THE SIEMENS-HELL PRINTER

A NOVEL TELEGRAPH SYSTEM

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EVERY telegraph system introduced since the days of smoke-signalling and shield-flashing represents an attempt either to obtain more rapid and reliable results under existing conditions or to take advantage of some new discovery offering increased possibilities. The system here under notice belongs to the first class. In the early 1930's, when this system was first introduced, methods of signalling on open-wire and cable circuits were varied and rapidly developing, but systems employing the morse code were still universally used for wireless telegraphy. A glance at the basis of the principal telegraph systems in use at that time will show wherein the novelty of the Siemens-Hell system lies.

Basic Systems

The most familiar systems are, of course, those employing the morse code, wherein the letters of the alphabet are represented by arbitrary combinations of a small number of dots and dashes, i.e. short and long signals. Development in Morse apparatus has been in the invention and perfection of instruments for transmitting and receiving messages automatically at steady high speeds so as to make the most economical use of expensive lines. The other most popular telegraphs, the Baudot and the teleprinter, both employ a code in which each letter is represented by an arbitrary combination of five signal units of equal length.

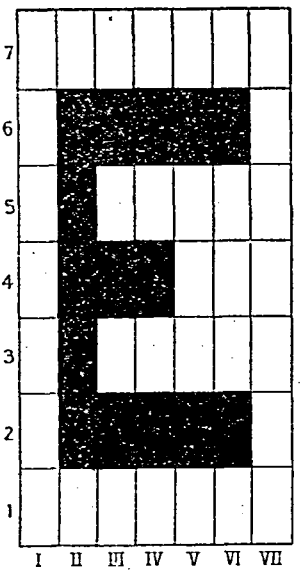

Fig. 1.—Basic build up of letters

Quite different in principle, but equally important in relation to the Hell system, is picture telegraphy. Here the matter to be transmitted, whether a picture or a page of print, is scanned photo-electrically, in successive narrow strips, and reproduced at the receiving end by what amounts to a reversal of the transmitting process. It will be appreciated that the electrical signals transmitted in picture telegraphy are directly related to the visual appearance of the matter concerned and are not linked with it by an arbitrary code.

Now it is well known that radio reception is liable to be marred by "fading" and by atmospheric disturbances. Under such conditions signal elements of a radio telegraph message will occasionally be suppressed due to fading, and false elements will be inserted by atmospheric "noises." If an arbitrary code is being used such alterations will completely alter the sense of the received message. An experienced telegraphist receiving Morse by ear can make an

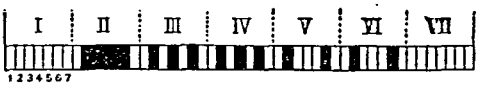

Fig. 2.—Impulse train produced by scanning Fig. 1

intelligent guess at the meaning of such signals, but a teleprinter can exercise no such discretion, and a wrong letter will be printed. With picture telegraphy, however, such disturbances can only result in the appearance of black or white specks on the received picture, a defect which rarely makes the picture unrecognizable.

Impulse Trains

It was this good feature of picture telegraphy which prompted the German engineer Hell to apply the same principle to a printing telegraph. His original instruments have been developed and commercialized by Siemens and Halske and are now widely used for wireless telegraphy under the name of Siemens-Hell Printer. In this system each letter of the alphabet is imagined as laid out on a rectangular grid of seven (originally twelve) units either way (Fig. 1). If such a letter were scanned photoelectrically, as in picture telegraphy, one vertical strip at a time, from left to right, the electrical impulse sequence would be as shown in Fig. 2.

In the Hell transmitter, therefore, each letter is represented by a cam disc, having its periphery cut in a manner corresponding to such an impulse train (Fig. 3). When the instrument is in use all these discs rotate on a common spindle at uniform speed. Above each disc, and just clear of it, is mounted a pair of contact springs. All these pairs of contacts are wired in parallel in the control circuit of the telegraph line or radio transmitter. The contacts are normally separated, i.e. no signal is sent out, but when it is desired to send out a particular letter a tongue of metal is inserted between the corresponding cam-disc and the lower spring of the associated contacts. The cam then causes the contacts to close and open and send out to line a series of impulses precisely similar in their timing to those which would have been produced by scanning the same letter strip by strip in a picture-telegraph transmitter.

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Practical Forms of Transmitter

The transmitter is made in two forms, manual and automatic. In the former, the insertion of the tongues between the cams and their associated contacts is effected by the operation of a keyboard similar to that of a typewriter. In order to guard against the depression of a second key while a letter is in course of transmission, a mechanism actuated by a cam on the main cam spindle locks the keyboard except for a short period in each revolution. Rhythmic operation of the keyboard is thus essential. The speed of this machine is 2½ letters per second. In the automatic transmitter which runs at double this speed, the in-

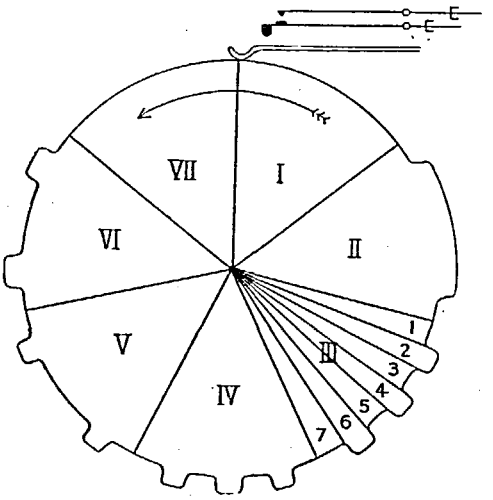

Fig. 3.—Diagram of cam disc for producing a letter E impulse train

sertion of the cam-following tongues is controlled by a perforated strip of paper exactly similar to that used in the teleprinter automatic transmitter, i.e. having holes corresponding to the "marks" of the five-unit teleprinter code punched in rows across the width of the strip. This paper-strip is prepared beforehand on a perforating instrument with a keyboard like a typewriter. The principle is essentially the same as that used in the Jacquard loom, where the combinations of heddles required for the weaving of a complicated pattern are selected in rapid succession by the automatic exploration of a previously perforated card.

Receiving Equipment

The receiving apparatus is very simple in its operation. As will be seen from Fig. 4 it consists of (*a*) an electromagnet having a blunt knife edge on the extension of its pivoted armature, (*b*) a spindle with a raised helix on its surface, mounted above and just clear of the knife edge, and rotating seven times as fast as the cam shaft of the transmitter, (*c*) a device for feeding a strip of paper slowly between the knife edge and the helix. An impregnated felt roller (not shown), riding on the helix keeps it moistened with ink. When the electromagnet is energized, i.e. when a signal is received from line, the knife edge presses the paper strip against the rotating helix and causes a line to be drawn across the strip by the point of contact. According to whether the signal received is continuous (line II, Figs, 1 and 2) or broken (line III, Figs. 1 and 2) so either the armature will be permanently attracted and a continuous line be drawn across the paper or it will be alternately attracted and released giving a broken line across the paper. The slow continuous feeding forward of the paper-slip causes the lines to slope slightly and to follow each other across the paper in regular succession. The letters are thus built up from small elements, just as in picture telegraphy but with this difference, which in news transmission is all-important, that each letter is visible and intelligible immediately it is printed without any waiting for the complete message to be printed, developed and fixed. In order that each letter shall be printed completely at least once in the width of the paper slip, the printing helix is taken twice round its spindle. Thus there are two points of contact between the helix and the paper and two impressions of each letter are produced in the width of the paper. One impression may be divided but the other will always be complete. The effect of a discrepancy between the speeds of the transmitter and receiver is that each transverse line is staggered with respect to the preceding one, and the lines of print thus run off the paper in a direction depending on which machine is the faster and at an angle depending on the magnitude of the discrepancy in speed. One impression of each letter will however be complete and legible.

Fig. 5 shows the appearance of printed strip typical of (*a*) perfect synchronism, (*b*) receiver

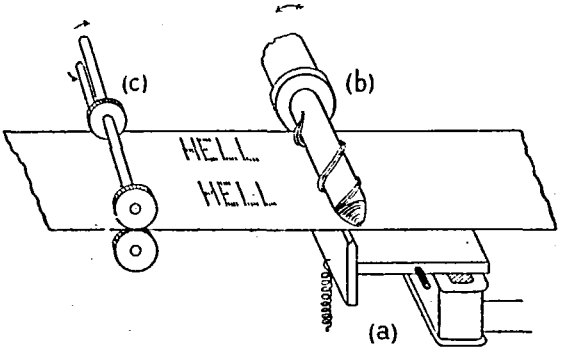

Fig. 4.—Diagram of receiving mechanism

running fast, (*c*) receiver running slow. The receiver is fitted with a combined centrifugal governor and speed regulator which can be adjusted while the machine is running. It is thus easily possible to remove any obliquity in the lines of print without interrupting reception.

From the foregoing it will be appreciated that where Hell instruments are used on a radio link the effect of fading is to suppress the incoming signal, with the result that the armature is not attracted and no line is printed, whilst atmospheric "noises" cause the armature to be attracted when it should not and marks to be made where the paper should be blank. Even when these disturbances are of sufficient magnitude and duration to make teleprinter or morse working by radio impossible, they rarely preclude Hell working.

The chief use to which the Hell system has been put is the broadcasting of news by press agencies. As the traffic in such circumstances is in one direction only and is not necessarily continuous, it is desirable that the transmitting station should be able to start and stop the motor of the distant receiving machine. This is effected by sending special signals of greater length than those occurring in the transmission of letters.

For use in permanent situations the automatic transmitter has practically ousted the keyboard instrument. This latter has, however, recently

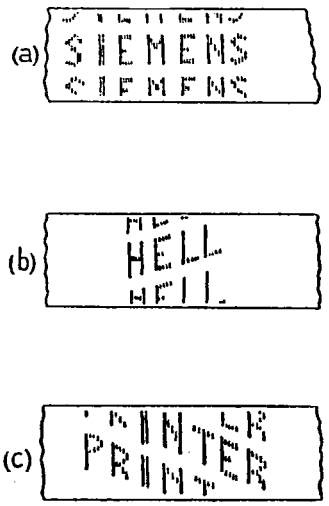

Fig. 5.—Typical correct and incorrect records

found wide use in a simplified and portable form known as the Siemens-Hell Fieldprinter. This instrument, designed primarily for operation from two car batteries, has a normal transmitter, receiver and appurtenances all under one cover. The chief simplification is in the transmitter where the cam discs have been replaced by a drum made up of a series of rings with conducting and insulating segments. The contacts and cam-following tongues of the normal transmitter are replaced by brushes which are brought into contact with the drum by the operation of the keyboard.

Enough has been said to show how novel yet simple in conception the Hell system is. The keyboard transmitter and the perforator on which the punched slip for the automatic transmitter is prepared can be readily operated by typing staff, whilst reception involves only periodic collection of the printed slip and occasional slight adjustments to the speed regulator. Furthermore, both the transmitter and the receiver are comparatively simple to maintain. Why then has this system not been more widely adopted? The answer is a very familiar one—"You can't get something for nothing." The fidelity of reproduction afforded by the Hell system is only gained at the expense of transmitting for each letter a number of signals far greater than is required in any other system of telegraphy. Thus if the rate of printing letters is to be comparable with that of other systems, the number of signals to be transmitted in a given time will be correspondingly greater than in these systems. This feature limits the number of such telegraph channels which can be accommodated within a given frequency band and, for working on land-lines free from interference currents, places the Hell system at such a disadvantage compared with, say, the teleprinter as to exclude it from this field. For use on radio links, however, the Hell system is almost unrivalled and, unless some really effective direct means of counteracting fading and atmospherics is developed, may well become the standard telegraph system for radio working.

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SHIPS

The watery heavens choke, and chill,
Whilst yonder ghostly gossamer of steel
Looms shadowy and large.
Here a great engine, cold and still,
Fades, then grows to a huge and ancient beast;
And there a stately ship glides slowly by,
Like a vast amphibian of Earth's young days.

Whilst walking through the mist in Northern sky,
I lost myself a thousand ages past.

JOHN GRAY.