

Touch-Tone telephone sets require more detailed testing than conventional sets. A special frequency test circuit has been developed for these tests.

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Testing the TOUCH-TONE Telephone Set

A STANDARD PART of telephone installation is testing the newly installed telephone set to make certain it functions satisfactorily. This testing has been fairly simple in the past—usually involving little more than a check on the telephone set ringer by means of a station ringer test circuit located in the central office. However, for the newly developed TOUCH-TONE telephone sets, a more detailed procedure is necessary. In addition to the “ring” test, the TOUCH-TONE set requires a test on the pushbuttons and transistor oscillator to determine if satisfactory frequencies and tone levels are being generated for each digit.

To accomplish this, a common systems TOUCH-TONE frequency test circuit has been developed that will connect into and work with the station ringer test circuits of the various telephone systems. These tests can be made by the installer from the customer station without aid from the central office.

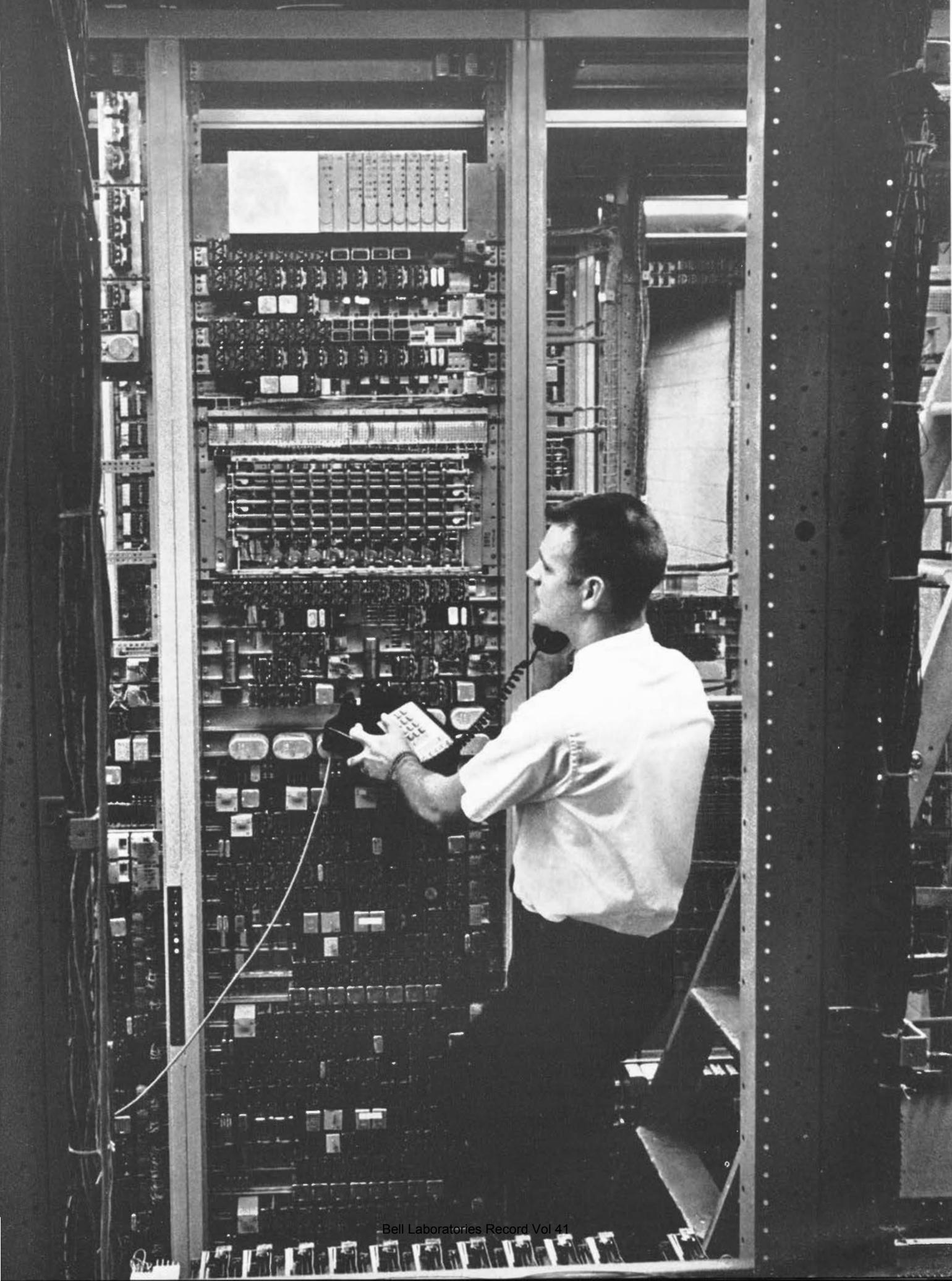
If trouble is suspected after the initial installation, the TOUCH-TONE test circuits can be connected to a customer line under control of the local test desk. The test man can then instruct the customer to key his TOUCH-TONE set to test the digits. By eliminating the telephone set as a cause

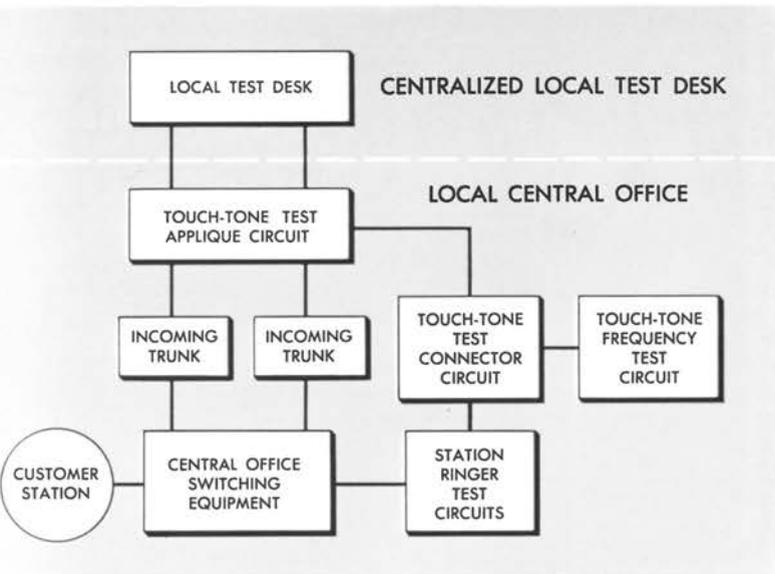
of the trouble, unnecessary service trips to the customer will be avoided.

The TOUCH-TONE test equipment consists of a connector and a frequency test circuit as shown on page 356. The station ringer test circuits for each system are modified to connect to the TOUCH-TONE test connector circuit. The TOUCH-TONE test connector circuit is composed of a single 100 point crossbar switch and associated control relays. It provides for connecting a maximum of ten inputs to a maximum of four TOUCH-TONE frequency test circuits. The inputs may be either station ringer test circuits or TOUCH-TONE test applique circuits.

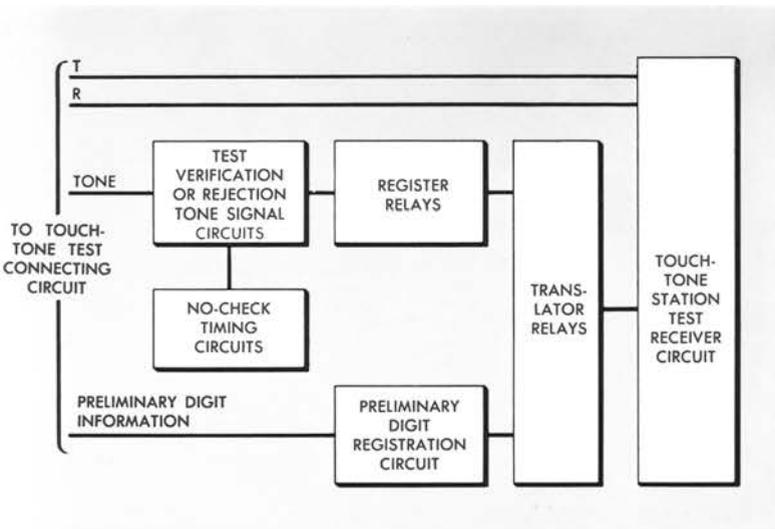
The TOUCH-TONE frequency test circuit employs a special test receiver associated with it. The receiver is less sensitive and has a narrower bandwidth than the TOUCH-TONE receivers used in service. With this feature the telephone TOUCH-TONE dial will fail in the test before it fails in service. The output of the test receiver operates translator relays that control register relays for

J. L. Buckingham observes operation of the Touch-Tone test equipment in the Columbus, Ohio Laboratory as he “dials” a test call.





The diagram above shows interconnection of the Touch-Tone test units with existing central office equipment.



Functional Touch-Tone test circuits parts are shown above.

each "good" digit dialed. At the conclusion of the test either a verification or a rejection tone signal is sent to the calling station indicating the condition of the TOUCH-TONE set.

The amplitude of the TOUCH-TONE signals delivered to the receiver depends on the impedance termination across which the receiver is bridged. Therefore, the impedance presented to the test receiver in the TOUCH-TONE test circuit is the same as the impedance encountered by a regular receiver on a service call.

The impedance presented to a TOUCH-TONE receiver on a service call is determined by the ap-

paratus across the line at the digit receiving circuit (Originating Register in No. 5 crossbar, for example). This apparatus is different, and therefore the impedance is different for each type of system and is also affected by the amount of current flowing in the station loop.

Since the station ringer test circuit terminates the station loop on a test call, the supervisory apparatus across the line in that circuit is identical to that provided in the standard digit receiving circuit employed in the particular switching system involved.

On a service call, dial tone is present when the first digit is dialed into a TOUCH-TONE receiver. Therefore, all digits are tested with the dial tone present. The dial tone used with the test circuit is identical to that used for regular TOUCH-TONE service in the office.

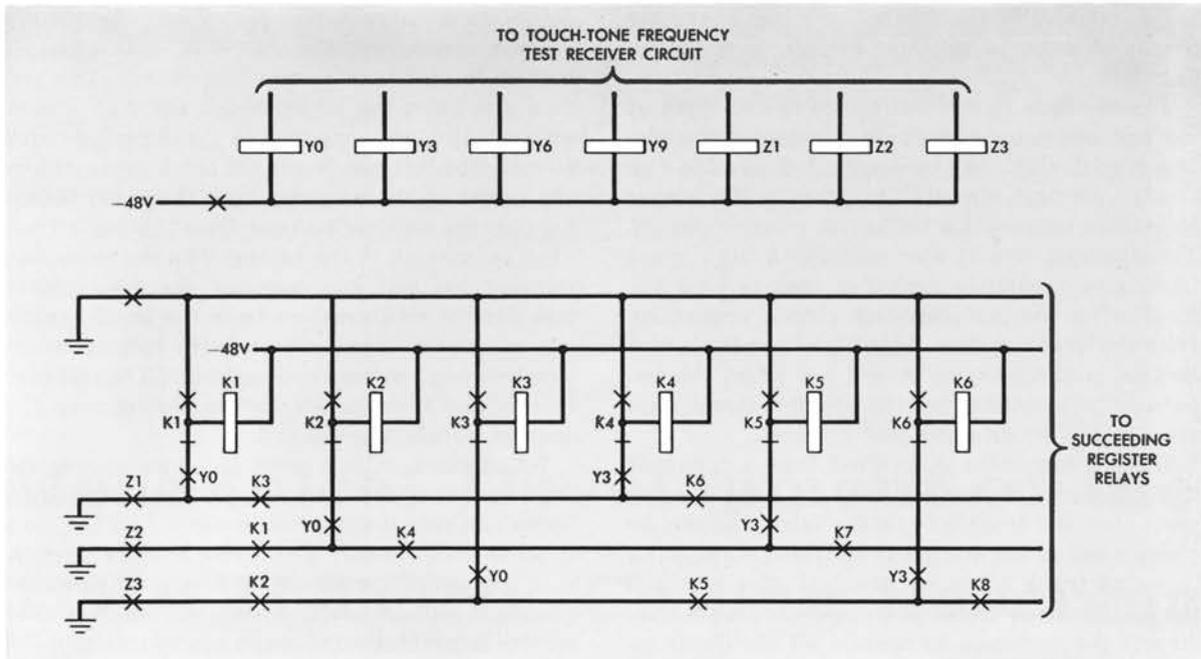
Special code connects test circuit

When an installer wishes to check the dial or ringer of the telephone set he has just installed, he dials a special code that causes the central office switching equipment to connect his set or line to a station ringer test circuit. Upon seizure, the station ringer test circuit connects to an idle TOUCH-TONE frequency test circuit through the TOUCH-TONE connector circuit. Dial tone from the TOUCH-TONE test circuit is then sent to the calling station as an indication that the test circuit is ready to receive the dial test. If all of the TOUCH-TONE test circuits are busy, no tone will be heard by the installer until one becomes idle and is connected to the ringer test circuit he has seized.

If the station being tested is a rotary dial telephone set, use of the TOUCH-TONE test equipment will not be required. In this case, the installer flashes the switchhook or dials a digit immediately after receiving the test circuit tone so the TOUCH-TONE test circuit will be disconnected and available for other test calls. This action also advances the station ringer test circuit to prepare it for the ringing test.

For a TOUCH-TONE telephone set a preliminary digit is first dialed (if required by the particular system involved) to indicate the type of ringing to be sent to the station on the ringing test. (Different types of ringing signals are used for selective ringing on party lines.) This information is transferred to the station ringer test circuit and stored there for later use in the ringing test.

A preliminary digit is also required if the station is a 4-wire telephone set to inform the frequency test circuit that 12 digits instead of 10 will be checked on the keyset test. (Four wire tele-



This partial schematic of the test circuit shows digit translation, registration, and check circuits.

phone sets have two extra keys—priority and special grade.)

Following the preliminary digit, the installer dials all the digits in numerical sequence. The frequencies generated by a TOUCH-TONE station consist of four in a low band and three in a high band. Each digit consists of one frequency from each band. As each digit is keyed, the pair of frequencies corresponding to that digit is sent over the customer line and picked up by the receiver in the test circuit. For each digit that satisfies the test receiver as to frequencies and levels, the receiver supplies output current from one transistor in its high band frequency group and one transistor in its low band frequency group to operate translator relays in the test circuit.

The illustration on this page shows a simplified diagram of the translator and register relays. The translator relays are designated to form an additive code arrangement. For example, when digit "5" is keyed, translator relays Z2 and Y3 operate. The translator relays operate register relays for each digit. A register relay, on operation, locks operated and prepares a path for the operation of the next register relay. Thus, all register relays must operate in sequence. If all the register relays operate, a verification tone signal is sent to the calling station immediately following the last digit dialed. If one of the digits fails to meet the requirements of the test receiver, the translator relay for that digit will not be operated and the

chain of operation for the register relays will be broken and none of the succeeding register relays will operate. In this case, a test rejection tone signal will be sent to the calling station following a no-check timing interval. The verification or rejection tone signals also serve as an indication that the test circuit has reset itself so the dial test may be repeated, if desired.

When the installer is satisfied with the dial test, he flashes the switchhook or merely hangs up to release the TOUCH-TONE test circuit and to prepare the station ringer test circuit for the ringing test. In either event the telephone handset going "on-hook" causes a current from the ringer test circuit to test the telephone set's ringer. Ringing continues until it is tripped by lifting the handset from the switchhook. With the ringing test completed, placing the handset on-hook concludes the call.

Local test desk checks dial

As previously stated, the TOUCH-TONE dial may be checked by the local test desk man with the cooperation of the customer. The local test desk may be located in another central office. A centralized local test desk may serve many local central offices of different types (i.e. Crossbar No. 1, Crossbar No. 5, SXS or Panel). In order to gain access to the TOUCH-TONE test equipment from the local test desk, the incoming trunks from the local test desk for each switching system are modi-

fied to connect to the TOUCH-TONE test *connector* circuit through an applique circuit, as noted on page 356.

The applique circuit has access to one input of the test connector circuit. It terminates the station loop during the test—arranged like the station ringer test circuits—to present the proper impedance termination to the test receiver circuit. The applique circuit also contains a high input impedance transistor amplifier that is used for monitoring the customer-test circuit connection from the local test desk. This high impedance connection is necessary so it will not affect the impedance termination that the applique circuit presents to the TOUCH-TONE test receiver.

When a complaint is received from a customer having trouble placing calls and the test man suspects that the trouble is in the telephone set, he places a call to the station to be tested through an incoming trunk in the local central office to which the station to be tested is connected. He then instructs the customer to operate all the digits on his telephone set dial in numerical sequence when the customer hears dial tone. With instructions to the customer completed, the test man operates a key that causes an idle TOUCH-TONE test circuit to be connected to the incoming trunk through the

TOUCH-TONE connector and applique circuits.

Upon connection, the TOUCH-TONE test circuit transmits dial tone to the station set. The test man also hears the tone through the high impedance monitoring connection in the incoming trunk circuit. The test man hears the tones generated by the subset as the customer keys them and listens for the test verification tone from the test circuit upon completion of the keying. The test man then releases his test key, causing the TOUCH-TONE test circuits to disconnect from the trunk circuit and return the trunk circuit to the talking condition between test man and customer. The test may be repeated if necessary, or the parties may disconnect, concluding the call.

TOUCH-TONE calling provides more convenient and faster service for customers. The average customer can TOUCH-TONE call in about half the time it takes with a rotary dial. These test features insure top operating condition for newly installed telephone sets. In addition, continued high quality service is maintained through procedures supplied for rechecking the telephone set with customer cooperation without visiting the customer premises.

Testing in this manner provides a minimum of inconvenience to the customer and a minimum of expense to the telephone company.

New Bell System Book On Satellite Communications Physics For High School Students

How do you calculate a satellite's orbit? What color should a satellite be? These questions and others like them are answered in a book titled *Satellite Communications Physics*, prepared by some of the scientists and engineers who designed and developed the Telstar satellite. The 88-page illustrated book is Bell Laboratories' most recent aid to high school science education. Teachers and students may obtain copies, without charge, from local Bell telephone companies.

Part 1 explains some of the reasons for communicating by means of man-made satellite, describes the progress made in space communications, and points out some of the problems that had to be solved. It was written by the editor, Ronald M. Foster, Jr. Part 2 contains six case histories about the problem-solving techniques involved in designing a communications satellite, keeping it working in outer space, and repairing

it even after it has been placed in orbit. The authors are Franz T. Geyling, Peter Hrycak, Joe S. Courtney-Pratt, Kenneth D. Smith, Peter D. Bricker, and E. Jared Reid, all of Bell Laboratories.

Satellite Communications Physics is written to give science students an idea of "what it feels like" to confront some of the actual problems encountered by scientists and engineers who worked on the Telstar project. Each problem is taken from a somewhat different technological area: aerospace mechanics, mechanical engineering, optics, electronics, psychology, and electrical engineering. In each case the solution of the problem is based on fundamentals—on basic principles of classical physics taught in high school.

The book is challenging and satisfying to teachers and students seeking some understanding of the physics of satellite communications.