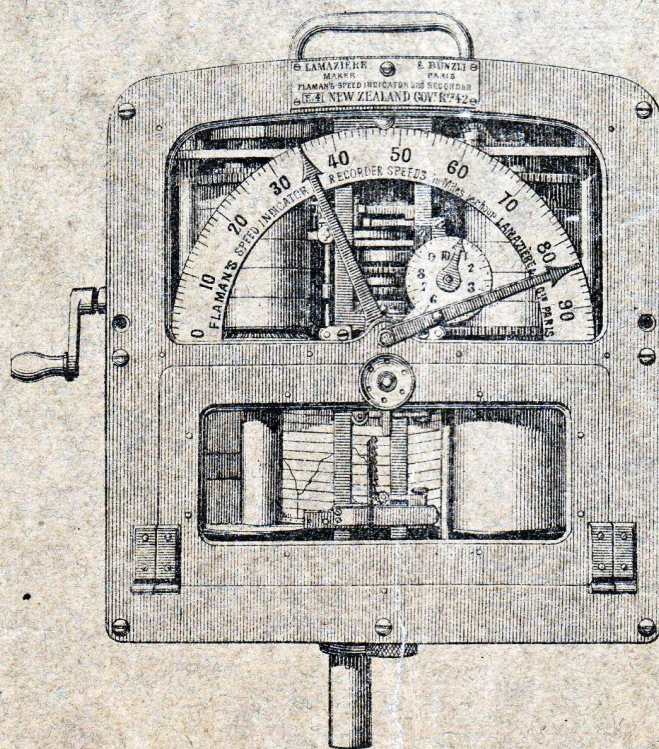


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SPEED INDICATOR AND RECORDER FOR LOCOMOTIVES

(FLAMAN'S Patent)

Description and explanations
of diagrams



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Introduction.

Until recently, speed recorders have been considered a luxury and used occasionally only to obtain data for special or technical purposes, but with increasing demand for economy in operation and safety in handling traffic, it is being recognized that an indisputable record of the movement of a locomotive or train is becoming a necessity.

It has long been known that ignorance or neglect on the part of the enginemen is responsible for damage to equipment which adds to cost of maintenance and must be accepted as unavoidable until some check is used. That foreign roads, where most attention is paid to details, and records of cost are at a minimum, insist on speed recorders as part of the regular equipment, is evidence of their value. Carelessness at crossovers, on grades or other points where speed limits should be observed, if not dangerous, will cause damage to both equipment and track; and on lines with dense traffic, on the observance of speed limitations depends the safety of passengers. In many countries, where traffic is most dense, the Boards of Trade and similar organizations have decided that recording speed indicators are indispensable for the safety of railway passengers; and have, in consequence, ordered railway companies to equip every passenger engine with such instruments.

Object.

The Flaman Speed Indicator and Recorder was designed to :

1. Measure the successive speeds of locomotives in periods of time of sufficiently short intervals to enable these indications to give as exactly as possible the law of the movement.
2. Indicate by means of a pointer upon a dial the successive running speeds in miles per hour.
3. Record upon a paper band which unrolls at a rate proportionate to the distance travelled, the speeds, the distances, the time of running, and time of the stops.

Description.

Speed being by definition, the distance travelled in a unit of time, an apparatus serving to measure, indicate, and record the speed usually necessitates the introduction of clockwork to limit the time periods and also to register the time of running and of stopping; therefore the Flaman Recorder is the combination of a clock movement with a revolving shaft, turned by the movement of the locomotive, to the rotating parts of which, it is directly connected through a suitable transmission. The clock mechanism times the revolution of the shaft thus measuring the speed of the locomotive.

Measure
of the speed.

Speed measuring of a locomotive presents certain difficulties on account of the wide range of speed and the incessant variations in the rates of velocity; therefore, in this apparatus in which the time and speed mechanisms are interconnected, the successive intervals of speed measuring has been selected as 4.8 seconds so that the measure takes place 12.5 times per minute or 750 times per hour.

The continuous movement of rotation of shaft A (plate 1.KL) revolving in a given proportion to the locomotive wheels, is transformed into the alternating rotary movement of a ratchet wheel E (mounted loose on a vertical axis and constantly under the recoil action of a spring) through the four sided cam C, lever and pawl D. The clock mechanism drives a vertical shaft B at a uniform rotational speed equal to 4.8 seconds per revolution, and through levers I, P and G, trip lever and pawl D, allowing ratchet wheel E to return to its normal position at each revolution of shaft B - or 4.8 seconds, to begin again its rotation. The arc through which ratchet wheel E travels during this time period of 4.8 seconds thus measures the speed of the locomotive and this result is transferred to the pointer which indicates on a dial the speed in miles per hour, and also to a cross head carrying a style which inscribes a diagram giving a permanent record of the acceleration, speed, and stops.

Record
of the speed.

Registration of the speed is made upon a band of paper unrolled proportionately to the distance travelled, by means of a style carried by a cross head which transforms into perpendicular lineal displacements or ordinates, the angular displacements of the pointer. The length of these ordinates is proportional to the speed.

Indication
and Record of time.

The clock mechanism, which should be wound by hand before starting, is kept wound by the rotation of driving shaft A and will run for about an hour after the locomotive stops. On the face of the instrument is a small round dial graduated into minute spaces with a minute hand indicating the lapse of time. Through proper gearing, a time style is actuated. When the engine is standing the style traces a vertical line whose height represents a minute for every $1/16"$ of rise. When the engine is running and the paper moving horizontally beneath the rising style, the vertical line is transformed into an oblique line more or less inclined as the speed is greater or less.

References.

- A Main driving spindle of recorder.
- B Clock shaft.
- C Driving cam for pawl.
- D Driving pawl of ratchet wheel measuring speeds.
- E Ratchet wheel measuring speeds.
- F Stud on wheel E.
- G Stop-pawl of ratchet E.
- H Cam to ungear the pawl D of the ratchet E at end of periods of speed measure.
- I Lever actuated by cam H to ungear the pawl D.
- J Indicator hand of recorder.
- K Ratchet wheel transmitting to hand J the angular displacement of ratchet E.
- L Stud on lower face of ratchet K serving to determine its angular position against the stud F of wheel E.
- M Stop-pawl of ratchet wheel K.
- N Cam actuating stop pawl M of ratchet K.
- O Cam actuating stop pawl G of ratchet E.
- P Lever for gearing the pawl D with the wheel E at commencement of each period of time.
- Q Cam actuating lever P.
- R Toothed sector solid with hand J.
- S Rack transforming circular movement of speed hand into a vertical motion of which the ordinates are proportional to speeds.
- T Speed recording style.
- U Spiral cam actuated by clock work.
- V Time-recording style actuated by cam U.
- X Paper band for receiving speeds, times, distances and stop durations.
- Y Driving barrel for paper band, the needle points of which perforate the paper at intervals corresponding to 1 mile.
- Z Fixed stop determining position of ratchet wheel at rest against stud F.
- W Hand-key for winding up clock.
- W' Automatic clock winder operated by the movement of the locomotive.

Recording apparatus.

The recording apparatus consists of two inscribing styles, T and V (plate I.EF) placed in the front of the case and between the magazine spool X' and receiving spool X'', to the right and left respectively, the paper being moved from one to the other by the driving cylinder Y immediately behind the styles.

Adjusting screws allow the positions of the two styles T and V to be set to the zero line corresponding with a state of rest in both.

A spring is set to operate against the pivoting holder with a force sufficient to cause the style to make a visible black line. The styles are made of brass wire and are held by tightening screws at the extremity of style carriers.

Two spring pawls placed in front of the holders turn the styles one quarter revolution during each ascension, the effect of which is to render the diagrams clearer by continually renewing the point of the style in contact with the paper.

Safety Latch :

To avoid accidents to the apparatus in case of the speed to be measured exceeding the maximum for which it is designed, the ratchet wheel E is fitted with a stud, constituting a safety latch, which, at such moments raise the pawl D and prevents the apparatus from working. The same device also prevents accidents in case of the stoppage of the clock by the non-working of the lifting pieces of pawl D during the running of driving shaft A.

Paper winding :

The driving barrel Y placed in the front centre of the indicator feeds the paper and its

surface serves as a table for the marking styles T and V.

Both upper and lower edges of the barrel are studded with projecting points which perforate the paper and draw it along from right to left. The points are so spaced as to represent the travel of one mile so that the perforations on the upper and lower edges of the paper correspond to the distance of one mile on the rail. An extra point indicates a complete revolution of the barrel Y, corresponding to a distance of 12 miles.

The barrel Y is driven by pinions placed under the small bed plate in the lower part of the indicator deriving their motion from driving shaft A plate I.O.P and may be turned by hand by means of the knob Y', projecting beneath the case of the indicator, but to do so, it is necessary to open the door and draw out lever (plate I.Q.R) to disconnect the gearing.

Diagram paper:

The paper employed for recording the diagrams is metallized on one side, so that the recording styles, made of brass and wire, leave a black line. Each band has a length of about 110 feet rolled on a cardboard tube and is sufficient to record diagrams of a total length of 4300 miles travelled by the locomotive.

Types of recorder:

The instruments differ only by the maximum speed and by the length of the period of time, which they can indicate and record, and are:

E-1 94 miles per hour and 10 minutes 250 revolutions shaft A per mile.

E-3	94 miles per hour and 30 minutes	250 revolutions
E-4	47 miles per hour and 10 minutes	500 revolutions
E-6	31- $\frac{1}{3}$ " per hour and 30 minutes	750 revolutions
E-7	120 " per hour and 10 minutes	250 revolutions
2-8	A special type similar to E-1 is provided with a device which records the danger and clear positions of signals when being passed by the locomotive.	

Application to locomotives.

The Flaman recorder can be applied to any type of locomotive without any modification and only requires that the transmission gearing from which the recorder is driven shall be arranged to make one turn of driving shaft A for each revolution of a driving wheel 180-21. 6/32 inches in diameter, or for 4/1000 of a mile or 21' - 14/32" travelled or 250 revolutions of shaft A per mile (except type E-4, making twice or 500 revolutions and E-6 making three times or 750 revolutions per mile).

After selecting the location for the recorder in the cab, suitable brackets should be bolted in place to support it, also straps provided at the back to which it may be bolted. A pad of leather should be inserted between the bottom of the case and the bracket on which it is to be supported and no part of the weight of the instrument should bear upon the shaft or bolts through the lugs securing it to the side of the cab. The holes in the straps should therefore be ovalled out vertically and a pad of felt placed between the case and the straps before the lug bolts are tightened.

Connection from the recorder to the

transmission gear is made by a sleeve projecting through the bottom of the casing and into which the forked end of the driving shaft is inserted with a slight play, so that no part of the recorder need be disturbed in connecting up the transmission (plate II).

The movement is usually transmitted to driving shaft A by attaching an arm to the crank or side rod, carrying a stud and actuating a crank which transmits the rotating movement to the vertical shaft through bevel gears contained in the gear boxes. (Plate II).

Should it become necessary to transmit the movement through a horizontal distance a second gear containing its set of gears must be used. Care should be taken to see that these boxes are properly secured and braced. (Plate II). It is customary to provide for flexibility by the use of universal joints in the several shafts connected direct to the gears.

It is important to provide for contraction and expansion or any variation between centers of gear cases by sleeves or slip joints in the shafts, and also to provide suitable bearings for shafts, both horizontal and vertical, see plate II.

It should be noted that the driving shaft A may rotate in either direction, the working of the indicator remaining the same whether the shaft turns one way or the other.

Should it be found desirable to stop or start the recorder while the locomotive is running, a disengaging gear may be placed in the vertical shaft at any convenient point as shown in Plate

The pinions contained in the gear cases must be designed with a ratio suitable to the diameter of the wheel whose motion is to be transmitted to the recorder and can be found by the following formula,

$$\frac{D}{80 - \frac{21.6}{32}} = \frac{N}{N'}$$

D = diameter of engine wheel from which the motion is derived

N = number of teeth of the driving pinion

N' = number of teeth of the driven pinion

From the preceding, it is apparent that it is rarely possible to plan pinions of the ratio required to indicate absolutely the speed of the locomotive, and even if this were done, the wear of the tires would modify the result after a certain period of service. All methods of deriving the measure of the speed from the wheel of the vehicle are subject to the same difficulty.

Whenever necessary to obtain a closer approximation between the circumferential speed of the engine wheel and that indicated by the instrument, different pinions modifying the result may be substituted in the gear cases. See tables.

Corrections to be made in the reading of the indicated and recorded speed.

The diameter of tires varies with their wear and in all systems of speed indicating apparatus basing the speed upon the number of wheel revolutions within a given time, it becomes necessary to allow for the differences of diameter arising from the wear. Speed in miles per hour is expressed by

$$V = \frac{\pi D n \times 3600}{63360}$$

D diameter of wheels driving apparatus in inches
 n revolutions per second

The speed corresponding to a given number of revolutions will be as the ratios of the diameters and if this diameter be 84 inches, and may be reduced by wear to 81 inches then the speeds corresponding to these two diameters will have a ratio of

$$R = \frac{D}{D'}$$

that is to say, in taking as unit the speeds corresponding to the original diameter of drivers, the differences to be allowed for in wheels having the two limit diameters mentioned will be shown in the following table:

New tires 84"

Worn tires 81"

$$R = \frac{81}{84} = 0.96427$$

Dia. of wheels										
84"	10	20	30	40	50	60	70	80	90	100
81"	9.642	9.285	28.928	38.570	48.213	57.856	67.498	77.141	86.784	96.427
Dif.	0.358	0.715	1.072	1.430	1.787	2.144	2.502	2.859	3.216	3.573
84"	110	120								
81"	106.069	115.712								
Dif.	3.931	4.288								

It will be observed then that for a difference of 3" in the diameter of the driving wheels, the difference of the speeds for a given number of revolutions will be 3.57 per cent; ranging from 0.35 at 10 miles to 4.28 at 120 miles.

Therefore, to arrive at the exact value of the speed, the speed indicated or recorded must be multiplied by the ratio between the actual diameter

of the wheel and the original diameter upon which were established the speeds indicated by the instrument.

In order to reduce the amount of the corrections, two sets of pinions should be provided for each type of locomotive, one set for new tires to be used until the tires are worn to one half the diameter of the maximum wear diameter, and another set to be used from the medium wear diameter to the completely worn out diameter of the tires.

By this arrangement, the error in the speed indication of the apparatus is reduced to a quarter, of that which it would be were transmission designed only for the two extreme diameters of the tire as when new and completely worn down to the limit.

For example, for 34" tires the error will not be more than $\frac{3.57}{4} = 0.89$ per cent or at 100 miles per hour, .89 miles or 156 yards instead of 3.573 miles; moreover, this error of .89 miles is a maximum since the maximum wear of tires has been supposed; the average will therefore be only 78 yards which for all ordinary running conditions may be neglected.

However, if it is desired to know the exact value of the speed indicated or recorded, this can be done by measuring the tread of the tire of the individual engine so as to establish a ratio between this diameter and that of D' for which the indications of the apparatus are exact.

The diameter D' being known as also the actual or momentary diameter D , the ratio of $D/D' = R$ is obtained, and multiplied by the value of the recorded speed, as well as by the recorded distance, to arrive at the actual speed and exact distance.

For the correction of distances, the exact distance between any two points on the speed diagram may be found in comparing the length sought with the length shown on the diagram between two given points whose mileage is well known, as for instance, between two stations.

Apply and Remove
Diagram paper.

Barrel X' or magazine bobbin is set in the right hand side of the case and barrel X" or receiving bobbin is set in the left hand side of the case. To remove magazine bobbin X', press latch spring y' to release y, throw lever y to the right by grasping shaft y", which connects their ends, which will free bobbin X' so that it can be withdrawn. Reverse this operation to replace bobbin.

One flange of magazine bobbin X' can be unscrewed to insert the roll of paper. This roll is wound on a cardboard tube, in the inside of which there is a groove fitting over a tongue on the stem of the bobbin; insuring the turning of the bobbin, along with the roll of paper.

After inserting the loaded bobbin and levers y have been caught in to place by spring catch y'; throw back the two style carriers and draw one end of the paper over and in front of the feeding cylinder Y, being sure that the edges are under the two pressure feet V'V". Then turn knob Y', unrolling enough of the band of paper to be rolled around the core of receiving bobbin X", and fasten it there to by means of the "U" spring, provided for this purpose. The record surface should roll to the inside. A spring acting on the upper flange of the bobbin, and two

springs pressing against the paper roll, prevent the paper unrolling through vibration of engine while running. Plate I. MN. To remove diagram, roll off a portion of the band, by turning knob Y' cut the paper and pull the wicket Z back to the left after releasing its spring catch, to free the bobbin; then draw lever W' out, pressing the inner end against lower flange of bobbin and turn the bobbin by hand until table W" is arrested by stop w when it will be in exact position for removal. Reverse the operation to replace. Receiving bobbin X" has one loose flange at the upper end for allowing removal of the roll of recorded paper.

Reading diagrams.

Plate III is the reproduction of a diagram of train running from a starting point A to terminal B with intermediate stops at C, D, E, F, G, and H and on this diagram have been inserted explanations tending to show how various particulars may be deduced.

First:

1 - The speed diagram represented on the lower part of the band scales $5/16"$ per mile longitudinally, and $7/32"$ per 10 miles vertically for the type E-1 recorders.

2 - Punctured points at intervals of $5/16"$ on both the upper and lower edges of the band correspond to successive miles while intermediate points occurring at intervals of $60/16$ correspond to intervals of 12 miles.

3 - The time diagram represented on the upper part of the band scales $1/16"$ per minute and is in division of 10 minutes to the top line.

Second:

1 - Speed lines all originate and terminate

on the zero or bottom line of the speed diagram, and these correspond with the perpendiculars $a-a_1$, cc_1 , $d-d_1$, $e_2-e_3-e-e_1$ etc..., on the time diagram and are automatically traced during stops and of a variable height according to the period of time elapsed during these stops.

b. Slacks are represented by a falling speed line describing a curve approaching to the zero line as at J & K; and simultaneously the time line, instead of being straight, is curved and tends to rise perpendicularly.

c. Slipping of driving wheels is indicated by sudden peaks or vertical lines emerging from the speed line N, N' at the point at which the slipping occurs.

d. Shunting, runs to and from stations, stand pipes, etc..., are represented by a series of little curves of limited height representing 10 or 20 miles per hour which precede or follow or come in between the regular speed diagrams, such as at $A''A$, BB' , DD' .

Required now, to determine:

1. Speed of train at 14 miles from departure station A, and time taken to reach that point.

The point at 14 miles from A is at $X = 5/16'' \times 14 = 4 \frac{3}{8}''$ along the band, and measuring this length from A, we get the point X whose perpendicular XX' is $1 - 93/320$ inches in height which gives $V = 413/320'' = 59$ miles per hour as the speed of the train at the point considered.

To ascertain the length of time occupied in that distance we measure the vertical height $a_1-a_2 = 8/32$ inches, $X-X_1 = 7/32$ inches and to the sum of these add $20/32$ inches for the period marked by the line X and comprised between the two points a_2 and X_1 , the sum thus obtained being divided by

2 gives the time in minutes required.

$$T = \frac{8 - 7 - 20}{2} = \frac{35}{2} = 17.5 \text{ minutes}$$

2- What has been the duration of a stop?

a- The time marker not falling during stops as at P, we measure distances $p_1 - p_2 = 5/32$ inches and divide by 2,

$$t = 5/2 = 2.50 \text{ minutes or } 2'30''$$

b- The time marker falling during a stop of less than 10 minutes as at F, we measure distances $f_2 - f_1 = 1/32$ and $f - f_1 = 5/32$, add and divide by 2,

$$t = \frac{1+5}{2} = 3'$$

c- When the length of stop, exceeds 10 minutes as at O, we measure the ordinate $O - O_1 = 5/32$,

$$t = 5/2 = 2.5 \text{ or } 2'30''$$

which is the duration of the stop plus a certain number of periods of 10 minutes each to be found by reference to the train sheet. It is easy to recognize whether the marker has dropped once or there are several superimposed lines.

Shop Care of Recorders.

Packing : - The transportation of the apparatus requires certain attention. They are usually packed in cases specially arranged and into which they fit, which serve also for their transport when sent for repairs, to prevent damage in handling.

Erecting Apparatus : - Recorders are delivered ready for working without the necessity of dismounting any of their parts for erection on the engines.

Seals : - The screw-on front of the apparatus

is secured with 2 lead seals which are a guarantee that the recorder has not been meddled with before delivery. These seals should be examined and found intact. They should not be broken except for making repairs and then only by the workman intrusted with the work. Little time or trouble is involved in sealing it and it is a systematic method of insuring that the apparatus is never opened except by those responsible for its care. The only part that may be opened is the small lid or glazed door in the lower part of its front and which serves for the insertion of spools of paper, the removal of the diagrams recorded thereon, and for regulating the marking styles. This door or lid should be secured by means of a third seal and only broken when required by those charged with the duty of attending the recorders at the various depots.

Repairs to Indicators or their Transmission.

In case of non-working of the apparatus, and the cause is due to the transmission gear, the necessary repairs can be made at the roundhouse; but if the defect is in the recorder itself, it should be removed, and sent, properly packed in its case, to be repaired.

If it is sent in an ordinary packing case - a course to be avoided, care should be taken not to pack it with straw, hay, or any materials producing dust or dirt or fibre when broken up, the presence of which may lead to the expense of a thorough cleaning when such was unnecessary. In boxes made specially for packing whatever is necessary, because

the cross brace in the box suffices to keep the instrument from moving about in transit.

The paper record must be left in the defective recorder.

Supply of paper Bands,
Brass Styles, Bobbins,
and other Supplies.

Every recorder is sent out with its band of paper in place and a certain number (3) reels of paper accompany it, so providing enough paper for a distance of 12000 miles, together also with a spare spring for securing the paper to the receiving bobbin, X" and two marking styles mounted in their holders.

Besides this, it is the rule for each principal shop to keep the following spare parts in store, in order to facilitate the work of the man intrusted with the supervision of the indicators.

- 1 Winding key
- 1 Magazine bobbin X'
- 1 Receiving bobbin X"

Being dependant upon clock work the speed indicators are sensitive apparatus which to work well, must be maintained in perfect condition. To insure normal working of the instruments, observe the following rules:

Roundhouse Care
of Indicators.

The regular care of the indicators, usually by one man told off for this duty, requires:

1. Oiling of the upper part of the shaft in the indicator.
2. Removal of the paper band or part of paper band inscribed with the diagrams.
3. Filling up indicator with a new band when the old one is nearly run out, and

4. Writing in the necessary indications on the paper before the engine leaves to take a train on any new trip. Besides these indications the date should also be given bearing the name of the depot where the examination is made.

1. Shaft Oiling: - The top of the indicator shaft should be oiled every 3000 to 3500 miles. To do this, the screw plug is removed from the upper part of the box and in the hole thus uncovered six or eight drops of watchmakers oil poured and the plug screw inserted again and screwed down tight.

2. Removing the recorded diagrams: - If the bobbin X' still contains a sufficiency of paper for further trips, it is only necessary to unwind a short end of band by turning the button V', and then fixing the extremity on the core of the bobbin X" by means of one of the spring clips of U shape.

3. Inserting a band of paper: - A new band of paper must be inserted if the bobbin X' no longer contains sufficient for the next trip to be made.

If the length of wire forming the styles is insufficient for the trips to be made, the old wire should be removed by unscrewing the screw fixing the end socket of the holder, after having turned the style carrier back through an angle of 90 degrees and a new wire inserted and fixed by screwing up in the holder.

gear between the engine wheels and the recorder, and in keeping the whole outside part in clean condition and particularly in keeping the clockwork wound before starting from a terminal station or upon the road whenever a halt of more than 30 minutes has occurred.

1. Oil every day with ordinary mineral oil all the transmission gear between the wheels and the instrument. That is replenish :-

a - the oiler fitted on one of the sides of the indicator. This oiler has a needle conduit requiring a plug trimming and lubricates the main driving spindle of the apparatus.

b - the different greasers fitted to the gear cases and to the guide supports or articulations of the transmission rod.

2. Watch that the bolts securing the apparatus and the transmission do not become loose.

3. Wind up the clock work, as already described, a few minutes before leaving the engine house to take on the train, and after any stop exceeding 25 or 30 minutes while on the road, beyond which time interval the clockwork movement may run down. This rule is most important, otherwise, if neglected drivers risk the possibility of completely suppressing the record of time passed during long stops.

4. After winding up the clock, in the engine house or before any fresh start after a long stop on the road, take out the winding handle which, notwithstanding the clip formed by the brass cover over the key hole, may become shaken out and lost

during the journey. Nevertheless, it is useless to withdraw the handle in those dispositions of the recorder where it does not occasion any hindrance, it is then held in position by means of a small plate which can be moved upon a pivot and brought into the center of the winding gear where it fits into a groove provided on the central stem of the handle, and the plate being then fixed upon the box by means of a set screw the handle can not drop out.

5. During runs, follow the indications of the apparatus not only to take account of the speeds but to observe the working of the apparatus. In case of any mishap deranging the working of the apparatus, the transmission must be disconnected at the first stop.

6. Keep the recorder and its connections always in perfectly clean condition.

7. Give notice upon return to the engine house of any derangement or irregularity in the working of the apparatus and order the necessary repairs or modifications.

Table giving corresponding diameters to bevels of 14 to 20 teeth.—Diameters in $\frac{1}{32}$ ".
N - Number of teeth on bevel fixed to horizontal shaft (Driving shaft).

<i>N</i> - Number of teeth on bevel on vertical shaft, fixed as extension on Indicator shaft.	$\frac{1.000 - 8.110}{8.110} = \frac{32}{2581.6}$		14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	
	N x 2581.6		3611h2	3872h	413056	438872	464688	490504	516320	542136	567952	593768	619584	645400	671216	697032	722848	748664	774480	800296	826112	851928	877744	903560	929376	955192	981008	1006824	1032640	
14	2581	2766	2950																											14
15	2409	2581	2753	2925	3097																									15
16	2257	2420	2581	2742	2904	3065																								16
17	2126	2277	2429	2581	2733	2885	3037																							17
18	2007	2151	2294	2438	2581	2725	2868	3011																						18
19	1902	2038	2173	2362	2440	2581	2717	2853	2989																					19
20	1807	1936	2065	2194	2323	2452	2581	2710	2839	2968																				20
21	1721	1844	1966	2089	2212	2335	2458	2581	2704	2827	2950																			21
22	1642	1760	1877	1994	2112	2229	2346	2464	2581	2698	2816	2933																		22
23	1571	1683	1795	1908	2020	2132	2244	2357	2469	2581	2693	2806	2918																	23
24	1505	1614	1719	1828	1936	2043	2151	2258	2366	2474	2581	2689	2796	2904																24
25	1445	1548	1652	1755	1858	1962	2065	2168	2271	2375	2478	2581	2684	2788	2891	2994														25
26	1390	1489	1588	1687	1787	1886	1985	2085	2184	2283	2383	2482	2581	2680	2779	2879	2978													26
27	1338	1434	1529	1625	1721	1816	1912	2007	2103	2199	2294	2390	2485	2581	2677	2772	2868	2964												27
28	1290	1383	1475	1567	1659	1751	1844	1936	2028	2120	2212	2305	2397	2489	2581	2673	2766	2858	2950											28
29	1246	1334	1424	1513	1601	1691	1780	1869	1958	2047	2136	2225	2311	2403	2492	2581	2670	2759	2848	2937										29
30	1204	1290	1376	1462	1548	1635	1721	1807	1893	1979	2065	2151	2237	2320	2409	2495	2581	2667	2753	2839	2925									30
31	1165	1249	1332	1415	1498	1582	1665	1748	1832	1915	1998	2081	2165	2248	2331	2415	2498	2581	2673	2748	2831	2914	2996							31
32	1129	1210	1290	1371	1452	1532	1613	1694	1774	1855	1936	2016	2097	2178	2258	2339	2420	2500	2581	2693	2742	2823	2904	2984						32
33	1092	1173	1251	1329	1408	1486	1564	1642	1721	1796	1877	1955	2033	2111	2190	2268	2346	2423	2503	2581	2659	2738	2816	2894	2972					33
34	1063	1138	1214	1290	1366	1442	1518	1594	1641	1746	1822	1898	1974	2050	2126	2201	2277	2353	2429	2505	2581	2657	2733	2809	2885	2943				34
35	1032	1106	1180	1253	1327	1401	1475	1548	1622	1696	1741	1844	1914	1991	2065	2139	2212	2286	2331	2434	2507	2581	2655	2729	2802	2876	2950			35
36	1003	1075	1147	1219	1290	1362	1434	1505	1577	1649	1721	1792	1864	1936	2007	2079	2151	2223	2294	2366	2438	2509	2581	2653	2725	2796	2868			36
37	976	1046	1116	1186	1255	1325	1395	1465	1535	1604	1674	1744	1814	1883	1953	2023	2093	2162	2232	2302	2372	2442	2511	2581	2651	2721	2790			37
38	951	1019	1086	1154	1222	1290	1358	1426	1494	1562	1630	1698	1766	1834	1902	1970	2038	2106	2181	2241	2309	2377	2445	2513	2581	2649	2717			38
39	926	992	1059	1125	1191	1257	1323	1390	1456	1522	1588	1654	1721	1787	1857	1919	1985	2052	2118	2184	2250	2316	2383	2449	2515	2581	2647			39
40	903	968	1032	1097	1161	1226	1290	1355	1419	1484	1548	1613	1678	1742	1807	1871	1937	2000	2065	2129	2194	2278	2323	2387	2452	2517	2581			40

This technical drawing shows a detailed cross-section of a mechanical assembly, possibly a steam engine component. The drawing is oriented vertically, with the main body of the assembly on the left and a smaller, more complex component on the right. The main body is labeled with various letters (A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z) indicating different parts. The smaller component on the right is labeled with letters (A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z) and has dimensions (10 3/4, 1 1/2, 1 1/2, 3 1/2, 6, 1 1/2, 1 1/2) indicating its size. The drawing is a technical illustration, likely from a patent or engineering manual, showing the internal structure and components of the machine.

[illegible]

This technical drawing illustrates the internal mechanism of a mechanical instrument, possibly a chronometer or a watch movement. The central feature is a large, semi-circular scale with markings from 0 to 100, labeled "FLAVANTS RECHONNEUR DE TEMPS" and "LAB. RECHONNEUR DE TEMPS". The scale is divided into two main sections, each with a sub-scale. The left section has markings from 0 to 100, and the right section has markings from 0 to 100. The central mechanism includes a large gear (A) and a smaller gear (B). Other components labeled include C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z, and A'. The drawing is a detailed cross-section, showing the internal structure and the arrangement of the various parts. The overall design is complex and precise, typical of mechanical engineering drawings of the early 20th century.

Section *EF* Plate I

This diagram, labeled 'Fig. 1', shows a complex mechanical assembly in cross-section. The device is housed within a rectangular frame. At the top, a vertical shaft with a pulley is visible. The main body consists of several horizontal layers or components. Key parts are labeled with letters: H (top left), J (below H), L (below J), N (below L), P (below N), and R (bottom left). Internal components are labeled B, C, D, E, F, G, I, K, M, O, Q, S, T, U, V, W, X, and Y. A dimension of '5 1/2" 18' is indicated in the lower central part. The bottom of the device features a large, complex base labeled Y'.

Automatic winding up of clock work

Arrangement of bobbins for paper rolls

Hand feeding of paper rolls

Ratchet and pawl for measuring speed

Section *MN*Section **QR**

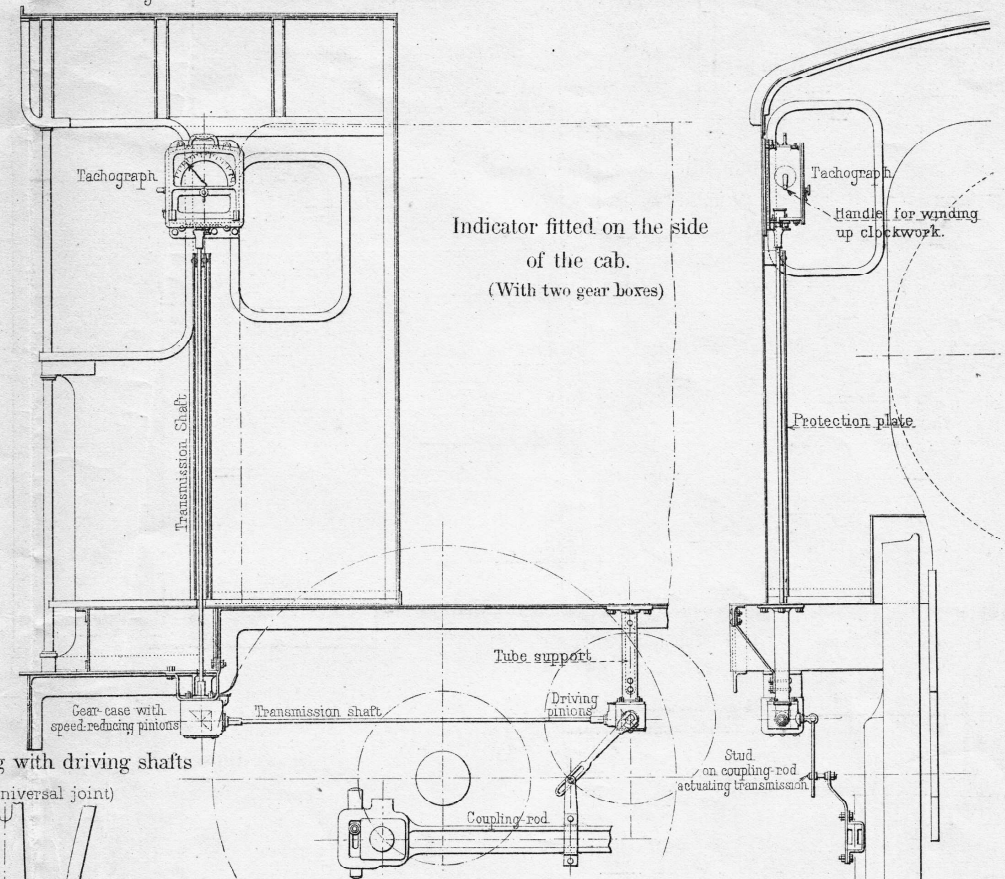
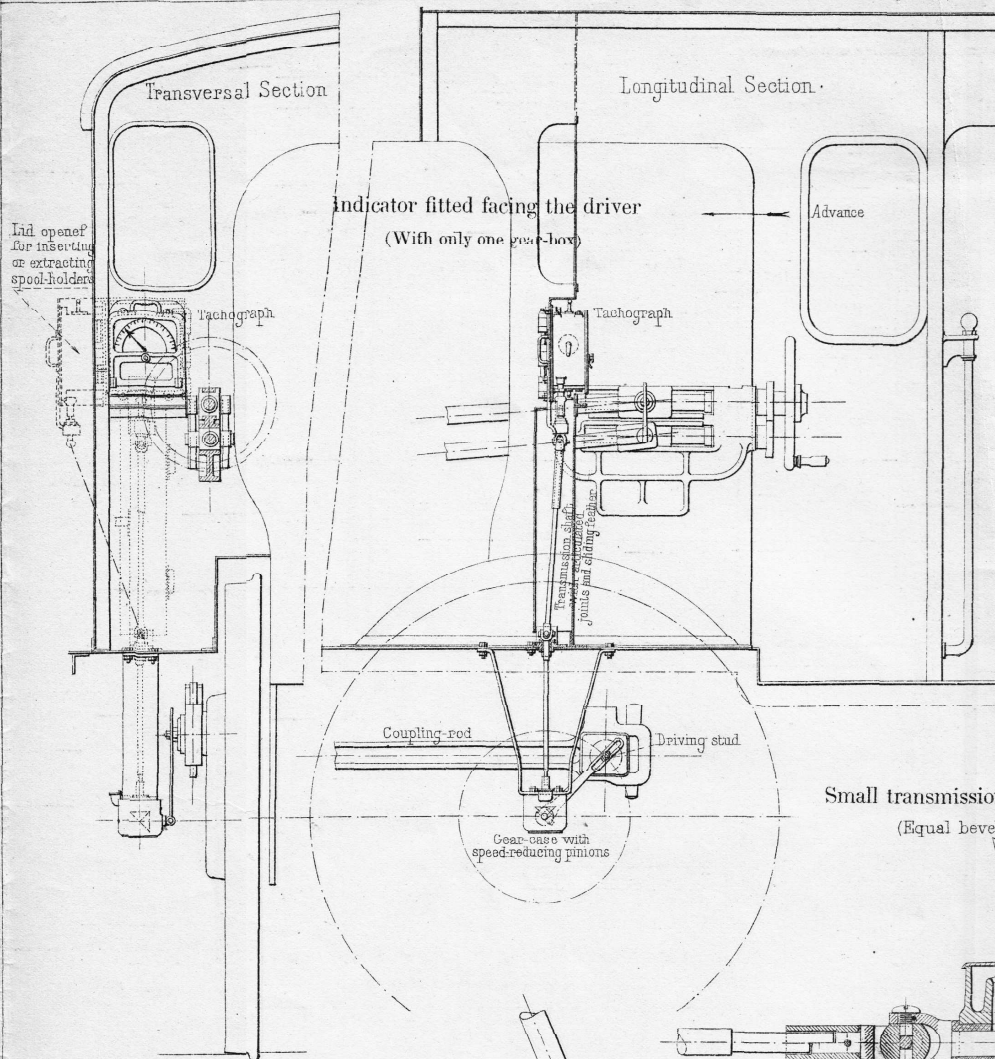
A detailed technical drawing of a mechanical device, likely a steam engine or pump, shown in a plan view. The device is housed within a rectangular frame. Two large circular components, labeled A and B, are positioned on the left and right sides, respectively. A central assembly, labeled C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z, is located in the center. The drawing includes various mechanical parts, such as pistons, valves, and connecting rods, and is annotated with letters and numbers to identify specific components. A small detail view of a valve or piston is shown at the bottom center, labeled C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z.

Drive for paper bobbins

Section *OP*

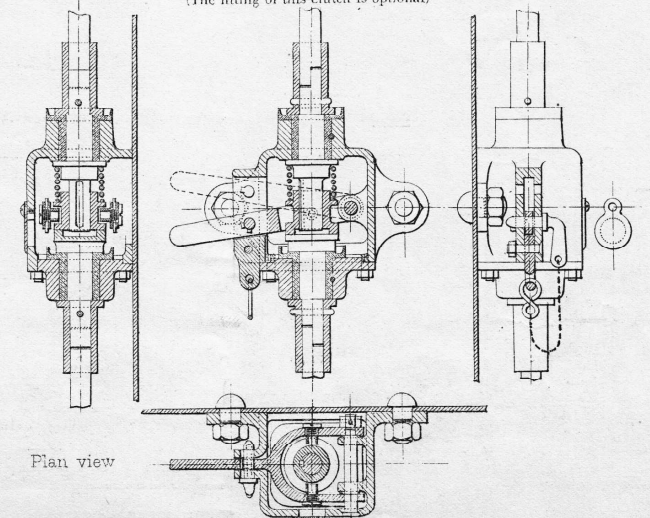
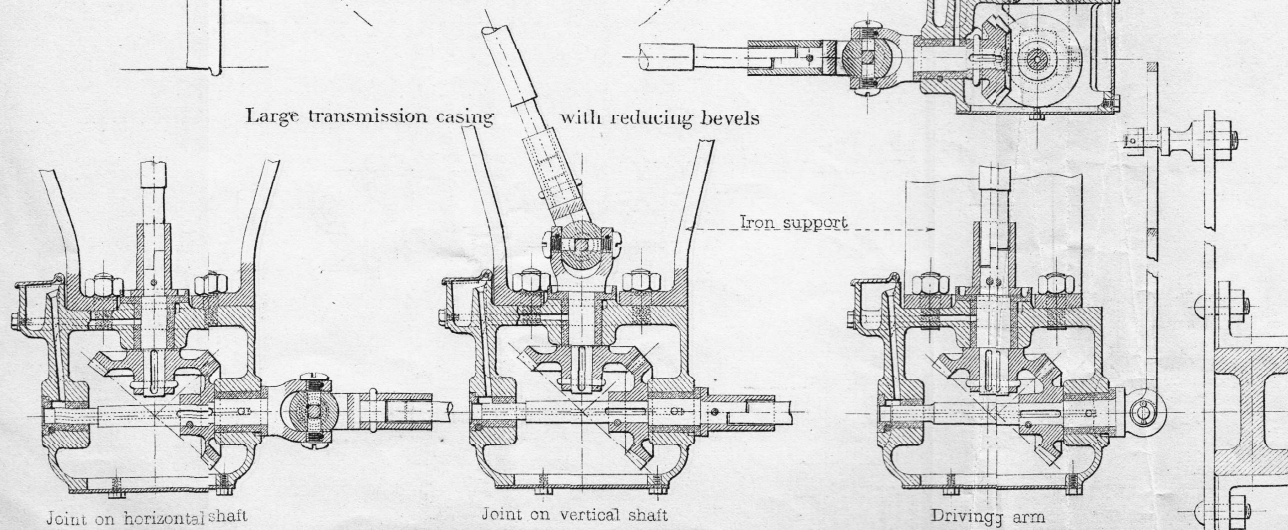
This technical drawing illustrates the internal mechanism of a watch movement, specifically the escapement and gear train. The diagram shows two large circular components, likely the escapement wheels, labeled X' and X''. These are connected to a central gear train. A small gear, labeled Y, is positioned between the two main wheels. A lever, labeled Z, is shown in the center, connected to the gear train. A small component, labeled S, is located at the bottom center, and a component labeled V is shown below it. The entire mechanism is housed within a rectangular frame, with various screws and mounting points visible. The drawing is a detailed cross-section, showing the internal components and their assembly.

[illegible]



Small transmission casing with driving shafts
(Equal bevels and universal joint)

Clutch for throwing driving shaft out of gear
(The fitting of this clutch is optional)



Reproduction of Train-running Diagram recorded by the FLAMAN Tachograph

Plate III

(Full-size diagram in ENGLISH MEASURES)

NOTE

1. The lines and inscriptions in red which figure in the accompanying diagram are printed uniformly throughout the whole length of the bands of paper upon which are inscribed the diagrams of distances, speeds and times.

2. The lines and punctuations in grey represent the automatic inscriptions of distances, speeds and times.

3. The lines and inscriptions in blue are only given on this diagram for purposes of reference and to guide in the interpretation of the diagrams shown here.

The lines and inscriptions printed in red and detailed in the following paragraphs *a b c d* and *e* are for the purpose of facilitating the reading of the diagrams.

a The arrow shown at the top of the speed diagram with the inscription "Direction of running" shows in which direction to read the lines denoting speeds and times inscribed by the tachograph.

b The inscription $10/32$ inch per Mile gives the measure of the unwinding of the paper band, which is proportional of the distance covered on rail at the rate of $\frac{10''}{32}$ per Mile.

The mileages covered are indicated by perforations in the upper and lower borders of the paper band, these perforations occurring at intervals of $\frac{10''}{32}$ and are represented by grey punctuations on the specimen diagram here reproduced. The double point printed on the diagram every $3 \frac{24''}{32} = \frac{120''}{32}$ represents the double perforation made in the paper to indicate that the driving barrel for the paper has made a complete revolution corresponding to a total distance of 12 miles.

c The lines at the lower part of the diagram, for the reception of the speed records, are ruled with a width appar of $\frac{7''}{32}$ between each representing 10 miles per hour. There are 11 of such lines with a total height of $\frac{70''}{32} = 2 \frac{6''}{32}$ registering up to 100 miles per hour at the rate of $\frac{7''}{320}$ per mile of distance traversed

d The lines on the upper part of the band for the reception of the time diagram have a total height of $\frac{20''}{32}$ subdivided by lines of $\frac{2''}{32}$ in height each one representing intervals of 1 minute or altogether 10 minutes from the datum line.

e The numbers printed on the scales of speeds and of times indicate the corresponding speeds or times of each longitudinal division.

