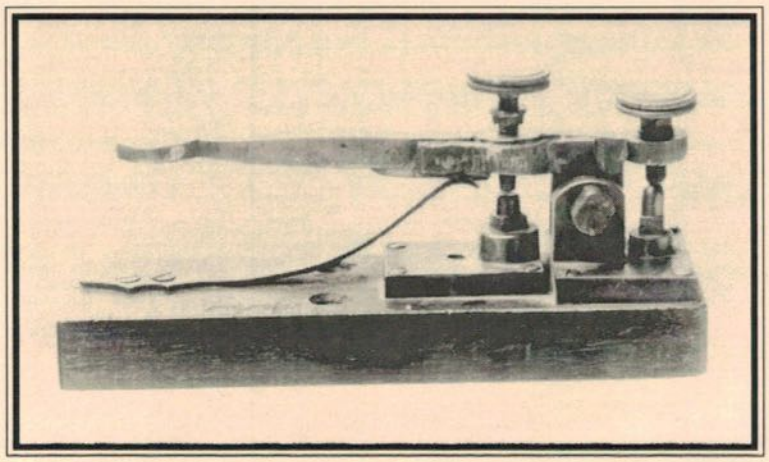
THE STORY OF THE KEY

BY LOUISE RAMSEY MOREAU W3WRE

and

AMERICAN TELEGRAPH INSTRUMENT MAKERS 1837 ~ 1900



The Best of "MM" ~ Volume 1

A Morsum Magnificat Publication

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'The Story of the Key'

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Contents

The six articles giving the title to this publication appeared in successive quarterly issues of the English language edition of Morsum Magnificat from No. 6 (Winter 1987) to No. 11 (Spring 1989). They also appeared earlier in the Dutch language edition of MM, Nos. 14–19 (1986–87)

The author, Louise Ramsey Moreau W3WRE, was a highly respected telegraph historian and collector of Morse keys who was always ready to share her knowledge and expertise with others. She was Key & Telegraph Editor of the Antique Wireless Association's *Old Timer's Bulletin* for many years and wrote (and also co-authored with Murray Willer VE3FRX) some superb features on keys in the annual *AWA Review*. She was also editor of 'YL News and Views' in *QST* for a number of years.

In our second issue, MM2 (Winter 1986), and in an article titled 'The Key' in MM5 (Autumn 1987), she told us about herself. Born and bred in Johnstown, PA, she attended school and university in Pittsburgh. Her interest in telegraphy began when, as a sophomore, she studied American history. Just to prove her interest she bought a bug, a 'telegraph' hand key, a Johnson Speedex and a J38, thinking that with these she had covered the field of telegraphy!

From these four pieces grew a collection of more than 300 items, ranging from the first hand keys of the 1840s to the early electronic monsters of 1941. She was told by 'the doyen of collectors, W2ZI' that anyone can just amass, but the true excitement of collecting keys comes

from their different kinds of construction, dating them, and researching their history.

'Thanks to Ed's advice', she told *MM*, 'my own curiosity, and a long line of harassed librarians, my key collection, and the history behind it symbolises the history of the key from its earliest days.' Her fascinating 'Story of the Key' tells much of this history, and many of the photos illustrating each chapter are of keys in her collection.

As her interest broadened she wrote a history of communications, covering over 3000 years, and went on to study the expansion of American military communications during the war years. She was licensed as a radio amateur in 1953, as W3WRE. In 1962, living in California, she was WB6BBO, but returning East she reverted to W3WRE, working with CW '99.99%' of the time.

In 1976 she was nominated to the Telegraph Hall of Fame. She received the Houck Award for Telegraph History from the AWA in 1974, and the President's Award from YLRL for her investigation into the history of women in communications. In 1980, she received the Ralph Batcher Memorial Award of the Radio Club of America.

She was a member of ARRL, SOWP (Society of Wireless Pioneers), MTC (Morse Telegraph Club), a charter member of the Johnstown Amateur Radio Club, an Honorary member of the Antique Wireless Association and a Fellow of the Radio Club of America. She was also a reader, contributor to, and strong supporter of *Morsum Magnificat*.

Louise became a silent key on 15 April 1994, aged 77, and her historic key collection was passed to the Antique Wireless Association's museum at East Bloomfield, NY.

The Story of the Key, the first of a series presenting 'The Best of Morsum Magnificat', is dedicated to her memory in grateful recognition of all the help and encouragement she gave to *MM* from its earliest days.

Geoff Arnold G3GSR
Editor

Tony Smith G4FAI
Consultant Editor

1

MILESTONES

In order to identify, date and catalogue the keys of the communications field, it is necessary to research a great many early publications, for there is no single reference on the subject.

The material here will not include every key, for some three hundred patents for keys from 1844 to the present time have been issued in the USA alone, and that total does not include any military or foreign instruments. Rather, this study illustrates what may be called 'milestones' in the evolution of the key that may assist in dating and cataloguing them.

Birth of the Key

May 1844 saw the 'birth' of the key. There were, of course, earlier methods of manual transmitting such as the drop handles used to activate the Needle telegraphs in Europe; and Samuel Morse had a number of elaborate and cumbersome devices to indicate his binary code.

Then, in early May, as Alfred Vail tested the wires only a few weeks before the Baltimore–Washington demonstration of the Morse telegraph, he found that it was possible to create the code by the simple method of opening and closing the circuit 'much in the same manner as a key does a door'. He built an instrument that very much resembled

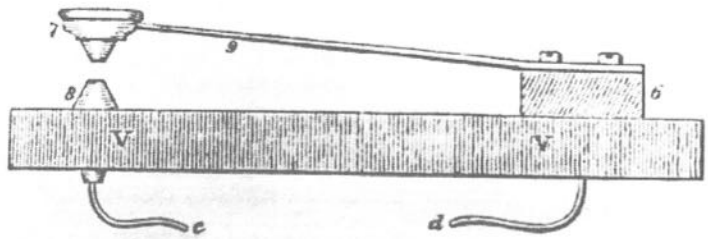


Figure 1.1: Correspondent, 1844

the later 'strap key' of the railroads, and both he and Morse gave it the same designation that had been chosen for the earlier sending instruments, the 'Correspondent' *(Figure 1.1)*.

That key was actually a temporary instrument for the first demonstration, but within six months, by November 1844, Vail had perfected the principle on which all keys since then have been based, described by him as 'a lever acting upon a fulcrum.'

Lever Correspondent

As with the first one, all the metal parts of the new key were brass, including the contacts. Each part was mounted separately on the operating desk, and the spring was merely a strip of metal that supported the lever to hold the contacts apart when not in use.

Following Morse's idea, Vail named the new instrument the 'Lever Correspondent' *(Figure 1.2)*; and in those early

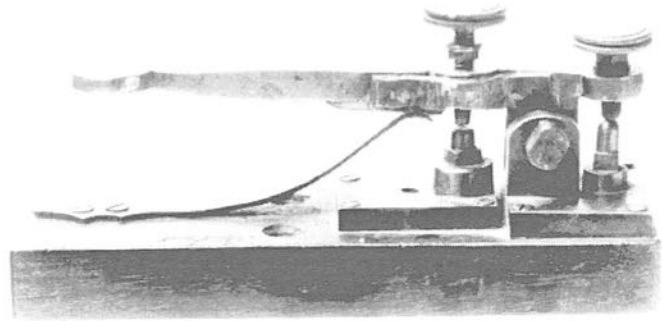


Figure 1.2: Lever Correspondent

days, and into the late 1850s, the contacts were referred to as the 'hammer' and the 'anvil', terms easily understood in those days of the village blacksmith.

The straight lever style was the only type used by the growing profession for the next three years, but by 1848 the need for more easily operated keys was apparent for the operators did not find the straight lever comfortable.

Camelback

The curved lever first appeared in the Camelback design of 1848 *(Figure 1.3)*. Since the spring was not considered to be of any help in operating, the heavy exaggerated curve shifted the balance so that the weight was to the rear of the lever. This caused it to fall back automatically after keying,

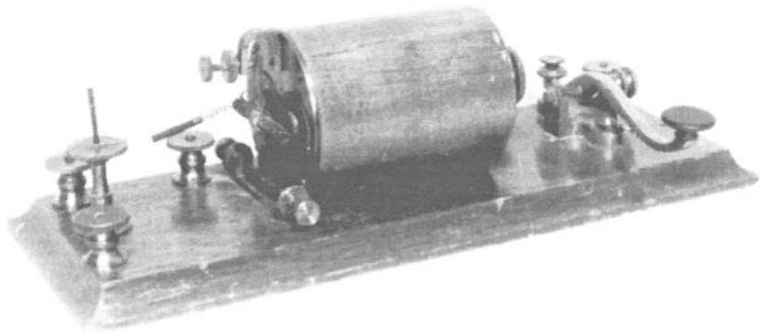


Figure 1.3: Camelback Key

and the spring remained the same as that on the Vail key.

Because there was no provision for a circuit closing switch, a window catch was mounted near the key. Remember, it was a brand new industry and everyone was learning by doing!

At that time, there was no commercial production of telegraph equipment, and all keys were made to order by instrument makers. The first camelbacks were made by Thomas Hall of Boston, Charles Chubbock of New York, and the Chester Brothers, also of New York. It was not until 1860 that commercial manufacture of telegraph instruments started with the L.G. Tillotson Company.

The Coil Spring

In 1850, Thomas Avery, an assistant to Morse, introduced the coil spring *(Figure 1.4)*. This was placed to the rear of the lever at first, but within a short time it was moved to under the centre for better balance, thus obviating the need for the heavy weight of the lever at the rear.

By 1851, the parts of the key were no longer mounted separately but were assembled on a metal frame. Although

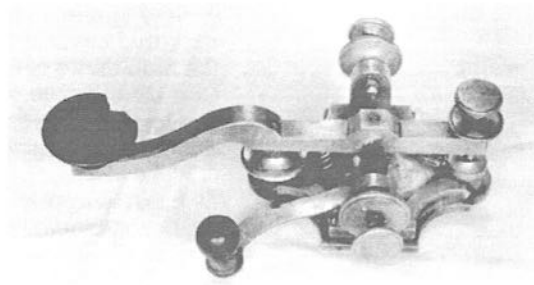


Figure 1.4: Coil spring

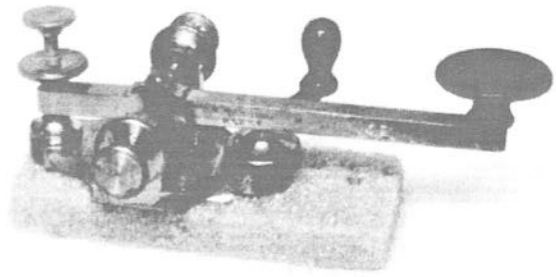


Figure 1.5: Henning Straight Lever

the Camelbacks were preferred, the straight lever continued to be used as the telegraph companies permitted an operator to work with the key that suited him best *(Figure 1.5)*.

Portable Instrument

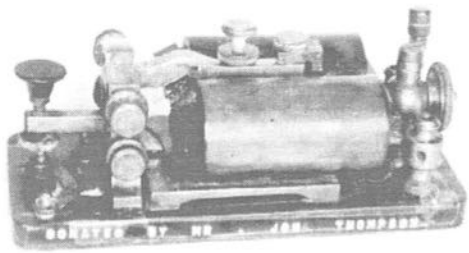
As the telegraph industry expanded, the need for some sort of portable instrument that could be used to test wires produced the compact 'Linesman's Test Set' in 1859. More properly called the 'Pocket Key and Sounder', these miniature units were used for trouble shooting the wires at the top of the telegraph poles *(Figure 1.6)*. They were probably the first transceivers, and were used effectively by the military of both sides during the Civil War.

Search for Perfection

In 1860, the Camelback was perfected by George M. Phelps of the Western Union Company. He redesigned the key for perfect balance, slimmed the lever and, recognising the importance of the spring, added provision for adjustment of spring tension *(Figure 1.7)*.

Figure 1.6: Pocket key and sounder

These Phelps improvements were copied by most of the major telegraph companies. The 1860 modifications not only gave a lighter, more easily operated key, but also made the high curve of the Camelback style unnecessary. The lever began to smooth down in 1874, as seen in the C.W. Lewis keys of the Western Electric Company *(Figure 1.8)*.



Despite their excellence, however, the improved Camelback and the Lewis keys had a grave drawback; and the

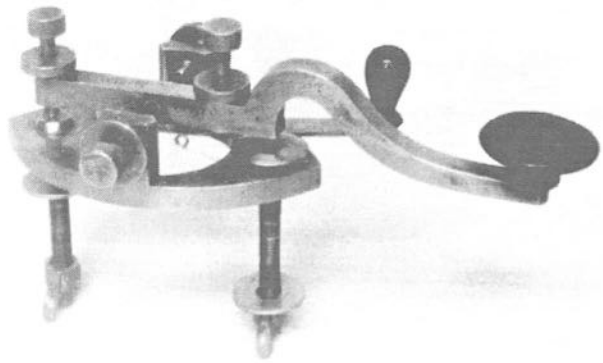
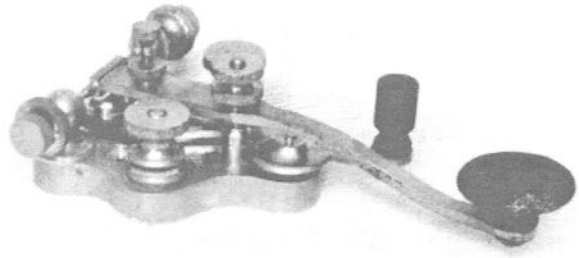


Figure 1.7: G.M. Phelps Improved Camelback

'fulcrum' was the problem. Made of steel, it was inserted through the brass lever, eventually causing the softer red brass to wear so that the lever slipped off centre. This caused poor sending – and usually plenty of profanity on the part of the operator!

Figure 1.8: C.W. Lewis Key



Solid Trunnion Lever

The needed changes appeared in February 1881 when James H. Bunnell received a patent for the 'Steel Lever Key' *(Figure 1.9)* that was accepted by all the telegraph companies and railroads. The steel lever was cast with the trunnion, or fulcrum, as a single unit to guarantee a firm connection of the contacts. The hollow oval frame gave a light portable instrument, although the

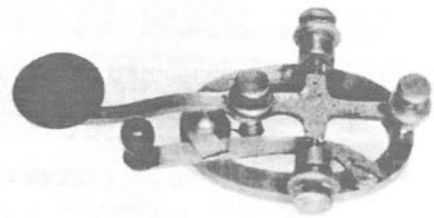


Figure 1.9: Bunnell 'Steel Lever' key, 1881

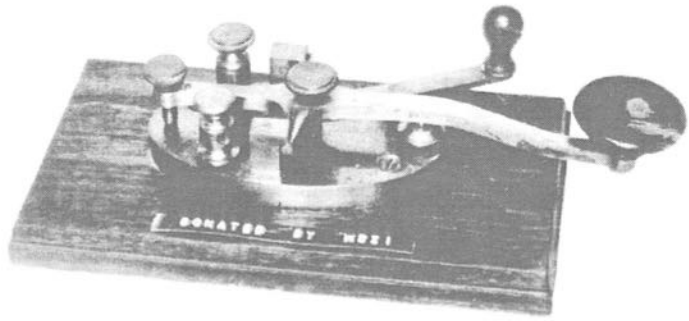


Figure 1.10: Tillotson 'Victor' key

leg and semi-leg styles were employed for permanent installation in many offices.

The L.G. Tillotson Company produced another style of the solid trunnion lever in 1882, over the Hamilton patent, using a knife-fitting between the trunnion and the standards (*Figure 1.10*). Advertised as the 'Victor Key', it proved so popular that even after Tillotson went out of business the Bunnell Company continued to produce it as late as 1918 under that name.

1886 Advert. for Tillotson's 'Victor' key

THE "VICTOR" VICTORIOUS!

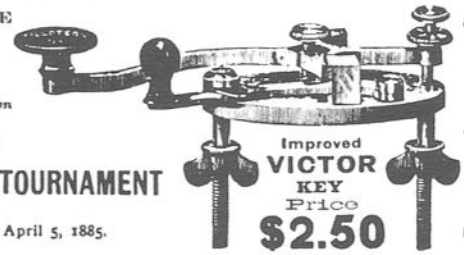
THE FASTEST TIME IN THE WORLD.

All Previous Record Broken

AT THE

TELEGRAPHERS' TOURNAMENT

In New York, on April 5, 1885.



500 Words, 2,368 Characters, sent in 10 Min. 32 Sec.,

ON THE

"IMPROVED VICTOR"

TELEGRAPH KEY.

Send for Descriptive Circular.

LIVE MEN WANT LIVE KEYS!

We have had so many inquiries from Telegraphers (especially Railroad men) and others, as to whether we would accept part cash and their old key in exchange for our Improved Victor Telegraph Key, that to accommodate them we have determined as a matter of experiment, to consent to such a trade for a short time. So that until further notice we will send post-paid one New Improved Victor Key to any address in the United States or Canada, in exchange for any other old telegraph key whatever, that is accompanied with $1.75 in cash. The old key can be mailed to us at a cost of about ten cents.

In the case of Telegraph Managers and Superintendents who have a number of keys for exchange, the express will often prove the cheapest transport.

NOTE.—When we are not required to pay postage or express charges we will bill the Improved Victor Key under the exchange system at $1.60 net.

E. S. GREELEY & Co., Successors to

L. C. TILLOTSON & CO., Nos. 5 & 7 Dey St., New York.

Spring Variations

The spring also went through several changes after 1844. There was, of course, Avery's coil spring that has never changed; but there was also a single wire bent in a shape that may well be called a 'safety pin' spring because of its appearance *(Figure 1.11)*. So far as can be found, it was introduced in various patents of the late 1850s and early 1860s.

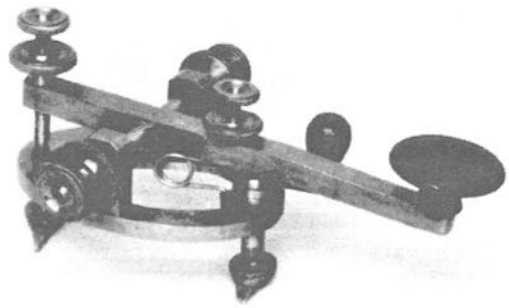


Figure 1.11: 'Facer' key with 'safety pin' spring

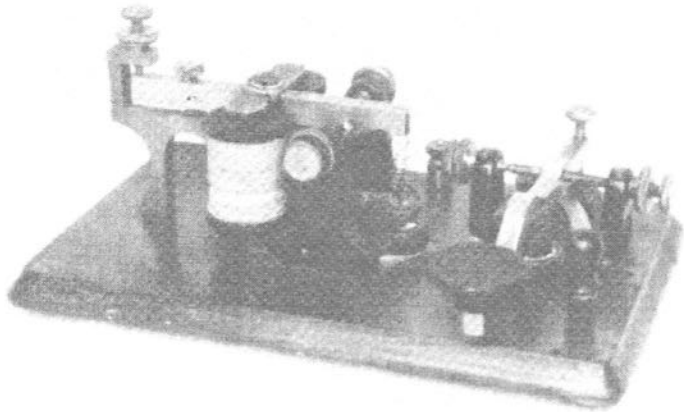
The Camelbacks remained in use after 1881 since some operators still preferred them. Also some were produced without spring tension, i.e., in the practice or learner's KOB (Key on Base) sets *(Figure 1.12)*.

However, the Steel Lever Key proved to be the best style for the huge amounts of copy handled on all wires, and has remained as the standard telegraph key.

Telegrapher's Paralysis

These huge amounts of material, running from ten to eighteen thousand words, and handled by an operator in a single trick *[i.e., shift – Ed.]* brought on the occupational disease of the profession, 'Telegrapher's Paralysis', or 'glass arm'.

Figure 1.12: Key on Base



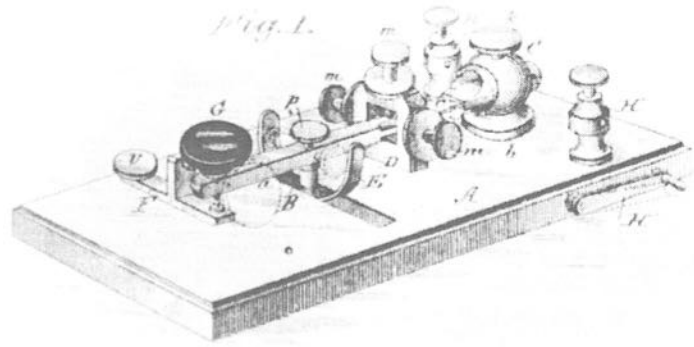


Figure 1.13: 'Convertible Telegraph Key', 1886

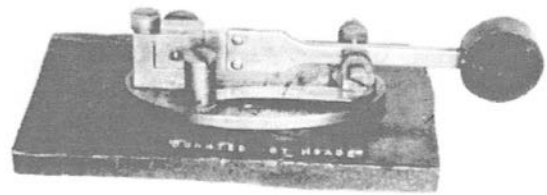
This hazard, caused by the vertical action of the hand key could, and often did, cause permanent disability. Since the telegraphers themselves had been responsible for most of the changes for the better in the instrument, they also came up with the ideas to alleviate, if not prevent, this problem.

The earliest known attempt was the 'Convertible Telegraph Key' *(Figure 1.13)*, of J.A. Maloney and A.G. Johnson, of 1886. This was a straight lever that could be operated vertically or turned to either side for horizontal operation as either a left-handed or right-handed key.

Double Speed Key

Two years later, in 1888, the horizontal principle was perfected and advertised as the 'Double Speed Key' by the Bunnell Company *(Figure 1.14)*. More popularly known as the 'side swiper', because it was manipulated from side to side to create the code, the latter name became the generic term for any key that used horizontal operation and has never been the copyright of any manufacturer. This key was still being produced by Bunnell for the telegraph in 1920, and was later used for radio after CW replaced spark.

Figure 1.14: 'Double Speed' key, 1888



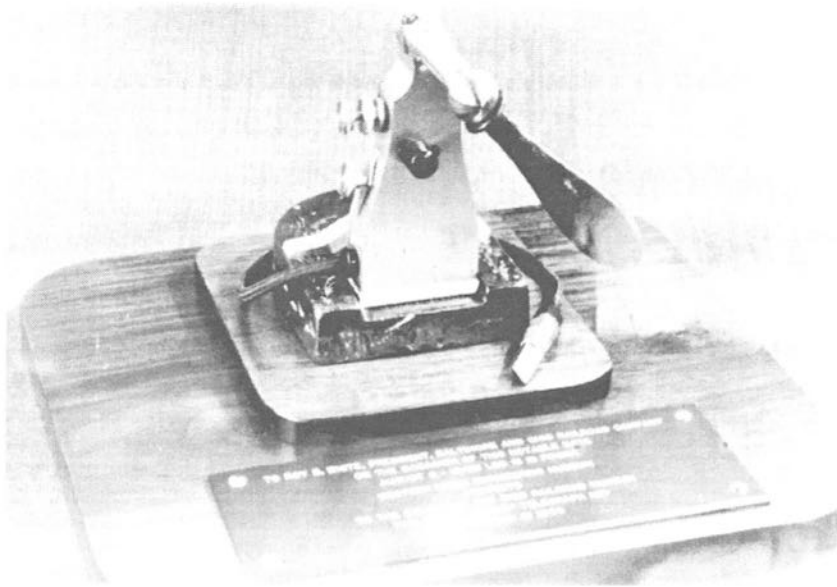


Figure 1.15: 'Twentieth Century' Key, 1900

'Pump Handle'

One other key that was devised for this problem was the 'Twentieth Century' Key *(Figure 1.15)* of John F. Skirrow and Charles Shirley, manufactured by the Foote-Pierson Company in 1900.

Shirley devised the horseshoe-type base, but Skirrow was responsible for the unusual key that could be worked by grasping the handle to move it up and down, or tapping it with any finger or the fist if desired, again intended to help the victims of the 'glass arm'. As might be expected, the profession promptly nicknamed it the 'Pump Handle Key'.

Outstanding Names

In the story of the key, several names are outstanding: Alfred Vail, who gave us the lever principle; Thomas Avery for the coil spring; George M. Phelps who saw the advantages of adjusting the spring's tension; and, of course, J.H. Bunnell who took the ideas of these men, and added a few of his own, to produce the Steel Lever instrument that has never been surpassed as a hand key.

2

VARIATIONS ON THE VAIL THEME

As the telegraph industry expanded, the field for instrument production was wide open and, in a majority of cases, the operators themselves developed many of the improvements and needed changes in design. Then, as manufacturing organisations realised that the industry could be a profitable market, the instruments were produced by them.

The invention of the fire alarm apparatus, which supplanted the watchman's rattle, put keys into the alarm boxes *(Figure 2.1)* to signal the box number to headquarters, to call multiple alarms, as well as to send a general release at the end of the fire.

Railroad Keys

The railroad industry needed and got keys for use on their wires; but although the camelbacks came into use as early as 1848, only four years after the telegraph made its first appearance, many of the keys produced for the railroads

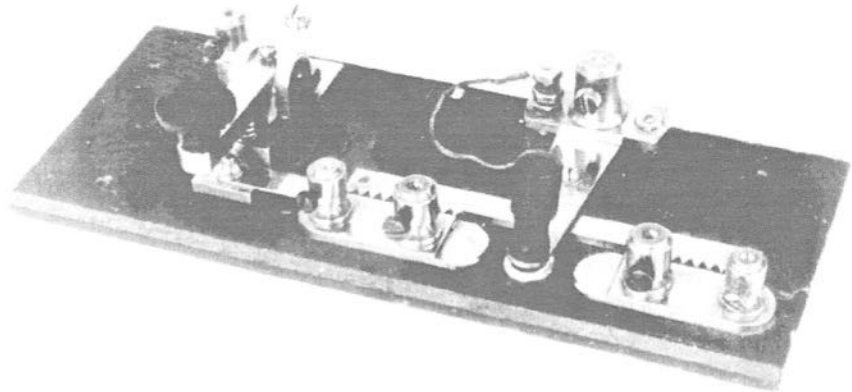


Figure 2.1: Fire Alarm Key

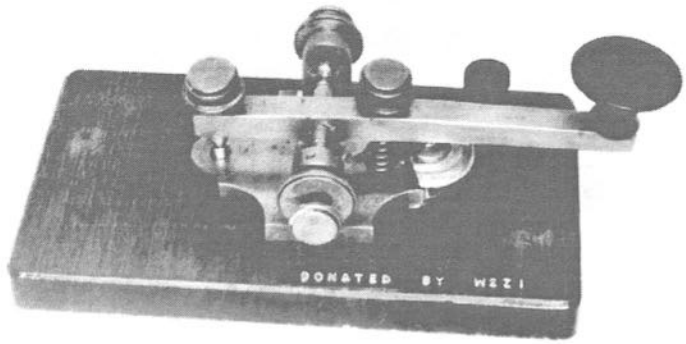


Figure 2.2: Straight Lever Style

remained the straight lever style *(Figure 2.2)* until well after 1860. Also, for signalling purposes a strap key *(Figure 2.3)*, actually a miniaturised version of the first telegraph key, the Correspondent of 1844, was used.

Many of the railroad keys were produced in the extremely elegant designs which were so much a part of the last half of the nineteenth century. One style in particular was advertised with the name 'The Wizard' *(Figure 2.4)*. It was, in shape, a replica of the 'semaphore', having the key on one side, with a spring-mounted contact as well as a coil spring for the lever. The reverse side was cast in the semaphore detail, including simulated signal lights on the arm!

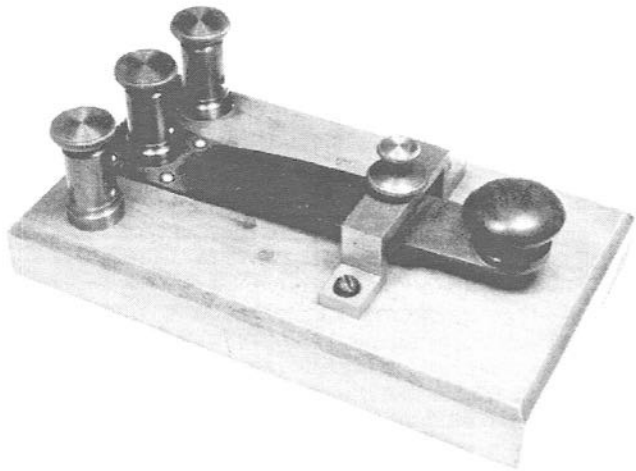


Figure 2.3: Railroad Strap Key

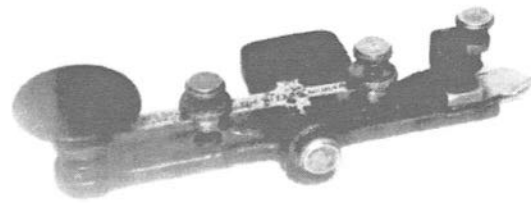


Figure 2.4: The 'Wizard'

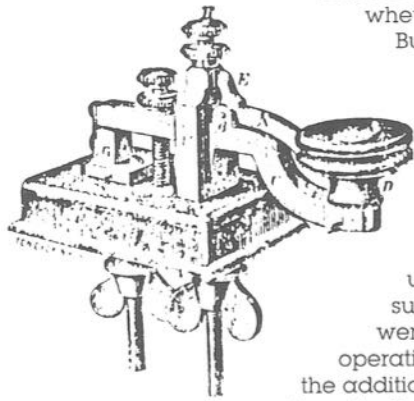
Open and Closed Circuits

The system of open circuit telegraphy was almost exclusively used in Europe, and only a few lines in the USA employed this method. However, for those few that did use it, the manufacturers offered the 'Open Circuit Key'. It had the same lever design as the others with the exception that when the key was at rest the line was open to the next station, and when closed the battery was connected into the line for operation. In appearance there is no difference from closed circuit keys.

The method of closed circuit telegraphy used in the USA sparked all sorts of inventions. Everybody, it seemed, had ideas in the beginning to improve the key. The method of closing the circuit when not operating came in for all sorts of devices starting with a simple catch (the type used to close windows) wired into the line to act as a switch.

This developed into the present style switch mounted on the key frame. In many cases this switch could be mounted either left or right of the frame, depending on whether the operator was left or right-handed. But despite the very early inclusion of the switch, the field produced a number of seemingly labour-saving devices such as the self-closing keys, produced as late as the 1870s.

Figure 2.5: Davis Key, 1860



One of the more popular styles, endorsed by the *Scientific American* in 1860, was the Davis Key (*Figure 2.5*). As with the other self-closing types, this key utilised a double lever and knob, one superimposed above the other so that both were operated simultaneously. Thus, during operation the circuit was open, but upon release the additional knob and lever, wired into the circuit, automatically closed the key when not in use.

Other self-closing keys of the 1850–60 period utilised the same principle, some with the centre of the knob as a separate part that governed the circuit closing system. All

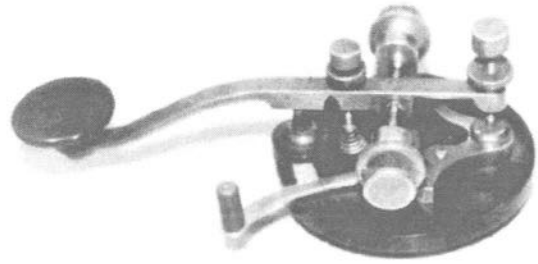


Figure 2.6:
C. Plumb key, 1884

styles were in use for a short time, but the original switch on the frame has remained as the most successful.

Circular Frame

In 1884, the C. Plumb key *(Figure 2.6)* manufactured in Buffalo, became moderately popular. The smoother line of the lever curve was a step away from the camelback design that rapidly became obsolete after the Civil War, although the trunnion, or fulcrum, action was still the same as the earlier keys.

The solid circular frame was a unique feature that set this key apart from those with the standardised oval frame that had been adopted for most key designs.

Many Excellent Instruments

Here it should be noted that the evolution of design from that first crude lever to the universally accepted Bunnell 'Steel Lever' involved almost 40 years (November 1844 to 1881), and most of the earlier keys were excellent instruments.

Records were made as early as 1885. When Prof. Morse asked for some sort of evidence of the efficiency of his system, young Jimmy Leonard copied 55 words a minute (with pen and ink!) which were sent by James Fisher using a camelback key having the fixed spring tension of that period.

It should be mentioned that Jimmy Leonard was a professional telegrapher and was fifteen years old; and 'Lightning Slinger' Fisher was eighteen.

New Techniques

The introduction of diplex and quadruplex telegraphy brought a new key to the industry. The Pole Changer, or reversing key *(Figure 2.7)* was designed to change the

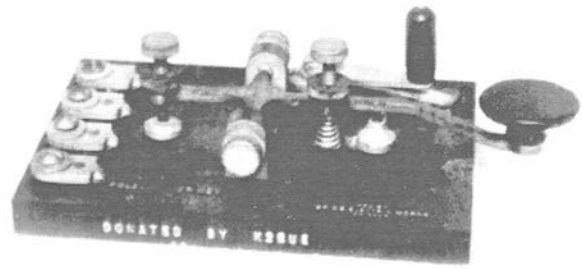


Figure 2.7: Pole Changer key

direction of the current at each depression of the lever. By this method it was possible to operate in the new systems that handled two messages simultaneously on a single wire, both in the same direction (diplex) or two messages from each end simultaneously (quadruplex).

In 1858, with the Atlantic cable, an entirely new form of wire operation was introduced because of the nature of the system. A dual-lever alternate current key *(Figure 2.8)* was designed for use on subterranean as well as submarine cables.

The two levers were necessary because the cable employed the full characteristics of alternating current. When one key was depressed positive current was sent into the line; when the other key was depressed current of negative polarity was sent.

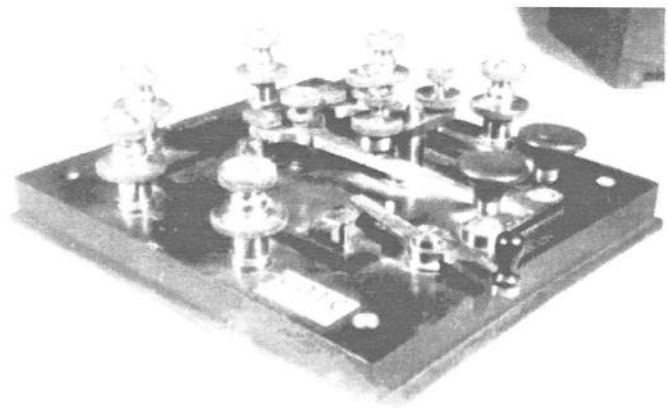


Figure 2.8: Dual lever key for subterranean and submarine cables

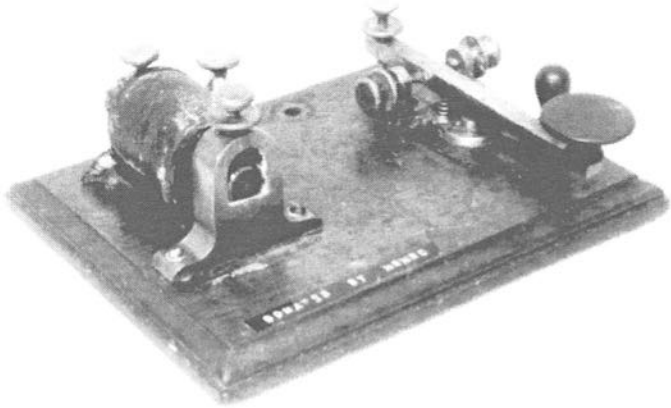


Figure 2.9: KOB Set

KOB Sets

In the late 1840s, Charles Chubbock invented the 'Pony Sounder'. With it came the possibility of creating instruments which could be moved from their fixed positions in the offices – a form of portable telegraph station with the sounder and key mounted on a small wooden base. These were promptly called 'Key on Base' (shortened to 'KOB sets' by the industry) *(Figure 2.9)*.

The Chubbock sets, as with all instruments of 1850, had each part of the key mounted separately on the wooden base. The operators discovered that dirt and impurities collected and caused poor operation, so the KOBs, as with individual keys, were then assembled on single frames.

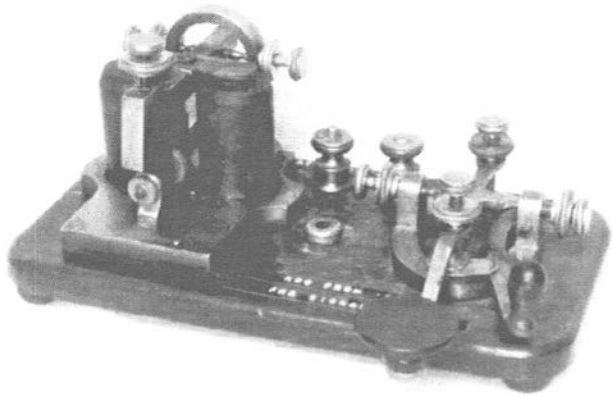


Figure 2.10: Altoona KOB, 1889

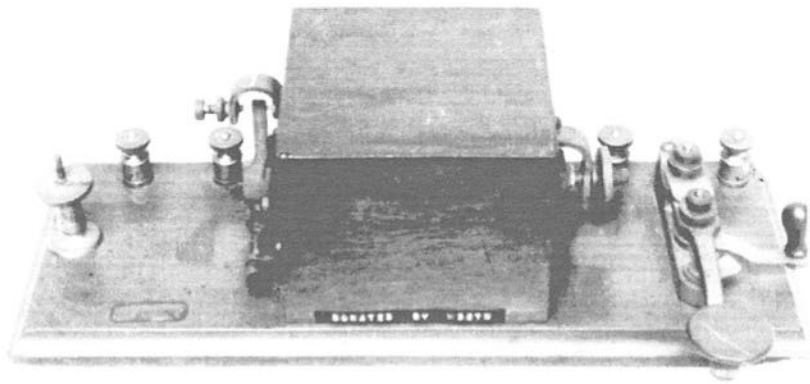


Figure 2.11: Western Electric KOB, 1886

Some of the finest of the telegraph KOBs, as well as single keys and sounders, were made at the Altoona Shops of the Pennsylvania Railroad. The 'Altoona' keys (*Figure 2.10)*, as they were known to the profession, were made by master craftsmen and included the latest improvements that had been introduced by other manufacturers.

The KOBs were not limited to just key and sounder; a key with a box relay was also known as a KOB. The Western Electric Company introduced the Steiner key and 'Sounding Box' relay (*Figure 2.11)* in 1886. The Steiner key is actually a lever mounted on a narrow solid metal frame, utilising a strip of spring metal in the centre of the lever to create spring tension. Much later, the Bunnell Company slimmed the size of the relay, using the Barclay invention of the 'Snare Drum' relay with their successful 'Triumph' steel lever key.

Speed Keys Next

Over the years, the operator was not only the man behind the key, but also the man behind the improvements he found necessary to turn out the thousands of words to be sent each time he sat at the key.

The speed keys, the semi-automatics, would not appear on the wires until after the end of the Nineteenth Century. These will be the subject of the next part of the Story of the Key.

3

THE 'LIGHTNING SLINGER'... VIBROPLEX

The 'sideswipers' and types of keys manufactured to help those who were afflicted with 'telegraphers' paralysis' did indeed assist a great many to continue in the profession; but they were not designed for speed, and speed was essential to be able to clear the huge work loads that the operators handled each day.

In 1879 Walter Phillips devised the Phillips Code that consolidated all the different codes in use and eliminated many of the 'box car' abbreviations invented by the operators. This code did speed up transmissions but was not the full answer.

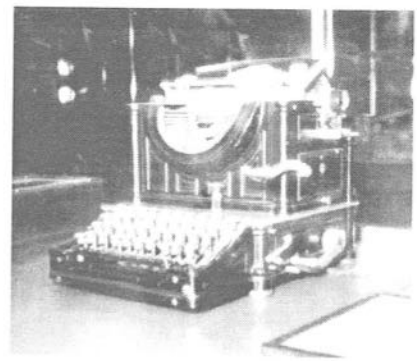
'Fit only for a bug'

In the 1880s Phillips had also applied for a patent for a vibrating key as did a number of others. However only a few operators used these early attempts at speed keys because the ineffective forms of damping resulted in blurry sending, and split dots. The crack 'A-wire' operators condemned them as 'fit only for a bug', or a 'bug's key'.

The word 'bug' as used on the wires during the late nineteenth and early twentieth centuries was pure telegraphic profanity. To these men a 'bug' was a lousy operator with a fist that only a mother could love. Those kings of the wire who were proud of their ability to send from ten to eighteen thousand words in a single trick would have nothing to do with the early ineffective instruments.

Then, in 1902, Charles Yetman received a patent for a 'Telegraphic Transmitter' *(Figure 3.1)* which was nothing but a typewriter that transmitted the Morse characters on a wire. The major drawback was the necessary skill and ability to type. Unlike teletypewriters this was for

Figure 3.1: Yetman, 1902



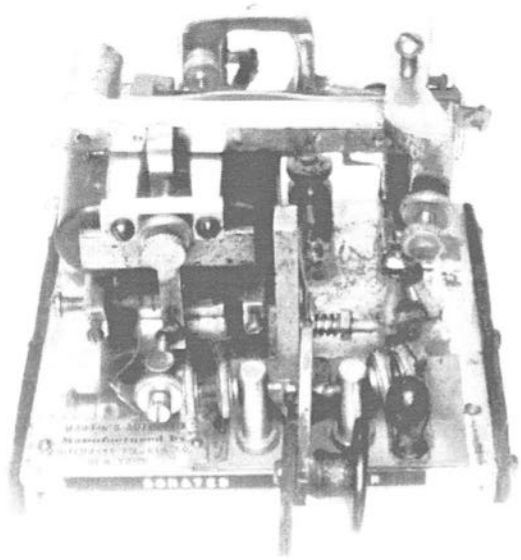


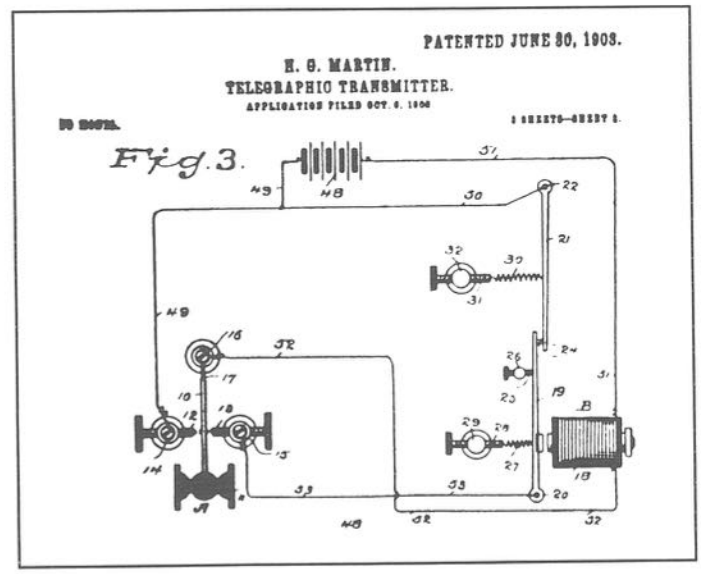
Figure 3.2: Martin Autoplex

transmitting only and the copy was still received on a sounder. The Yetman was in use for a number of years in a few offices.

First Semi-automatic

A year after Charles Yetman received his patent, Horace Martin was granted one for the first of the semi-automatic keys. This key, called the 'Autoplex' *(Figure 3.2)*, was battery powered by two dry cells and utilised a pair of magnets from a sounder to hold the vibrator stationary when dashes were being made. This clumsy, heavy instrument was made for Martin by the United Electric Company of Norcross, Georgia, and was accepted and used for several years.

In 1903 when Martin received U.S. Patent 732,648 *(Figure 3.3)* for his 'telegraphic transmitter' he sewed up the entire field. In those eight pages of drawings and specifications he


PATENTED JUNE 30, 1903.

H. O. MARTIN.

TELEGRAPHIC TRANSMITTER.

Fig. 3.

Figure 3.3: Martin Patent # 732,648

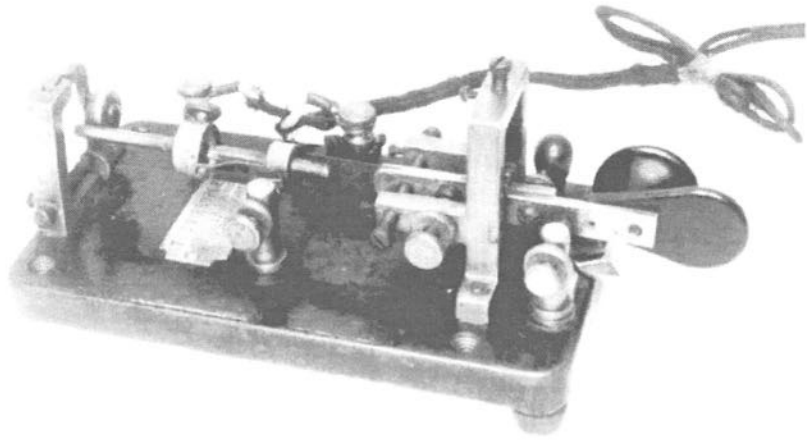


Figure 3.4: Vibroplex 'Original', 1904

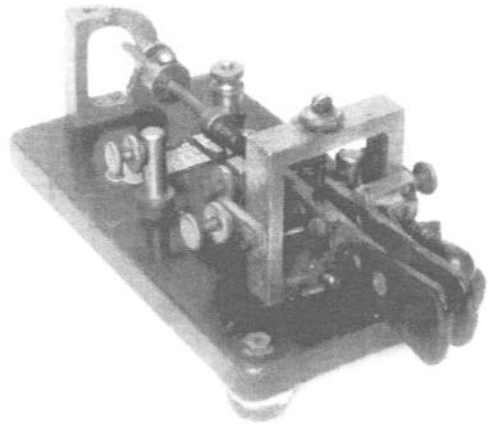
included every possible method of creating dots automatically and dashes manually. With it he slammed the door on any possible attempts to produce semi-automatic instruments, with just two exceptions.

Enter the Vibroplex

Even as the Autoplex was being sold to telegraphers, Martin was working on a radically improved model that went on the market in 1904, which he called it the 'Vibroplex'.

That 1904 key is the 'Original' model *(Figure 3.4)*, and the only difference from the modern chrome and red lucite versions is the mounting of the dot contact. In 1904 it was a straight strip of metal attached to the pendulum but by 1906 Martin had changed it to the familiar 'U' style of mounting.

Figure 3.5: Vibroplex 'Double Lever', 1911



All the early Vibroplex were custom built by Martin to order in a small shop at his home in Brooklyn. All Martin keys had a black japanned base with the gold carriage trim, and all the name-plates were labelled '"The Vibroplex" by Horace G. Martin New York'. The Vibroplex Company name-plate began to appear on the keys with the Number 4 model in 1914.

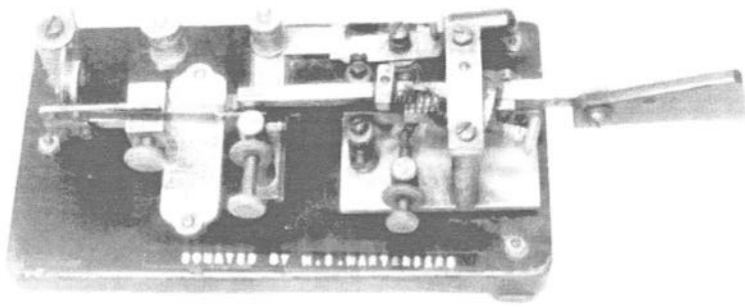


Figure 3.6: Vibroplex 'X' model, 1912

New Ideas

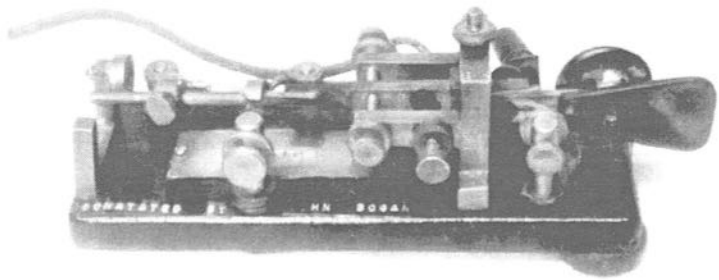
Martin was continually coming up with new ideas to improve this key. The problem of split dots, or possible 'lash back' after the thumb-piece controlling the dots was released was more effectively handled by the 'Double Lever' Vibroplex in 1911 *(Figure 3.5)*, with separate levers for dots and for dashes.

The following year the 'X' model *(Figure 3.6)* went back to the single lever, but utilised a single contact for both the dots and dashes with a special strip that held the pendulum stationary while the dashes were being made.

1912 also saw the first official listing of the Vibroplex name as a registered trademark, both in advertising and stamped as trademark number 84,356 on the name-plate.

About this time, Martin teamed up with James Albright, and the Albright Company began producing Vibroplex keys, some from Albright's typewriter offices in New York City, and some from Martin's Brooklyn location. From then on the name-plates were all of the more familiar style

Figure 3.7: Vibroplex '#4', 1914



although the 'Lightning Bug' logo did not appear until the 1920s.

Smaller Keys

There was a need for a smaller key that could be easily carried for use at sports events, conventions, in fact for any activity in the field. So in 1914 Martin designed the Vibroplex '#4' *(Figure 3.7)*, the half-size version of the 'Original', later to be advertised as the 'Blue Racer'.

However, for some there was still the problem of curtailed space for operating in telegraph offices. There is nothing so crowded as a wire chief's desk and the speed keys took up too much room – even the smaller '#4' was too large – so it was back to the drawing board for Horace Martin.

He didn't take much time incorporating the single contact feature of the 'X' model into a vertical style semi-automatic *(Figure 3.8)* mounted on a 2½ x 3½-inch inverted U-shaped base that fitted into a very small area. This patent appeared in 1917 as the 'Upright Vibroplex' or 'Wire Chief's Key', which the operators nicknamed the 'Vertical Bug'. Both the 'Upright' and the 'X' models were discontinued by Vibroplex in 1925.

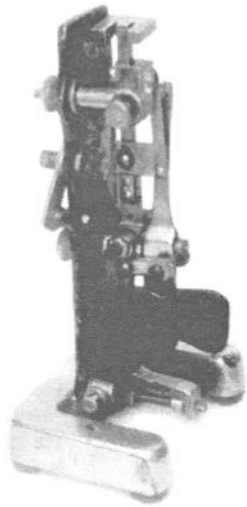


Figure 3.8: Vibroplex 'Upright', 1917

'Bug' Copyright

The term 'bug' that was so scathingly given to the earliest vibrating keys had stuck to any kind of semi-automatic; however the originally profane definition had long since disappeared as such terms do (for the record, it was replaced by 'lid' and 'plug').

Martin and Albright picked it up in typical 'if-you-can't-fight-'em-jine-'em' fashion and registered the word, with a stylised 'Lightning Bug' design, as one of the copyrights and trademarks of the Vibroplex Company.

Greatest of All

Vibroplex was busy with military orders during the First World War so it was not until 1923 that the newest and greatest of all the Martin patents appeared. Called the Vibroplex '#6' *(Figure 3.9)*, and later advertised as the 'Lightning Bug', it was offered with a choice of red, blue, green, nickel or the well-known black base.

Probably the smoothest operating and most efficient of all the Martin keys, it was later chosen by the military during World War Two as the work horse of the Signal Corps, the 'J-36', and was selected by the Navy as their speed key.

After the exclusive manufacturing rights of Vibroplex, as

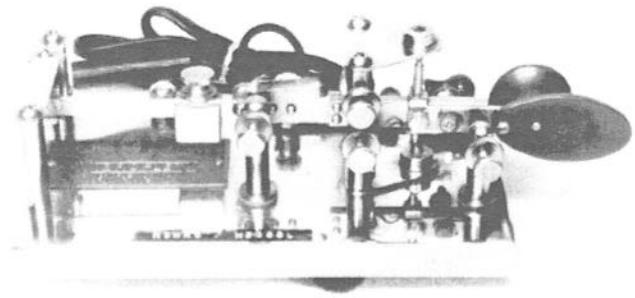


Figure 3.9: Vibroplex '#6', 1923

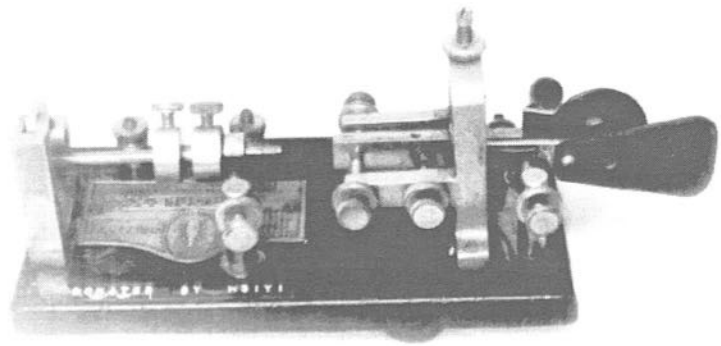
well as the patent monopoly, expired the market was wide open. But in 1930 Martin produced one more design, the 'Martin Junior' *(Figure 3.10)* for use in radio, for since CW had replaced Spark it was possible, at last, to use semi-automatics on the air.

Exit Martin

Martin left Vibroplex in the 1930s and organised the Martin Research and Manufacturing Company, making 'Martin Flash Keys'. In 1940 he sold his jigs, dies and patents to the J.H. Bunnell Company who produced the 'Bunnell-Martin Flash Key *(Figure 3.11)*.

The Vibroplex Company continued to produce the original Martin designs with many new models for amateur radio: the 'Zephyr', 'Champion', 'Blue Racer' and, under the aegis of John La Hiff, the De Luxe models from 1941. Then, after World War Two and the introduction of electronic keyers, the 'Vibrokeyer', a key that activated this type of keyer.

Figure 3.10: Martin 'Junior', 1930



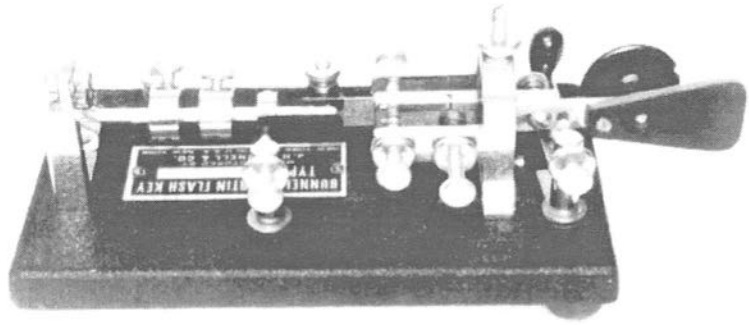


Figure 3.11: Bunnell-Martin Flash Key, 1940

Telegraphic Legacy

The story of the bug and the story of the Vibroplex are the same story. It is the story of Horace G. Martin (*Figure 3.12*), a telegrapher who recognised the need for speed, an inventor who answered that need, and a clever businessman who turned a term of opprobrium into the designation now popularly associated with all semi-automatic keys.

References Used

There are no formal published works covering Vibroplex. All material in this article is based on the Martin patents, the keys themselves, personal correspondence and interviews with persons who knew Horace G. Martin. *[Since this article was written the Vibroplex Co has published* The Vibroplex Co., Inc. 1890 to 1990 *by William R. Holly, K1BH. – Ed.]*

Figure 3.13: Vibroplex Name Plate, 1941

Picture Sources

Figure 3.1 – Henry Ford Museum.
Figures 3.2, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9, 3.10, 3.11 – W3WRE Library.
Figure 3.3 – US Patent Office.
Figure 3.12 – Vibroplex catalogue.
Photography: Ralph Williams N3VT.

Figure 3.12: Horace G. Martin

4

GOOD GUYS, BOOTLEGGERS, AND BASTARDS

No matter how carefully we try to cover all eventualities an opening usually occurs somewhere. And so it was with Horace Martin's semi-automatic key, for there were two exceptions that sneaked past his almost blanket patent.

In 1906, just two years after the Vibroplex appeared, W.O. Coffe of Cleveland, Ohio, invented the Mecograph, and in 1909 J.A. Hulit of Topeka, Kansas, received a patent for a third style of semi-automatic key.

The Hulit instrument *(Figure 4.1)*, was a two-lever spring driven key. As with Vibroplex, the dashes were made manually with one lever, while the dots were created by a second lever that activated a key-wound spring. Thus, by winding and rewinding like a clock the dots were produced, and these keys were marketed by the Hulit Company until 1911.

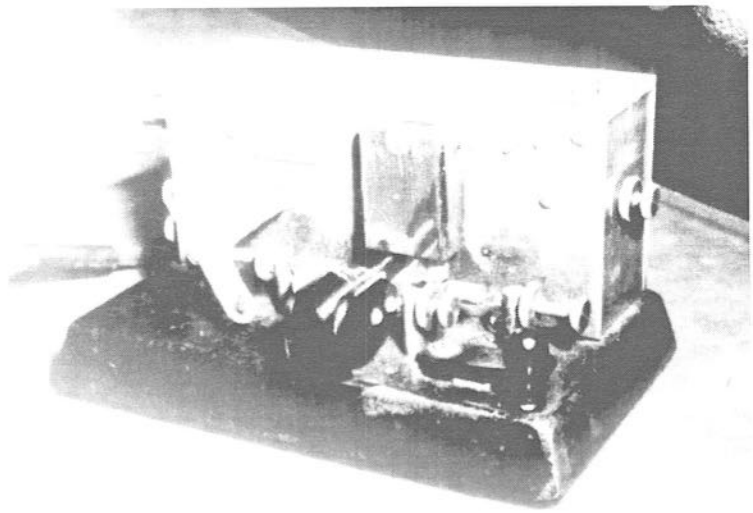


Figure 4.1: The Hulit Transmitter, 1909

The Coffe invention, manufactured by the Mecograph Company in Cleveland, used a vertical design so that the pendulum, or vibrator, swung freely *(Figure 4.2)*. But, as with Hulit, there was a loophole; in this case it was the spring action that bypassed the Martin patent rather than the physical design.

Mecograph Company

Vibroplex made dots by creating tension in the spring, while Mecograph utilised release of spring tension. Thus, with that principle they were able to continue the commercial production of semi-automatic keys and not infringe the Martin patents.

The Coffe idea was the beginning of Mecograph. The following year Benjamin Bellows changed the vertical design. He applied the original idea to a horizontal base with the finger pieces mounted at right angles to the pendulum and

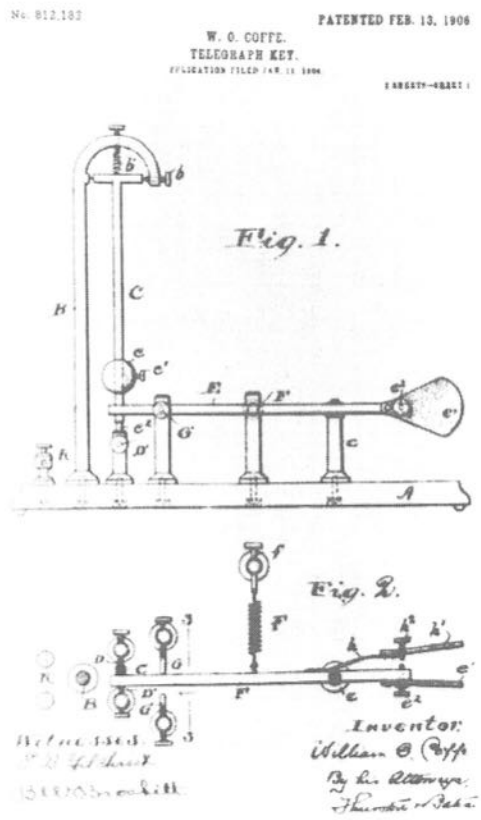


Figure 4.2: Mecograph-Coffe Patent, 1906

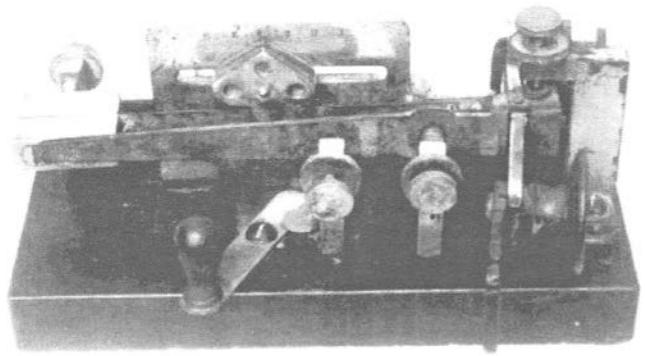
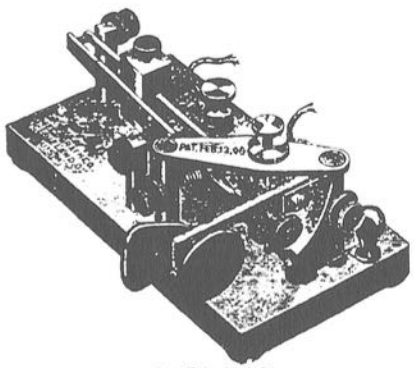


Figure 4.3: Mecograph-(Bellows), 1907

TO THE TELEGRAPHISTS.



IF you wish to forge ahead, get a MECOGRAPH and show "The Chief" that you are the proper parties for promotion and the best class of work. Your principal difficulty has been to get a clean cut "h" or "5," both in and out, and this has often led you to ask: Is there no way of overcoming it? **Well, the Mecograph Answers the Question.** There is only one motion of the thumb—to the left—to get any number of sharp, clear and distinct dots. This is hard to believe, but it is a fact. Dashes are made by the opposite movement.

To the broken down man the Mecograph is a God-send, while to the still strong arm an insurance against failure. Adaptable to any circumstances, it can be operated on the knee as well as on the bench. The speed at which "stuff" can be got through is wonderful, and without diminution of clearness,—while a slow pace detracts nothing from perfect Morse. It can be attached to, or detached from, any wire instantly, requires neither winding nor batteries, and is adjustable to the needs of the sender.

All this sounds too good to be true, but every sentence is correct, and the claims can be and are substantiated.

THE MECOGRAPH is in daily use on the heaviest land and submarine circuits in the Commonwealth, has successfully worked through repeaters, and the users are eloquent in their admiration, as witness the many testimonials (unsought) received. Here are two:—

MESSRS. EDMANSON & CO.,
Block Arcade, Melbourne.

Electric Telegraph Department,
Chief Office, Sydney, 6th June, 1907.

GENTLEMEN,—I received the MECOGRAPH in good order and condition. It is a very nice little instrument, and I am thoroughly satisfied with it. After a few hours' practice I transmitted all my business with it; and now, after having had it three weeks, I am pleased to announce that it is a perfect success. I am making such rapid improvement that I can almost send as well as ever I did. It is a great boon to me after the many years I have labored with a bad arm sending on a Morse key. I can honestly recommend the MECOGRAPH to any Telegraphist, because it is so easy to learn and so readily manipulated that work is made exceedingly easy.

Yours faithfully,
(Sgd.) T. G. ANSON.

Mr. E. HARRIS, of the Electric Telegraph Department, South Australia, writes:—"I am quite satisfied with the MECOGRAPH, and feel confident it will prove a real success. I use it continuously on heavy circuits, and have no trouble in getting business through."—11th June, 1907.

We say **you cannot afford** to be without a MECOGRAPH. It is steadily supplanting the old key in America, and those Americans are not far behind in seeing and adopting "things slick."

The demand for the instruments has been such that the first three shipments were secured long before their arrival, but there are plenty more coming, so order early.

Price. £2 10s.: neat Carrying Case, **7/6**. POSTAGE: Victoria 1s. 6d.; Interstate, 2s. 8d.

EDMANSON & Co., of Block Arcade, MELBOURNE,

Are the Sole Agents in Australia of the Manufacturers,

THE MECOGRAPH COMPANY, of CLEVELAND, Ohio, U.S.A.

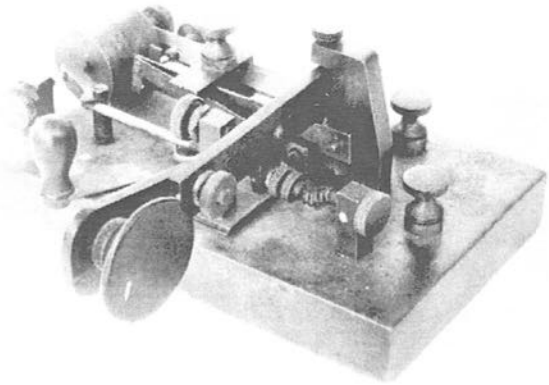


Figure 4.4: Mecograph-(Bellows), 1909

Mecograph Number Two *(Figure 4.3)*, popularly called the 'Right-Angle Bug', was born. The dot speeds were controlled by a speed indicator in the centre of the base to govern the movement of the vibrator.

In 1908, Mecograph marketed a combination key with both a hand key and a semi-automatic on a single base. The entire mechanism was enclosed in a case with only the key knob and the two finger pieces exposed for operation. The style was produced so that the operator could easily switch to either type of operation with a minimum of arm movement.

Then, in 1909, they came back with a smaller version of the Number Two model *(Figure 4.4)* changing the speed control from arbitrary settings to an adjustable slide mounted on the vibrator to control the dot speeds. 1910 saw the only Mecograph that did not have the right-angle principle but utilised a straight lever pendulum.

After the death of Benjamin Bellows in 1913, the Mecograph Company was absorbed by Vibroplex who then listed themselves as the 'Vibroplex and Mecograph Company', with J.E. Albright as sole agent for several years.

Bootleg Copies

The semi-automatic key was very popular and obviously turning into quite a financial success, so just about everybody with an idea tried to get into the act despite those all-covering Martin patents. From 1912 on, several manufacturers began making and selling semi-automatics. They couldn't break the Vibroplex control but they tried.

In 1909 the Thomas J. Dunn Company advertised the 'Dunduplex' *(Figure 4.5)*, a dual purpose instrument, a two-lever semi-automatic with plunger type knobs mounted on

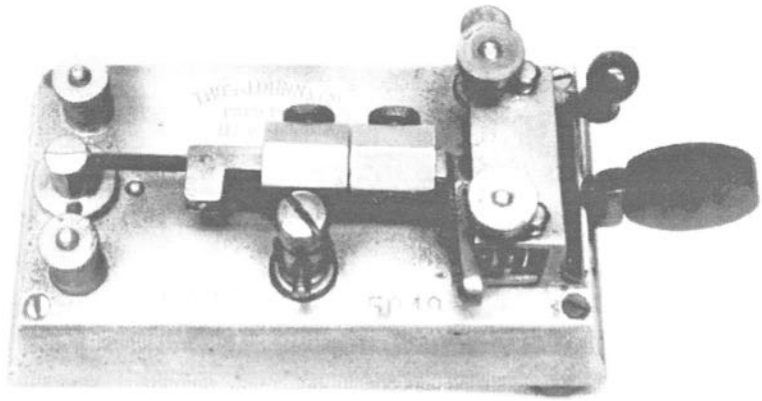


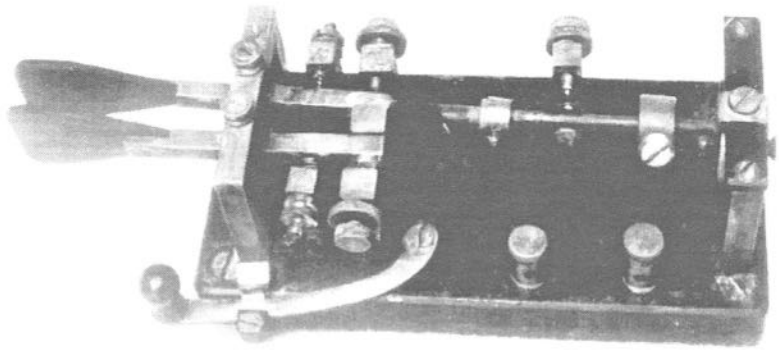
Figure 4.5: Dunduplex, 1909

the bridge that permitted the operator to operate by 'drumming' on them to produce the code. Automatic dots were produced by either method of operating.

In 1912, the William MacDonald Company was selling a two-lever key *(Figure 4.6)* with all brass working parts using a brown dielectric sub-base, mounted on a heavy metal base, that very much resembled Martin's 1911 Vibroplex. Others also had that same type base with a four-leaf clover style logo containing the letters D.T.Y.G. stamped on the base.

The James M. Dickson key was sold by the Mt. Auburn Specialty Company, and the O.M. Thomas Electric Company sold keys made by Oliver Thomas. But the most flagrant carbon copy came from the A to Z Electric Novelty

Figure 4.6: MacDonald, 1914



Company of Chicago (*Figure 4.7*). This key was a copy of the Vibroplex 'Original' right down to the black Japanned base with gold 'carriage trim' markings, bearing the name plate 'The Improved Vibroplex'.

Non-Vibroplex Keys Banned

All these instruments were being commercially sold and the telegraphers who bought them were using them even though the Vibroplex company had knocked their makers out of business because of patent infringement. A favourite key that worked well and suited the operator was all they wanted, so although the bootleg companies were no longer in business the keys were still being used in many offices across the country.

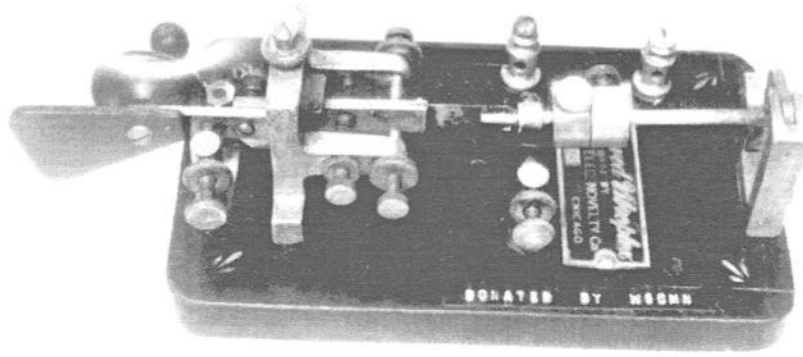


Figure 4.7: A to Z, 1914

However, J.E. Albright and Horace Martin weren't about to relinquish the legal priorities that had been firmly established by Vibroplex. They had won the patent fights, so the next step was to stop the use of the keys in the industry.

Albright convinced the telegraph companies that Vibroplex was the only legal key. Going even further, he published a warning to the operators in the leading journals of the profession: 'All who are now using machines purchased from Mt. Auburn Specialty Company; O.M. Thomas Electric Company; Max Levy of the A to Z Electric Novelty Company; Thomas J. Dunn Company, are daily liable to prosecution.' And the telegraph companies themselves issued orders that independently manufactured bootleg keys could not be used on their wires by the operators.

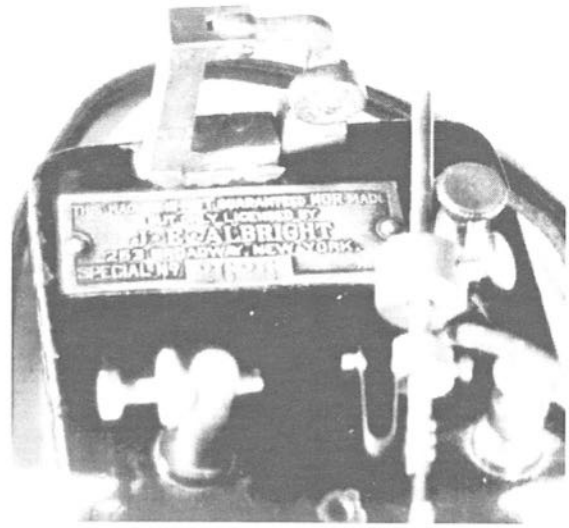


Figure 4.8: Albright License (Close-up)

'Bastard Bugs'

Now a great many of these keys were excellent instruments, in some cases equal to Vibroplex in operating performance. And from the beginning it had been the policy of the railroads and the commercial telegraph companies to permit the telegraphers to work with the keys of their choice thus, of course, producing more efficiency and greater output.

The telegraph fraternity were a hard-headed independent group of skilled professionals. When the order was received they refused to accept it, and attempts to enforce it almost caused an operators' strike. Then, just before the irresistible force of the companies' orders met the operators' intransigent stand head-on, a compromise was reached.

All the semi-automatics that had been blackballed through legal action were to be inspected. If an instrument met Western Union requirements of clean sending with no split dots, could be set to send eleven dots a second, and was comparable to Vibroplex, then the inspector passed it for use. The proud owner was then permitted to purchase a 'license', a brass plate *(Figure 4.8)* that read:

'This machine is not guaranteed nor made but
only licensed by J. E. Albright.'

Each licence had a serial number, identified as a 'Special Number' for keys used by Press Associations, Railroads, or individual owners; or as a 'Special Western Union Number'. The licences cost two dollars, and as soon as one was

attached to a key it became legal. The semi-automatics receiving such a licence were informally nicknamed 'The Albright Bug', or 'The Legal Bug'; but most often they were known to their operators as 'The Bastard Bug'.

No Longer Needed

During the First World War, inspectors from the Albright Company were asked by the War Department to inspect and approve the semi-automatics purchased by the Signal Corps for military use, to ensure efficient operating on their circuits.

When the exclusive manufacturing rights were relaxed in the early twenties, there was no longer a need for the so-called 'Albright License' since by then many manufacturers were producing semi-automatic keys quite legally.

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2. *The Journal of the Telegraph,* October 1914.
3. Mecograph Patents.
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Picture Sources

Figure 4.1 – Henry Ford Museum.
Figure 4.2 – US. Patent Office.
Figures 4.3, 4.5, 4.6, 4.7 – W3WRE Library. Photography: Ralph Williams N3VT.
Figure 4.4 – Collection: John Elwood WW7P. Photography: Ray Nelligan.
Figure 4.8 – C.S. Moore.

5

SEMI-AUTOMATICS... OPEN SEASON

By the end of the first world war the Vibroplex exclusive manufacturing rights had relaxed. A few years later CW was replacing spark, and then the name of the game in semi-automatic keys was 'every man for himself'. With the market now wide open for both wire and radio in advertising, even the formerly forbidden 'bootleg' keys were being used on the wires.

The twenties saw Bunnell, Lytle, Signal, Logan, and Lippencott instruments in operation – all variations of the original 1904 Martin principle of speed sending with greater comfort. But, as in the many that followed, each aimed to provide some shade of difference in design that would possibly be more preferable to the potential buyer.

'Gold Bug'

The J.H. Bunnell Company, who had been making Martin's 'Autoplex' as late as 1917, opened the market utilising a

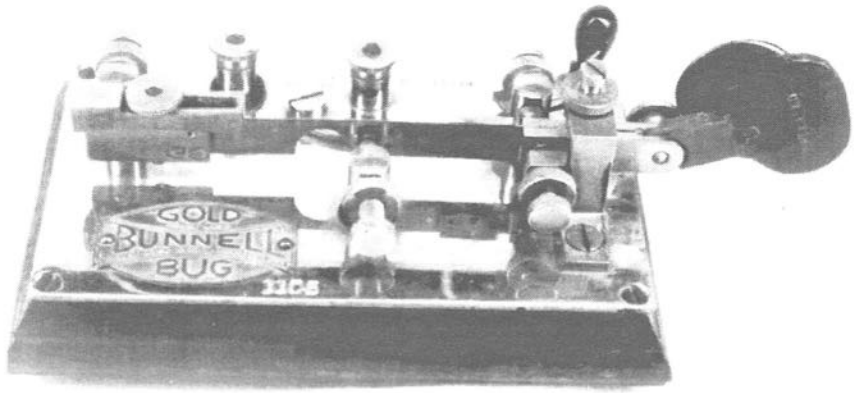


Figure 5.1: Bunnell 'Gold Bug', 1922

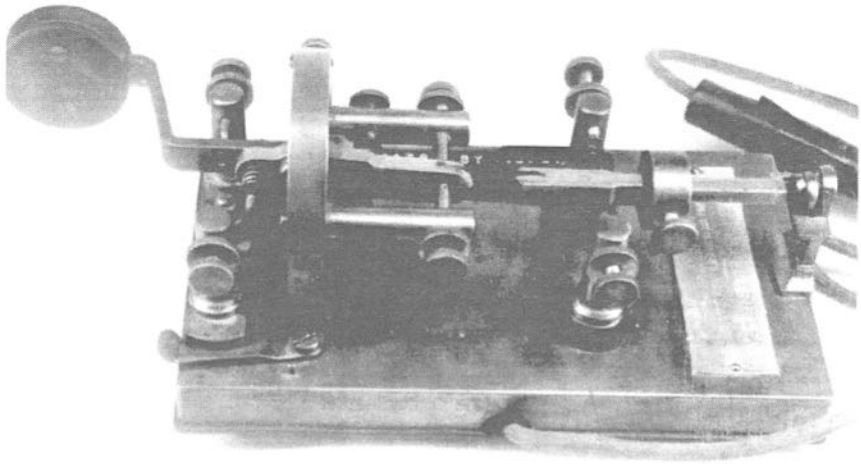


Figure 5.2: 'Lytle Triplex', 1922

familiar designation with their product, the 'Gold Bug' *(Figure 5.1)*.

Here, Bunnell employed a weight at the extreme end of the pendulum that could be extended or shortened to control speed. An ingenious feature was the mounting of the

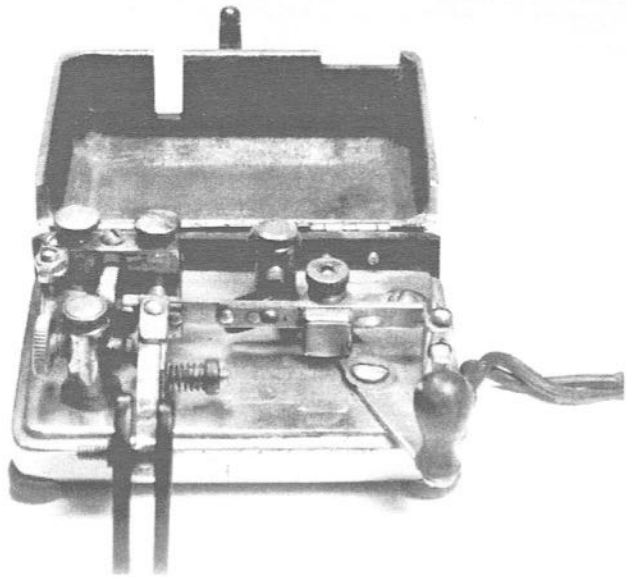


Figure 5.3: 'Ultimate', 1925

vibrating dot contact against the right side of the pendulum, with an opening through the pendulum for this vibrating contact, thus eliminating lashback and split dots. The entire key was nickel-plated but the nameplate was advertised as gold-plated to illustrate the name of the key.

In 1922, the Philadelphia Thermometer Instrument Company introduced 'The Lytle Triplex' *(Figure 5.2)*. As the name implies, this key could be operated three ways: as a left or right hand semi-automatic, or as a hand key. The circular bridge supporting the pendulum could be turned and locked on either side, or vertically for manual operation – a return to the principle of the Maloney and Johnson style of the early side-swipers of 1886.

The '73' Key

Another key that reverted back to an earlier design, the 'Ultimate' of 1925 *(Figure 5.3)*, was patterned after the right-angle principle of the Mecograph. Mounted on a $3^{3}/_{4}$ x $2^{1}/_{4}$in base, this miniaturised semi-automatic had a hinged

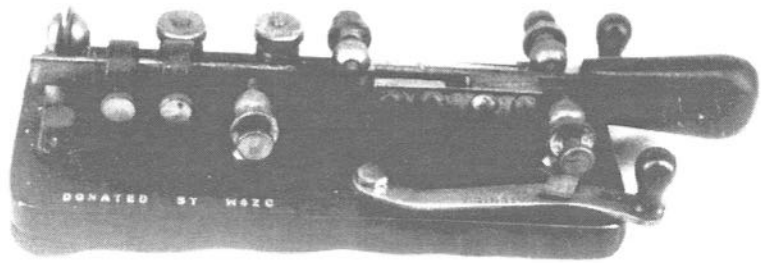


Figure 5.4: Signal Electric 'Sematic', late 1920s

metal dust cover that exposed only the circuit closing switch and the thumb and finger pieces.

This became known as 'the 73 key', because of the numeral on the nameplate, and was designed principally to be easily carried by a telegrapher for operation away from the office. The following year, two less expensive models of this key were produced for the Amateur market using a 'white metal' that deteriorated making it unfit for use.

Then, in the late 1920s, the Signal Electric Company of Menominee, Michigan, combined the semi-automatic with a 'side-swiper' in their 'Sematic' key *(Figure 5.4)*. This had a circuit closing switch on each side of the base and a lock to secure the pendulum during manual operation. The switch to the right was opened for the key to operate as a side-swiper, or both could be opened and the lock disengaged for semi-automatic operation.

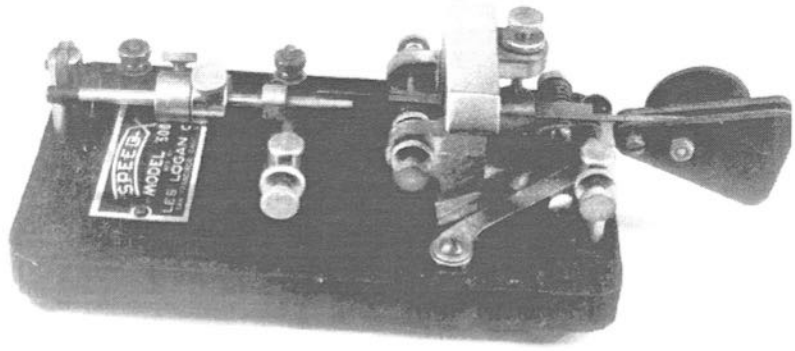


Figure 5.5: Les Logan 'Speed-X', late 1920s

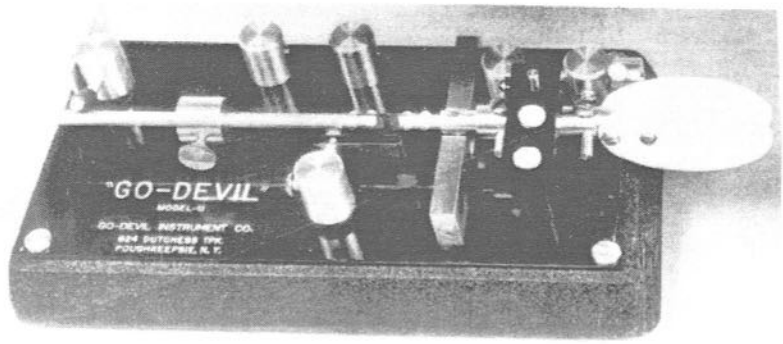
Logan/Johnson 'Speed-X'

The Les Logan Company in San Francisco marketed the 'Speed-X' keys at the close of the 1920s. As with other earlier instruments they too attempted to combine both manual and semi-automatic operation in the design. The Logan 'Speed-X' *(Figure 5.5)* had a high 'T'-shaped bridge for carrying purposes and, if turned on the side operated as a hand key.

The period 1930 through 1941 saw the introduction of new names as the field expanded, with McElroy, Telegraph Apparatus, Johnson, Electric Specialty, and Go-Devil in addition to the earlier keys.

'Speed-X' acquired a new identity in the 1930s with the

Figure 5.6: A. H. Emery 'Go Devil', 1933



E.F. Johnson Company taking over that name with the patents of the Logan company, and continuing production of the Logan designs. Then in 1934 the Signal Electric keys were also absorbed by Johnson, who produced all the Signal instruments in addition to the so-called 'Johnson Bug' that used the more familiar semi-automatic style reminiscent of the Martin designs. 'Speed-X' was then almost synonymous with Johnson until the 1970s.

But the thirties saw more than Johnson. Late in 1933, A.H. Emery of Poughkeepsie, NY, introduced the 'Go-Devil' *(Figure 5.6)*. This key could, by using a locking device on the dot contact, act as a side-swiper or, by releasing the lock, have semi-automatic action. This instrument was

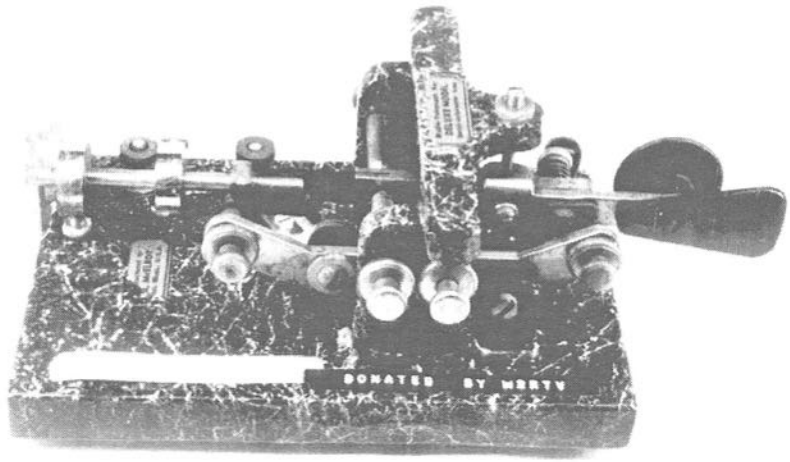


Figure 5.7: 'Mac-Key', 1940

claimed to be able to operate effectively with very high voltages. A slimmed-down version was re-introduced in the late 1950s.

Mac-Keys

A year after the 'Go-Devil' appeared, Ted McElroy, the undisputed World Champion Speed King, produced his 'Mac-Key'. This followed the earlier Logan idea of turning it on the side for use as a hand key or as a semi-automatic. He later offered the key in a marbleised enamel style *(Figure 5.7)*, as well as a less expensive model.

New models appeared every year, culminating in the 1941 chrome-plated, tear-drop design, 'Super Stream-Speed', much desired by collectors.

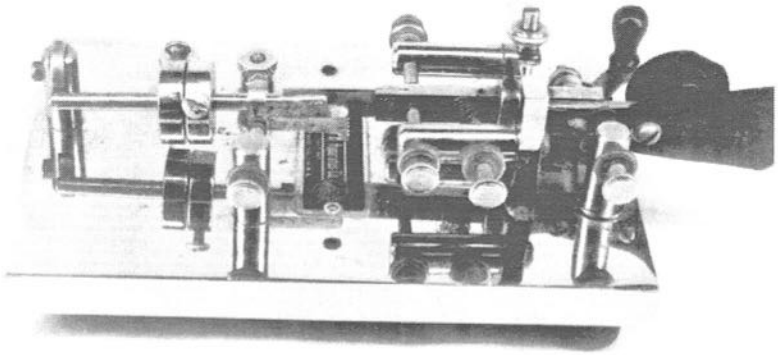


Figure 5.8: Telegraph Apparatus Co. 'Speed Key', mid 1930s

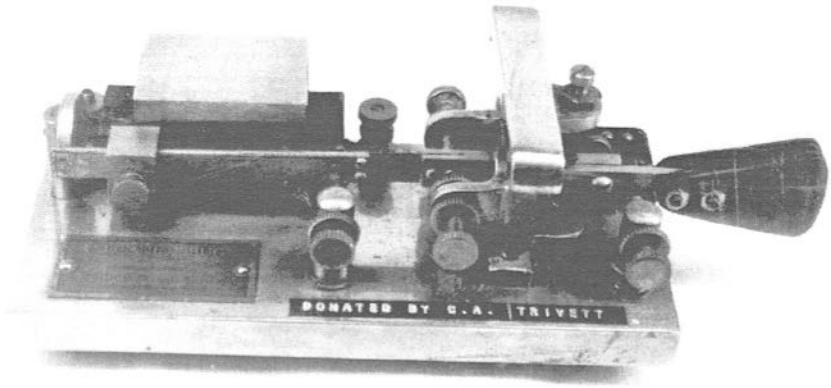
Semi-automatic in Kit Form

In the mid-30s the Telegraph Apparatus Company of Chicago advertised their 'Speed Key' (*Figure 5.8*), offering either a heavy chrome or coloured lacquer base. The pendulum was mounted through a $1^1/_4$ x $3^3/_4$in rectangular bridge. During World War II the Lionel Company produced these keys for the armed services.

1935 saw the 'Electro-Bug' *(Figure 5.9)* made by the Electro Manufacturing Company of San Francisco. This key bore a close resemblance to the Logan 'Speed-X', but a major difference was the addition of a switching mechanism in the base. This provided a series of resistances to adjust the dot-relay to operate with various types of current if necessary.

Then in 1939 the Electric Specialty Company of Cedar Rapids, Iowa, produced the only semi-automatic to be sold

Figure 5.9: Electro Manufacturing Co. 'Electro Bug', late 1930s



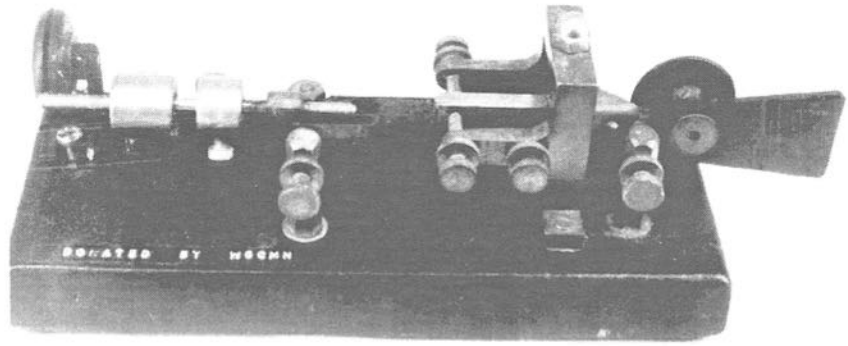


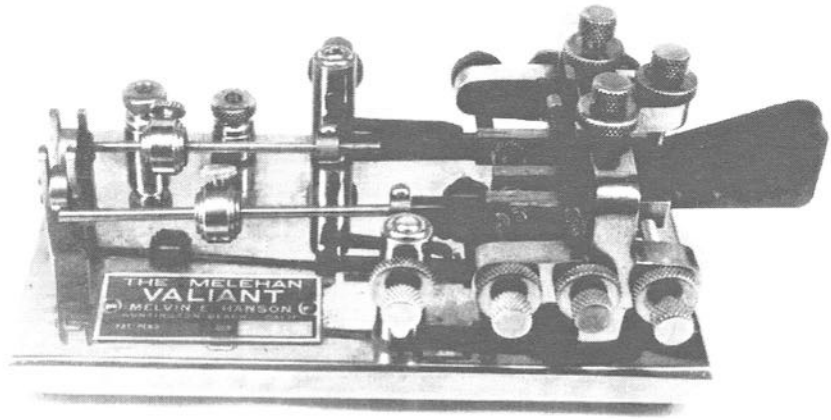
Figure 5.10: 'Radio Speed Bug', 1939: Kit for radio amateurs

in kit form. This 'Radio Speed Bug' *(Figure 5.10)* was designed principally for Amateur use and featured a large hard rubber damper to reduce lashback of the pendulum.

Fully Automatic

Also in 1939, and primarily for Amateur Radio use, the manually operated, spring-driven, fully automatic key of Melvin E. Hansen, W6MFY, of Newport Beach, Calif., was advertised. This was the 'Melehan Valiant' *(Figure 5.11)*, which was actually two completely separate units, one to make the dots and the other to create a series of dashes. After WWII, production was resumed but by then the electronic keys gave too much competition.

Figure 5.11: 'Melehan Valiant', 1939: Primarily for amateur use



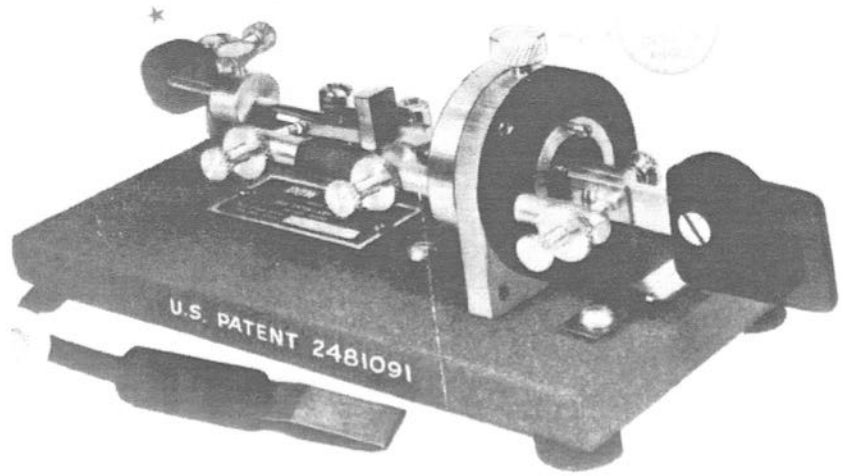


Figure 5.12: 'Dow Key': 1949

The post-war period also saw the 'Dow-Key' *(Figure 5.12)*, based on the Lytle design, adjusting to the most comfortable position of the operator's hand. In 1949, Horace Martin Jr., son of the inventor of the Vibroplex, introduced the 'Roto-plex' *(Figure 5.13)*, utilising a ball-bearing movement that had been originally designed for military use during WWII.

1957 saw the Bunnell 'Speed Key' *(Figure 5.14)*, a streamlined version of the Bunnell-Martin 'Flash-Key'. From 1960 on, the semi-automatic field narrowed as the electronic keys became more and more popular.

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1. *QST* magazine.
2. *CQ* magazine.
3. *Telegraph and Telephone Age*.
4. US patent indices for the years 1920–1949
5. Correspondence with Gordon Dow.

Picture Sources

Figure 5.3 – Dave Pennes WA3LKN.
Others – W3WRE library.

Figures 5.13 and 5.14 appear on page 44

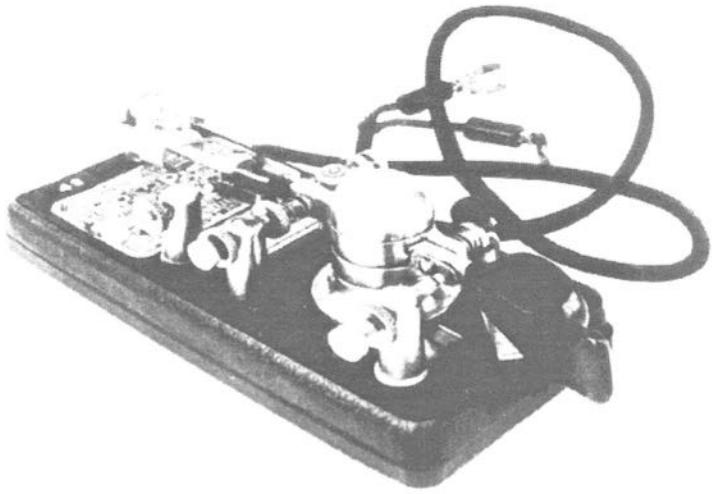
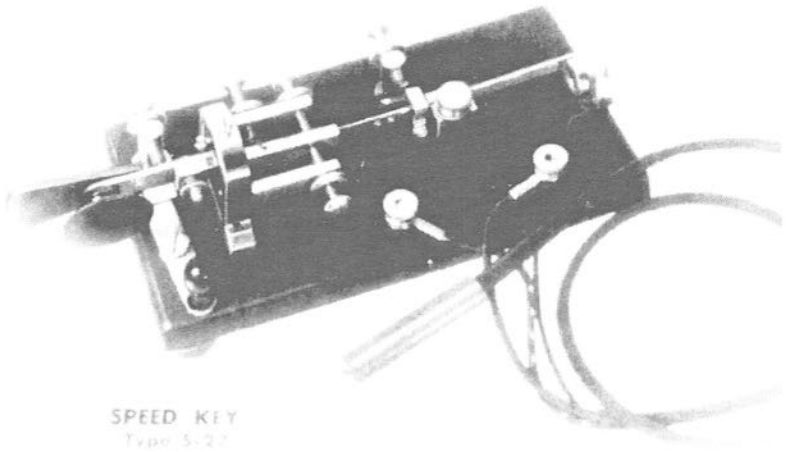


Figure 5.13: Horace Martin Jr. 'Rotoplex', 1949

Figure 5.14: Bunnell 'Speed Key', 1957



6

THE FIST OF KING SPARK

When wireless entered the communications picture everything except the operator and the transmission code changed; King Spark spoke with a mighty voice and the antennas blazed with the power of his fist *(Figure 6.1)*.

The tremendous power generated by the transmitter made it possible for the operator to monitor his signal three ways simultaneously. He could see the blue spark jump across the electrodes of the gap; hear the crashing roar of his fist as he closed the key; and smell the ozone that built up in the shack.

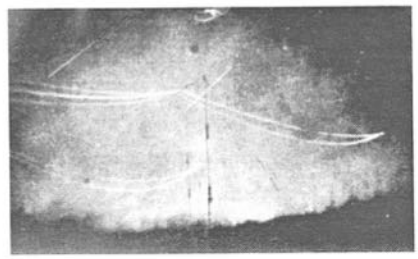


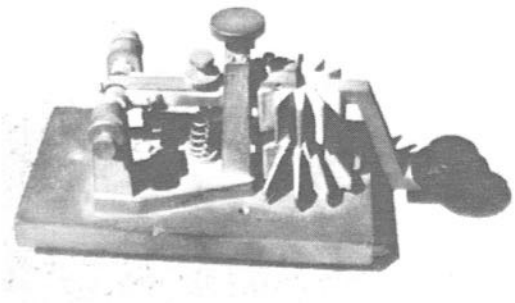
Figure 6.1: Clifden Antennas

Enlarged Contacts

The conventional telegraph key could not be used because it was placed in the primary circuit of the transmitter and the high current was too much for the small contacts to handle. Thus the contacts were enlarged to give a broader surface. Some keys used silver contacts half an inch or more in diameter, and because of the large amount of heat generated on contact, cooling fins or flanges were provided to assist dissipation of the heat *(Figure 6.2)*.

Figure 6.2: American deForest 10kW Navy Key, finned for heat dissipation

The lever, in turn, became larger to support the contacts and the entire key design reverted to the original telegraph styles of the 1840s. All metal working parts were mounted separately on a heavy slate, wood, marble or dielectric base, providing insulation to protect the operator.



Jack Binns at the key of a reconstructed transmitter similar to the one with which he sent the first radio distress call (CQD) in history from the sinking S.S. Republic in 1909.

New York Times, January 22, 1956

Figure 6.3: Jack Binns with Masse Key

Skirted Knob

One other safety feature, not mandatory but generally adopted by most operators, was the 'skirted knob', over the years popularly but erroneously nicknamed the 'Navy Knob'. Actually this is of European origin, adopted by ship's operators who found the 'skirt' afforded additional protection against their fingers accidentally touching the lever.

Most American keys were designed with the curved lever that identifies the instruments of this country. An exception, however, was the Masse Wireless Telegraph Company, reflecting the English origin of Walter Masse who designed their straight lever instruments. They also manufactured the largest of the hand keys, one of which was used by Jack Binns, radio operator of the R*epublic, (Figure 6.3)* for his historic 'CQD' in January 1909.

Designed with a fourteen inch long cast brass lever; contacts with flat, square cooling surfaces; and all parts mounted on a slate base, this key weighed eighteen pounds. These large capacity keys were, of course, used to interrupt very high current, particularly those in the mighty 'rock crushers' of the coastal stations.

Leg Style

The smaller capacity keys used on ships and lower power wireless stations were constructed in much the same style as

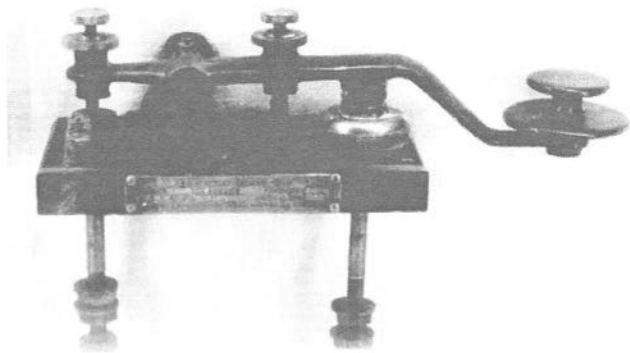


Figure 6.4: US Navy Key

the larger ones. Those made for the United States Navy for shipboard operation were leg style *(Figure 6.4)* to ensure steady operation aboard ship.

With the wiring under the surface of the operating desk there was further protection for the operator. Many of these keys were rated to handle up to thirty five amperes of current without arcing while others, particularly those of the Marconi company were rated at fifty to sixty amperes.

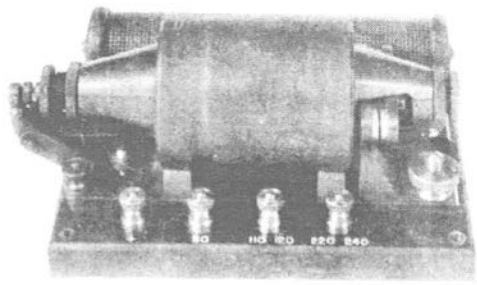


Figure 6.5: Relay Key

Relay Keys

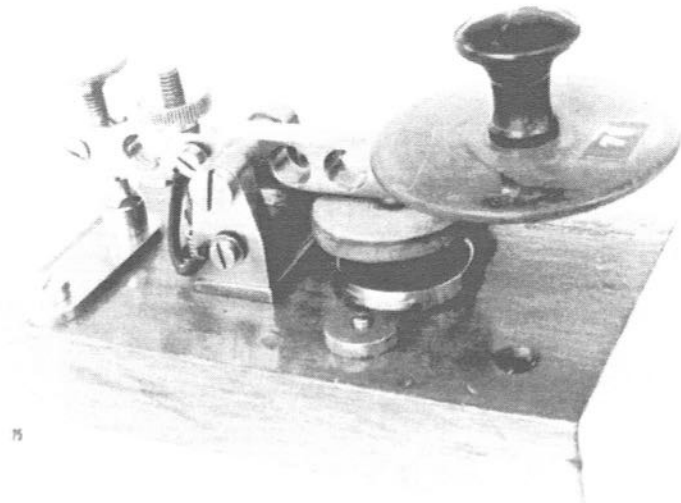
Often, smaller keys, or keys with small size contacts, were operated through a Relay Key *(Figure 6.5)* placed between the key and the transformer primary to prevent arcing.

These keys, actually solenoids, operated in parallel with the key for very large power transmitters. The relay key was used to break the primary circuit in air but another style, the 'Oilbreak' key *(Figure 6.6)*, operated with the solenoids immersed in oil to prevent arcing.

Break-in

There was provision for break-in operation during the spark era by means of a rather primitive 'T-R' switch that was part of the instrument, as in the Marconi Company's 'Grasshopper' key *(Figure 6.7)*. Here the key was not only

Figure 6.6: Ducretet & Roger Oil Break Key (French)



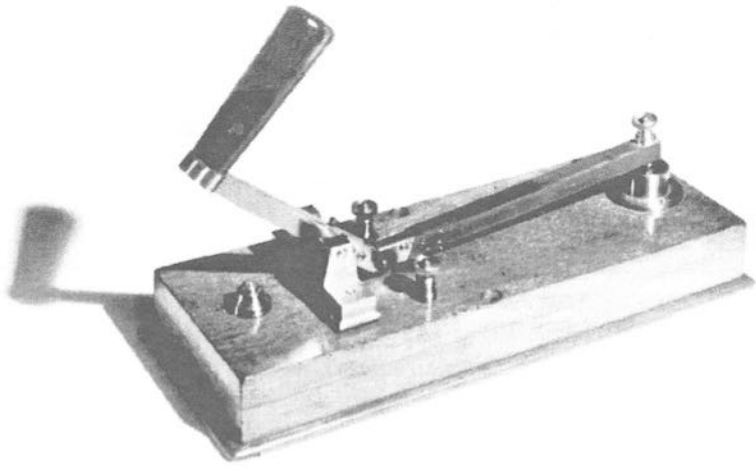


Figure 6.7: 'Grasshopper' Key

wired for transmission but an additional contact broke the receiving circuit, thus providing protection against damage to the fragile coherers during transmission.

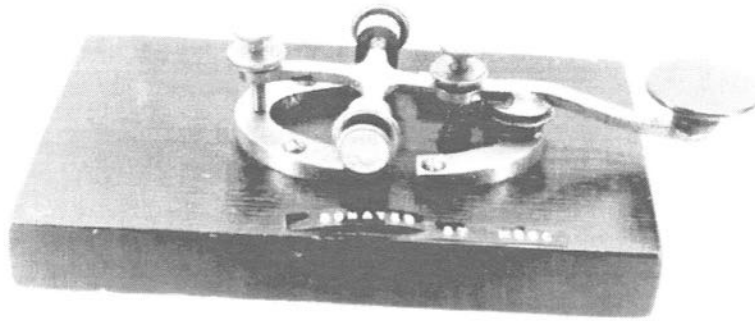
This type of key was used in Marconi's maritime experiments at the turn of the century.

Ham Keys

The huge keys that handled the power of the spark were of course designed for commercial use, but there was a new demand as the amateur radio operators increased in numbers.

Figure 6.8: 'Dime' key. Standard key modified by hams

'Joe Ham' couldn't afford these expensive instruments so, as with most of his equipment in the earliest days of radio, he built his own spark key. He modified a telegraph key by



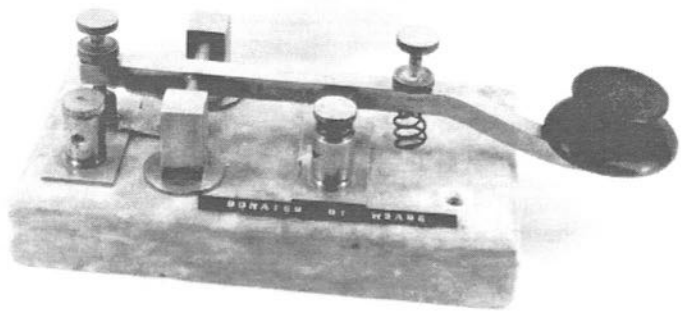


Figure 6.9: Clapp-Eastham Co. 'Boston Key'

replacing the contacts with dimes, cutting the frame to adjust it so the contacts would meet. Mounting this newly made spark key on a block of wood, he was in business with the dear-to-the-hearts-of-all-old-timers 'dime key' *(Figure 6.8)*.

The fact that he had ruined or defaced a coin of the realm didn't worry him at all. He was only interested in getting on the air, and for twenty cents he could do just that.

Dream Key

Of course there were commercially produced keys for the Amateur. In 1915, the Clapp-Eastham Company of Boston offered a smaller capacity key that, although produced for the luxury liner and the yachting trade, was the dream key of every Amateur.

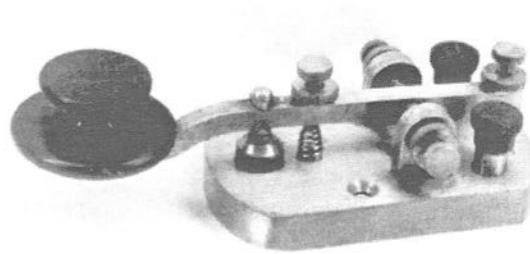
The so-called 'Boston key' *(Figure 6.9)* with a marble base and German silver plated working parts was advertised at $15.00. Other manufacturers also offered marble base keys, but to the Amateur the smoothly operating Boston key rated as 'Number one.'

Figure 6.10: Signal Electric Key, with replaceable contacts

All Brass

For the brasspounder's delight, the Signal Electric Company of Menominee, Michigan, made a key that assembled all brass parts on a solid brass frame *(Figure 6.10)*.

They advertised a choice of $^{3}/_{16}$, $^{1}/_{4}$, or $^{3}/_{8}$-inch contacts that could be unscrewed and replaced when they became worn,



and J.H. Bunnell offered a similar style brass key. This style became more widely used as spark refined, and the larger keys were no longer necessary.

Heavy Duty Sideswiper

The problem of 'telegrapher's paralysis', called 'glass arm' by the wireless fraternity, still plagued operators. As with other wire instruments, the small contacts of the 'sideswipers' could not be used with spark so a heavy duty style of the horizontal key appeared *(Figure 6.11)*.

These keys, with extra large contacts, usually mounted on a slate base were quite popular, particularly with Amateurs. Perhaps the best known is the 'Cootie Key' of Bob Karlowa, 9XR, although this kind of key was also sold by J.H. Bunnell and was offered by Sears Roebuck and Montgomery Ward.

Bugs Not Suitable

It is generally accepted that because of the power involved during the spark era semi-automatic keys could not be used. This was not only because of the small contacts but also because the spark equipment could not follow the very high speeds of which these keys were capable.

However, one successful experiment was conducted with a Vibroplex, in 1909, by E.N. Pickerill at the Waldorf-Astoria station 'WA' *(Figure 6.12)*.

Mr Pickerill wrote, 'I hooked it up with a big Relay key in parallel with the transformer and the other operator was startled as those strings of fast dots came through and asked what the heck was going on.'

'Oddly enough, my transmitter handled it well but the receiving equipment could not follow the fast dots of my Vibroplex.' So far as is known, this is the only documented record of the use of a semi-automatic key with spark operation.

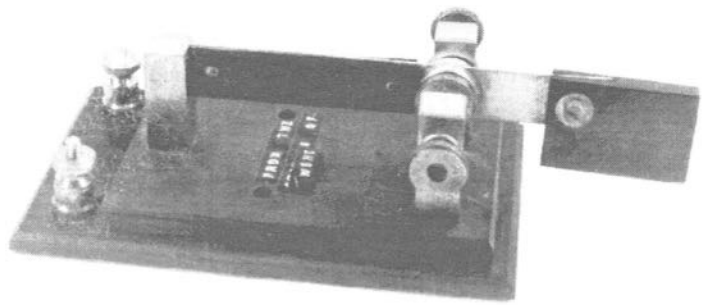


Figure 6.11: Cootie-style Key, heavy-duty sideswiper for spark operation

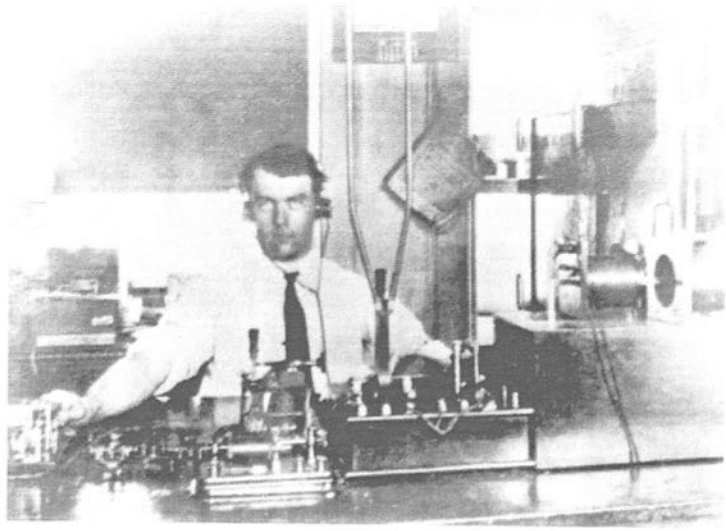


Figure 6.12: Pickerill and 'Bug' at 'WA'

End of a Reign

When King Spark was deposed by CW in the early 1920s there was no longer any problem with transmitting power and keys.

From that time to the present the small telegraph instruments have been used for radio operation. After World War Two military keys were adopted for radio use and, in the speed key field, electronic keys began to appear.

For the Record

Three men are responsible for the key. Alfred Vail, who gave us the first lever action. Jesse H. Bunnell, the curved steel lever, and Horace G. Martin for his contribution to operating speed – the bug.

Down the years, however, it has been the telegrapher himself who has developed and given the industry the improvements that have contributed most to the efficiency and comfort of his fellow operators.

Suggested References

1. US Patent Indices for the years 1901–1920.

Picture Sources

Photos 6.1, 6.4, 6.5, 6.8, 6.9, 6.10, 6.11 – W3WRE library.
Figure 6.2 – W6GVY.
Figure 6.3 – Radio Club of America Yearbook 1959.
Figure 6.6 – Collection: John Elwood WW7P.
Photo: Ray Nelligan. Figure 6.7 – Science Museum, London.
Figure 6.12 – C.S. Moore.

American Telegraph Instrument Makers 1837–1900

This table first appeared 1987 in *DOTS & DASHES*, Journal of The Morse Telegraph Club, Inc., Vol. XV Nos. 2-3-4. Dates shown are only approximate and are based on trade catalogs, patent dates, advertisements and other ephemera. Corrections or additions are welcome; please write Roger W. Reinke, 5301 Neville Court, Alexandria, VA 22310, USA, or phone 703-971-4095.

MAKER	ADDRESS	CITY	DATES	PRODUCTS	NOTES
American Electrical Works	61 Stewart St.	Providence, R.I.	c. 1880	"Steiner" keys	
...Same...	461 Clark Ave.	Cleveland	1894		
Anders, George L.	[See Welch & Anders]				
Anderson Bros.		Peekskill, N.Y.	c. 1875	Practice sets	
Avery, Thomas C.		New York	1848	Keys	
Ayers, Tillotson & Co. (A)	333 Chestnut St.	Philadelphia	1865-67	General line	
Bain, Alexander			1849-51	Chemical Printers	For O'Reilly's lines.
Barber, Palmer & Jones		Utica, N.Y.	c. 1875		(S) Utica Fire Alarm.
Barnes, Edmund F.			1847	"Columbian" Register	*1*
Barton, Enos M.	[See Gray & Barton]				
Baxter, William	[See Speedwell Iron]				
Blattner (A)		St. Louis	1851	General line	
Bliss, George H. & Co. (V)	41 Third Ave.	Chicago	1873-76	General line	(S) Western Electric .
...Same...	220 Kinzie St.	Chicago	1876-79	General line	...Same...
Bliss, George H.	76 Market St.	Chicago	1879	General line	As Electric Mdse. Co.
Bliss, Tillotson & Co. (A)	126, then 171 S. Clark	Chicago	1868-70	General line	
...Same...	247 S. Water St.	Chicago	1870-74	General line	(S) Geo. H. Bliss & Co.
...Same...	54 S. Fourth St.	Philadelphia	1874	General line	
Bradley, Dr. Leverett	7 Exchange Pl.	Jersey City	1867-73	General line	Also made fire alarm.
Buell, Nelson A.	26-27 Waring Block	Cleveland	1872-84	General line	(S) W.B. Cleveland.
Buell, M.A.	26 Waring Block	Cleveland	1870-76	"Eureka" sounders	"...and Sons" variant.
...Same...	86 Bank St.	Cleveland	1876	General line	
...Same...	76 Frankfort St.	Cleveland	1876-82	General line	
...Same...	144 Superior St.	Cleveland	1882-84	General line	(S) W.B. Cleveland.

1 With Zook; a "copy" of Morse's patent?

Bulkley, Charles S.			1848	Registers	***2***
Bunnell, Jesse H.					With Tillotson 1876-78.
Bunnell, J.H. & Co.	70 Courtlandt St.	New York	1878-80	General line	[See Partrick, Bunnell]
...Same...	106-108, then	New York	1880-	General line	
...Same...	112 Liberty St.	New York	-19??	General line	***3***
Burrell, Samuel J.	[See Merchant's Mfg.]				
Burritt, J. & Son		Ithaca, N.Y.	1865	Registers	
Calahan, Edward A.		New York	1867	Printers	Improved Law's ticker.
California Electrical Works	134 Sutter St.	San Francisco	1877-	General line	James Gamble on Board of Directors.
Cardwell, Dr. G.A.		New York	1896-	Keys and sounders	
Carter, Franklin S.	[See Partrick & Carter]				
Caton Instrument Shop		Ottawa, Ill.	1851-72	General line	***4*** (S) Western Electric.
Channing, Dr. W.F.	[See Farmer, Moses G.]				
Chester, Charles T.	104 Centre St.	New York	1855-58	General line	John N. joined 1858.
Chester, C.T. & J.N.	104 Centre St.	New York	1858-71	General line	John N. died 1871.
Chester, Charles T.	104 Centre St.	New York	1872-80	General line	***5***
Chester, Partrick & Co.	38 S. Fourth St.	Philadelphia	1868-72	General line	***6*** (S) Partrick, Bunnell.
Chubbuck, A.S.	Hotel St.	Utica, N.Y.	1852-69	General line	Western Union supplier.
Chubbuck, S.W.	Hotel St.	Utica, N.Y.	1852-69	General line	
Clark, James J.		Philadelphia	1845-61	General line	"...and Sons" variant.
Clark, William		Philadelphia	1846-47	"Harp" registers	James' father.
Clark, J.J. & Co.	19 E. 20th St.	New York	1861-68	General line	Harrisburg in 1868.
Cleveland, W.B. (V)	144 Superior St. S.	Cleveland	1884-	Practice sets	Manager at Hicks & Shawk.
Cooperative Mfg Co. (V)	216½ Walnut St.,	Philadelphia	1871-76	General line	
...Same... (V)	218 Pear St.	Philadelphia	1876	General line	

2 "Copy" of Morse's patent
3 Acquired 19?? by INSO Electronic Prods. (Dr. Joe Jacobs, prop.) Inventory liquidated 1989-
4 The Caton shop, James Gamble, Sup't. (see Calif. Elec. Wks.) was owned by the Illinois & Mississippi Telegraph Co.
5 Stephen Chester joined his brothers in 1867, but left in 1868 to join Partrick in Chester, Partrick & Co.
6 See *5*

(A) May have been an agent only, and probably not an instrument maker.
(V) Verification sought that this firm actually made instruments.
(S) Succeeded by ...

"General line" products include at least keys, sounders and relays.

MAKER	ADDRESS	CITY	DATES	PRODUCTS	NOTES
Crain, George H. & Co. (V)	145 S. Clark St.	Chicago	c. 1871		
Davis, Daniel Jr.		Boston	1842-48	Relays	(S) Palmer & Hall.
Davis, William E.	319 Newark Ave.	Jersey City	1869-74	General line	Elegant machining.
...Same...	341 Newark Ave.	...Same...	1874-	"Uncle Sam" sounder	
Day, S.F. & Co.		Ballston Spa, N.Y.	c. 1865	General line	
Day, W.E. & Co. (A)		Pittsfield, Mass.	1876	General line	
Decker	[See Lannert & Decker]				
Delaney Patent Relay Co.	61 Broadway	New York	1881	Relays and sounders	
De Mier, John R.		Coulterville, Ill.	1877	Relay "cut-out"	
Donaldson, Dr. R.B.		Washington	1842-48	Relays	(S) Palmer & Hall.
DuBois, Charles H. & Son	61 Ann St.	New York	1850-88	General line	
Durant, Charles	86 Nassau St.	New York	1869	"Nonpareil" Relay	Pope connection?
Edison & Murray	10 Ward St.	Newark, N.J.	1869-73	Registers, keys	*7*
Edison & Unger			c. 1873		
Edmands & Hamblet	40 Hanover St.	Boston	c. 1868	"Magneto" telegraph	
Electrical Constr'n & Maintenance Co.		San Francisco	1871-88	General line	(S) California Electrical Works.
Electrical Supply Co.	109 Liberty St.	New York	1875-85	General line	Also made "Prosch" key.
Electric Improvement Co.		Galesburg, Ill.	c. 1872		(S) Western Electric.
Electric Merchandising Co. (A)	76 Market St.	Chicago	1879	General line	George H. Bliss, Mgr.
Electric Telegraph Works (V)	2nd & Chestnut Sts.	Philadelphia	c. 1871		(S) Fleming, Potter.
Empire Electrical Mfg Co.	27-38 Walnut St.	Brooklyn	c. 1887	"Snapper" sounders	
Erpelding, J.	[See Huttman, W.E.]				
Facer, W.E.	48 S. 4th St.	Philadelphia	c. 1868	General line	
Farmer, Moses G.		Boston	1852-57	Repeaters	*8*
Farmer & Woodman		Boston	1857-62	Repeaters	
Fleming, Potter & Co. (V)	Pine & Chestnut Sts.	Philadelphia	1870-71	General line	
...Same...	2nd & Chestnut Sts.	Philadelphia	1871-	...Same...	
Foote	[See Shawk & Foote]				
Foote, Pierson & Co.	82-84 Fulton St.	New York	1896-	General line	

7 Edison also used Bradley's shop.
8 Farmer invented duplex, developed Boston Fire Alarm system with Channing.

Fowler	[See Lewis & Fowler]				
Frederick, Pearce & Co. (A)		New York			
Frey, Joseph J.B.	213 Church St.	New York	1870-	Self-closing key	With A. Illig.
Gaynor Electric Co. (A)		Louisville	c. 1875	Registers	
Gilliland & Co. (A)	41 Dey St.	New York	1875	General line	
Gold & Stock Telegraph Co.	195 Broadway ***9***	New York	1876	Printers	***10***
Gray & Barton (A)	162 S. Water St.	Chicago	1869	General line	Elisha Gray, inventor.
...Same...	479 State St.	Chicago	1870-72	...Same...	(S) Western Electric.
Greeley, E.S. & Co.	5 & 7 Dey St.	New York	1885-96	General line	(S) Foote, Pierson & Co.
Grinnell, H.B. & Co. (A)	7 Murray St.	New York	1875-78		
Hall, Thomas		Boston	1846-66	Keys, relays	(S) Palmer & Hall.
Hamblet	[See Edmands & Hamblet]				
Henning, R.					
Hicks, George B.	144 Superior St.	Cleveland	1858-62	Repeaters	
Hicks & Shawk (A)	...Same...	...Same...	1869-84	General line	***11***
Hinds & Williams	318 Washington St.	Boston	1850-56	General line	(S) Charles Williams, Jr.
Hochhausen, W.		New York	c. 1875	Keys, sounders	
House, Royal E.			1848-	Printers	Made by J.B. Richards.
Hughes, David E.			1855-59	Printers	(S) G.M. Phelps.
Huttman, William E.	154 S. Water St.	Chicago	c. 1867	"Made to Order"	With Erpelding, J.
Illig, A.	[See Frey, J.J.B.]				
d'Infreville, George		New York	1881	Keys	
Jenkins, M.R.		Browning, Mo.	1886	"Double Acting" key	Made by Bunnell.
Johnson, W.H.		Louisville	c. 1870	Sounders	

9 This building subsequently became AT&T headquarters.
10 Gold & Stock quotation services used instruments made by Phelps, Edison, Pope and Grey.
11 Before 1869 this was a Western Union shop, making instruments marked accordingly.

(A) May have been an agent only, and probably not an instrument maker.
(V) Verification sought that this firm actually made instruments.
(S) Succeeded by ...

"General line" products include at least keys, sounders and relays.

MAKER	ADDRESS	CITY	DATES	PRODUCTS	NOTES
Jones	[See Barber, Palmer]				
Jones	[See Pearce & Jones]				
Jones, C.E. & Bro.	58 Pike's Opera House	Cincinnati	1878-80	General line	
...Same...	51 W. Fourth St.	Same	1880-82	Same	
...Same...	Carlisle Bldg.	Same	1882-87	Same	
Jones Electrical Mfg. Co. (A)		New York		Box Relays	Made by Bunnell.
Keeling, J.S.	16 Broadway	New York	1865-67	General line	
Kline	[See Nickolaus & Kline]				
Know & Shain		Philadelphia	c. 1870	Keys, registers	
Lannert & Decker		Cleveland	1876-77	General line	
Lannert, J.A.		Cleveland	1877-81	Keys & sounders	(S) Lannert & Decker.
Laws, Dr. S.S.		New York	1866	Printers	Gold report'g ticker, built by Chester.
Lewis & Fowler Mfg. Co.	27-35 Walworth St.	Brooklyn	1886-87	"Concklin's" keys & Sdrs	(S) Empire Electrical Mfg. Co.
Lyman, A.B.	91½ Seneca St.	Cleveland	1876-80	General line	"Phil Sheridan" line.
...Same...	36 S. Water St.	Same	1880-94	Same	(S) I.H. Moses.
Mack, F.G. & Co. (A)	55½ Frankfort St.		1877-		
Manhattan Electrical Supply Co.	54 Water St.	New York	1880	General line	"MESCO" later variation.
...Same...	32 Courtlant St.	Same	1888-		
Merchant's Mfg. & Constr'n Co.	50 Broad St.	New York	1872-76	Printers	Sam. J. Burrell, Sup't.
...Same...	40 Broad St.	Same	1876	Same	
Mona Manufacturing Co.	PO Box 178	Newark	1874	"Snapper" sounders	
Moses, I.H.	36 S. Water St.	Cleveland	1888-97	Keys and sounders	
Murray	[See Edison & Murray]				
National Electric Co.		New York	c. 1890	General line	
New Haven Clock Co.	29 Murray St.	New York	1883-90	General line	(S) National Electric?
Nickolaus & Kline			c. 1876	"Monitor" relay	
Norton Telegraph Works	Broadway & Broome St.	New York	1852-55	General line	(S) Charles T. Chester.

Palmer	[See Barber, Palmer]				
Palmer & Barber		Utica	c. 1875		(S) Utica Fire Alarm.
Palmer & Hall		New York	1847-49		
...Same...		Boston	1850		
Partrick	[See Chester, Partrick]				
Partrick, Bunnell & Co.	38 S. Fourth St.	Philadelphia	1872-75	General line	(S) Partrick & Carter.
...Same...	22 Dey St.	New York	1874-75	Same	
Partrick & Carter	38 S. Fourth St.	Philadelphia	1867-76	General line	
...Same...	114 S. Second St.	Same	1876-	Same	
...Same...	125 S. Second St.	Same	1891-97	Same	
Pearce & Jones	64-66 John St.	New York	c. 1875	General line	
Pearce, R.K. & Co. (A)	54 S. Fourth St.	Philadelphia	1878	General line	
...Same...	38 S. Fourth St.	Same	1879-	Same	Bought Tillotson's office.
Pennsylvania Railroad Co.	Altoona Shops	Altoona, Pa.	c. 1880	General line	
Phelps, George M.		Troy, N.Y.	1855-71	General line	
Phelps, William P.		Same			With George Phelps.
Pierson, E.M.			c. 1860	Repeaters	
Pope, Edison & Co.	78-80 Broadway	New York	c. 1869		(S) F.L. Pope & Co.
Pope, F.L. & Co.	194 Fulton St.	New York	1869-72	General Line	"Nonpareil" instruments.
...Same...	38 Vesey St.	Same	1873-74	Same	
...Same...	80 Broadway	Same	1874-	Same	
Pope, R.W.	Box 5278	New York	c. 1876	"Snapper" sounders	
Post & Co.		Cincinnati	1880-	General line	
Potter	[See Fleming, Potter]				
Putt, D.W. & Co.		Wellsville, O.	1870-74		Practice Sets.
Redding Electrical Co.	30 Hanover St.	Boston	1884-85	General line	
Redding, Jerome & Co.	Same	Same	1877-82	Same	(S) Redding Electrical?
Richards, J.B.	621 Grand St.	New York	1854	Registers	[See House, Royal E.]
Rogers, H.D. & Co. (A)		Cincinnati			
Rogers, Henry J.			1850		"Improved" Bain's patent.
Rogers, J.		New York	c. 1850	Relays	Same as Henry?

(A) May have been an agent only, and probably not an instrument maker.
(V) Verification sought that this firm actually made instruments.
(S) Succeeded by ...

"General line" products include at least keys, sounders and relays.

MAKER	ADDRESS	CITY	DATES	PRODUCTS	NOTES
Sargent, William D.	812 Race St.	Philadelphia			(S) U.S.Telegraph & Supp. Co.
Schuyler & Smith			1843	Registers	100 pounds plus.
Shain	[See Knox & Schain]				
Shaw Electric Co. (A)		Philadelphia	c. 1880	Practice sets	
Shawk	[See Hicks & Shawk]				
Shawk & Barton (V)	98 St. Clair St. ***12***	Cleveland	1869	General line	(S) Hicks & Shawk.
Shawk & Foote	55 Center St.	Cleveland	1870		
Smith, Charles T.		Washington	c. 1844	Magnets	For Morse.
Smith, F.C.	1041 Penn Ave.	Pittsburgh	1886	"Herbert" key	
Smith, Gilbert	[See Schuyler & Smith]				
Speedwell Iron Works		Morristown, N.J.	1837-38	Port rules, registers	Wm. Baxter & Alfred Vail, principals.
Splitdorf, H.	[See Clark & Splitdorf]				
Springer, L.C. (A)	162 S. Water St.	Chicago	c. 1865	General line	
Standard Electric Works		Cleveland	1883-84	"Stevens" keys	
Standard Electric Co. (A)	502 Fourth Ave.	Louisville	1886		
...Same... (A)	410 Third Ave.	Same	1888		
Stokell		New York	1846	Magnets	For Morse.
Telegraph Supply & Mfg. Co.	130-134 Champlain St.	Cleveland	1871-74	"Dirt Cheap" Instruments	
...Same...	Leader Bldg.	Cleveland	1874-84		(S) W.B. Cleveland.
Tillotson	[See Bliss, Tillotson]				
Tillotson & Co.	262 Broadway	New York	1862-65	General line; Cumming	Keeling a partner.
Tillotson, L.G. & Co.	8 Dey St.	New York	1865	Periphery Contact	E.S. Greeley a partner.
...Same...	26 Dey St.	New York	1865-67	key, and "Victor"	
...Same...	11 Dey St.	New York	1868-72	Instruments.	
...Same...	8 Dey St.	New York	1872-80	Same,	Bought Gamewell in 1879.
...Same...	5 & 7 Dey St.	New York	1880-85	Same.	(S) E.S. Greeley & Co.
U.S. Telegraph & Supply Co. (A)		Philadelphia	c. 1870		
Unger	[See Edison & Unger]				
Union Electric Co.		New York	c. 1875	Keys	
Utica Fire Alarm Telegraph Co.	106-108 Liberty St.	Utica, N.Y.	1879-88	General line	"Earthquake" practice set.

12 See *10*

Vail, Alfred	[See Speedwell Iron Works]				
Viaduct Mfg. Co.	Relay Station, B&O RR	Baltimore	1884	General line	
...Same...	4 S. Howard St.	Baltimore	1894-	Same	
Ware, H.		Cincinnati	c. 1865	Keys	
Watts	[See Davis & Watts]				
Watts & Co.	47 Holliday St.	Baltimore	1872-78		(S) Davis & Watts.
Welch & Anders	30 Hanover St.	Boston	1876	Printers	(S) Jerome Redding?
Wessman, Gustav	11 Spruce St.	New York	c. 1853		
Western Electric Mfg Co.	220 Kinzie St.	Chicago	1872-	General line	***13***
Williams	[See Hinds & Williams]				
Williams, Charles Jr.	109 Court St.	Boston	1856-72	General line	(S) Western Electric.
Woodman	[See Farmer & Woodman]				
Zook, Samuel K.	[See Barnes, Edmund F.]				

(A) May have been an agent only, and probably not an instrument maker.
(V) Verification sought that this firm actually made instruments.
(S) Succeeded by ...

13 "Manufacturing" dropped from title c. 1884.

"General line" products include at least keys, sounders and relays.

Industry Leaders to circa 1890

This is only speculation based on the frequency with which instruments seem to appear in collections, extent of advertising, etc., but the dominant makers in approximate order were:
Bunnell; Western Electric & Tillotson/Greeley, tied; Partrick & Carter; Phelps; Williams; Redding; New Haven Clock Co; Clark, Chester & Chubbuck, tied; Watts, Buell, DuBois, Lyman and Pope not far behind.
In the 1890s Manhattan Electrical Supply Co. was a very large supplier, but Bunnell and Greeley (the "Ludwig" mechanical set) actually may have provided many if not all of their instruments. Some Manhattan catalogs show illustrations of instruments labeled "Bunnell."

Other Notables in Instrument Development

There were many inventors/engineers who contributed substantially to instrument development, such as Milliken, Stearns, Curtiss, Toye and others. They are not listed individually because they apparently did not make instruments other than for patent purposes.

Why Sounders Replaced Registers

"By 1849, operating by sound was becoming prevalent... The reception by register, the constant winding, the mistakes made by copyist caused by imperfect hearing, the whirr of the wheels, the breaking of the weight cord and the howl caused by damaged toes, the delay, the labor of all this was palpable and sought deliverance... It soon became, for all large offices, universal." – James D. Reid, *The Telegraph in America,* pp.190-191.

Index to keys, etc., pictured in 'The Story of the Key'

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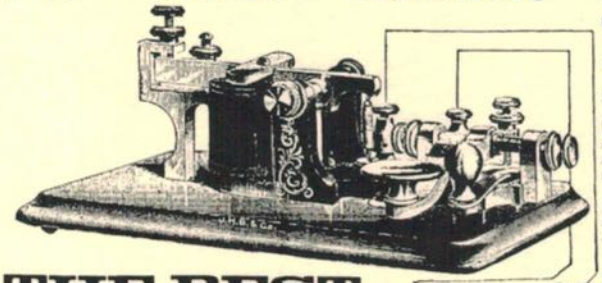

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