Edison departed for England on 23 April and returned to the United States on 25 June. This two-month trip was his first overseas and it provided him with an international perspective at an early point in his career. The purpose of the trip was to demonstrate the automatic telegraph system of the Automatic Telegraph Company for the telegraph department of the British Post Office and to quicken British interest in the system. Edison achieved this goal. In addition he had an opportunity to think further about the application of his “balancing the line” approach to automatic telegraphy and to experience the frustration of working with a coiled undersea telegraph cable.

As a representative of the Automatic Telegraph Company, Daniel Craig had sought unsuccessfully to have George Little’s automatic system tested on English lines since early 1870. The English were already well acquainted with automatic telegraphy, having used Charles Wheatstone’s system since the late 1860s, and both chief telegraph engineer Richard Culley and superintendent Frank Scudamore were wary of Daniel Craig’s extravagant claims of having successfully transmitted from 1,000 to 1,500 words per minute. George Harrington then began to ease Craig out of Automatic Telegraph, which held both Edison’s and Little’s patents, and in the first months of 1873 company agent George Gouraud met with Scudamore in London. As a result, Culley and Scudamore agreed to a demonstration of the American system, but they remained skeptical about its novelty and performance. Indeed, Culley believed that changing to what was then known as the Little system would be impractical even if it could perform as claimed, because the British Post Office did
Edison was impressed by the quality of British telegraph lines. Next to this sketch he wrote: “The wires from London to Liverpool are the best strung wires I ever saw.”

Two American operators were to work the equipment for the test. If they achieved a minimum of 500 words per minute over a 300-mile wire, the telegraph department of the British Post Office would shoulder the expenses of the demonstration and consider adoption of the system.

On 23 April, Edison and Jack Wright, a co-worker from the Automatic Telegraph Company, sailed for England, arriving in early May with transmitters, receivers, a supply of chemically treated paper, and strips of perforated tape prepared in America (they brought no perforators). Edison went to the postal service office on Telegraph Street in London, and Wright departed for Liverpool. Wright’s two combination transmitter-receivers were damaged in transit when porters dropped them, but one was salvaged. For about two weeks, Edison and Wright tested the instruments and adjusted the circuits in preparation for the demonstration. They found that the underground wires at each end of the line distorted the signals, so they moved to the outskirts of the cities where they could connect directly to overhead lines. The trials took place on Friday, Monday, and Tuesday, 23, 26, and 27 May 1873. The original agreement required eight transmissions of 1,000 words on each of three days at an average rate of 500 words per minute; the actual number of transmissions was successively six, eight, and nine. The system, which became known as Edison’s instead of Little’s, performed as stipulated. It tested with a low of 437 and a high of 572 words per minute.

After completing these trials, Edison stayed in England for another two weeks, during which he experimented with the automatic telegraph system on a coiled 2,200-mile cable that was in storage at Greenwich. His tests on this cable failed, however, and he had difficulty understanding why. In mid-June he sailed for New York, arriving home on 25 June. Although Edison’s automatic telegraph had passed the British Post Office’s test, the British did not adopt it. Instead, they hoped to devise improvements in the Bain system and circumvent Edison’s patents.

1. Except as noted, all correspondence, memoranda, and reports relating to the British tests of the American automatic telegraph system are in ATF.

2. Bain’s automatic system also had been used earlier. Kieve 1973, 82.

3. Richard Culley to Frank Scudamore, 12 May 1873. The automatic telegraph of Charles Wheatstone worked as fast as 120 words per min-
ute, depending on the length and wiring (undersea, underground, or aboveground) of the circuit. Prescott 1877, 702–11.
4. Jack Wright to TAE, 14 May 1873, Cat. 299, Lab. (TAEM 6:133).
5. Test results are in six tables in ATF.
7. Joseph Murray's testimony, Quad. 70.9, p. 99 (TAEM 9:813).

The Controller—

The trial of Mr. Edison's Automatic instrument commenced on Friday the 23rd inst at 2 pm—

It was found practically impossible to carry out the trial strictly according to the instructions laid down, owing to the limited supply of prepared paper, and from the fact that a large quantity had been consumed in the preliminary experiments—

Instead therefore of a column showing the time occupied in sending a thousand words, a column was made with the heading "No of words received" and the time occupied in receiving a given number was entered under the heading "Total time"—

During the first day of the trial no adjustments were made after starting at 2.8 pm. The speed attained each half hour exceeded 500 words per minute, with the exception of one instance when 455 words only were received—This reduced speed was however evidently caused by the sender at Liverpool miscalculating the number of revolutions made per minute by his sending gear and not by any defect of the wire or apparatus.

The marks in each trial were good but manifested a tendency to run together—this tendency was however much less marked when the receiving band was made to travel faster—

On the second days trial the speed was in three instances below 500 owing as on the first day to the sender not properly computing the rate of speed at which he was propelling the punched band—

During the fifth and sixth trial the wire was used three minutes by Mr Edison in obtaining a score or two of words from L'pool, which resulted in his making a readjustment occupying but a second— Two other adjustments were made between the two following half hourly trials but they did not occupy more than a fraction of a second each—

The stock of prepared paper having run out on the previous
days trial, a fresh supply had been made, but this paper* was very wet, and unsuited for immediate use—

It is believed that the adjustments mentioned were made solely with the view of shunting part of the current* in order to remedy this evil as far as was possible—

The average speed maintained through the day was 501 words per minute—

The third and last days trial was commenced by the two first half hourly results indicating a speed of 467 and 482 words per minute— The three following results showed that the rate had exceeded 500 words per minute— The character of the marks in each of these five trials could not be said to be good, but they were readable—

The wire was changed before* the sixth trial, and a marked improvement took place, the signals being very good and clear— With one exception the marks were recorded at the rate of 500 words per minute, and that exception was caused by the difficulty of precisely fixing the actual speed of transmission—

It appears to me that the sole advantage of this system over the Wheatstone is the established fact of its much higher speed— It has the disadvantage that the prepared paper being damp is easily torn by the accidental pressure of the fingers or by other untoward means— The marks also are not durable, vanishing from the paper in a few hours* and liable by contact to become transferred to other portions of the same band— Should it however become advisable to work at a higher rate of speed in preference to increasing the number of wires I should consider these objections of but minor importance— The punched paper could be preserved for record, and the chemically prepared paper thrown aside—

It is perhaps right to point out to you that by this system it would be necessary to maintain a staff of writers of sufficient strength always in readiness to deal with the greatest amount of work likely to be sent through at any one time—

An accumulation of slip for* even a few minutes whilst additional hands were being brought up to meet the momentary pressure, would be—for the reasons previously mentioned— fatal to the work—

Bearing in mind these conditions I can see no reason why with a proportionate increase of staff over the Wheatstone complement there should not be proportionally increased results—

I think that I should not be under* estimating the proper
working speed on our L'pool wires to be 400 words per minute, at which rate the marks have invariably been perfect—

I might mention that no adjustment appears to be necessary beyond that of the shunt—and that the instrument can readily be worked* by an ordinary good Morse clerk, and by care being taken that the prepared paper is neither too wet nor too dry—

J. W Eames

ALS, UKLPO, ATF, Item 73. On paper headed “TELEGRAPHS,” in upper left corner under embossed seal. “Enclosure to Mr. Fischer’s report of 30 May 1873—Report (with 4 enclosures) from Mr Eames to the Controller of the Central Telegraph Office with ene” written in an unknown hand at top of first page.*Repeated at end of one page and beginning of next.*Interlined above.

1. Henry Fischer was controller (i.e., financial officer) of the central office of the British telegraph service in London.

2. On 22 May, Culley wrote out the “Conditions of the final trial of the Little Automatic System” (Item 73, ATF). The test was supposed to determine the time needed to transmit 1,000 words; instead, the receivers recorded the number of words sent in two minutes.

3. The paper for receiving that Edison brought with him. Compare the explanation given by David Lumsden in Doc. 319.

4. That is, 2:08 P.M.

5. The sender was Jack Wright (n.d.), who had come from America with Edison for the tests. Wright, a telegrapher since 1862, had been night manager of the Western Union office in Boston and had roomed with Edison when Edison worked there in 1868–69. He had come to work for the Automatic Telegraph Co. in New York in 1872. Cat. 299, Lab. (TAEM 6:133); Brief for Field, p. 61, Wiley v. Field.

6. Edison put shunts around both the receiver and the transmitter; see the diagram in Doc. 319.

7. See Chapter 12 introduction, n. 3.

8. By the end of 1873, Edison had developed a chemical solution that made permanent marks on the paper. Sir James Anderson to Scudder, 5 Jan. 1874, Item 67, ATF.

9. J. W. Eames was a staff member in the central office of the British telegraph service assigned to monitor the tests. Henry Fischer to the Secretary, 20 May 1873, Item 67, ATF.

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The Engineer in Chief

In reporting upon the trial of Edison's modification of the Bains (or rather Littles)** Automatic System of Telegraphing I found that it was impossible literally to carry out the form suggested in the instructions—the paper ran out at such a speed
that it would have been impossible to note with any certainty the point at which marks commenced or ceased—¹

The method adopted therefore was to run a a number of words through from an endless band noting by a chronograph the time taken in receiving a given length of slip, the number of words on which were counted, the time taken up by adjustments,² if any, being likewise noted—

The facts during the 3 days trial were as follows—

1st Day— we used some rolls of Chemical paper brought over by Mr Edison from America which were of sufficient length to record over 1,100 words—the actual number of words received in 2 minutes being noted with one exception the numbers were in excess of 500 words per minute the exceptional³ case being 455 words per minute— this however was simply due not to any defect but to the fact that as both Transmitter and Receiver are turned by hand, the transmitting clerk at L'pool had guessed the time badly.

The Battery used was Groves Carbon & Zinc as in America—60 cells—³

No adjustment beyond that necessary at the first Start was required throughout the day—

The marks throughout the day were quite legible and readable, although there was a slight tendency in the dots to run together— this was partly due to the receiver being turned rather slowly in order to economise paper a spur being given now and then to [-]-shew the effect of increasing the speed of the paper— When the receiver was turned at the same speed or in excess of the transmitter the marks came out quite distinctly—

At the finish I had a slip run through at about 700 and also one at 400 words per minute—the former although not what could be called good was readable the tendency of the marks to run together being much greater than at 500— at a speed of 400 the marks were perfect

2nd⁴ Day— It was found that the Battery at Lpool had either been inadvertently left on Short circuit—or allowed to run down and the acid had to be replenished—8 half hourly trials were made during the day—

All the old paper having been used on Friday some fresh paper was prepared on the Saturday by hand this paper was much too wet for giving the best results—

We commenced with the same adjustment as on Friday— the marks were the same as on that day except that they were

The English Venture

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inclined to drag a little more owing to the wet state of the paper (this is an old fault in the Bains system and gave rise to much trouble).\textsuperscript{4} (It is practically difficult to secure paper exactly of the proper degree of dampness.)\textsuperscript{5}

At the 5th trial 3 mins was taken up in altering the compensation\textsuperscript{6} to suit the paper—the marks afterwards coming out very fairly—

during the 7th trial the slide was moved once while receiving—

On 3 of the trials today the speed was under 500 words per minute—due as the Lpool clerk not turning fast enough, his object of course being to keep as near to the 500 words as possible—The Rolls of paper used today being wound loosely by hand would not record more than from 250 to 500 words at each trial, the variation in the total number of words received being due partly to this fact and partly to the paper breaking before the rolls were run out, from their being too wet—the best results as is well known are obtained when the paper is just sufficiently damp to record signals—The average speed obtained during the day was 514 words per minute—at the finish I again had slips put through at

800 words marks rather light and just readable
400 words marks perfect—
100 words without compensation a a continuous line was received and had to reduce speed to about 30 words per minute to obtain readable signals—and even at this speed the static discharge from the wire was very evident—

On the 3d day Weather very wet and slight Contact\textsuperscript{7} on all wires, sufficient to shew on the sensitive paper employed—on the first two trials the clerk at Lpool did not turn fast enough, and I had an extra slip put through to see what marks over the 500 words per minute were like. they were readable but not good and would not do for general traffic on such an inclement day as this. it might have been got over by additional Battery power but there being only 60\textsuperscript{8} cells at Lpool this could not be done—The wire used was via the canal\textsuperscript{9} and shewed a good deal of leakage and the shunts employed 250 ohms at Lpool and about 60 at TS\textsuperscript{9} the line being over 4000 allowed very little current \#10 do the work. This will perhaps be best shewn by a rough sketch of the connections—

May–June 1873
The magnets in the shunts forming the compensation to counteract the static discharge from the line—I had a Rly wire joined up for the 2 pm and subsequent trials—after which the marks at 500 words were received quite clear and distinct—the whole of the trials were made on a No 8 wire, but at the close I tried the effect of substituting a No 4 wire, the result being that the received signals at 500 words were as anticipated much more clear and heavy, and readable although inclined to run at 740 words—

The average results of the 3 days trial may be summed up as follows:

1st day 534 words per minute
2nd day 514 "  "
3d day 513 "  "

The signals at these speeds were quite legible and readable taken simply as an experimental trial, but in practice I consider that 400 words would be the maximum that could be obtained on a good wire between TS and L'pool—that is, on a wire free from contact—The static inductive effect can be compensated for while contact cannot.

The apparatus is simply a Bains there being nothing new in the application to it of the Automatic principle or in the Chemicals employed, but it has the important addition of the Compensating Magnets. this as applied to the Bains System is new and it is this addition that enables these high speeds to be maintained.

Mr Edison informs me that he has tried all the methods of compensating by condensers and Batteries but none of them give results equal to the magnets.

The chemicals used being a solution of Iodide of potassium and starch the marks only last for a few hours—

D Lumsden

1. See Doc. 318, n. 2.
2. “Adjustments” refers to the resistance Edison placed in shunts around the instruments to counteract the self-induction of the line. See the sketch accompanying this document.
3. The modified Grove cell—also called a Bunsen cell—in use on American lines produced about 1.9 volts, compared with the approximately 1.1 volts of the cells used on British lines. Because the Grove cell also possessed a lower internal resistance than its British counterpart, it put out a considerably higher current. At some point in his experiments, Edison realized that reception was improved by increasing the current on the line. Culley later mentioned his fear that the heating effect of that current would set the covering of insulated lines afire “if incautiously applied.” Atkinson 1910, 868–71; King 1962a, 241–43; Culley to Scudamore, 22 Dec. 1873, Item 102, ATF; Doc. 337. Compare the story that Dyer and Martin attribute to Edison about the battery used in this test (1910, 1:150).
4. A fine brush.
5. See n. 2.
6. That is, the resistance in the shunt was changed.
7. Leakage of current to ground.
8. Britain’s extensive canal system connected Liverpool and London via several routes. One source identifies the canal referred to here as the Bridgewater Canal, part of which ran south from near Liverpool. Dyer and Martin 1910, 1:150.
9. Telegraph St. in London, the location of the central office of the telegraph service.
10. A wire running alongside a railway.
11. In the Birmingham gauge, commonly used in England, no. 8 wire was 0.165 inch in diameter.
12. No. 4 wire was 0.238 inch in diameter, Birmingham gauge.
13. Smear together.
14. In a 6 June 1873 note to Frank Scudamore, Culley wrote, “The invention which has been tried . . . is quite new. It is distinctly different to the processes which have been previously brought before my notice.” Item 74, ATF.
15. David Lumsden, an experienced telegraph operator, was submarine (i.e., cable) superintendent and electrician for the British postal service during the early 1870s. Baker 1976, 110–11.

AUTOMATIC TELEGRAPh CIRCUITS Doc. 320

The following document is from a notebook Edison used while in England conducting tests of his automatic telegraph
system in May and June of 1873. Only a few of the entries in the notebook relate directly to these tests, however. Instead, Edison recorded ideas for improvements of the automatic telegraph system, particularly the design of circuits that had occupied him in the six months prior to his trip to England. Doc. 320 illustrates how he varied a basic design, seeking new ways of achieving a goal. In this case he was arranging combinations of resistance, capacitance, and induction, working from the “balancing” principle explicated in the patent application he executed in New York City the same day he sailed for England.

1. PN-73-00-00.2, Lab (TAEM 6:872–906).
2. One drawing, however, appears to depict an automatic instrument:

3. In this six-month period Edison applied for and was issued eight patents on such circuit designs: U.S. Pats. 135,531, 141,772, 141,773, 141,776, 147,311, 147,313, 147,314, and 150,848.

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Notebook Entry: Automatic Telegraphy

[A]
AX, NJWOE, Lab., PN-73-00-00.2 (TAEM 6:874).

1. See headnote above.

2. The circles in these diagrams represent automatic telegraph transmitters and receivers.

3. The label "art" means "artificial line."

May–June 1873

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Edison used this notebook while experimenting with his automatic telegraph on a cable at the Greenwich works of the Telegraph Construction and Maintenance Company. These experiments took place in early June 1873, following his demonstration of his automatic telegraph system for the British Post Office. Edison obtained access to a coiled cable awaiting installation on the Brazilian line. He was unaware that the distortion typical on a long underwater cable would be severely augmented by the coiling. Edison later said that the first dot he transmitted came out on the chemical paper as a twenty-seven foot mark. The best transmission speed he could achieve in two weeks of experimenting was about two words a minute, while contemporary transatlantic cables transmitted from ten to seventeen words a minute.

1. PN-73-00-00.1, Lab. (TAEM 6:820–71). An undated, two-page fragment labeled “Greenwich,” which was probably created by Edison during or immediately following his trip to England, shows several circuit diagrams for working a cable. Cat. 297:75(4), 76(r), Lab. (TAEM 5:728, 731).

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Notebook Entry: Automatic and Cable Telegraphy

Resistance pretty dry paper 1 Cup through Mirror Gal[vanometer] Thomson$^2$ 500,000 ohms with 5 cells 100,000 showing proportionate to cells applied

Thomson's Gal will give quick deflectin through 4 millions ohms

The English Venture
Mine gives dot in 10 seconds through 1 millins $\Omega$ ohms $\times$ 5 cups, & mirror & its own R of 500,000 with 5 cups give mark right along.

Hence to make paper very sensitive $\varphi$ in high resistance circuit add at receiving inst enough cups to just make a scarcely perceptable mark & work upon the batty at other end thus.

705 miles cable

AX, NJ|WOE, Lab., PN-73-00-00.1 (TAEEM 6:824).

1. See headnote above.
2. Thomson's mirror galvanometer was used for receiving signals on cable telegraphs.
3. Edison's automatic receiver.
6000 ohms

No tailing at 20 words per minute but could see that at higher there would be Especially if the Circuit or Resistance for discharging was increased

Lester\(^2\) says 1200 ohm Mirrors\(^3\) used for receiving insts low R

The internal resistance of 300 those Gutta percha batteries\(^4\) is 37000 ohms or 123\(\frac{1}{2}\) ohms per cell oh god

Length sections wire\(^5\)

Sect. Knots
1 & 7—154.644 1 & 2
2 & 3—187.071 3 & 4
5—130.662 5 & 6
6 & 7—140.596 7 & 8

Lester says he & Wy Smith\(^6\) watched Earth Currents\(^7\) all one night at Valentia\(^8\) Changed from P[ositive] to N[egative] Sometimes 4\(\frac{1}{2}\) minute the others 15 minutes he measured potential one time twas 50 cells =

The English Venture 606
Joints never test as well as regular core impossible make perfect joint Wetherell\(^9\) says guess that's reason won't allow more battery—chemical action =

AX, NjWOE, Lab., PN-73-00-00.1 (TAEM 6:828).

1. See headnote, p. 604.
4. This is probably a reference to the Menotti battery, whose flat, circular anode was soldered to a gutta-percha-covered wire. It was used primarily for testing and for long cable lines. Prescott 1877, 60–61; and Ternant 1881, 246–47.
5. The numbers here are the same as those indicated on the drawing in the notebook entry that follows (Doc. 323).
6. Willoughby Smith served as electrician of the Gutta Percha Co., which later became the Telegraph Construction and Maintenance Co., and made a number of important contributions to cable telegraph technology. He later served as president of the Society of Telegraph Engineers (Appleyard 1939, 289). For Smith’s contribution to cable telegraphy see Smith 1974 and Bright 1974.
7. Earth currents are caused by differences in the electrical potential of the earth along the length of a cable.
8. Valentia, Ireland, was the eastern terminus of the first successful Atlantic cable.

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Notebook Entry: Automatic and Cable Telegraphy

[London, c. June 10, 1873]

Greenwich Expts\(^2\) Metallic Circuits\(^3\)

insert instrument and use perforated paper see what speed obtainable with each section to earth direct & then with all sections on probable result = at high speeds Cable on other side increase speed

May–June 1873

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1. In seeking to "balance" the line, Edison appears to be using the reaction discharge magnets at the receiving end to counter static charge on the line and prevent tailing (see Doc. 317, n. 3). He proposed a similar arrangement in his U.S. Patent 147,311, whereby several magnets were combined with a switch in order to bring any number of them into a shunt circuit. This arrangement is very similar to that found in Edison's U.S. Patent 160,405 (see patent drawing, Cat. 297-65 [TAEM 5:567]).

2. In two undated fragments, probably written before his trip to England, Edison indicated the use of very small holes in the perforations (see headnote, pp. 562-63; Docs. 306 and 307; and Cat. 297:65 [TAEM 5:667]).

3. In another notebook (see headnote 3), Edison indicates such a box to several drawings (see headnote, p. 563). In his notes on the line (see patent drawing, Cat. 297-15 [TAEM 6:865]), an undated fragment describes the construction of a magnetic box (Cat. 297-15 [TAEM 6:865]). Edison also apparently used such a magnetic box in some of his duplex experiments (see headnote, pp. 562-63; Docs. 306 and 307; and Cat. 297:65 [TAEM 5:667]).
to keep the line statically charged in order to overcome tailing problems. Cat. 297:12(3-4), Lab. (TAEM 5:479-80).

Notebook Entry: Automatic and Cable Telegraphy

Also try this

Turn quick  Keep it charged

Greenwich

[London, c. June 10, 1873]
500 words a minute turn
Then put X at C

AX, NjWOE, Lab., PN-73-00-00.1 (TAEM 6:838–41). 'Followed by “over” to indicate page turn.

1. See headnote, p. 604.

Notebook Entry: Automatic and Cable Telegraphy

[London, c. June 10, 1873]

inst in bridge
Vibrator

Good I think
Vary P[ositive] chg battery till it will charge cable equal to X Transmitter battery

AX, NjWOE, Lab., PN-73-00-00.1 (TAEM 6:842).

1. See headnote, p. 604.
2. See Doc. 327 for a similar vibrator drawing.
Notebook Entry: 
Automatic and Cable Telegraphy

[London, c. June 10, 1873]

Vibrator

AX, NjWOE, Lab., PN-73-00-00.1 (TAEM 6:854).

1. See headnote, p. 604.

Notebook Entry:  
Automatic Telegraphy

[London, c. June 10, 1873]

Big thing

AX, NjWOE, Lab., PN-73-00-00.1 (TAEM 6:855).

1. See headnote, p. 604.
for a half current for a dash last half weak

Use only one hole large for dash & make other holes small & sep pen insulated

AX, NJWOE, Lab., PN-73-00-00.1 (TAEM 6:859).
1. See headnote, p. 604.

have 3 condensers with wire coil put in at Washington & work condenser System at NY with Charlestown if good send 3 condensers 1/2 way bet W & Chn

AX, NJWOE, Lab., PN-73-00-00.1 (TAEM 6:859).
1. See headnote, p. 604.
2. This refers to the line of the Southern and Atlantic Telegraph Co.

ascertain if on an artificial of say 500 or even 100 miles, there will be any difference between a battery with zinc & coke or copper or other higher metal & coke = Also on same cable
see if there is any difference between or see if and record is made on at least 500 miles of artfcl cable by keeping a quantity battery of 10 cups on & make signals by putting on ten & taking off—the extra ten arranged to give extra quantity only also ascertain if better signals can be received over an art with 50 cups, Bridge\(^1\) put & kept on line at recg station and working\(^2\) with 10 cups at sending station. in trying the differences take batteries out bridge but keep it on & at same resistance

Thus

\[
\text{Charge \& discharge a large Condenser or several large Condensrs. Through a very delicate high R Engine—Revolving Armature = so as to get a perpetual revolution in the Engine = }^b
\]

ascertain if some magnetic arrangement might not be made so as to be included within the circuit\(^c\) to work so that it would exactly neutralize the static charge in So many knots\(^3\) of Cable if these devices Could be put in the Cable & their Capacity would remain as Constant as the Capacity of the Cable = it would be valuable =

Try two insulated disks of rubber on which is a strip of Zinc & of Copper Connected together = This stands still now another disk 100th of an inch from it revolves slowly & also\(^d\) with immense rapidity This disk has one Strip Copper. See if influence would generate E. & Connect to Sensitive Galvanometer =

AX, NJWOE, Lab., PN-73-00-00.1 (TAEM 6:863, 862, 860).
\(^*\)Remainder of paragraph written over unrelated, canceled drawing.
\(^b\)"perpetual ... Engine" partially written over unrelated drawing.
\(^c\)"within the circuit" repeated at end of one page and beginning of next.
\(^d\)Interlined above.

1. See headnote, p. 604.
2. Wheatstone bridge.
3. Nautical miles.
Notebook Entry:
Automatic and Cable Telegraphy

1 knot 8 by 8

Double Condsr high R secdy chge Condenser opposite
good

AX, NJWOE, Lab., PN-73-00-00.1 (TAEM 6:865).
1. See headnote, p. 604.

Notebook Entry:
Automatic and Cable Telegraphy

Try iron wires in Compensating Magnets also in that secondary Inductn coil compensator

something in it
or to ground

AX, NjWOE, Lab., PN-73-00-00.1 (TAEM 6:867).
1. See headnote, p. 604.

See if through 500,000 ohms anything can be put into the Iodinde\(^2\) that will reduce its resistance = and obtain the mark with one cup of battery = In testing the sensativeness of iodized paper test with one or two cups battery through 500 000.

Through this resistance Try and see which battery 2\(^a\) cups Daniell\(^3\) or grove\(^4\) will give the mark quickest =

It may be that Signals may be given with 20 cups grove & spaces by 20 cups Daniel Secondary batteries Have 6. foot square lead sheet or coke\(^5\) secondary batteries made to be used at receiving end These send back charge & act like a Condenser but have the advantage that they send\(^b\) a long back charge & low Resistance it may be that they cannot be put in the main if so place in shunt

AX, NjWOE, Lab., PN-73-00-00.1 (TAEM 6:868). *Circled. \(^v\)To this point, paragraph written over unrelated drawing.

1. See headnote, p. 604.
2. Edison used potassium iodide (KI) as a recording solution.
3. The Daniell cell, a modification of John Daniell's constant-voltage cell, was regarded as especially well suited for closed circuit telegraph systems. Consisting of copper and zinc electrodes in dilute sulfuric acid and separated by a porous diaphragm, the 1.1-volt Daniell battery was so reliable that it was used as a standard through the 1870s. King 1962a, 241–43; Prescott 1877, 48–52; Atkinson 1910, 868.
4. William Grove's battery used electrodes of zinc and platinum in solutions of sulfuric acid and nitric acid. It was expensive and—because the acids gave off corrosive fumes—dangerous. Its 1.9-volt output, however, was almost double that of the Daniell. King 1962a, 243; Prescott 1877, 64–66; Atkinson 1910, 869–70.

May–June 1873 615
5. Secondary batteries (storage batteries) could store electricity when charged by a primary battery or generator. One type used lead sheets in a solution of dilute sulfuric acid; another used zinc and carbon electrodes. Prescott 1877, 81–82.

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Notebook Entry: Automatic and Cable Telegraphy

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Varly Cable System

Try this. Obtain some metal that will not decompose iodide and then attach it to the platina pen so as to reduce resistance.

AX, NJWOE, Lab., PN-73-00-00.1 (TAE 6:869).

1. See headnote, p. 604.
2. British telegraph engineer Cromwell Varley was an expert in cable telegraphy. In 1862 he developed an artificial line system that electrically balanced cables by combining condensers and resistances. His system was widely used in cable telegraphy. DNB, s.v. “Varley, Cromwell Fleetwood”; Bright 1974, 639-40, 658.

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Notebook Entry: Automatic and Cable Telegraphy

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It is probable that the return magnetic charge can be obtained freer and with less shunting of the current by this arrangement that directly by magnets. The primary coil should have probably 5000 ohms res & the secondary about the same = ²
It might be well to try & see if the delicacy of the paper might not be increased by keeping it statically charged or by passing a current (Local) in opposite directions through it or by the addition of several Cups in the secondary circuit & use no box on oth page—

When I get home have 1000 cups glass ½ size Cable Gutta P[ercha] Cups made for testing at someones expense

AX, NJWOE, Lab., PN-73-00-00.1 (TAEM 6:870). “Gutta P Wks Wharf Road City Road N” written at top of page. Text from here to end of next paragraph written over unrelated, canceled drawing.

1. See headnote, p. 604.
2. The primary and secondary coils are the overlapping rectangles in the drawing.
3. The electrochemical sensitivity of the recording paper.
4. Here Edison refers to the drawing (which is on the facing page of his notebook). He proposes replacing his magnetic box (see Doc. 324, n. 2) with a battery of opposite polarity to the one on the main line. Instead of using the discharge from the magnets to counter the static charge, he uses an opposing current from the battery.

My Dear "Tom,"

I am in receipt of yours this morning, and proceed to answer it Immediately as a mail goes out today. In all you say about Batteries I "Copper you & go one better"— I'll explain = You remember I was using the Leclanche between here & Washn. Well as soon as we got Charleston, I moved it down to the Cotton Exchange & put it in operation—results not satisfactory—thought more Battery was wanted—added 100 Cups more—results no better— Whereupon it began dimly & slowly to creep into my Brain that Intensity was not such a great desideratum after all—& that the Carbon Batty was the best

Here I cried Halt— I had gone to the length of my rope— I had tested an Idea of some other man— & found it fruitless

Never having originated any of my Own worthy of mention—I thought my self at a Dead locke, & proceeded to put the Carbon Batty "Where it would do the most good"— That I found to be, of course with the Shunt as awe worked it to Pittsburg Part plain & part magnetic— And now comes the Dawn—

DeLaney & I got to confabing one night as to the nature of this shunt—and we both concluded it was not a ground Shunt at all—but a Metallic Circuit— This Led D. to remark
"Well if we haven't found something new—we have found something that it will be worth while to remember." I did remember it and explained to JCR next day, that my Opinion was that instead of leaking off the surplus Current & giving us greater Intensity this Shunt arranged thus—

being simply a Metallic Short Circuit, Operated to "Increase the Consumption of Material & per Consequence, the amount of Current fed to the Line—still it had not gone through my Darkened mind yet what this Operation really Implied.

That night going over to Phila On a Pullman. Parlor Car. It struck me all amidship, & so demoralized me that Sunday morning found me with Red Eyes & a Headache. I came back Monday am, rushed in to J. C. & told him I was "Excited" & was Either going to Do something at last or prepare for oblivion. I explained how the Shunt Operated to Increase the "Quantity" and reduce the Intensity—How in this New Departure, I found an Explanation of my failure to receive as rapidly from you at Pgh. as you did from me. (I had a Batty—Bought from a chemist—composed of very large stone Cups—Containing Double the quantity of ordinary Carbon) How—also I accounted for no end of funny, & previously inexplicable actions. (My times limited I must "Cut it".)

In short—so satisfied him that quantity was neccessary & in it we would solve the problem of 500 a minute from Charleston. He Immedy authorized me to buy a large quantity Batty & try it. It now stands in Batty room, awaiting trial—two Days have gone by but could not get wire. Your letter comes Confirming my hopes (But also stealing my thunder) Nevertheless—I think the Old partnership, in which Reiff bound you & I—will stand so slight a crucial test—Heres my hand Old Boy on the Extrordinary work you have accomplished among em Britshers—You certainly have had much to contend with, & I tell my Friend J. C. no other man living would have brot. success from out of such a labor-y nthine Complexity—(Big?) & that I am glad I did not go to

The English Venture 618
London—My Love to the Queen—and my regards to all the rest of the Boys Including Jack14 & the Blonde Col.15

Sorry my time is so limited—I'll go you another by next train

E H J

ALS, NjWOE, DF (TAEM 12:1047). Interlined above.

1. Edison's letter has not been found. In view of the speed of Atlantic shipping and Edison's arrival home by 25 June, this letter, as well as Docs. 338 and 339, could not have reached him until after his return.
2. In the game of faro, to "copper" a card means to bet against it. OED, s.v. "Copper."
3. The Leclanche battery.
4. The central cotton market in New York City. See Doc. 131, n. i.
5. Voltage.
6. The Bunsen cell, in which the anode was a carbon rod. It could produce a considerably greater current than the Leclanche cell.
7. Nothing is known of these experiments.
8. "Plain" refers to an ordinary rheostat, a resistance with little self-induction; "magnetic" refers to a coil with an iron core and hence high self-induction.
9. Patrick Delany, a telegraph operator since 1861, was at this time probably assistant general manager of the Southern and Atlantic Telegraph Co.; he was later general manager of the Automatic Telegraph Co. He became a full-time inventor in 1885, developing inventions in telegraphy and other electrical fields. Taltavall 1893, 242-43; NCAB, 13:590; New York Times, 21 Oct. 1924, 23.
12. Doubling the carbon would approximately double the current.
13. A "quantity battery" would have cells arranged in parallel and would probably contain cells capable of producing a heavy current (e.g., Bunsen cells).
15. George Gouraud.

From Joseph Murray

Newark Thursday June 12th 1873

Sir

I Received your welcome letter after I wrote to you1 I stated all in that letter but since I Received yours I wish to post you on some points the Gen.2 does mis you now he wants advise in regards to Manhattan3 and you are his best adviser on the points in question he would like to see you very much—but stick where you are if it is profitable to you dont feel uneasy on account of shop I shall keep it square till you return my pay roll is less than ($300) per week and we are doing very well I made (6) Regesters4 for Bentley5 ($550b)

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Joseph Murray was associated with Edison early in his Newark career and became his manufacturing partner in 1872.

set toy Inst also (25) set of Keys Sounders & Relays also altering Universal to (15) teeth star wheel making parts lighter making them like model of Burgmans Except Break which is Better and different to model also altering stock printers to 15 teeth star wheel they work well in circuit now I am getting along nicely dont fret about shop or your Family all is well here I only want time to fix up all outside bills and partywhich I am doing sloy but sure Edison sell to Fleming or Scalp Hays for that (£100,000) if possible dont wait one hour let it rip Automatic is dead here only when you are present to give it life business is very dull money is worse than ever I got ($3,000) note from Reiff in exchange for my note of same amount I expect Miller will get it discounted for me soon so I can use it to pay off old bills believe me I have had hard time since you left I lost 11 lbs in one month but I shall die in the Harness if I ever do die I often get out of small holes — Unger draws hard on me and no mercy yet I float and mean to come out victorious Reiff feels good over your success so does Harrington they Blow loud for Automatic I met Johnson he told me you wrote to him he feels good but is not our special Friend I know more than he thinks of I shall tell when we meet I keep him in check some he condemned all our Tables and Inst I am doing some little for automatic and they owe us I am nearly square with Gold & stock but Gen Give Thou & Bergman Contract to alter Universal printers in opposition to us they told Gen all new improvements belong then and they would get patent out for said if he did not give them the printers to alter so you can imagine what trouble they were to me in this affair I hope you will kill them when you come home if I dont before I have been nearly wild with all pressure brought to bear on me I now see clear out of the woods Miller has done nothing since you left about Toy Inst WU has not done anything since you left —

I will meet all notes without selling Machinery but I shall be left poore as it takes all profits to meet said demands —

I have said all about business here I want you to stick where you are look after stock printers as Lord Hays is president of London stock Exchange sound him. Callahan arrived here few day ago began by telling how bad Edison printers were they were failure EW Andrews told me there was now in circuit (100) Inst in London — find out from Hays all prospects for future orders as we are now improving them on

The English Venture
fast speed and can make superior Inst than what is now in use. Go see all you can dont work all day & Knight and not see anything. Go outside see every place where you can Get any Ideas from—

I want you to fix Applebaugh if possible he is yours Bitter Enemy yet he is very Friendly to me. Scott is working all possible way against us. Every day I have some part of Inst to take home out of order they are all left on (Gens) desk with complaint and he is out of sorts about Manhattan. He told me if ever one of the altered printers give out he would not let us have anymore work. I shall fix it all right with him on those points Wagner can tell you how these fellows try to beat us by finding fault with Inst without any cause—

our stock printer altered beats all others so does Universal they work fine our tools is now useless for future use on Both Stock & Universal but I shall make them pay for it. We shall yet flourish in all our endeavors. Everything goes nicely. Batchelor does very well he is very cautious about his work— I have all confidence in his honest efforts to do well feel perfectly easy in regards to us in Factory my only fears is with Private line department and Scott on stock Printers. I wanted to alter Transmitter for stock Circuit but Scott said Edison Automatic Transmitter would not do so Kenny altered Hand Transmitter to Go with our printers and the cant find fault with them now. I cut new type wheels for each Inst— Renovate all the old printers make as good as new furnish all part for ($25) each we can do well at this price—now Farewell answer if you can your

J. T Murray

if you want small sum say 50 I shall send it to you

wife & Baby is well fat as she can be they dont suffer she has had ($200) and did not pay one bill out of it. I dont Blame her or find fault with her. I payed intrest in Sav- ing Bank till Jan $175 also $25 to Ross Cross &c also Unger notes several other


1. Neither letter has been found. See Doc. 337, n. 1.
3. The Manhattan Quotation Telegraph Co., organized in 1872 to compete with the Gold and Stock Telegraph Co.
4. Morse receiving instruments.
5. Henry Bentley was a pioneer in intraurban telegraphy. At this point he was building a system in Philadelphia. Reid 1879, 597–601.
6. This may have been a learner's telegraph instrument.
7. Private-line printer.
8. See Doc. 195 textnote.
9. Sigmund Bergmann; see Doc. 313.
10. John Fleming, a London merchant, was one of the men to whom Edison was trying to sell patent rights for his automatic telegraph system (Agreement between TAE, George Harrington, Josiah Reiff, and Smith, Fleming and Co., 2 Sept. 1873, DF [TAEM 10:1261]). Lord William Montagu Hay was chairman of the board of the Exchange Telegraph Co. in London.
12. William Unger held a $10,000 note on the shop (see Doc. 264).
14. Henry Thau (b. 1848?) had been one of Edison's machinists. He had left Edison by early 1872 to establish an instrument-making shop in New York with a partner, David Hermann; by the time of this letter he was in business on his own. Sigmund Bergmann had made for the Gold and Stock Co. a model of the universal private-line printer which incorporated significant alterations (see Doc. 313). Wilson 1872, 539, 1193; Thau's testimony, pp. 61-63, Wiley v. Field; App. 1.D379.
15. Regardless of the truth of the situation or Murray's feelings about the two men, Edison maintained relations with them for many years, calling upon them for important work.
16. W. K. Applebaugh was an assistant superintendent of Gold and Stock, in charge of private lines and the bank department. Later he took an active interest in the Manhattan Quotation Telegraph Co. and the Domestic Telegraph Co. "Private Telegraphy," Telegr. 9 (1873): 19; Reid 1879, 622, 633.
17. George Scott.
18. G. Wagner was a Western Union employee. Reid 1879, 626.
19. Evidently the design of the printers was sufficiently altered to require new patterns and jigs. See Doc. 280, n. 16.
20. A modification of the transmitting portion of the universal private-line printer. See Doc. 211.
22. That is, a breakwheel.
23. Marion, born 18 February 1873.

New York June 13/73

From Edward Johnson

My Dear Edison—

I have been cogitating and experimenting considerable of late and have come to the conclusion that I know a thing or two about the why's & the wherefores of results obtained =

1st = I started out to discover why the shunt at transmitting station Improved the writing, I having a notion that it was something more than a mere leak with a counter acting attachment = I found that Instead of it being in the form of a leak—thus—

The English Venture
It was—a reality no leak at all—but simply a short circuit around the Batty (as we had accidentally always made it)—thus—

—Now the effect of this is—not to leak off the Battery—but simply to violently excite it into action, & force its quantity production = You might say that—Putting the shunt to a separate ground, & thus destroying the metallic connection—was in reality short circuiting the Battry & would produce the same result—but it don't—I have tried it—as in first diagram a Dozen times, and it produces no marked good results—while the Instant you put the ground shunt ground & the Battty ground together their is an Illumination = and wondrous results are obtained = I deducte from this that the violently exciting of the the Battry by the metallic circuit produces great quantity—without giving it an Outlet—except by the wire—while the separete ground—or ground proper—excites it and absorbs it at same time —so much for that. Col Reiff thinks it Impt. that you should know of this discrimination, that I have discovered existing between the Ground proper, & the metallic circuit, as you may not have thought of it yourself, and might possibly get on the Ground shunt—in some of your experiments & “Wonder why you didn't obtain the proper results”

Now for another feature = You reccollect, when the Insts. were made you proposed to put zinc to line—saying “If You would just as soon have it that way I'd prefer it, as it will save Insulation”. I told you it didn't make a particle of difference to me—

Now I'm of a different Opinion—"CN" calling for "Reds" Hold up a min “-.--” “-.--” “-.--” Ha! = Inst took 20 minutes to get 16 Reds & copy them with only one man, and that on the Franklin wire from here to Washn—& the S[outhern] & A[tlantic] from there to Chastn with all the Paralel wires working & Induction fearfu l heavy, & not a single msg—repeated—aor correction made—or a word asked for—nothing but OK’s & Ya’s & a final OK Ya’—in just 25
mins from time first got him—Morse working thro. repeater at Washn—& auto working straight—Button cutting out Repeater at each Ya—& cutting in at end—Relay shunted for Indicator at Washn?—Hows this?— = It does make a difference By receiving on from the Ground & using shunt at transmitting station I figure the Operation to be this =

The current from Batty is sent out of Batty at each closing— & performs the the following work—

  1st Sends the working current to receiving station by the ground Earth—

  2d Engenders in the Wire upon its return (or completion of ckt)—the static—which, passing into the earth at transmitting station shunt (or leak) flies thro the earth again on its round trip (the ckt being continuous insofar as the static current is concerned) [-] passes on to the paper just behind the working current—thus causing a tailing =

  3d Charges the magnet in the shunt violently—causing it to send a powerful countercharge on the Wire

Here are 3 operations performed by the main Batty— Now I find that to use a long shunt at transmitting station, You must “cut” it at receiving end—to get rid of the pursuing static = & this cutting—so weakens—what current has come through that the writing is very fleeting—& soon disappears— While If you use a short shunt and “cut” it like the Dickens—at transmitting station—no sRheo—is needed at all at Receiving end & all the current arriving is utilized— the effect being, to make the writing very Dark & heavy—which is the effect obtained— My theory is—that the static flows principally out of the wire at Transmtg end, as at that end—the wire being the heaviest chgd—the most static is engendered— & the operation of the magnet in the shunt is to meet & annihilate this “Major” static before he enters the earth—from the wire, & thus operates to prevent any static from passing on to the paper except what comes from the wire back into the earth at receiving end, & that of course comes underneath the paper = & is not noticeable = This looks as if I should then at all times be able to receive on Direct current by a regulating shunt at Trans end—which I now do = not using a Rheo. for either Washn or Chastn = My opinion being that by so doing you obtain these results

  1st Getting Receiving station nearer centre of Circuit =

  2d Annihilation of static at point where it practically originates

  3rd The Consequent ability to utilize all the whole volume of current that arrives

*The English Venture*
Am I sound—or can you pick me to pieces— I Certainly have good ground for my deductions, since I have practical demonstration of the effect that my theory Implies.

Let me hear from you—I am so Infernal busy that I haven’t time for a word beyond such as are actually neccessary to express my Ideas—otherwise I should bedaub your high flown sentences about ‘em Britishers My regards to Jack† Yours

E H Johnson

Let me put it briefly this way— = Use your Box in a place where it does not operate to carry part of the current to the Ground—but still operates to Destroy the static current— Is’nt that quite a discovery for an amatuer—to be shure we have done it for a long time—but none of us discovered the fact &made a proper use of it—until now—I’ll be a good pupil of ure’s yet.—this is it plainer

ALS, NjWOE, DF (TAEM 12:1051). †Followed by a series of marks that may represent Morse code characters. ‡Separated from key to figure by rule.

1. See Doc. 337, n. 1.
2. A “leak” is current that is inadvertently flowing to the ground.
3. The label on the drawing is “Magnetic & Plain.”
4. Compare the following sketch and description with Doc. 317. The figure label is “M & P.”
5. That is, elicit a greater current.
6. Charleston, S.C.
7. The meaning of “Reds” is unknown. Perhaps short for “red hots”—that is, urgent messages.
8. “—” was the American Morse signal for the numeral “i.”
9. Johnson was receiving messages from Charleston on a chemical receiver. “All the Paralel wires working & Induction fearful heavy” would normally produce an indistinct signal, but the apparatus delivered clear messages. At the end of each message, Johnson had to acknowledge receipt by signaling Charleston with a Morse key (“OK’s & Ya’s”). An operator in Washington, D.C., alerted by an indicator, switched a repeater into the circuit for Johnson’s acknowledgment and switched it out again for the next automatic message.
10. That is, if a high-resistance shunt is used on the transmitter, the current must also be shunted (“cut”) around the receiver. However, if the transmitter shunt has little resistance and a significant portion of the current is diverted there (“cut it like the Dickens”), no shunt is needed at the receiver.

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12. Andrew Ure, a British chemist and scientific writer, published a number of popular works on science and technology. *DNB*, s.v. "Ure, Andrew."

New York, June 24 1873

My Dear Edison—

I enclose a new pen—1/3rd the diameter of those in use—\(^1\)
I find by it I prolong the Dot 3 times, or thereabouts—and am thus enabled to cut as much as I please & yet get a full "Morse Key" Dot= \(^2\) which is simply Increasing the size of Holes—with minus a proportionate Increase of speed of running the paper—I also find absolute perfection of Dashes\(^3\)—so that I can send slow & "copy by sound" without being able to detect the slightest jar in the Dashes—or any of that short jerky writing =

I am having this Patented in your name,\(^4\) as also the metallic short circuit arrangement—\(^5\) They merely go in as supplements to your patents—Try this Pen, & then give me your opinion  Hastily Yours  

E H Johnson

Keep\(^c\) this to yourself as It is the only DSize that will give maximum speed  EHJ


1. That is, a transmitting stylus for the automatic telegraph. Probably Johnson knew by this time that Edison would soon be in Newark.
2. Meaning not clear.
3. Two pens side by side were used to transmit; dashes were formed by punching overlapping holes alternately rather than by making a long hole. See Doc. 142.
4. Johnson could not legally patent an invention of his in Edison's name and did not; nor was this invention patented in Johnson's name.
5. See Docs. 337 and 339. Edison had already executed an application for this circuit (U.S. Pat. 147,313) on 23 April, before leaving for England.