TELEPHOTOGRAPHY

By CHARLES A. PARKER, '32

Operating in Boston, New York, Atlanta, Cleveland, St. Louis, Chicago, Los Angeles, and San Francisco, the Bell System offers a unique service in the field of communication, the transmission of pictures over its telephone lines. An account of how telephotography, as this is called, serves the press and business world would be one of great length because of the many uses to which these telephotos are put. The dispatching of picture "scoops" by the press, the transmitting of drawings, data, detailed advertising, and even fingerprints are a few of the uses.

But, interesting as the commercial applications of telephotography are, the method by which these pictures are sent distances as great as the width of our continent is even more interesting to the engineer or layman.

A general conception of how telephotography works may be obtained by talking in terms of the ordinary stereopticon. It is apparent that if a stereopticon were so adjusted as to cast its picture on a sensitized film instead of the customary screen, a negative would be obtained which, when developed and printed, would be identical to the original. In this case the sensitized film was exposed over its entire surface at the same instant. Now let us modify our stereopticon a little. Instead of the lamp shining through the whole plate at once, we will confine it to one point at a time by narrowing our source of light down to a single needle-point beam. If we move this beam up and down the width of the plate, translating it across the length, we will find when we develop and print the negative that our picture is made up of a number of parallel lines. The number of lines per unit width will, of course, determine the quality of the picture. If an opaque screen were placed between the stereopticon and the film, and some sort of a circuit were arranged to convert the parallel lines of light in their succession into electric current, and again some device were designed to convert the current back into light shining on the sensitized film, it can be seen that the picture could still be secured on the film. The answer to these "ifs" is telephotography, to the details of which we will now turn.

At the sending end, the picture to be transmitted is reduced or enlarged to a 5-inch by 7-inch positive, this being the standard size of telephotos. This positive is placed on a cylindrical rotatable framework with the 5-inch width as a circumference. The framework is then placed on the shaft of the sending machine. A beam of light shines through the positive transparency upon a photoelectric cell. The beam of light analyzes the transparency much in the same manner that the needle on the old type phonograph traverses the surface of the cylindrical record. But, whereas the record merely rotates and the needle-arm of the phonograph swings on a horizontal plane, our beam of light remains stationary and the cylinder advances .01 inch per revolution. This continuous line of light, as we said, shines on a photoelectric cell mounted inside the rotatable framework. It is this piece of apparatus that converts the light into proportional electric current.

The principle of the cell is that the light striking the alkaline cathode causes electrons to be emitted. These electrons are attracted to a biased anode. The very weak currents set up a potential across resistance, which is applied to the grid of an amplifying element.

A modulated 1300 cycle carrier frequency serves to carry the picture impulses over the line. The side-bands are from zero to several hundred cycles in width. In order to suppress the direct current components and harmonics from the modulator, a transformer and band filter are inserted. A single element terminal amplifier, with monitoring arrangements, is connected between the filter and the line.

The transmission of the modulated 1300 cycles is strictly a telephone proposition, even though there are a few considerations not ordinarily encountered. The problem now is to receive the picture. As in the sending circuit, we have connected at the junction of the apparatus and line a

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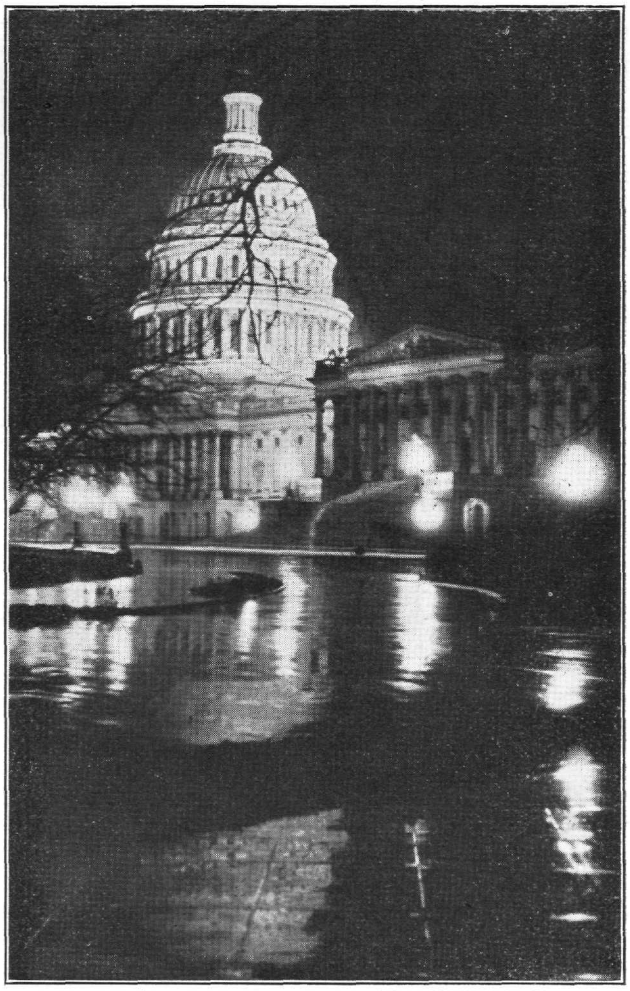

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terminal amplifier. A band-filter is then inserted, the function of which we will describe in taking up the synchronization of the sending and receiving machines. The two element amplifier next encountered serves two purposes: first, the starting of the receiving machine when the sending machine momentarily cuts off the carrier frequency at the beginning of the transmission; second, the amplification of the carrier and its side-bands after the transmission is under way. The heart of the receiving set is a light valve, which, under magnetic control, causes the width of an aperture to vary proportionally with the incoming current. The receiving machine contains a cylinder on which is rolled the 5-inch by 7-inch sensitized film on which the picture is to be received. This cylinder rotates and advances in the same manner as the sending machine, and, by a control system, runs in exact synchronism with it. The light from the light valve then traces on the revolving cylinder a continuous line. This gives us the negative, which when developed will be seen to be made up of fine lines, almost too fine to be seen without a glass. As we said, the cylinder advances .01 inch per revolution. The shaft rotates at 90 R. P. M. and the length of the cylinder is 7 inches. That means that there are 100 lines to the inch and that 7.77 minutes are required for the transmission.

The question of synchronizing the two machines is a most important one. If there is any discrepancy in the starting of the two machines or any change in the speed of either machine during the

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transmission, the picture will be spoiled. I remember seeing one picture in which a decapitated gentleman was standing above his own head all because the receiving machine did not start soon enough. The starting of the receiving machine, as was mentioned, is controlled by the sending machine's cutting off the carrier frequency, thus stopping the space-current in the second element of the receiving picture amplifier and operating a relay. The speed of the two machines is regulated by a speed control channel, separated by band-filters from the picture channel. This channel operates at a frequency of 480 cycles. At the sending end a 60 cycle tuning fork interrupts this control frequency, and by other contacts operates itself and drives the sending motor. At the receiving end this interrupted control frequency is detected, operating a relay and in that way driving a tuning fork with a natural period of vibration of 60 cycles. This fork serves to drive the receiving motor at the same speed as the sending motor. The method by which the forks do this is, briefly, that the fork contacts control the connecting of the D. C. supply to the field magnets of the synchronous motors.

Our final consideration is the line over which the channels are transmitted. The line used must be selected with regard for the length involved. For instance, a 500 mile circuit could not be composed of heavy-loaded cable because of the transients and phase distortion. Fifty miles of such cable is the maximum over which satisfactory transmission can be obtained. With that point taken care of any standard telephone circuit, cable or open wire, may be used. Any circuit satisfactory in frequency characteristics is satisfactory for picture transmission. Several conditions affecting telephone transmission affect picture transmission equally, while others may affect one more than the other. On a telephone circuit a momentary interruption or noise may necessitate only the repetition of a couple of words; on the picture circuit this means a repetition of the whole picture. Therefore, the picture circuit should be free from the action of regulating devices such as pilot-wire regulators during the transmission of the picture, and from such conditions as echo, line noise, and static. The problem of maintaining the proper levels is extremely important since the control and picture channels will modulate if the level is too high, even though there is no overloading at the repeaters.

Providing that the transmission of a telephoto has evaded all the pitfalls enumerated, and it almost invariably does, the received picture is exceptionally satisfactory. It bears none of the whorls and waves that newspaper reproductions of radio-transmitted pictures have led many people to imagine are a part of all electrically transmitted pictures. The accompanying picture was made from a negative secured by the process of telephotography.

INSISTENT

He: I want to marry your daughter.

Father: Have you seen my wife yet?

He: Yes, but nevertheless I prefer your daughter.—*Sawdust.*