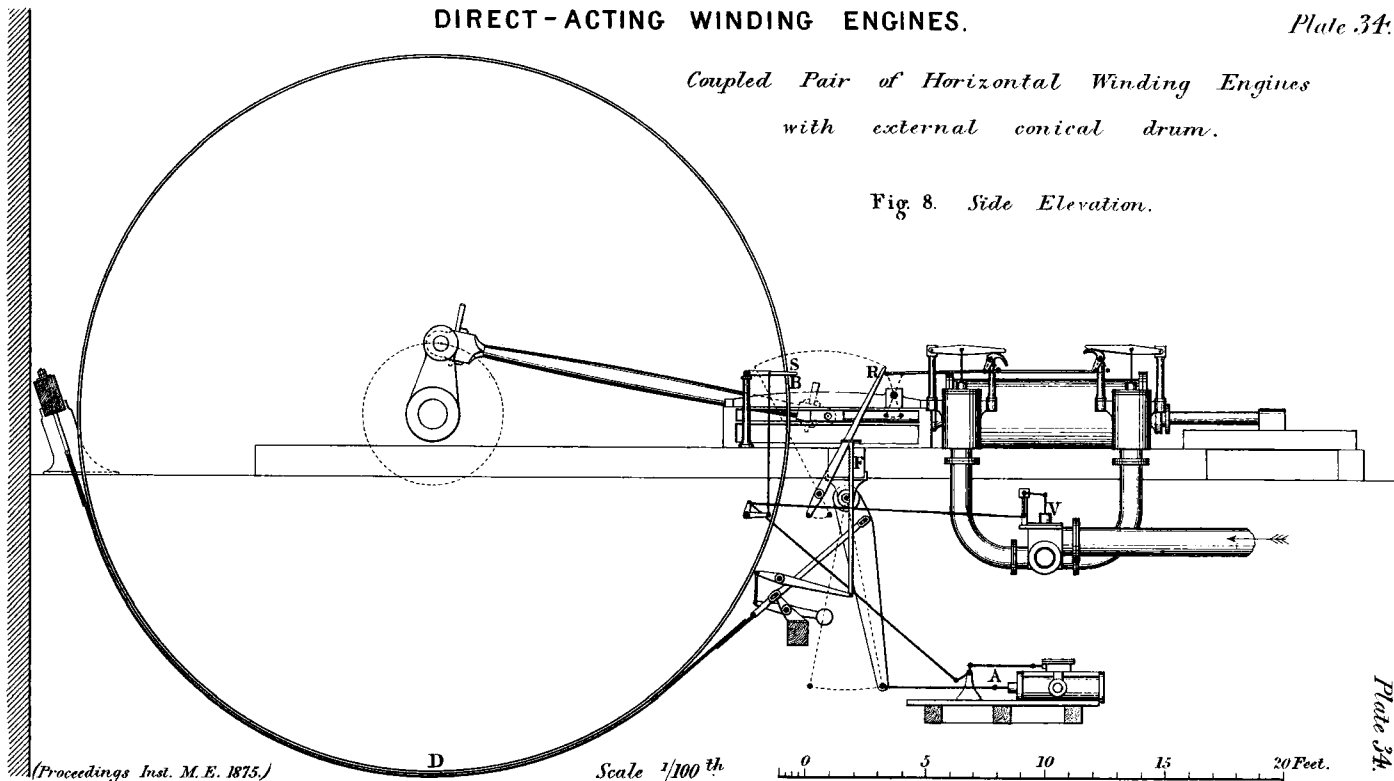
Plate 33.

# DIRECT-ACTING WINDING ENGINES.

Plate 34.

*Coupled Pair of Horizontal Winding Engines  
with external conical drum.*

Fig. 8. Side Elevation.



(Proceedings Inst. M. E. 1875.)

Scale 1/100 th.

0 5 10 15 20 Feet.

# DIRECT-ACTING WINDING ENGINES.

Plate 35.

*Coupled Pair of  
Horizontal Winding Engines  
with external conical drum.*

Fig. 9. Plan.

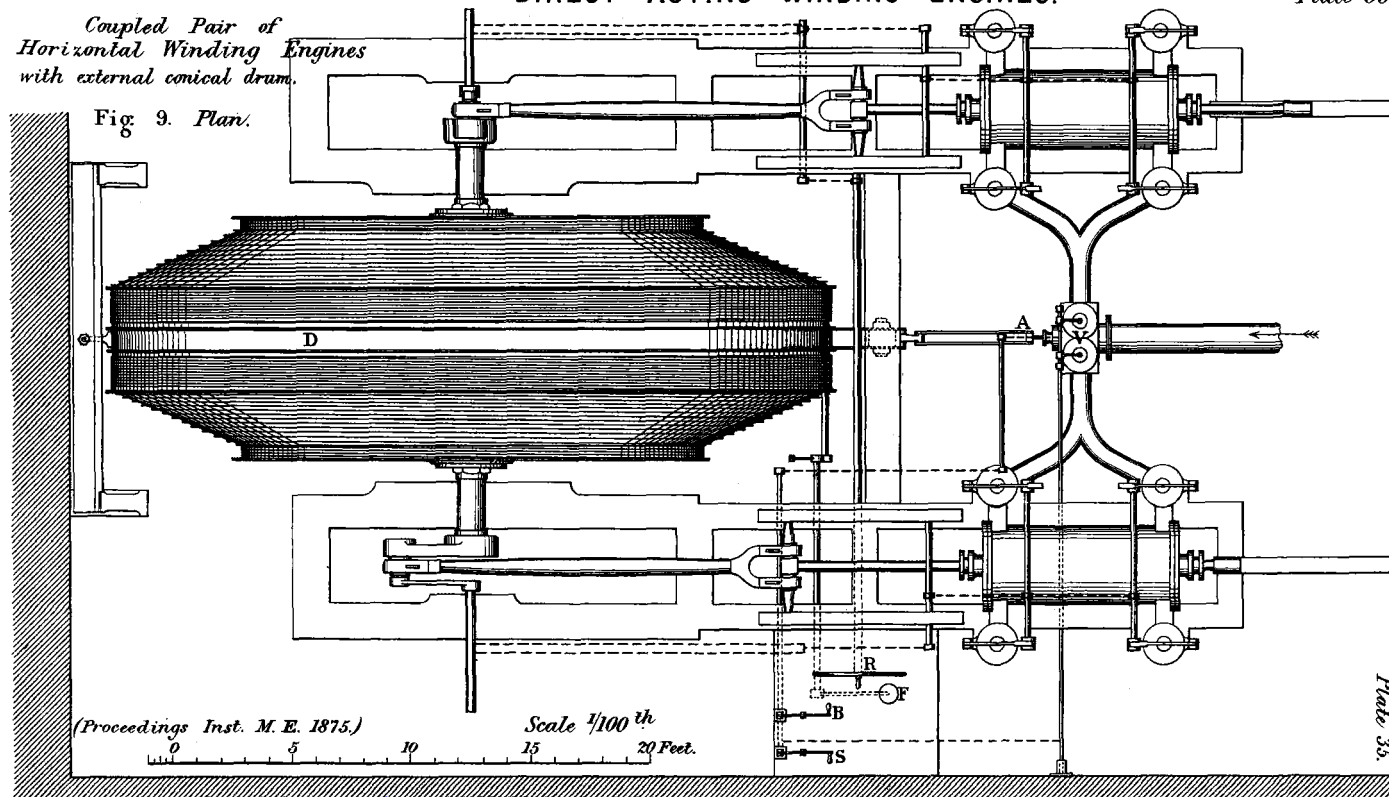
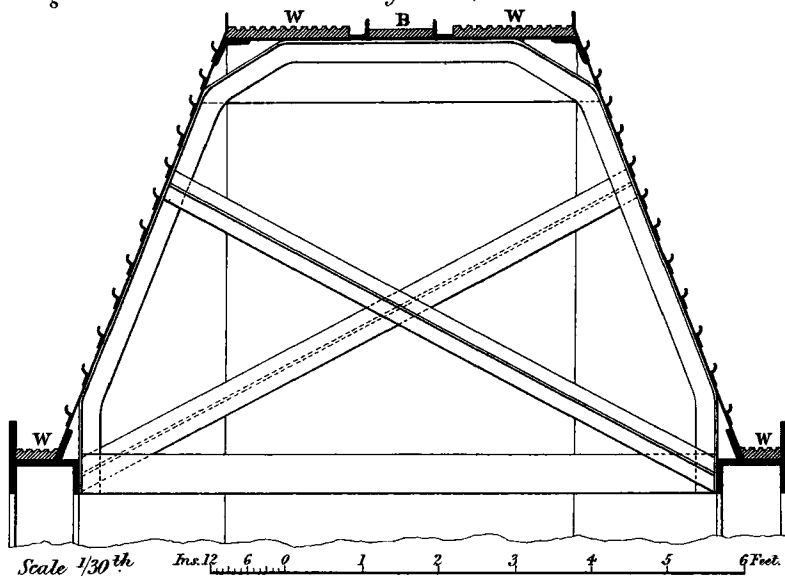


Plate 35.

Fig. 10. *Section of Conical Winding Drum, diameters 19 ft. and 30½ ft.*



*Diagrams of Conical Winding Drums.*

Fig. 11.  
Diameters  
13 ft. and 20 ft.

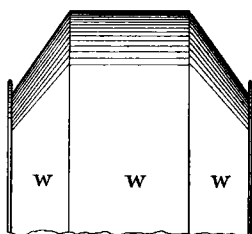


Fig. 12.  
Diameters  
19 ft. and 30 ft.

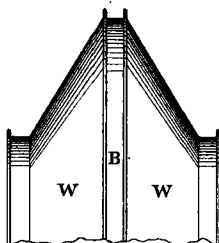
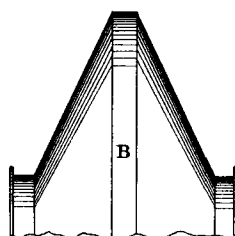


Fig. 13.  
Diameters  
17½ ft. and 31½ ft.



W wood lagging grooved for ropes.

B break surface.

Fig. 14.  
Diameters  
16 ft. and 27 ft.

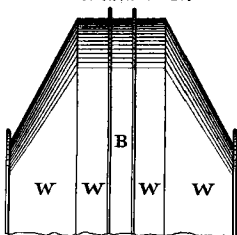


Fig. 15.  
Diameters  
20½ ft. and 30 ft.

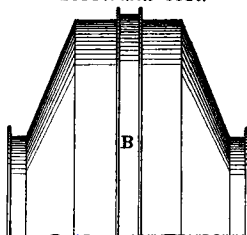
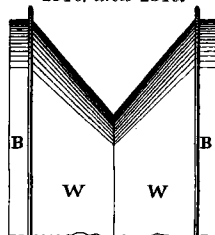
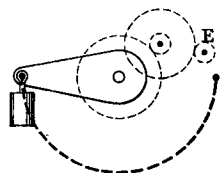


Fig. 16.  
Diameters  
18 ft. and 25 ft.



*Other modes of Counterbalancing.*

Fig. 17.



*Lever or Crank Counterbalance.*

Fig. 18. *Pendulum Counterbalance.*

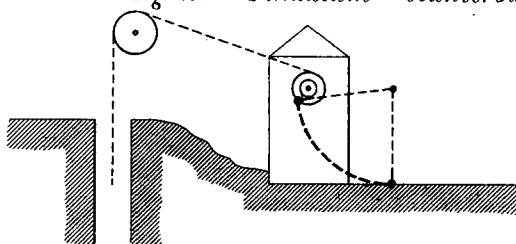


Fig. 19. *Inclined - Plane Counterbalance.*

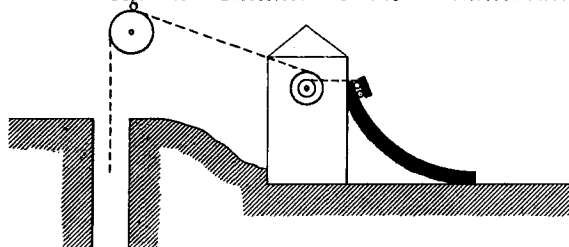


Fig. 20. *Chain Counterbalance.*

