

Aug. 20, 1946.

R. D. PARKER

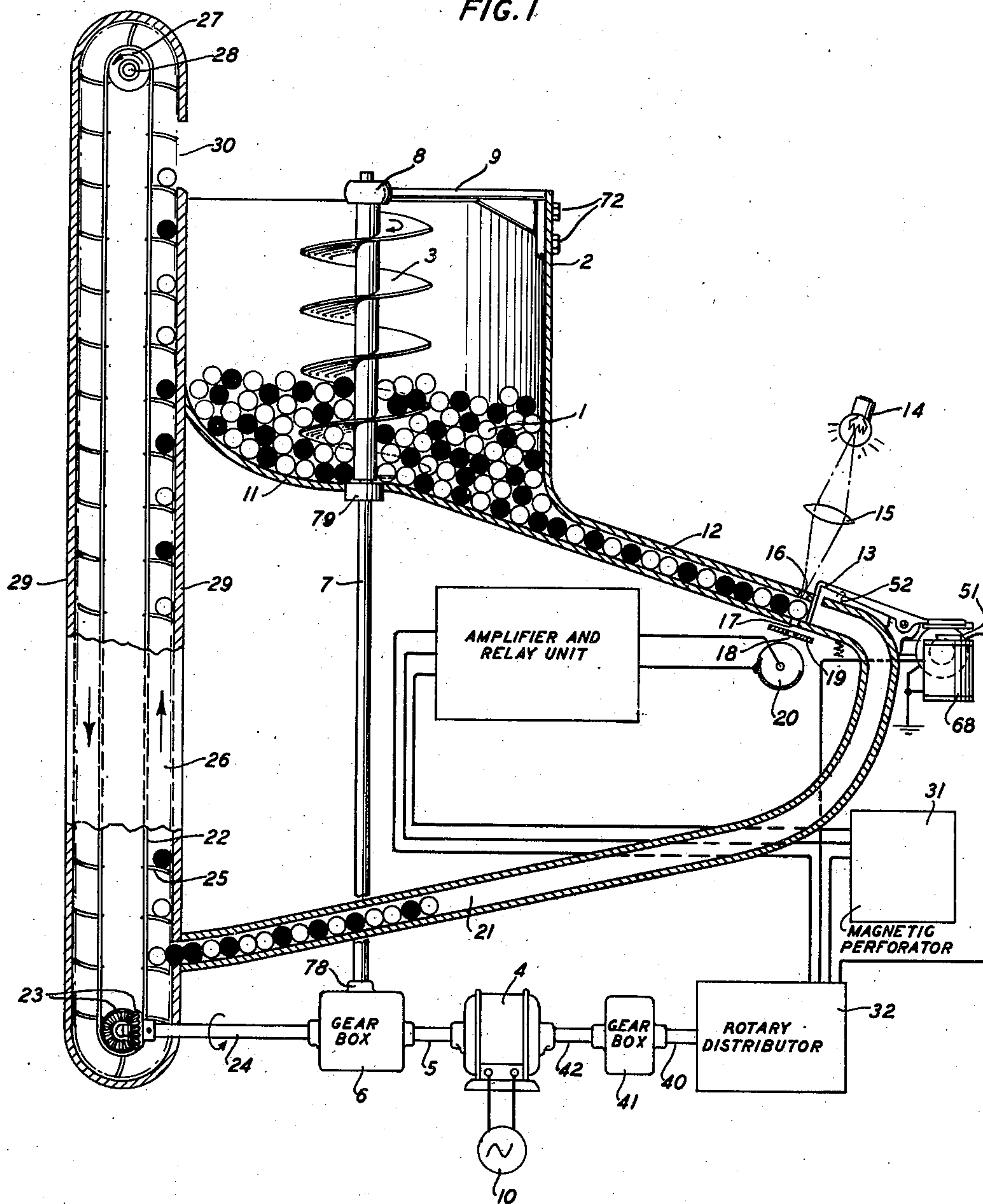
2,406,031

TELEGRAPH CIPHERING KEY TAPE MACHINE

Filed May 21, 1942

3 Sheets-Sheet 1

FIG. 1



INVENTOR
R. D. PARKER
BY *J. W. Schmitt*
ATTORNEY

Aug. 20, 1946.

R. D. PARKER

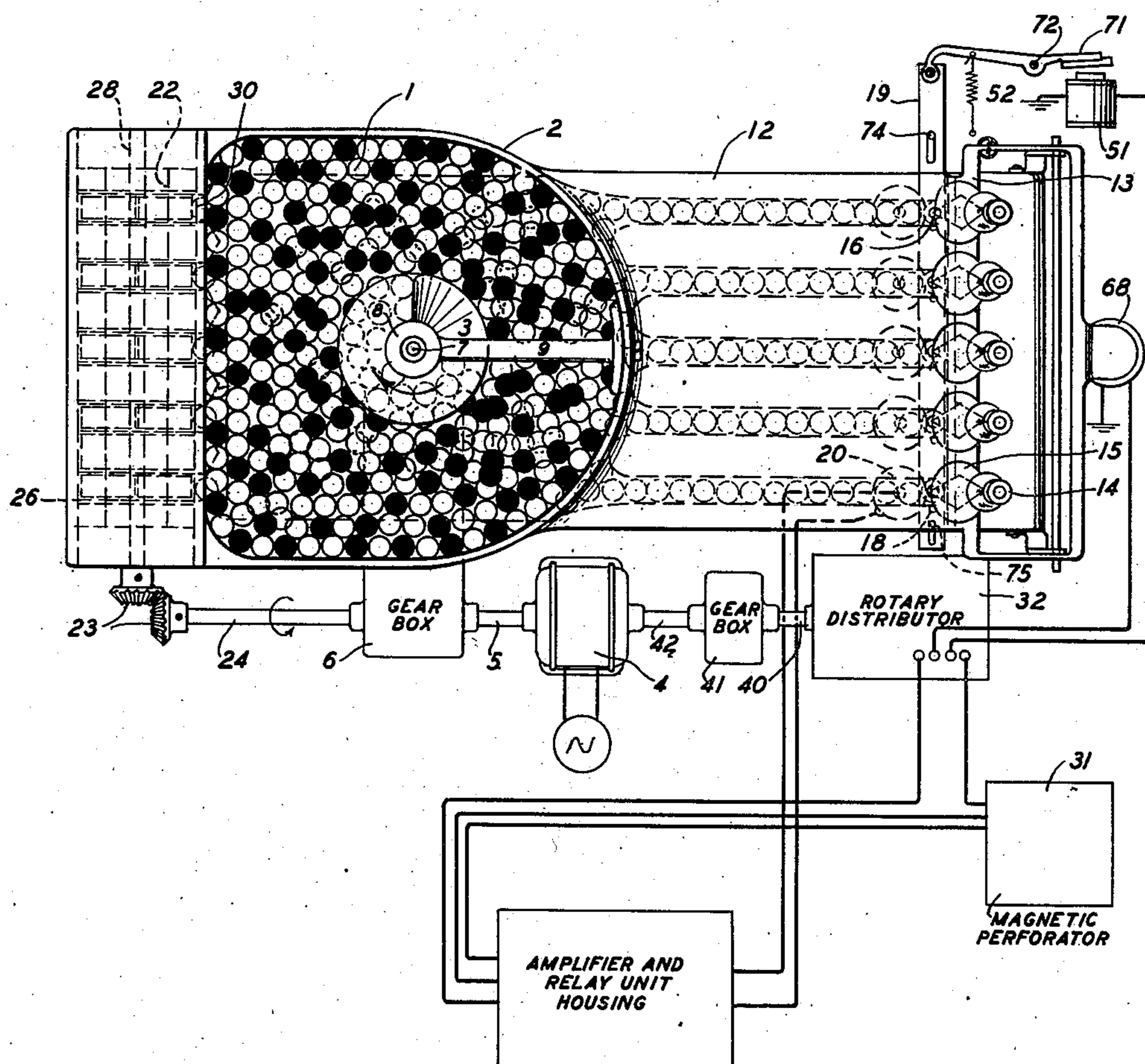
2,406,031

TELEGRAPH CIPHERING KEY TAPE MACHINE

Filed May 21, 1942

3 Sheets-Sheet 2

FIG. 2



INVENTOR
R. D. PARKER
BY *J. W. Schmied*
ATTORNEY

Aug. 20, 1946.

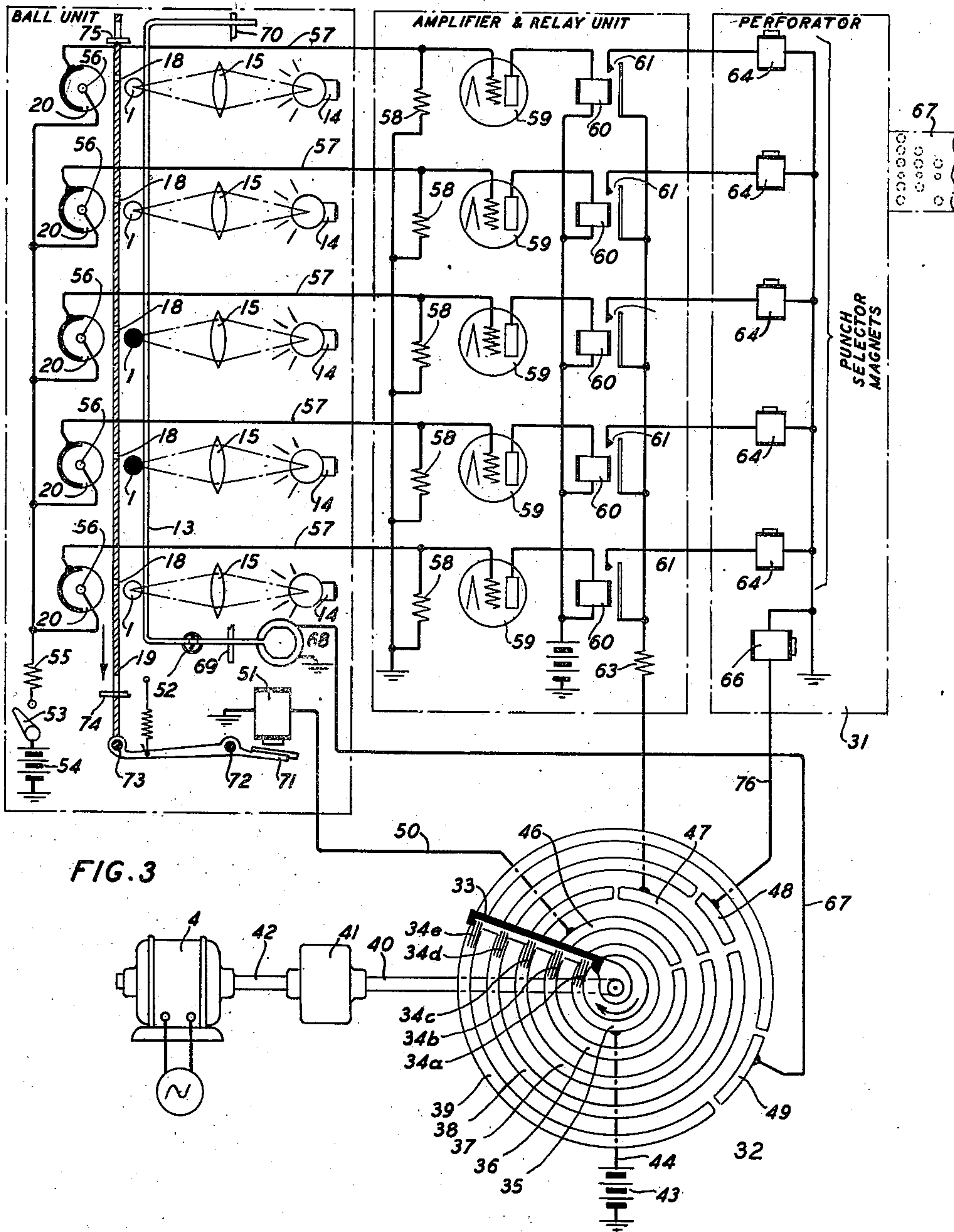
R. D. PARKER

2,406,031

TELEGRAPH CIPHERING KEY TAPE MACHINE

Filed May 21, 1942

3 Sheets-Sheet 3



INVENTOR
R. D. PARKER
BY *J. W. Schmied*
ATTORNEY

UNITED STATES PATENT OFFICE

2,406,031

TELEGRAPH CIPHERING KEY TAPE MACHINE

Ralzemond D. Parker, Brooklyn, N. Y., assignor to
Bell Telephone Laboratories, Incorporated, New
York, N. Y., a corporation of New York

Application May 21, 1942, Serial No. 443,909

8 Claims. (Cl. 178—22)

1

This invention relates to secret telegraph systems and particularly to the full mechanical production of a purely random key tape for use in enciphering and deciphering permutation code teletypewriter signals.

In a system of secret telegraphy presently known in the art in connection with which this invention may be used, the enciphered code elements as transmitted are the resultants of the elements of the regular Baudot code signal modified by the elements of what is known in the art as a key tape. The key tapes are prepared and supplied to each terminal in advance. The key tapes at each terminal are operated in synchronism. Each character element of the enciphered code may be made marking or spacing by suitable mechanism, depending upon whether each element of the regular permutation code representing the character and the corresponding element as randomly punched in the key tape are alike or unlike.

Previous proposals for making random ciphering or key tapes or equivalent devices have followed two general procedures.

In accordance with one procedure, tapes have been prepared at random manually by operators. This method has two undesirable features. First, it is laborious and time-consuming. Second, it seems doubtful whether a human operator can actually prepare a mathematically random tape and the deviations from randomness may be such as to aid unauthorized parties in deciphering messages. In any case, the effort to make it random increases the laboriousness of the task and adds a mental strain to the work.

In accordance with the second procedure, tapes have been prepared mechanically. Presently known mechanical devices, however, do not in fact produce mathematically random tape and, moreover, such devices generally are complex and expensive to construct. As a result, few, if any, such devices have been suitable for or applied to the making of tape. The invention herein insures the provision of purely random tape. The invention therefore promotes secrecy by insuring that the symbols punched in the tape do not follow any recurring pattern. The elements punched in the key tape in accordance with this invention, in other words, are purely random. Further, the key tape is produced entirely mechanically and its production does not require any manual manipulation whatsoever.

In accordance with this invention, equal numbers of two kinds of balls are thoroughly mixed and thereafter selected in random sets of five.

2

The key tapes are punched in accordance with the random selections. This provides purely random tape. If a tape having a controlled bias is desired it may be obtained by varying the numbers of the two kinds of balls relative each to the other as desired.

An object of this invention is the preparation of key tapes for enciphering and deciphering permutation code teletypewriter signals in a purely random fashion.

A further object of this invention is the preparation of purely random key tape for enciphering and deciphering permutation code teletypewriter signals entirely by mechanical means.

The invention may be understood from the following description when read with reference to the drawings herein in which:

Fig. 1 shows a side elevation of the apparatus;

Fig. 2 is a plan view of the apparatus; and

Fig. 3 shows the control circuit and tape punch selecting apparatus.

Refer now to Figs. 1 and 2.

A large number of balls 1, comprising equal numbers of two different kinds, are employed in this invention. Exactly half of the balls are opaque and exactly half are translucent. The balls are poured into a hopper 2. The balls are thoroughly stirred by a spiral worm 3. The worm is driven by a motor 4 and shaft 5 through a gear box 6 which rotates the vertical shaft 7 to which the worm 3 is rigidly secured. The shaft is held in position by bearing 78, fixed to the upper wall of gear box 6, bearing 79 secured to the lower portion of hopper 2 and bearing 8 which is integral with the horizontal bracket 9 secured to the right-hand wall of hopper 2 by bolts 72.

For an interval before tape is to be prepared, power is supplied from source 10 to motor 4 and the stirring mechanism comprising spiral worm 3 is operated to insure thorough mixing of the two kinds of balls. The bottom of the hopper 11 is an inclined plane sloping downwardly to the right. The lower portion 12 of the right-hand wall of hopper 2 is extended and inclined downwardly toward the right, generally parallel at the bottom incline plane 11 of hopper 2 and spaced therefrom to form therewith a chute. The balls gravitate at random into the chute which is arranged to accommodate five rows of balls extending downwardly to the right to the position of the transverse barrier 13 interposed in the paths of the five rows of balls.

The mechanism thus far described will effect the random selection at the barrier 13 of five

3

balls which may be opaque or translucent in any combination.

It is pointed out that whereas, in the description of the embodiment of the invention, apparatus for a five unit permutation code is described, the invention is not so limited. By the addition of a ball chute, a source of light, a photoelectric cell, an amplifier and relay and a punch selecting magnet, and making minor, obvious modifications to correspond, the invention may be applied to the manufacture of tape for permutation codes having six elements. There is no limit to the number of elements in a permutation code for which corresponding selections may be made in accordance with this invention. Further the invention may be applied to a wide variety of uses other than the punching of tape.

The two kinds of balls need not necessarily be present in exactly equal numbers. They may be present in unequal numbers and the relative numbers may be varied at will from time to time to produce what might be termed an opaque bias or a translucent bias. This would not be a departure from the principle of the invention unless the bias became considerable. Consequently, approximate equality of the two kinds of balls is all that is required.

It is pointed out, however, that as the number of one kind or the other of the two kinds of balls becomes preponderant a corresponding bias is introduced.

An electro-optical system comprising five similar sets of equipment is fixed in position immediately to the left of barrier 13. Each of the five sets of equipment comprises a lamp or other source of light, such as 14, a lens 15, and aperture 16 in the extension 12, an aperture 17 in the bottom inclined plane of the hopper, a displaceable aperture 18 in the common shutter 19, and a photoelectric cell 20.

Light from the lamp 14 is directed by means of the lens 15 at a ball which momentarily occupies a position adjacent the barrier 13 in one of the five rows. Depending upon whether the ball is translucent or opaque, the light will be passed or prevented from passing through the ball. Light which passes will pass also through the aperture 17 and, when shutter 19 is properly positioned in a manner to be described below, the light will enter a photoelectric cell 20.

By means of photoelectrical circuit to be described hereinafter, a perforating punch corresponding to a particular ball will be operated or prevented from operating to control the perforation of a tape in a corresponding position. Five punching magnets are controlled in this fashion.

After the punching has been effected the barrier 13 is operated in a manner to be described also hereinafter. The five balls which controlled the operation of the punching mechanism for a particular character pass the barrier and drop through the return chute 21 sloping generally downward to the left.

In order to return the balls to the hopper the mechanism is equipped with an endless belt 22 driven by gears 23 through shaft 24, gear box 6, shaft 5 and motor 4.

The endless belt is supported at the top by a pulley 27 which rotates freely on a horizontal shaft 28 rigidly secured in any convenient manner. Spaced from the belt on each side and at the top and bottom thereof is a guard 29 having an opening 30 above the top of the hopper.

Secured to the belt 22 are a series of transverse members 25 projecting at right angles to

4

the belt. Preferably the transverse sections formed by successive right-angle members 25 are separated into five individual compartments by means of vertical walls 26.

The balls are rolled into the individual compartments by gravity and are elevated by the continuous belt which moves in the direction indicated by the arrows. When the balls reach the position of the opening 30 they are rolled out of their compartments and into the hopper where they are again mixed with the large mass of balls by the helical worm 3.

The associated circuit which controls the shutter 19 of the optical system as well as barrier 13 and the perforator 31 will now be described.

Refer to Fig. 3. A rotary distributor 32, having a rotating arm 33 equipped with brushes 34a to 34e which engage a continuous conducting ring 35 and a plurality of segmented rings 36, 37, 38 and 39, is employed to control the operation of the shutter 19, the barrier 13 and the perforator 31. The rotating arm 33 of the rotary distributor 32 is rotated by means of a shaft 40 which is connected through gear box 41 and shaft 42 to the motor 4. Brushes 34a to 34e are all interconnected in parallel. Battery 43 is connected by means of conductor 44 to solid ring 35. As the rotary arm 33 is rotated, the insulating gaps between the rings are bridged by means of the brushes. Each of the segmented rings has a conductor connected to one of its segments which extends to an operating circuit. When rotary arm 33 is in the position shown, all of the circuits extending from the rotary distributor rings are deenergized as the brushes are not in position to extend the circuit from battery connected to solid ring 35 to segments 46, 47, 48 or 49. As arm 33 moves in a clockwise direction, when brushes 34a and 34b form a bridge between the ring 35 and segment 46, a circuit is established from battery 43 through conductor 44, ring 35, brush 34a, brush 34b, segment 46, conductor 50, and the winding of magnet 51 to ground, energizing magnet 51 which attracts armature 71, rotating it in a clockwise direction about pivot 72. The left-hand end of armature 71 is secured by means of pin 73 to the bottom end of shutter 19 which is moved downwardly through guides 74 and 75, tensioning spring 52. When shutter 19 is moved to its lower position the multiple apertures 18 are positioned so as to permit light to pass. Such of the balls 1 as are translucent will permit light to pass. Those of them that are opaque will prevent the passage of light. When the manual switch 53 is closed a circuit is established from battery 54 through switch 53 and resistance 55 to the anodes 56 of the five photoelectric cells 20 in parallel. In the case of cells associated with translucent balls, a current will flow through conductors 57 and resistances 58 to ground, making the potential of the grid of the associated three-element vacuum tube 59; normally non-conducting, more positive. This, in turn, permits current to flow in the associated vacuum tube plate circuit through the winding of the associated relay 60. The various relays of the group 60 will be operated or unoperated, depending upon whether the corresponding ball 1 is translucent or opaque. Each operated relay closes a corresponding contact 61. When the rotary arm 33 has moved into position such that brush 34c engages segment 47, a circuit will be established from battery 43 through conductor 44, ring 35, brush 34a, brush 34c, segment 47, resistance 63, through such contacts 61

5

as are closed and through the winding of magnets 64 associated with such closed contacts to ground, energizing magnets 64 corresponding to translucent balls 1. Magnets 64 position punches, not shown, in the perforator in position to punch a hole in a corresponding position of the tape in a well-known manner. When the rotary arm 33 moves into position so that brush 34d engages segment 48, a circuit is established from battery 43 through conductor 44, ring 35, brush 34a, brush 34d, segment 48, conductor 76 and the winding of hammer magnet 66 to ground, operating hammer magnet 66. The operation of the hammer magnet 66 operates the punches which have been set in the punching position by such magnets 64 as have been energized. Tape 67 will be punched in corresponding positions in a well-known manner.

When rotary arm 33 has moved into position so that brush 34e engages segment 49, a circuit is established from battery 43, through conductor 44, ring 35, brush 34a, brush 34e, segment 49, conductor 67, and the winding of barrier magnet 68 to ground, energizing barrier magnet 68. The operation of barrier magnet 68 rotates the bail barrier 13 about its fixed pins 69 and 70. This permits the five balls which determine the setting of the punch magnets to escape. As the various brushes of rotary arm 33 move off segments 46, 47, 48 and 49 the corresponding magnets are deenergized. Shutter 19 is restored to its original position by spring 52. The relays 60 which have been energized are deenergized, opening their corresponding contacts 61. The respective associated magnets 64 are deenergized. Hammer magnet 66 is deenergized. Barrier magnet 68 is deenergized and barrier 13 is restored. The restoration of barrier 13 is timed so that not more than one row of balls escapes into chute 21 on each cycle.

What is claimed is:

1. In a telegraph system, the method of preparing a key tape for enciphering permutation code telegraph signals which comprises: mixing equal numbers of two different forms of an object selecting at random a number of said mixed objects corresponding to the number of elements in the particular code and controlling the perforations of said tape in accordance with said selections.

2. In a telegraph system, the method of preparing a key tape for enciphering permutation code telegraph signals which comprises: (1) mixing equal numbers of two different forms of

6

an object and selecting at random a number of said objects corresponding to the number of elements in the particular code; (2) selectively controlling a plurality of tape perforating elements through an electromechanical device dependent upon the random selection of said objects.

3. In a telegraph system, a completely automatic, purely randomly controlled device for preparing key tape for enciphering permutation code teletypewriter signals comprising a container, a plurality of equal numbers of two different kinds of objects in said container, means for mixing said objects, means for randomly selecting a number of said mixed objects corresponding to the number of variable elements in a particular permutation code, a plurality of tape perforating elements and means for controlling the operation of said elements depending upon said random selections.

4. In a telegraph system, means for making purely random selections of two kinds of objects and means for controlling a tape perforator in response to said selections.

5. In a telegraph system, a tape perforator, an object mixing machine, means for making random selections of more than one class of objects mixed by said machine and means for controlling said perforator in accordance with the natures of the objects selected.

6. In a telegraph system, in combination, a device for making random selections, a photoelectric cell controlled by the selections of said device and a tape perforator responsive to said photoelectric cell.

7. In a telegraph system, a container, an equal number of two different kinds of units in said container, a device for thoroughly intermixing said units, a selection device for randomly selecting a number of said units corresponding to the number of variable units in a particular permutation code and means responsive to the selection of one of said kinds of units for operating a tape perforating punch.

8. A permutation code selector comprising means for controlling a fixed number of elements each of which is conditionable in a definite number of different ways, a series of bodies having individual degrees of translucency variable in number equal to said definite number, and means for utilizing said bodies in successive groups of said fixed number for conditioning groups of said fixed number of elements selectively.

RALZEMOND D. PARKER.