April 24, 1956 R. G. THOMPSON 2,743,398

ELECTROMAGNETIC TRANSLATING DEVICE

Original Filed July 18, 1950 2 Sheets-Sheet 1

FIG. 1.

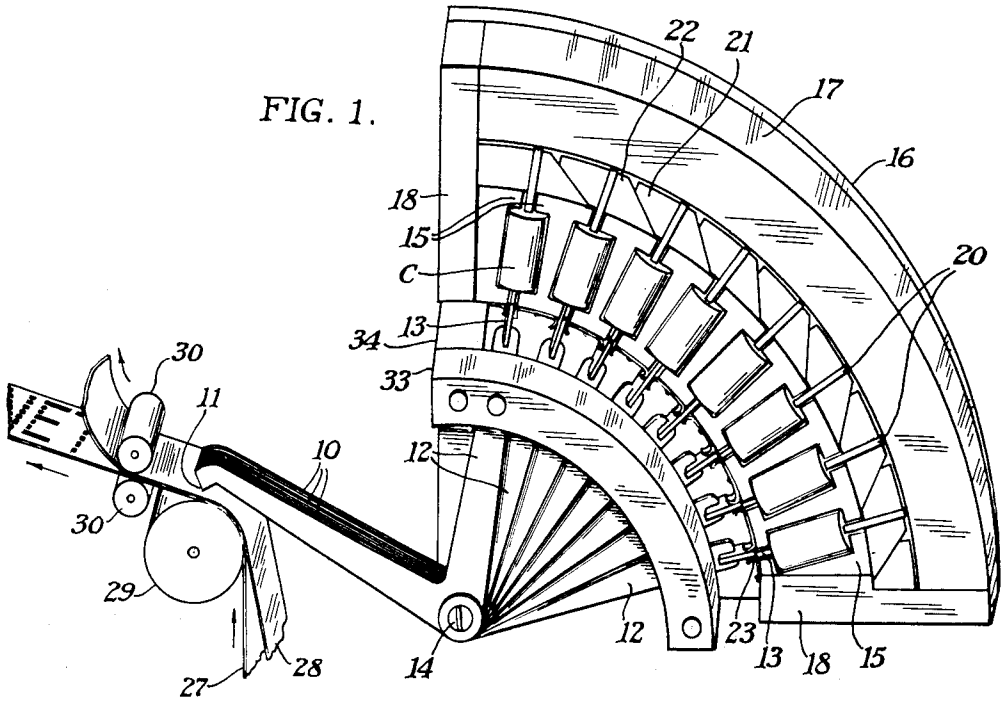


FIG. 2.

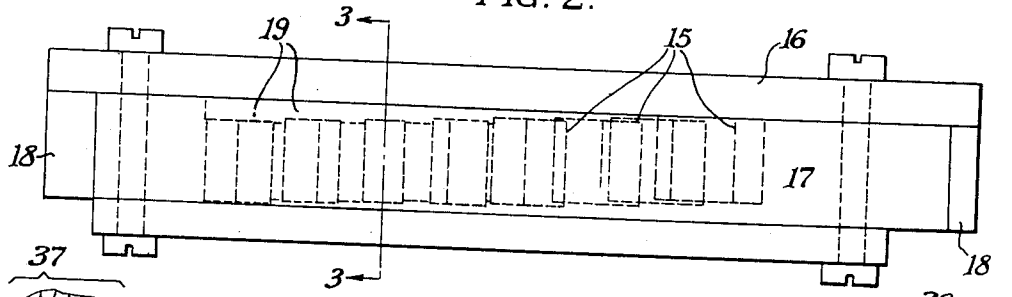


FIG. 5.

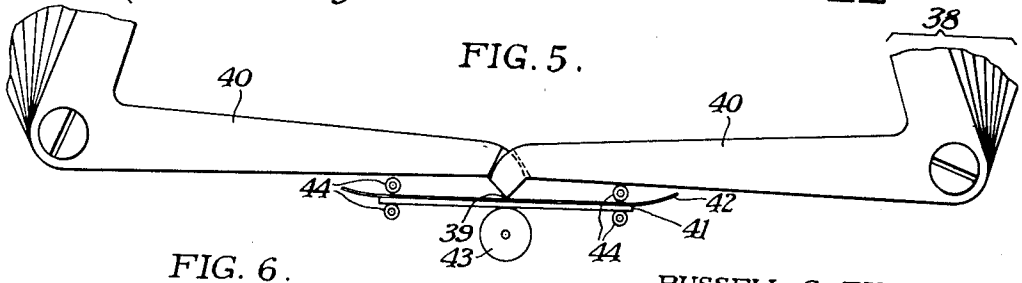
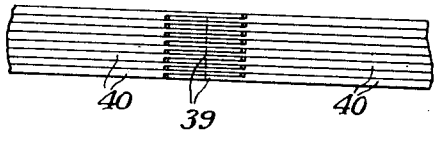


FIG. 6.



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FIG. 3.

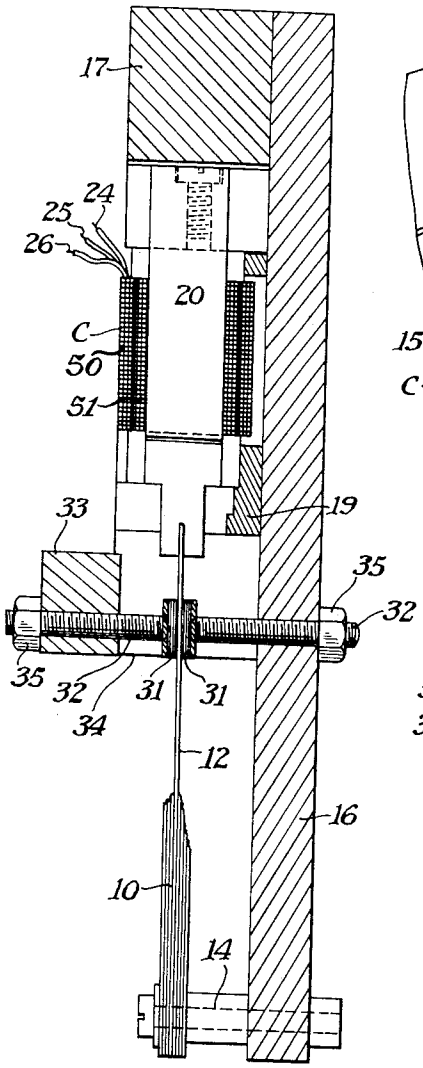
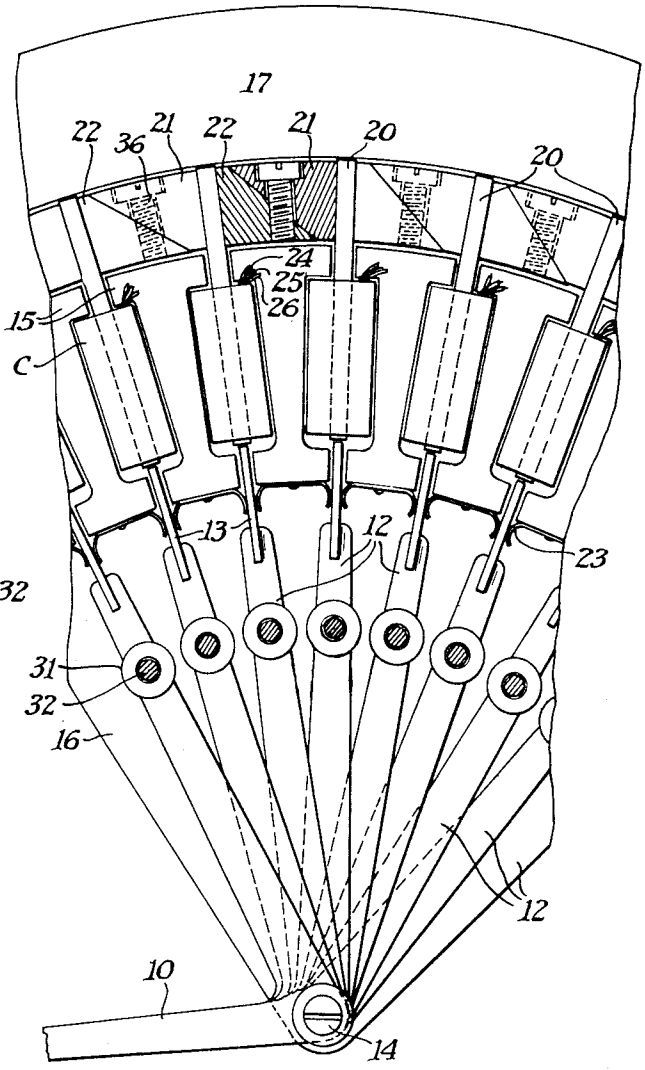


FIG. 4.



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ELECTROMAGNETIC TRANSLATING DEVICE

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Original application July 18, 1950, Serial No. 174,423, now Patent No. 2,659,652, dated November 17, 1953. Divided and this application December 18, 1952, Serial No. 326,758

5 Claims. (Cl. 317—189)

The present invention relates to signaling and more particularly to the high speed recording of facsimile or coded messages upon a record surface and is a division of my copending application Serial No. 174,423 filed July 18, 1950, now U. S. Patent No. 2,659,652.

The primary object of the invention is to provide an apparatus for producing visible characters from a plurality of character-forming signals received successively in groups.

Another object of the invention is to provide multiplex facsimile apparatus wherein a plurality of printing styli are arranged close together in a row for parallel scanning and are independently and simultaneously vibrated in accordance with received signals by individual electromagnetic drivers.

Another object of the invention is to provide a multiple styli printer actuated by a translating device comprising a plurality of vibrators polarized by the flux in a single magnetic circuit.

Another object of the invention is to provide an electromagnetic translating device having two alined airgaps and having an armature extending into one of the airgaps and a core centered in the other airgap whereby the armature is pivoted outside the device.

Other objects of the invention including the provision of a compact, efficient, high-speed multiple styli recording device will become apparent from the following description of apparatus embodying the invention when read in connection with the accompanying drawings in which:

Fig. 1 is a view in perspective of a recorder constructed in accordance with the invention;

Fig. 2 is a top plan view with a part broken away of the electromagnetic driver of Fig. 1;

Fig. 3 is a section along the line 3—3 in Fig. 2;

Fig. 4 is a partial view partly in section of a representative portion of the vibrator units of the electromagnetic driver of Figs. 1–3;

Figs. 5 and 6 are partial side and top views, respectively, of printing arms having their styli ends interleaved to increase definition while using sturdy printing arms.

The recorder according to the preferred form of the invention comprises a plurality of styli arranged in a row and adapted to be actuated by individual electromagnetic drivers sharing a common magnetic circuit and so mounted that the motion from each driver to its associated stylus is transmitted in a single plane and without twist.

The signals for actuating the drivers may be obtained by scanning characters or may be produced synthetically by any suitable means to provide properly timed pulses in predetermined combinations so that as a recording medium is fed transversely past the row of styli it will be marked to build up the character corresponding to the received signals.

For recording a single line of characters it has been found that seven-line definition produces very satisfactory results and for the purpose of illustrating the invention eight styli arranged in a row for parallel scanning are

shown in Fig. 1, although the invention is not restricted to any specific number of recording elements. One reason eight styli are chosen for recording seven-line definition is to compensate for possible unevenness of a line of characters being scanned at a transmitter from which the recorder receives its signals. That is, although the characters being scanned are the height of seven pickup scanning elements, eight such scanning elements are employed so that a slight lateral shift in the characters being scanned can be tolerated. If the received signals are derived from code wheels or the like then only seven styli need be employed.

The recorder shown in Fig. 1 comprises eight printing bars **10** provided with printing points or styli **11** arranged in a row. Each of the printing bars **10** is an arm of a bell crank lever, the other arm **12** of which is provided with an armature **13** and all of the levers are pivotally mounted on a suitable rod **14** for oscillatory movement about a common axis. The bell crank levers are made from thin flat stock and are assembled in adjacent parallel planes so that movement of the armatures **13** in these planes is transmitted without twist to the recording points **11**.

In an operating embodiment the bell crank levers comprised of the printing arms **10** and the operating arms **12** are .02 inches thick and in order to accommodate individual vibrators for the several armatures **13** the angles made by the arms **10** and **12** differ progressively by a given amount so that with the printing arms **10** in a plane normal to the plane of the bell crank levers the operating arms **12** are fanned out about the pivot rod **14**. Electromagnetic vibrator pole pieces **15** mounted on a main frame **16** of nonmagnetic material with their airgaps radially alined with the respective operating arms **12** share a common magnetic flux which may be provided by a permanent magnet **17** and its associated yokes **18** of magnetic material. The vibrator pole pieces **15** are laminated and preferably made from high frequency electric sheet steel. Also, the pole members **15** are preferably mounted on different levels to correspond to the levels of the operating arms **12** and this may conveniently be done by machining steps **19** (see Fig. 2) of the proper height on the main frame **16**. A core or stationary armature **20** is centered by nonmagnetic fittings **21** and **22** in one of the airgaps of each vibrator and extends towards the other airgap in which the armature tip **13** of the operating arm **12** is suitably centered as by leaf springs **23** of nonmagnetic material which may be secured to the exposed ends of the laminated poles **15**. The armatures **13**, which are of course magnetic, are secured to the ends of the nonmagnetic operating arms **12** in any suitable manner as by brazing or welding. The adjacent ends of the cores **20** and the movable armatures **13** should form as narrow an airgap as possible.

Each stationary armature or core **20** is surrounded by coils C comprising two oppositely wound activating coils **50** and **51** which are energized, respectively, through suitable leads **24** and **25**, and **24** and **26** (see Figs. 3 and 4) to move the armature **13** in either of two directions to raise or lower the printing arms **10**. The coils C can be arranged in any manner as long as the ampere turns in each coil are equal, e. g., the two coils can be arranged adjacent each other along armature **20** or in the preferred embodiment can be superimposed over each other as is well-known in the art. With this arrangement, one of the coils carries current on white, no current on black; and the other coil carries current only on black. The flux ϕp supplied by the permanent magnet **17** passes through the yokes **18** and serially through the pole pieces **15** and, since the airgaps are the same between the poles **15** and the cores **20** and the poles **15** and the armatures **13**, the flux ϕp divides equally be-

tween the two pairs of pole faces of each vibrator. When there is no current in either of the coils **50** or **51** practically no flux passes radially through the pole pieces **15** or the cores **20**.

Current in either of the coils **50** or **51** in any vibrator produces a flux ϕc in the core **20** and the armature **13** and $\frac{1}{2}\phi c$ in each adjacent pole piece **15** comprising such vibrator. With this arrangement it is well understood that the armature **13** will be moved to raise or lower its associated printer bar **10** depending upon the direction of the flux ϕc which, of course, depends upon which of the coils C is actually activated. Thus, the application of suitable signal currents to one of the coils C will create an unbalance which will pull the armature **13** to one side and when the other coil is activated, the armature **13** will be moved in the other direction. Since one coil carries current only on white and the other only on black when in operation, the printer bars **10** and their styli **11** are normally maintained in a raised position by one coil until the application of a suitable signal to the other coil changes the flux direction which causes the armature **13** to move to the other side. Upon completion of the signal to the other coil, the first-mentioned coil is immediately activated to again raise the bars and styli. Hence, the coils C selectively raise or lower the printer bars **10** and their styli **11** to record the characters represented by the signal currents on a suitable recording medium, such as a paper tape **27** and an overlying strip of carbon paper **28**, which is moved transversely to and between the row of styli **11** and a solid surface (shown in Fig. 1 as comprising a drum **29**) in any suitable manner as by rollers **30** actuated by mechanism, not shown, to advance the recording medium in the desired time relation with the received signals. This relation is not critical because for a given signal rate any variation in the speed of movement of the recording medium above or below an assumed ideal speed will merely result in a lengthening or foreshortening of the character in the direction of movement.

Referring now to Figs. 3 and 4, rebound of the printer arms **10** is prevented by dampening which may conveniently be accomplished by means of felt pads **31** pressed against opposite sides of each operating arm **12** by stud screws **32** in threaded engagement, respectively, with the main frame **16** and an arcuate yoke **33** spaced from and secured to the main frame **16** by blocks **34**. The pressure on the pads **31** is adjustable by turning the screws **32** which may be held in adjusted position by suitable lock nuts **35**.

The nonmagnetic fittings **21** and **22** for clamping the cores **20** are shown in more detail in Fig. 4. The fitting **21** is integral with or rigidly secured to the main frame **16** with its radial face accurately located for positioning one side of the core **20**, the other side of which is engaged by the radial face of the fitting **22**. The contacting surfaces of the fittings **21** and **22** are inclined with respect to their radial faces so that a screw **36** passing freely through the piece **21** and threaded in the piece **22** will when tightened force the radial face of the piece **22** firmly against the core **20**.

A modified arrangement shown in Figs. 5 and 6 makes it possible to record greater definition while retaining the desired sturdiness. As here shown, two recording units **37** and **38**, similar to the one described above, are arranged on opposite sides of the recording line with their styli **39** interleaved. Preferably the interleaved portions of the printing arms **40** on which the styli are formed are reduced in thickness to permit a greater number of printing elements per inch and still allow the use of sturdy printing arms **40**. Also, as shown in Fig. 5, the recorder according to the invention may be used to print on thick flat stock such as tabulating cards by advancing a card **41** and a carbon paper **42** over a platen such as printing roller **43** and beneath the styli **39** at the desired rate by any suitable means such as two pairs of feed rollers **44**.

It is preferred to use flat sheet stock for forming the bell cranks and to assemble the bell cranks in sliding engagement with one another so as to provide a certain amount of mutual lateral support. However, if desired, thin spacers may be inserted between the several bell cranks.

It will be noted that the several bell cranks are identical, except for the angle between their arms, so as to have the same weight and the same moment of inertia. This makes possible uniform print results since the application of equal forces to the several armatures **13** will produce equal acceleration in the printing arms **10** and thus the impact of each printing element or styli **11** on the carbon paper is the same, the slight differences due to gravity being ignored. It is important to uniform printing that the radius of gyration around the common axis be the same for each bell crank.

It is to be understood that the term "bell crank" is used in a broad sense to include a rocker, i. e., the two arms make an angle greater than 90 degrees, and that several recording units may be arranged in groups, one unit for each line or column to be recorded, so that several lines of characters may be recorded simultaneously.

While for the purpose of describing the invention a specific embodiment has been disclosed in detail, it will be obvious to those skilled in the art that various modifications will suggest themselves without departing from the scope of the invention as pointed out in the appended claims.

Having now described my invention, what I desire to secure by Letters Patent of the United States and what I claim is:

1. An electromagnetic translating device comprising means for producing a steady magnetic flux, pole members spaced to provide two airgaps in spaced and aligned relation for dividing the magnetic flux, a stationary core of magnetizable material extending through one of said airgaps and toward the other of said airgaps, an armature having a free end and pivotally mounted remote from said free end, said free end being disposed in said other of the airgaps and in close proximity to said stationary core, and an activating means including two oppositely wound coils disposed between said pole members and said airgaps and surrounding said stationary core for moving said armature toward one side of the other of said airgaps in accordance with the coil activated.

2. An electromagnetic translating device comprising permanent magnetic means for producing a steady magnetic flux, a plurality of pole members arranged with respect to said magnetic means to provide a plurality of two airgaps in spaced and aligned relation for dividing the magnetic flux, stationary cores of magnetizable material extending through each of one of said airgaps and toward the other of said airgaps, a plurality of armatures having free ends and pivotally mounted remote from said free ends, each of said free ends being disposed respectively in the other of said airgaps and in close proximity to said stationary cores, and an activating means including two oppositely wound coils disposed between each of said pole members and each of said airgaps and surrounding said stationary core therebetween for moving said armatures toward one side of the other of said airgaps in accordance with the coils activated.

3. An electromagnetic translating device comprising permanent magnetic means for producing a steady magnetic flux, a plurality of pole members arranged with respect to said magnetic means to provide a plurality of two aligned airgaps for dividing the magnetic flux, each of said two airgaps being radially aligned and spaced with respect to a common center, a stationary core of magnetizable material extending radially through each of one of said airgaps and toward the other of said airgaps, a plurality of armatures having free ends and pivotally

mounted at said common center remote from said free ends, each of said free ends being disposed respectively in the other of said airgaps and in close proximity to said stationary cores, and two oppositely wound energizing coils disposed between each of said pole members and each of said two airgaps and surrounding said stationary core therebetween for moving said armatures toward one side of the other of said airgaps in accordance with the coils activated.

4. An electromagnetic translating device comprising a non-magnetic supporting member, permanent magnetic means carried by said supporting member for producing a steady magnetic flux, a plurality of pole members spaced from said magnetic means and arranged on said supporting member about a common center to provide a plurality of two aligned airgaps for dividing the magnetic flux, said airgaps being radially aligned and spaced with respect to said common center, yoke members of magnetizable material connected to said magnetic means for conveying the magnetic flux serially through said pole members, stationary cores of magnetizable material mounted on said supporting member and extending radially through each of one of said airgaps and toward the other of said airgaps, a plurality of armatures pivotally mounted on said supporting member at said common center and having the free ends thereof disposed respectively in each of said other of the airgaps and in close proximity to said stationary cores, and an activating means including two oppositely wound coils disposed between each of said pole members and each of said two aligned airgaps and surrounding said stationary core for moving said armatures in either of two directions toward one side of the other of said airgaps in accordance with the coils activated.

5. An electromagnetic translating device comprising a

non-magnetic supporting member, a bar magnet carried by said supporting member for producing a steady magnetic flux, said bar magnet having one surface thereof generated about a center of curvature, a plurality of pole members spaced from said one surface and arranged on said supporting member to provide a plurality of two aligned airgaps for dividing the magnetic flux, said airgaps being radially aligned and spaced with respect to the center of curvature of said bar magnet, yoke members of magnetizable material connected to said bar magnet for conveying the magnetic flux serially through said pole members, stationary cores of magnetizable material mounted on said supporting member and extending radially with respect to the center of curvature of said bar magnet through each of one of said airgaps and toward the other of said gaps, a plurality of armatures pivotally mounted on said supporting member at the center of curvature of said bar magnet and having the free ends thereof disposed respectively in each of said other of the airgaps and in close proximity to said stationary cores, and an activating means including two oppositely wound coils disposed between each of said pole members and each of said two aligned airgaps and surrounding said stationary cores for moving said armatures in either of two directions toward one side of the other of said airgaps in accordance with the coils activated.

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