INTERURBAN CAR TESTS ON THE ILLINOIS TRACTION SYSTEM

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Thesis for Degree of Bachelor of Science
in Electrical Engineering

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May 26, 1905.

THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

Charles Edward Armstrong, Ralph Emmett Bowser and Maurice Leroy Carr

ENTITLED Interurban Car Tests on the Illinois Traction System

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE

OF Bachelor of Science in Electrical Engineering.

Morgan Brooks

HEAD OF DEPARTMENT OF Electrical Engineering.

ACKNOWLEDGEMENT.

We desire in this place to express our thanks to the officers of the Company and to all of its employees with whom we came in contact, for the consideration shown us while we were engaged in making the tests herein reported. Especial acknowledgement is due Superintendent H.C.Hoagland who arranged the night run schedules. To Mr.D.H.Sawyer,Engineer of Maintenance of Way, we owe our thanks for a profile of the road. Valuable assistance was rendered us by Master Mechanic Oscar F.Prior,by motorman Holtz, and by conductors Sowers and Poll. Messers. Smith, Greene, Akers and Winders, members of the Senior Class rendered us valuable assistance in reading instruments on the night runs.

C.E.Armstrong.

R.E.Bowser.

M.L.Carr.

INTERURBAN CAR TESTS
ON THE
ILLINOIS TRACTION SYSTEM.

On the following pages are described a series of car tests made on the lines of the Illinois Traction System, between the cities of Champaign,Illinois and Danville,Illinois. These tests were all made on the same car, Number 137, which runs regularly on a limited schedule between the two cities.

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R.E.Bowser.

M.L.Carr.

OBJECT OF THE TESTS.

The object of making the tests herein described was to determine the power consumption under different conditions of operation. Some of the conditions were those of actual operation and others were unusual ones, imposed with the object in view of obtaining data, from which some conclusions might be drawn as to the effect on economical operation of such conditions.

The different conditions are given below.

1. Running on regular limited schedule.
2. Running on the fastest schedule possible; all the regular limited stops.
3. Making the fastest possible time; no stops except those absolutely necessaby.
4. Running on measured stretches of level track.
5. Climbing known grades; running start.
6. Climbing the same grades from standstill.

GENERAL DESCRIPTION OF THE RAILWAY PROPERTY.

The road on which these tests were made is one of the McKinley Syndicate properties. It is 34.1 miles in length and connects the cities of Champaign, Urbana and Danville Illinois. At Ogden, 16 miles from Champaign, a branch line extends 6 miles south to Homer. The road runs over comparatively level country. However, at the Danville end of the line there are four heavy grades at Middle Fork Creek and the Vermillion river. There are some sharp curves in the line at Champaign, St.Joseph and Danville. The road is single track, laid with 70 pound

rails and is ballasted with cinders and gravel.

Power is furnished to the line at Champaign, St.Joseph, Fithian and Danville. At Fithian is a rotary converter sub-station which may be fed either from Danville, or Champaign. The power is transmitted to the substation as three phase current at 15000 volts pressure. At St.Joseph a storage battery floats on the line.

The trolley is of figure eight cross section, equivalent to a No. 000 wire in conductivity. It is fed by 0000 feeders, which extend the entire length of theline and are tapped in every 500 feet.

DESCRIPTION OF CAR NUMBER 137.

Type	Vestibule.
Length, overall	51 feet.
Total weight	67000 pounds.
No. Motors	4
Kind	G.E. #73.
H. P. of Motors	75 each.
Air Brake	National Electric Company.
Control	Hand.
Head Light	Wagenhall Arc Lamp.
Heaters	Western Star Hot Water.
Weight of Car Body	26500 pounds.
" " Motors	16500 "
" " Control Equipment	2000 "
" " Trucks	20000 "
" " Air Equipment	1200 "
" " Heater System	800 "

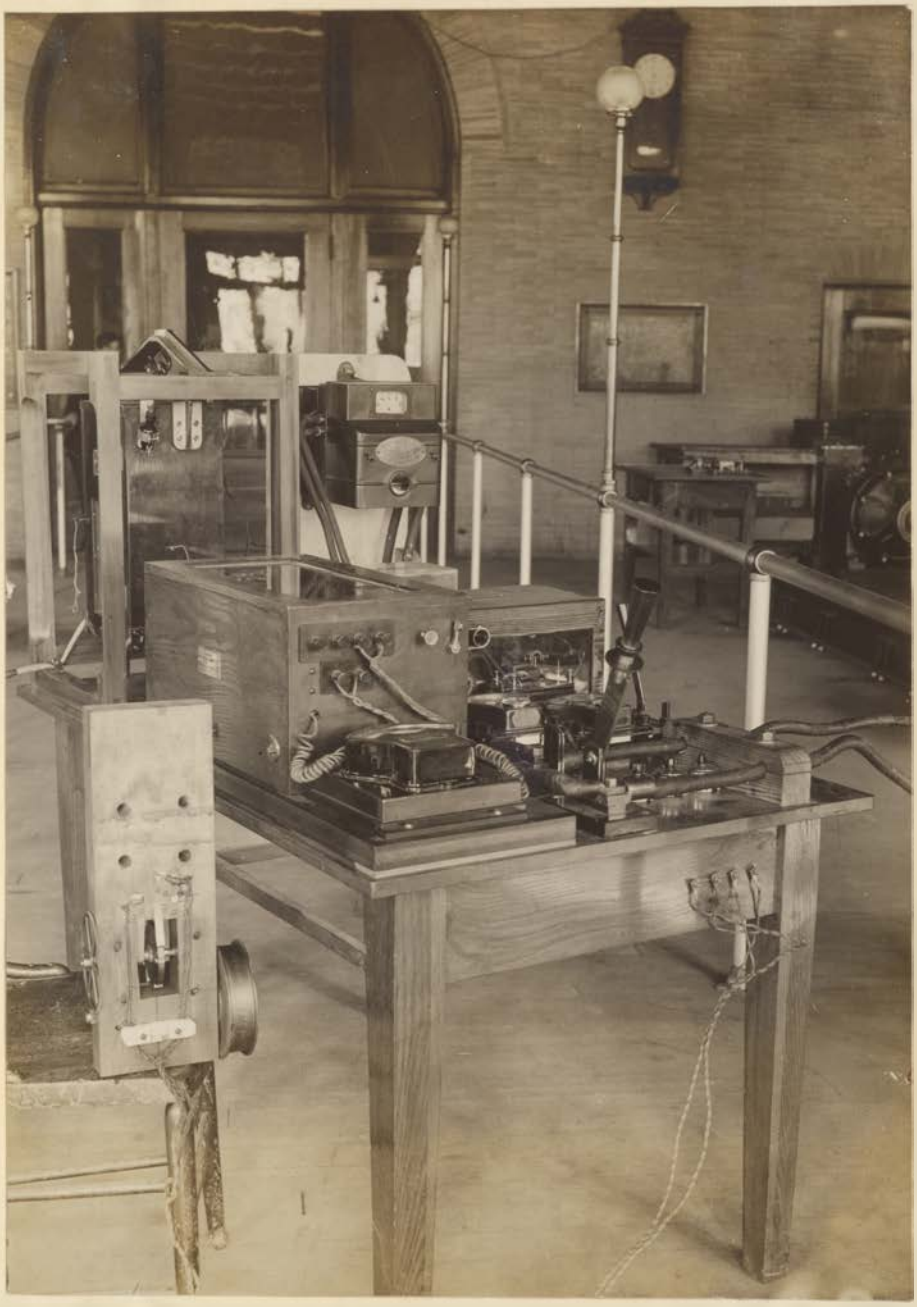
CAR NUMBER 137.

DESCRIPTION OF THE APPARATUS.

The apparatus used in the tests consisted of a General Electric recording ammeter, an Elliott Brothers (London) recording voltmeter, a General Electric railway recording watt-hour-meter, a Weston 800 ampere shunt and milli-voltmeter, a Weston 600 volt range voltmeter and a speed recording device. Photograph No.1 and Plate No.1 show how this apparatus was connected up on a strong table for use.

Recording Ammeter.

The G.E. recording ammeter is shown in greater detail in Photograph No.2. It has a capacity of 300, or 600 amperes depending on the connectionsof the current coils, whether series or multiple. This instrument consists electrically of two circuits, one through which the current to be measured flows, and the other circuit, one of fine wire of 2400 turns,through which one ampere of current from six storage cells is sent,which latter circuit is movable and carries the marking pen of the instrument. The movable circuit includes a rheostat and two electromagnets. The electomagnets damp the movements of the pen through the meddium of a brass vane attached to the movable system. The record of the instrument is made on a strip of paper 3.5" wide which is drawn under the pen by clock mechanism. Apen connected in a chronograph circuit serves to mark five second intervals on the paper. Athird pen in the circuit of the contact making mechanism which was belted to the car axle, made a record of the speed on the same strip of paper. The speed of the paper is variable within quite wide limits.



PHOTOGRAPH No. 1.

ASSEMBLED APPARATUS.

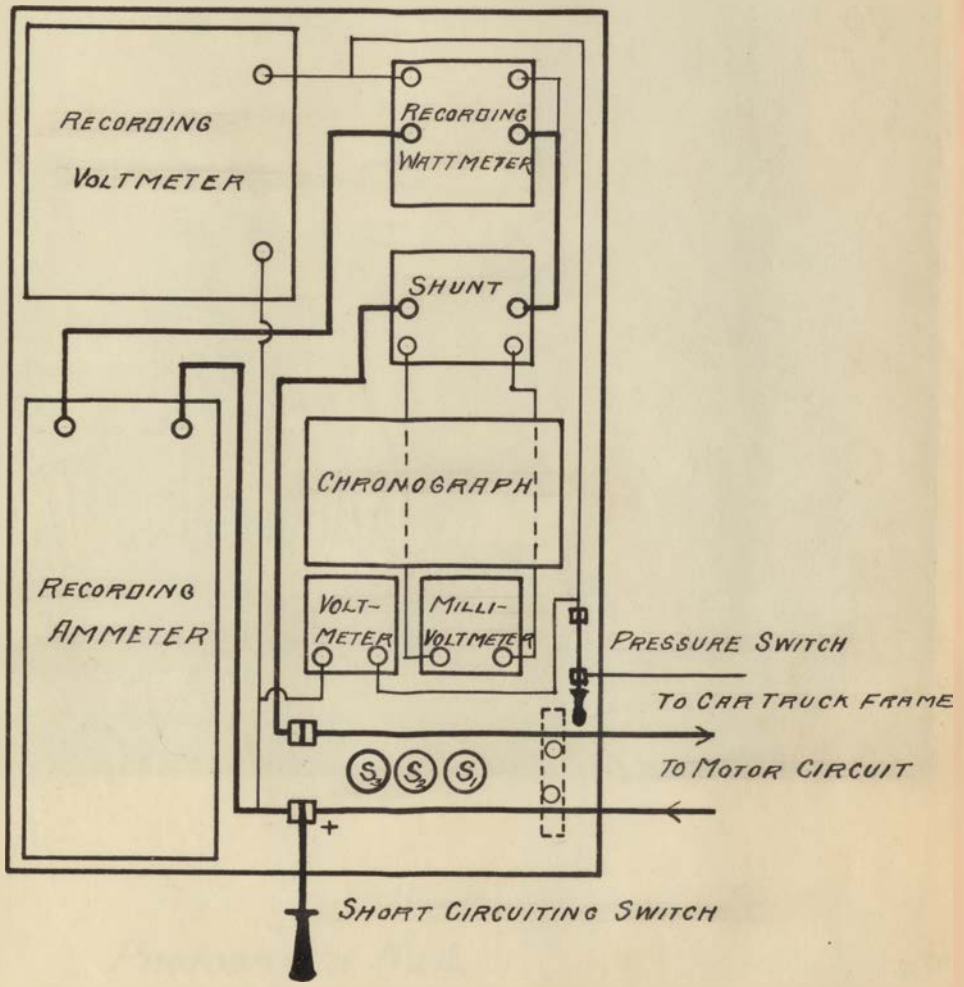
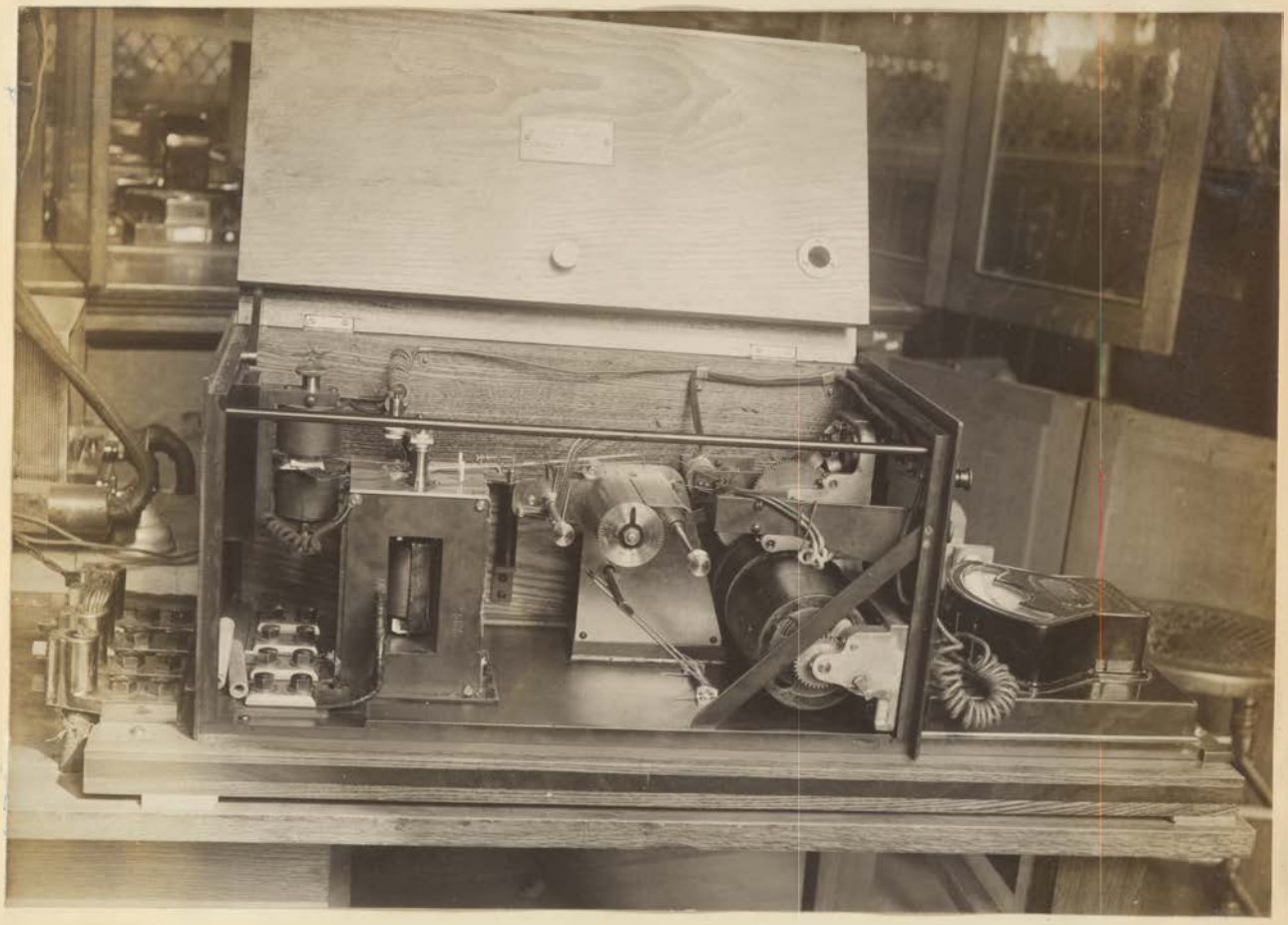


PLATE NO I.

DIAGRAM OF CONNECTIONS OF APPARATUS ON THE TABLE.



PHOTOGRAPH No. 2.

GENERAL ELECTRIC RECORDING AMMETER.

Recording Voltmeter.

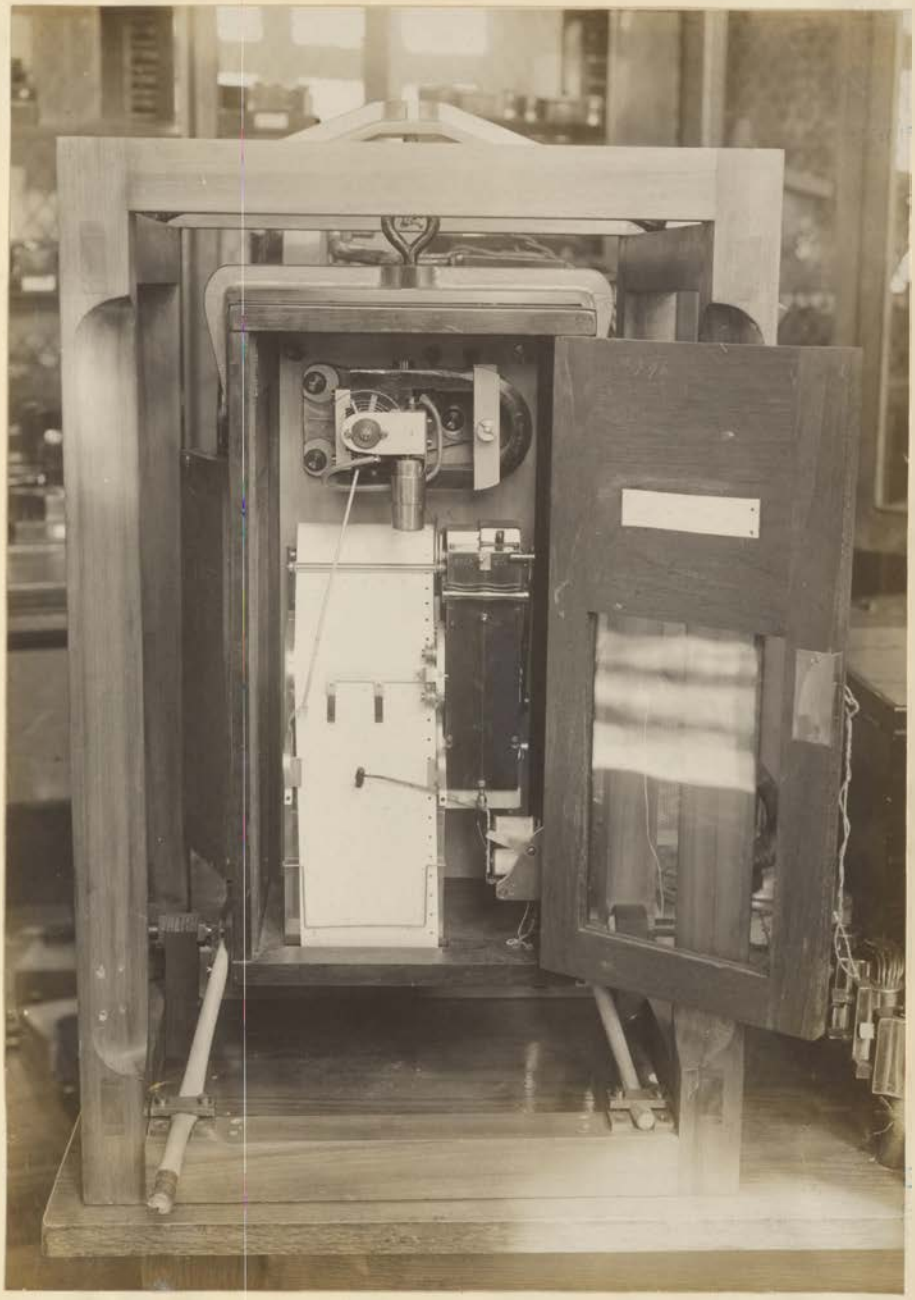
The recording voltmeter shown in Photograph No.3 was built by Elliott Brothers of London. The record is made on a strip of paper 3.5" wide which is drawn under the movable pen by clock work. The maximum rate of this strip is 6" per minutes. The movement of the needle is damped by a piston working in a cylinder filled with heavy oil. A time marking pen connected to the recording ammeter chronograph circuit was put on the voltmeter before the completion of the tests.

Speed Recorder.

In Photograph No.4 is shown the speed recorder. The flanged pulley is of the same diameter as the car axle to which it was belted. The pulley through a 1 to 8 reducing gear drove a rubber disk about three inches in diameter, which had set in it a brass contact piece, c, in Plate No.2. This contact piece is connected to the axle of the disk and to the circuit through the medium of the spring, b. Four brushes d, d, d, d, bear on the disk and are connected as shown to switches 1, 2, and 3. Closing switch No. 1, causes pen p to make one mark for each eight revolutions of the car wheel. When switches 1 and 2 are closed, a mark is made by p for every four revolutions of the axle. Closing all the switches causes p to make one mark for each two revolutions of the car wheel. The key, k, was used part of the time for indicating poles and stations. Closing the key caused the pen to make a horizontal dash on the ammeter record strip. Plate No.3 shows how the speed apparatus was attached to the frame of the car.

Wattmeter and Indicating Instruments.

The wattmeter used is an instrumentwith a special dial. The dial



PHOTOGRAPH No. 3.

RECORDING VOLTMETER.

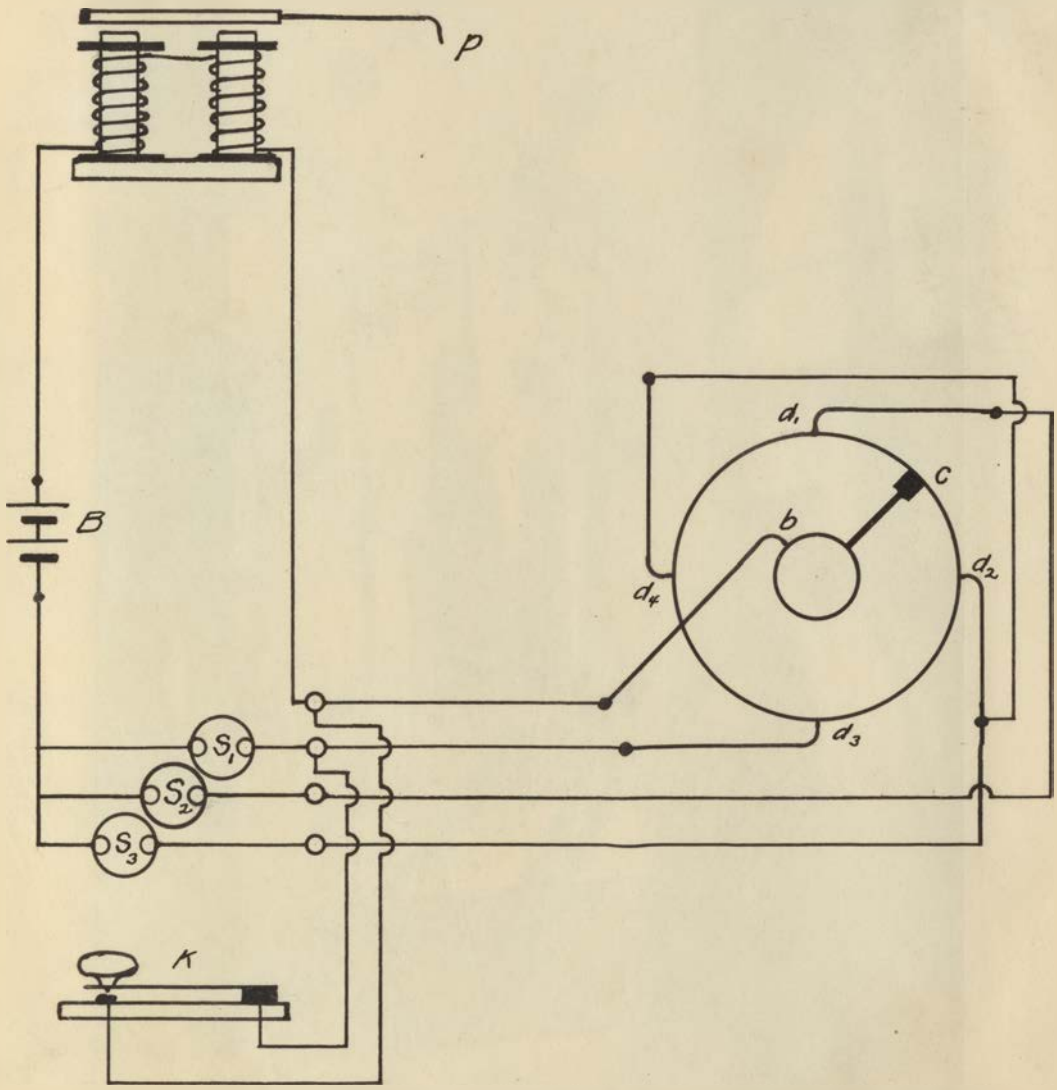
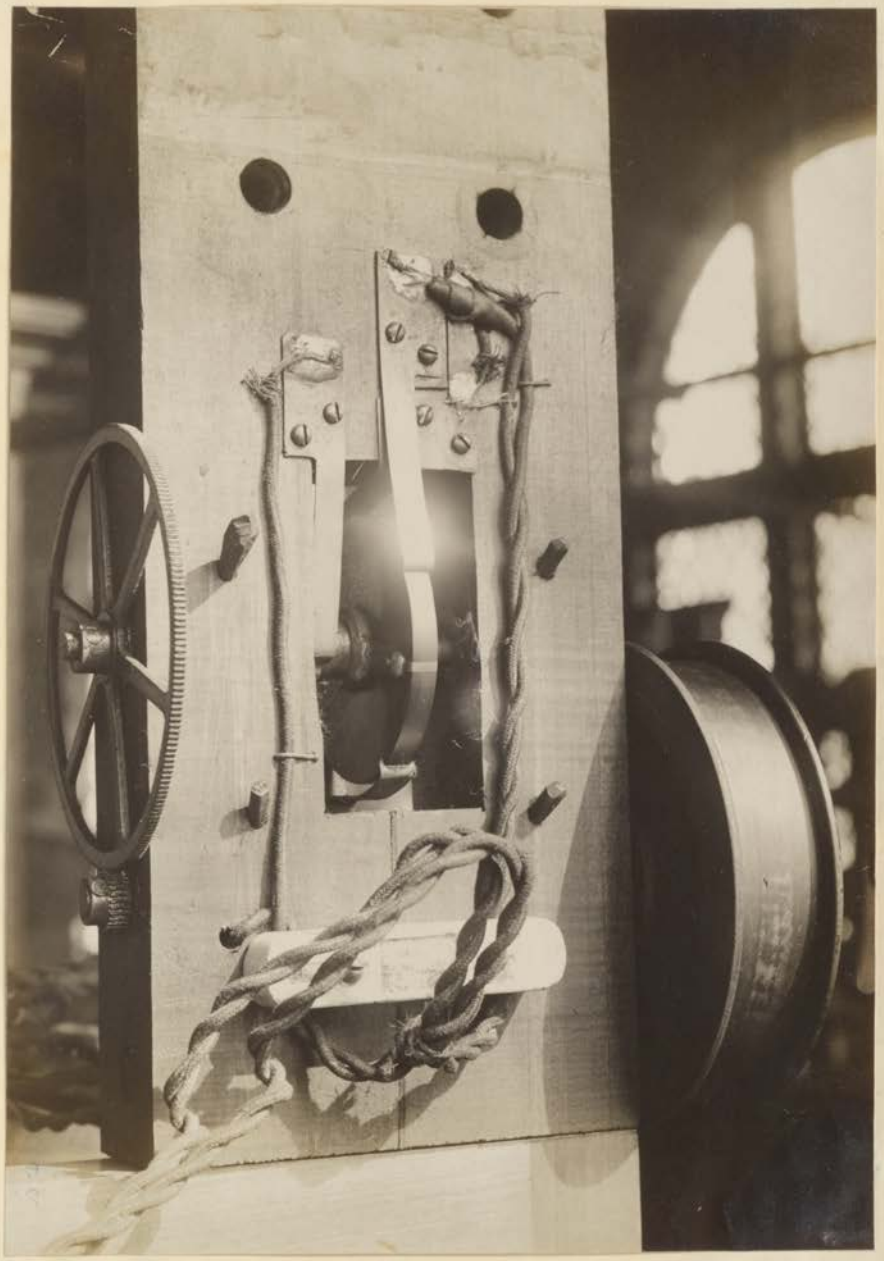


PLATE No. 2.

CONNECTIONS OF THE SPEED RECORDER.



PHOTOGRAPH No. 4.

CONTACT MAKER OF THE SPEED RECORDER.

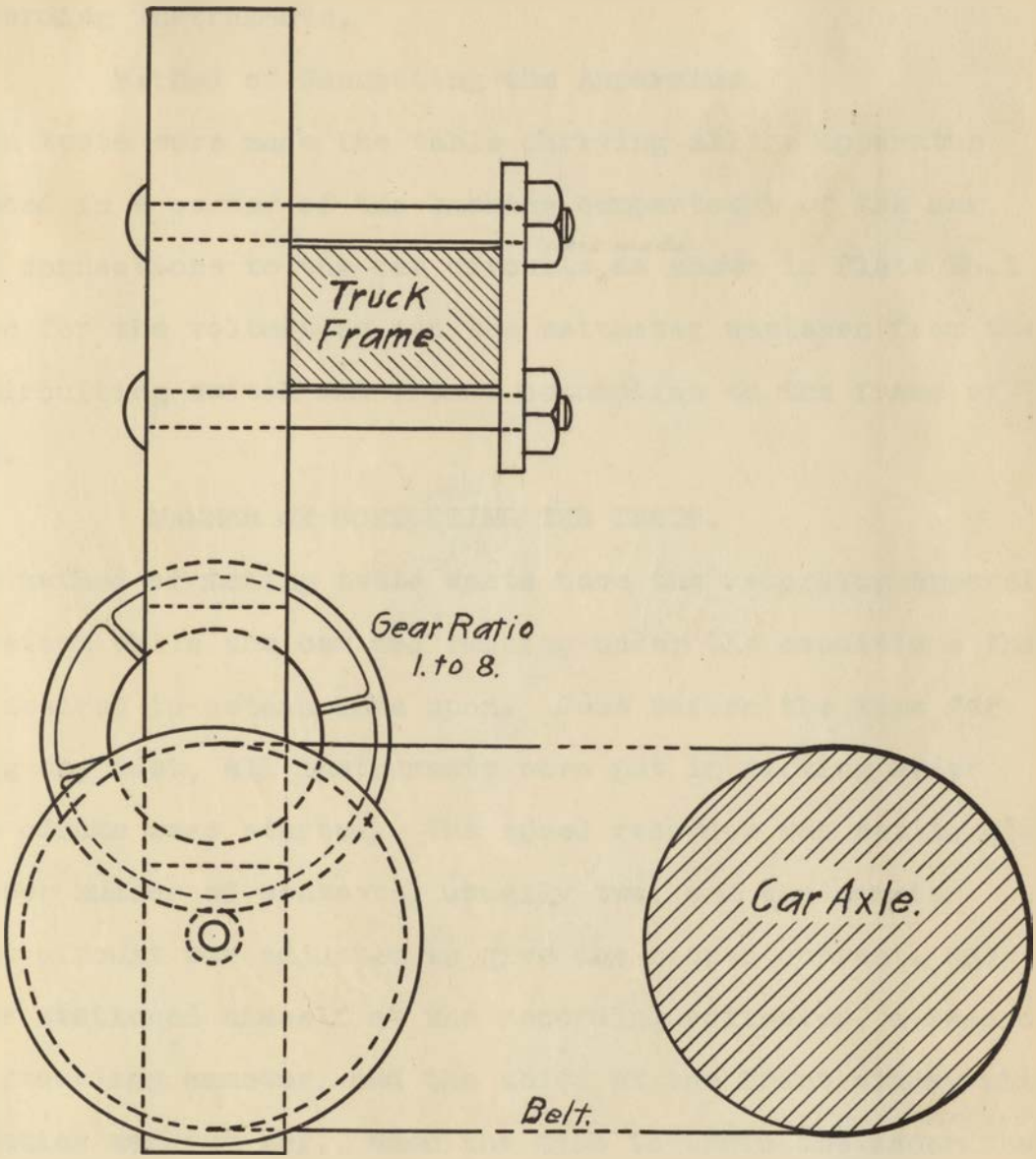


PLATE No. 3.

constant is 2, and each turn of the disk indicated 60 watt-hours.

The indicating ammeter and voltmeter were used as checks on the recording instruments.

Method of Connecting the Apparatus.

When tests were made the table carrying allthe apparatus was placed in a corner of the smoking compartment of the car and the connections to the car circuits were made as shown in Plate No.1. Pressure for the voltmeters and the wattmeter wastaken from the short circuiting switch and from a connection to the frame of the car.

MANNER OF CONDUCTING THE TESTS.

The method of making tests was to have the recording apparatus in operation while the car was running under the conditions that it was desired to obtain data upon. Just before the time for starting any test, all instruments were put in working order and the clocks were started. The speed recorder was set to give the proper number of contacts, usually two, and the ammeter rheostat circuit was adjusted to give the proper current. One observer stationed himself at the recording voltmeter, a second at the recording ammeter, and the third at the front window with the location marking key. When the time to begin the record had arrived the word, "Read" was given and the key depressed. The observers at theinstruments then marked on the strips the number of the observation, which was recorded with the wattmeter dial reading and the time by the man on the look out. Voltmeter and milli-voltmeter readings were taken occasionly as checks. On some of the runs, the wattmeter disk turns were counted when climbing grades and when running on the measured stretches of level track.

RECORD OF THE RUNS MADE.

Preliminary Run; Danville to Champaign, 6:00--7:25 A.M. April 12.

This was the first trial of the instruments on the car and the time was spent in gaining experience in their adjustment. It was soon found that the voltmeter needle damping was insufficient, and that the method of suspension of the instrument permitted too much vibration. The ammeter worked well except for a tendency of the paper to ride the pins on the driving drum. The speed apparatus gave no trouble whatever.

Run No.1. Champaign to Danville and return. 8:00--11:25 A.M April 12. Practice Run.

The recording voltmeter worked very much better, heavy cylinder oil having been substituted for the lighter oil before used. The suspension was improved by changing the method of anchoring the instrument in the carrying frame. Except for a slight time lag, the readings were found to agree exactly with those of the indicating voltmeter. Stations were marked and wattmeter readings were taken on this trip.

Run No.2. Champaign to Danville and return. 4:00--7:25 P.M. April 12.

All the instruments were in good working order during the entire trip. Readings of all the instruments were taken.

Run No.3. 8:00--11:24 Champaign to Danville and return. April 12.

The conditions were the same as in the preceeding tests, except that no passengers were carried.

No more tests were made until April 20 and 21. In the interval, the tops and bottoms of Stony Creek, Middle Fork and Danville grades were marked and a stretch of level track 11500 feet long, extending from pole No.454 to No.569, was chained and the ends were marked. A time marking pen, connected to the chronograph circuit of the recording ammeter, was put on the recording voltmeter and the suspension of the instrument was still further improved.

Special Runs April 20th and 21st.

Trouble was experienced in getting one of the pens to work onthe trip to Danville and no data was gotten. When leaving Danville at 10:00 A.M. on the return trip, a defective switch caused a slight accident to the air brake, which put the car out of service four hours. When the car next started out, trouble was again experienced with the pen and no data was taken until the next trip out from Champaign.

Special Run No.1. 4:00--7:25 P.M. April 20.

Readings were taken only on level track and the marked grades. Disk turns were counted.

Run No.4. Champaign to Danville and return. 8:00--11:25P.M. April 20.

The fastest possible time was made with all the local stops. Wattmeter readings were taken at frequent intervals. The disk turns were counted on the measured grades and on the level track.

Run No.5. Round trip Champaign to Danville. 11:38 P.M.--2:22 A.M.,April 20 and 21.

Limited stops and and the fastest possible schedule were

made on this trip. The same kind of data was taken as on the other trips. A pressure of 125 volts was observed on the Danville grade, due to the fact, that the line was being fed entirely from Champaign. Heavy rain and a head wind were encountered on the return trip.

Run No.6. Champaign to Danville and return. 2:32--4:45 A.M. April 21.

This was a speed run. No stops except those absolutely necessary were made. The pressure was good during the entire trip.

Special Run No.2. 10:00--A.M.--1:25 P.M. April 21.

Data was taken only on the marked grades and the measured level track. The revolutions of the wattmeter disk were counted.

Special Run No.3. 2:oo--5:25 P.M. April 21.

The same kind of data was taken on this trip as was taken on Special Run No.2, except that the grades and level track were taken from a standstill.

RESULTS OF THE TESTS.

On the pages that follow are given the results that were plotted and calculated from the data taken.

Calibration of the Speed Recorder.

In order to determine from the speed record the distance passed over in any given time, or to find the distance between any two points, it was necessary to calibrate the speed recorder which was done in the following manner. When the car ran over the level track, the beginning and the end of the measured section was marked on the ammeter record by means of the hand operated key, by an observer in the front end of the car. Knowing the distance, and the number of speed recorder marks corresponding, the space passed over by the car between two consecutive marks was easily calculated. The value of this constant, that was used in the calculations and the plotting, was the mean of several determinations made from the best of the data. With this constant, and the number of marks for a five second interval, the constant for obtaining the speed in miles per hour, was calculated. By means of this latter constant, the speeds that are plotted on the accompanying curves, were calculated. The speed apparatus gave no trouble and it was found that long distances could be accurately measured by counting the speed marks between the ends of the stretch in question, and then multiplying the number by the speed constant.

Curves.

From the graphical records made by the recording apparatus the seven accompanying curves were plotted. Distance was taken as constant and plotted as abscissa, and volts, amperes, speed in M.P.H., time in minutes, and elevation in feet were plotted as ordinates. By an inspection of these curves the ordinary operative condition at any point on the line may be seen.

On page30 of this report are samples of the voltmeter and ammeter records.

Total Power Consumption.

The total power consumption may be learned by an inspection of the data on page 29. It is interesting to observe that the power required to propel the car from Danville to Champaign is greater in each case than that required for the return trip, the difference being due to the difference in elevation of the two cities. Champaign is 133 feet higher than Danville; the difference in elevation corresponding to a uniform grade of 0.07%. The data in the table referred to was taken from the wattmeter readings.

The following calculations show the relation of excess energy as obtained from the data to the actual energy expended in lifting the car through the difference in elevation.

Average total energy going West	77.34 K.W.hrs.
" " " " East	69.96 " " "
" " " Round trip	73.65 " " "

Excess energy going West due to difference in elevation is 77.34 -- 73.65 = 3.69 K.W.hrs.

Weight of the car	67000 lbs.
Difference in elevation	133 feet.

Time to make the run 85 minutes.

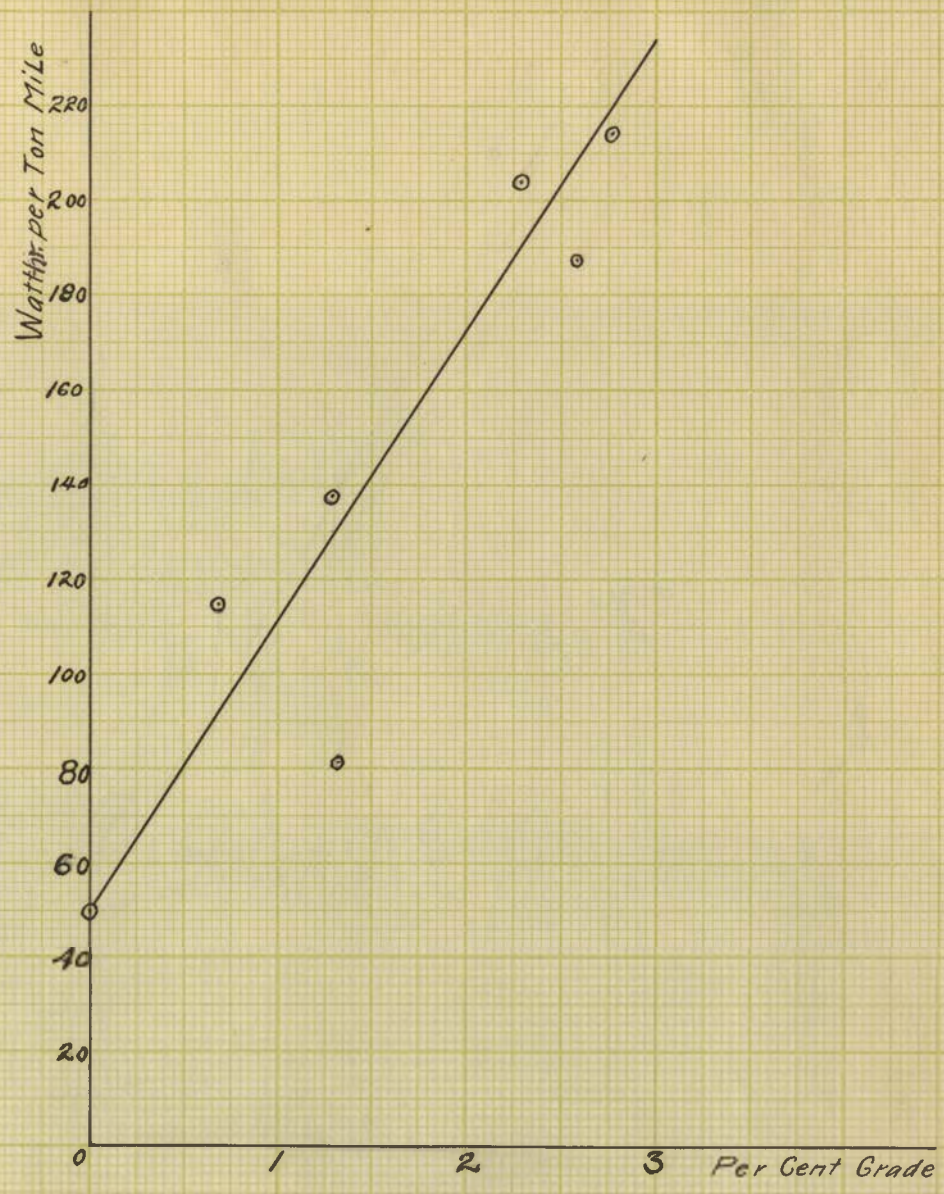
$$\frac{67000 \times 133 \times 85}{85 \times 33000 \times 60} = 4.5 \text{ H.P.hrs.} = 3.35 \text{ K.W.hrs.}$$

Difference = 3.69 - 3.55 = 0.34 K.W.hrs.

Power Consumption on the Grades and the Level Track.

The tables on pages 25, 26, 27, and 28, show the energy consumed on the marked grades and on the measured level track. The data was derived by taking a mean of the values, obtained by calculation from the wattmeter disk turns, by integration of the voltmeter and ammeter records, and from the wattmeter dial readings. In the most of the cases, the results are given for the heavy portion of the grade, for the less steep part of it and for the entire grade, from the lowest to the highest points.

On page 21 is a curve plotted between watt hrs. per ton mile and per cent grade. The values used were those that were determined under as nearly the same conditions as it was possible to get them. Those values that were taken from standstill, and those for the Danville grade going west, are more nearly consistent than are those from data taken when the car took the grades on the run. The effect of the momentum of the car is easily seen by an inspection of the data.



Watt-hrs per Ton Mile
and
Per Cent Grade.

G.E.A.
R.E.B
M.L.C.

VIEW OF LINE SHOWING TRAIN ORDER TELEPHONE.

MIDDLE FORK GRADE LOOKING EAST.

MIDDLE FORK GRADE LOOKING WEST.

Power Consumption on the Danville Grades.

Run No.	Date of Run	Direction of Run	Kind of Run	Time Climbing Grades	KW hours	Remarks.
1-S	April-20 4:00-5:25 P.M.	C to D	Regular Limited	1½ min.	2.73	Heavy Grade
2-S	April-21 10:00AM-11:25AM	" " "	"	1 min. 32 sec.	2.40	" "
3-S	April-21 2:00-3:25PM	" " "	"	1 min.- 47 sec.	2.40	" " From Standstill.
4	April-20 8:00-9:25PM	" " "	Local Schedule	1 min. 32.5 sec.	2.38	
5	April-20-21 11:37-12.52 PM AM	" " "	Fast Limited	2 min. 40 sec.	1.97	Voltage low
6	April-21 2:32-3:29AM	" " "	Speed Run	1 min. 5 sec.	2.60	Motors Parallel
1-S	April-20 6:00-7:25 P.M.	D to C	Regular Limited	2 min 5 sec	3.00	Heavy Grade
" "	"	" " "	"	4 min. - 42 sec.	6.38*	Whole "
2-S	April-21 12:00-1:25 P.M.	" " "	"	2 min. 2 sec.	3.30	Heavy "
" "	"	" " "	"	3½ min.	7.86	Whole "
3-S	April-21 4:00-5:25 P.M.	" " "	"	2 min. 10 sec.	3.40	Heavy " Standstill
4	April-20 10:00-11:25 P.M.	" " "	Fast Local Schedule	2 min 17 sec.	2.98	Heavy Grade
4	"	" " "	"	5 min 35 sec.	7.30	Whole "
5	April-21 1:2-2:22 AM	" " "	Fast Limited Sched.	1 min. 25 sec.	3.13	Heavy "
5	"	" " "	"	3 min. 52 sec.	7.47	Whole "
6	April-21 3:47-4:45 AM	" " "	Speed Run	1 min. 19 sec.	3.45	Heavy "
6	"	" " "	"	3 min 15 sec.	7.13	Whole "

Mean Power Consumption.

Direction	Part of Grade	% Grade	Length Feet	Total K.W. hrs.	KW hrs. Per Car Mile	Watts hrs. Per Ton Mile
C - D	Heavy	2.27	1800	2.41	7.06	210
D - C	"	2.59	2700	3.21	6.28	187
" "	Medium	.69	5800	4.23	3.85	115
" "	Whole	1.30	8500	7.44	4.62	138

*Not included in the mean.

Power Consumption on Middle Fork Grades.

No.	Date of Run	Direction of Run	Kind of Run	Time	KW hrs.	Remarks.
1-S	April- 20	C to D	Regular Limited	52 sec.	1.04	Heavy Grade
1-S	April- 20 4:00-5:25 P.M.	"	"	155 "	3.24	Whole Grade
2-S	April- 21 10:00-11:25 AM.	"	"	50 sec.	.96	Heavy Grade
2-S	April- 21 "	"	"	150 sec.	3.54	Whole Grade
3-S	April-21 2:00-3:25 P.M.	"	"	1 min. 50 sec.	3.50	Heavy Grade from Standstill
4	April-20 8:00-9:25 P.M	"	Fast Local Schedule	2 min. 25 sec.	2.93	Whole Grade
5	April 20-21 11:37 AM-12:52 AM	"	Regular Limited	52 sec.	1.18	Heavy Grade
5	April 20-21 "	"	"	2 min. 47 sec.	3.55	Whole Grade
6	April-21 2:32-3:29 AM	"	Speed Run	46-sec.	.93	Heavy Grade
6	April 21 2:32-3:29 AM	"	"	3 min. 5 sec.	2.81	Whole Grade
1-S	April- 20 6:00-7:25 P.M.	D to C	Regular Limited	58 sec.	1.50	Heavy Grade
2-S	April- 21 12:00-1:25 PM.	"	"	1 min. 10 sec.	1.80	" "
3-S	April-21 4:00-5:25 PM	"	"	2 min. 4 sec.	3.95	From Standstill
4	April- 20 10:00-11:25 PM	"	Fast Local Schedule	62.5 sec.	1.60	Heavy Grade
5	April-21 1:12-2:22 AM.	"	Fast Limited	55-sec.	1.50	" "
6	April 21 3:47-4:45 AM	"	Speed Run	51 sec.	1.14	" "

Mean Power Consumption.

Direction	Grade	% Grade	Length of Grade	K.W. hrs.	KW hrs per Car Mile	Watt hours Ton Mile
C-D	Heavy On Run	2.30	2700	1.06	2.07	62
"	Light Grade	.42	5000	1.78	2.26	67.2
"	Whole Grade	1.08	7700	3.19	2.18	65.2
"	Heavy G. Standstill	2.30	2700	3.50	4.16	204.0
D to C	Heavy G	2.76	2900	1.38	2.51	75
" " "	Standstill	"	"	3.95	7.16	214

Power Consumption on Level Track.

No. Run	Date of Run	Direction of Run	Kind of Run	Time on Track	K.W. hrs.	Remarks.
1-S		C to D	Regular Limited			
2-S	April-21 11:00 – 12:25 AM	" " "	"	4 min 27 sec.	5.88	
3-S	April-21 2:00 – 3:25 PM	" " "	"	4 min. 10 sec.	5.71	From Standstill.
4	April-20 8:00 – 9:25 PM	" " "	Fast Local	3 1/3 min	5.00	Dial Reading Only
5	April 20-21 11:37 – 12:52 PM AM	" " "	Fast Limited	3 min 55 sec.	5.22	
6	April-21 2:32 – 3:29 A.M.	" " "	Speed Run	3 min. 10 sec.	3.52	No intermediate Stop.
1-S	April-20 6:00 – 7:25 P.M.	D to C	Regular Limited	4 min. 35 sec.	6.21	
2-S	Apr.-21 12:00 – 1:25 P.M.	" " "	"	4 min. 45 sec.	4.74	
3-S	April-21 4:00 – 5:25 P.M.	" " "	"	5 min. 20 sec.	5.08	Time from Oakwood. No stop at Bronson.
4	April-20 10:00 – 11:25 P.M.	" " "	Fast Local	5 min 15 sec.	6.25	
5	April-20-21 1:12 – 2:22 AM	" " "	Fast Limited	4 min 5 sec.	5.71	Stop at Bronson
6	April-21 3:47 – 4:45 A.M.	" " "	Speed Run	3 min. 15 sec.	3.78	No intermediate stop.

Mean Power Consumption.

Direction	Distance	Condition	K.W. hrs.	K.W. hrs. Per Car Mile	Watt hrs. per Ton Mile
C – D	11500 ft.	One stop	5.45	2.50	74.6
" "	" "	No Intermediate Stop	3.52	1.61	48.2
D – C	" "	One Intermediate Stop	5.60	2.57	76.7
" "	" "	No stop	3.78	1.74	51.8
Mean	" "	One Intermediate Stop	5.00	2.54	75.6
"	" "	No stop	3.65	1.67	50.0

Power Consumption on Stony Creek Grades.

Run No.	Date of Run	Direction of Run	Kind of Run	Time Climbing Grades	KW hours	Remarks
1-S	April-20 11:00-12:25 AM.	C - D	Regular Limited	40 sec.	.90	
2-S	April-21 11:00-12:25 AM - PM	" "	"	42 sec.	.96	
5	April-20-21 11:37-12:52 PM - AM	" "	Fast Limited	37.5 s.	.904	
6	April-21 2:32-3:29 A.M.	" "	Speed Run	33 sec.	.96	
1-S	April-20 6:00-7:25 A.M.	D - C	Regular Limited	55 sec.	.98	To Muncie
2-S	April-21 12:00-1:25 P.M.	" "	"	1 min. 5 sec.	1.02	
4	April-20 10:00-11:25 PM	" "	Local Schedule	24 sec.	.90	
5	April-21 1:12-2:22 A.M.	" "	Fast Limited	35 sec	.87	
6	April-21 3.47-4.45 A.M.	" "	Speed Run	32.5 sec.	.67	

Mean Power Consumption.

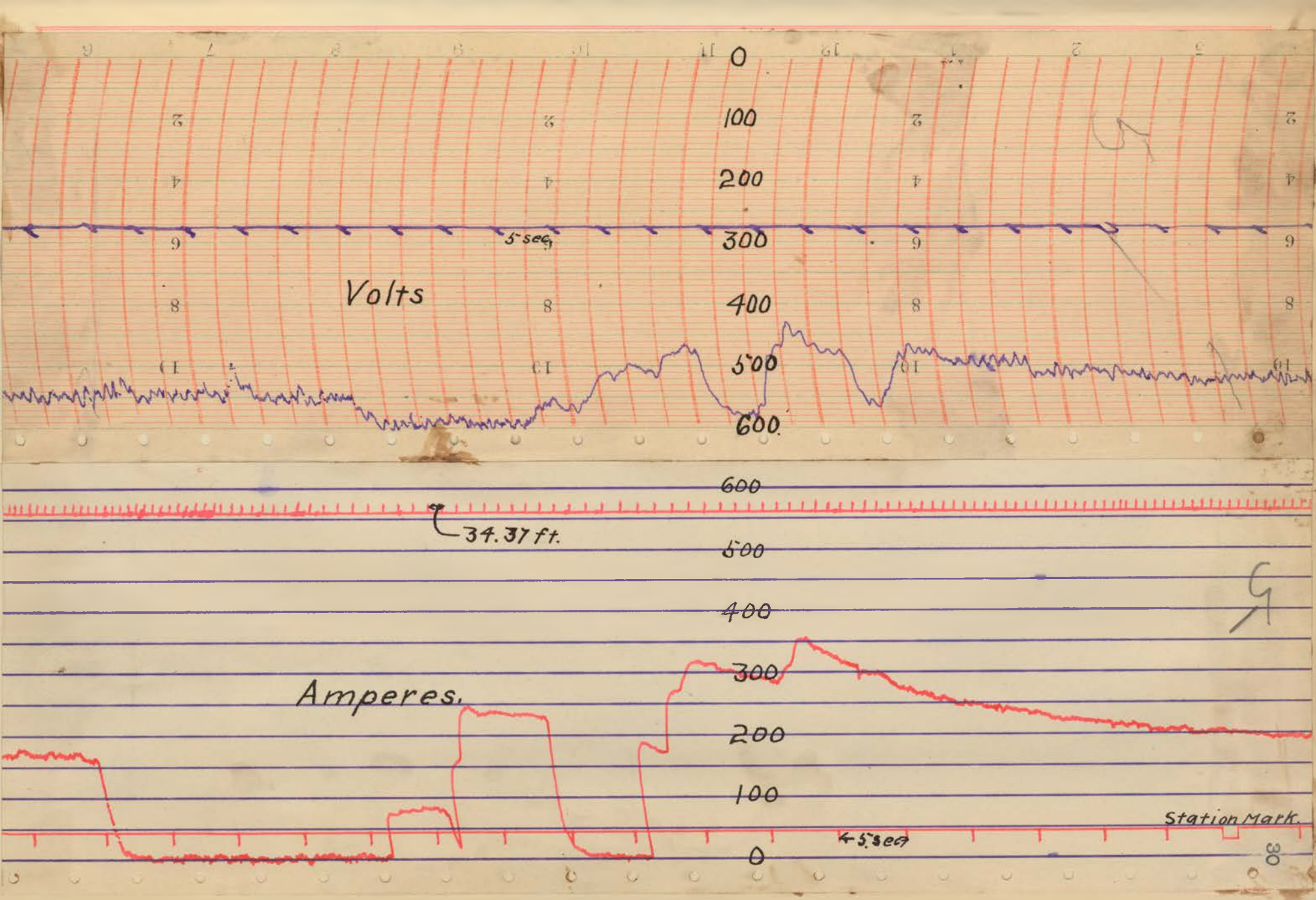
Directions	Part of Grade	% Grade	Length	Total KW hours.	KW hours Per Car Mile	Watt hours Per Ton Mile
C - D	Whole	1.33	18 00 ft.	.93	2.73	81.5
D - C	"	.935	3100 "	.94	1.60	47.8

Total Power Consumption on Through Runs.

Run No.	Date of Run	Direction of Run	Kind of Run	Time	K.W. Hours	Remarks
1	April - 12 8:03 - 9.25 A.M.	C to □	Regular Limited	1 hr. - 22 m	73.6	
1	" 10:00 - 11:28 A.M.	□ to C	"	1 hr. - 28 m.	76.6	
2	" 6:00 - 7:28 P.M.	C to □	"	1 hr. - 25 m.	65.8	22 passengers
2	" 6:00 - 7:28 P.M.	□ to C	"	1 hr - 28 m	75.2	25 "
3	" 8:00 - 9:24 P.M.	C to □	"	1 hr. - 24 m.	63.2	No passengers
3	" 10:00 - 11:27 P.M.	□ to C	"	1 hr. - 27 m.	75.8	" "
4	April - 20 8:00 - 9:23 P.M.	C - □	Local Stop Fastest Speed	1 hr. - 23 m.	82.0	" " Rain
4	" 10:00 - 11:23 P.M.	□ to C	"	" "	95.3	"Head Wind Heavy Rain
5	April - 20 - 21. 11:40 P.M. - 12:55 A.M.	C to □	Regular Limited Stops. Fast Speed	" 15 m.	77.8	All limited Stops.
5	" 1:25 - 2:22 A.M.	□ to C	"	" 6.5 m.	86.9	(3 min. delay at I.C. R.R. deducted) All limited stops
6	April - 21 2:32 - 3:29 A.M.	C to □	Speed Run	57.5 m.	67.8	3 stops
6	" 3:47 - 4:45 A.M.	□ to C	"	58 m.	72.2	" "

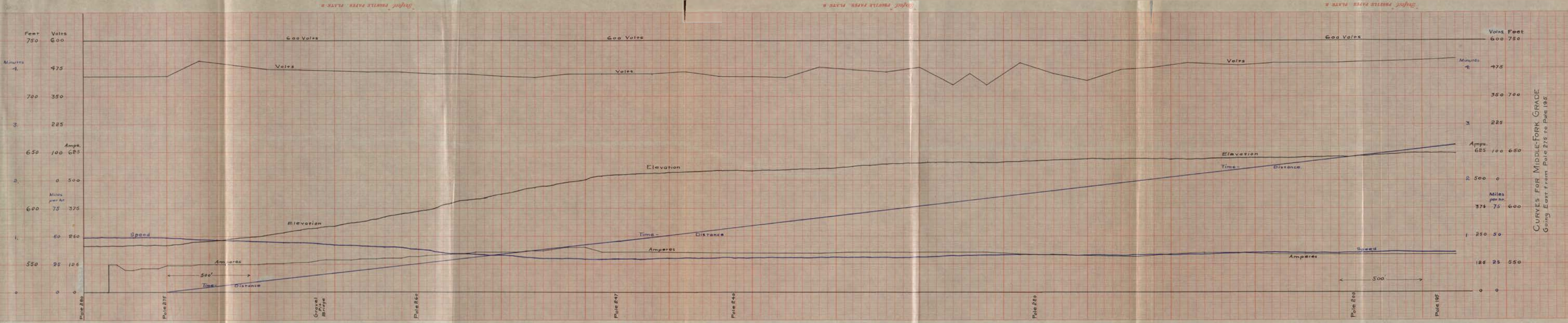
Mean Power Consumption.

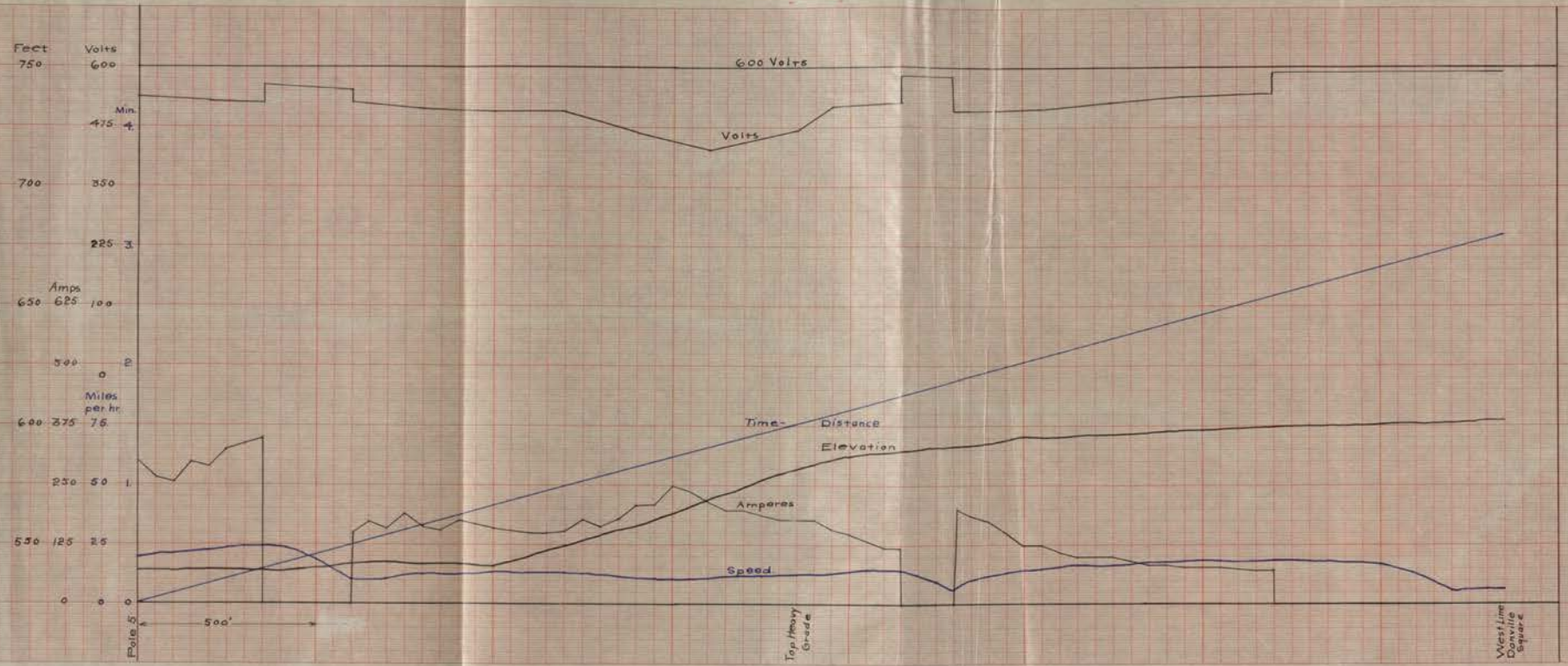
Direction	Total K.W.H.	K.W.H. Per Car Mile	W.H Per Ton Mile.
C to □	69.96	2.05	61.2
□ to C	77.34	2.27	67.7


0
100
200
300
400
500
600
5 sec
Volts
600
500
400
300
200
100
0
34.37 ft.
Amperes.
5 sec
Station Mark
30

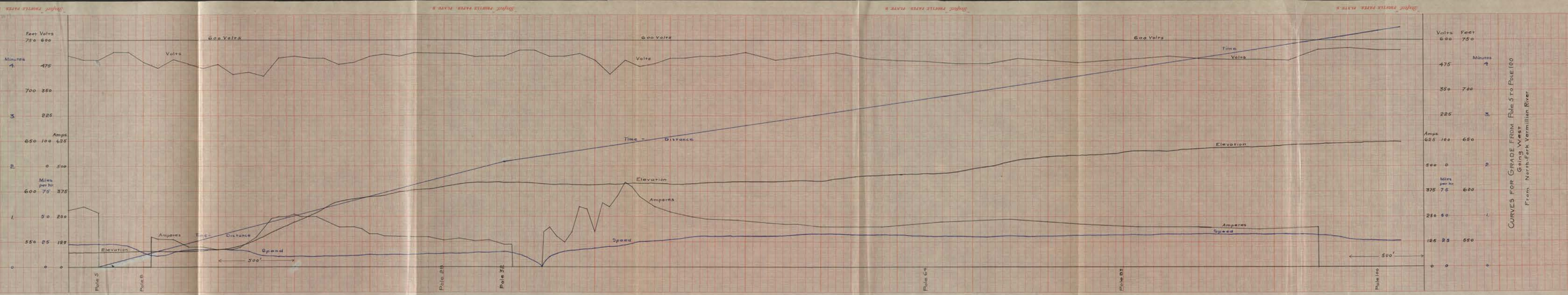

Power off at Danville
Pole 5
North Fork Bridge
4000'
West Line Public Square Danville
Amperes
Miles per hr
Min.
Curves for Complete Run
Champaign to Danville
All Limited Stops
Time, 69 Min.
Run No. 5


Curves for Complete Run
Danville to Champaign
All Limited Stops
Time, 65 Min
Run No. 5
Volts
Distance
Speed
Amperes
Miles per hr.
Minutes
Ill Cent Crossing
Champaign Office


Feet
Volts
750
600
Minutes
4
475
700
350
3
225
650
100
625
Amps.
2
0
500
600
75
375
Miles per hr
1
60
250
550
25
125
0
0
0
600 Volts
Volts
Elevation
Speed
Amperes
Time
Distance
500'
Pole 280
Pole 275
Gospel Ridge Bridge
Pole 260
Pole 247
Pole 240
Pole 220
Pole 200
Pole 195
Volts Feet
Amps.
Miles per hr
CURVES FOR MIDDLE FORK GRADE
Going East from Pole 278 to Pole 195

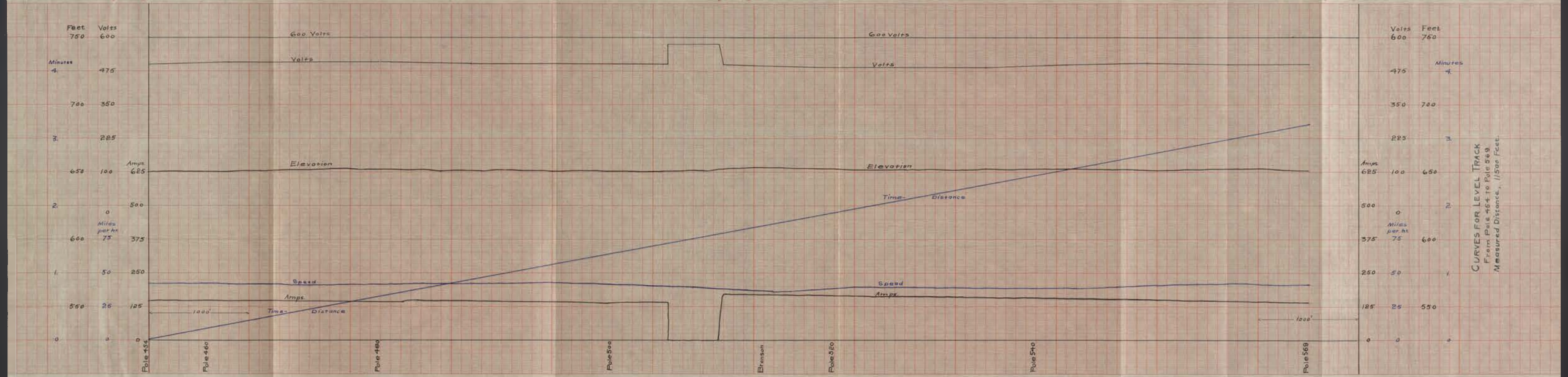


CURVES FOR GRADE GOING INTO DANVILLE
Eastbound
From Pole 5 to West Line, Public Square.



CURVES FOR GRADE FROM Pole 5 TO Pole 100
Going West
From North Fork Vermilion River

CURVES FOR MIDDLE-FORK GRADE
Going West from Pole 275 to Pole 301


Feet
Volts
Minutes
Amps.
Miles per hr.
600 Volts
Volts
Elevation
Time-Distance
Speed
Amps.
1000'
Pole 454
Pole 460
Pole 480
Pole 500
Ereson
Pole 520
Pole 540
Pole 569
CURVES FOR LEVEL TRACK
From Pole 454 to Pole 569
Measured Distance, 1/500 Feet.