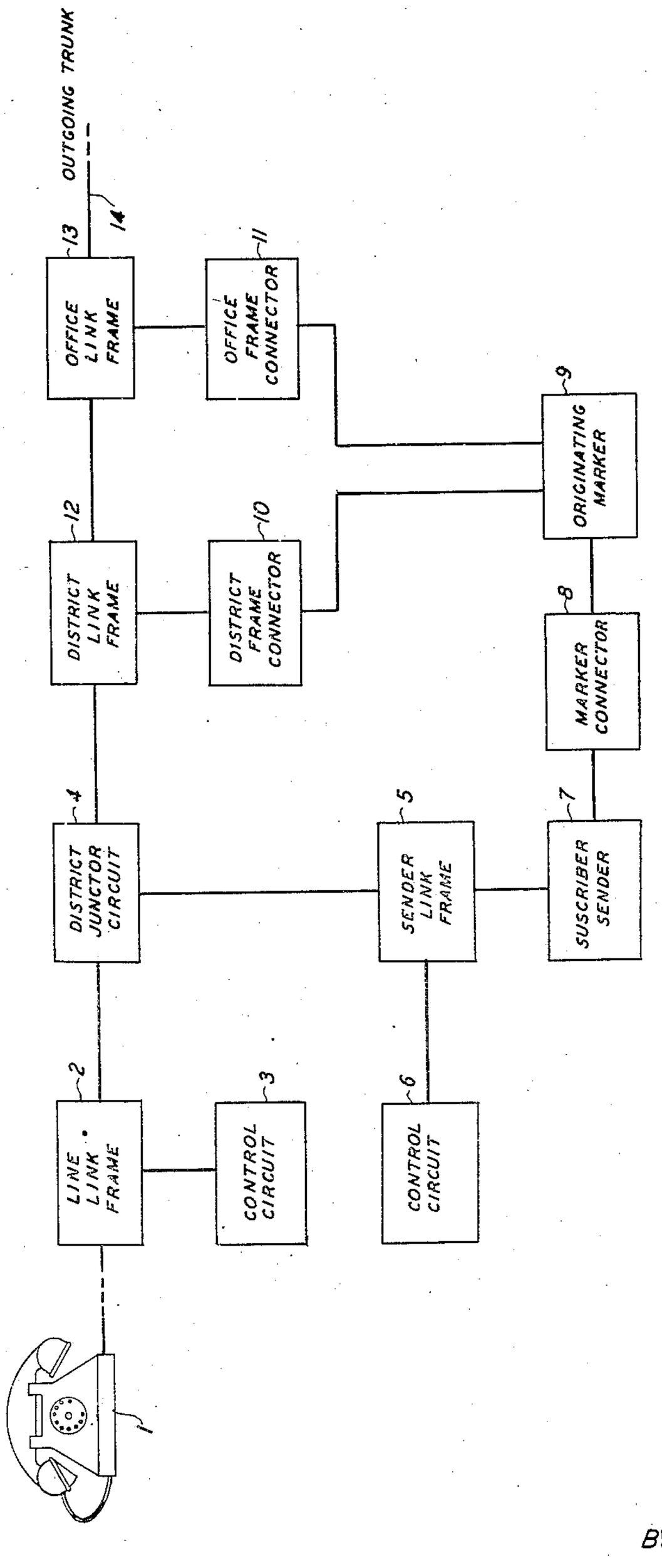
March 4, 1947. O. MYERS 2,416,710

MARKER CIRCUIT FOR CROSS BAR TELEPHONE SYSTEMS

Filed Dec. 28, 1943 10 Sheets-Sheet 1

FIG. 1



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MARKER CIRCUIT FOR CROSS BAR TELEPHONE SYSTEMS

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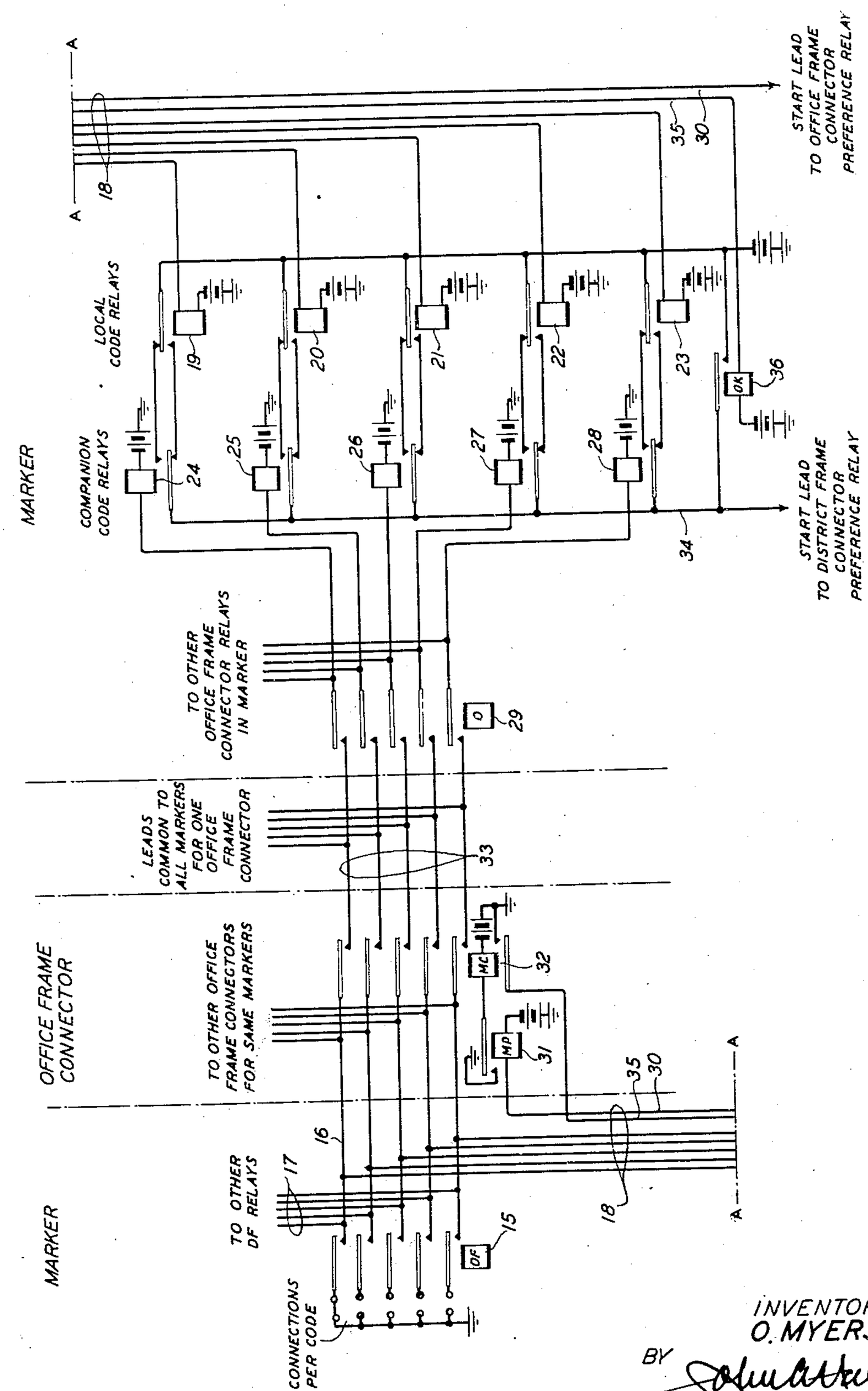
FIG. 2



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MARKER CIRCUIT FOR CROSS BAR TELEPHONE SYSTEMS

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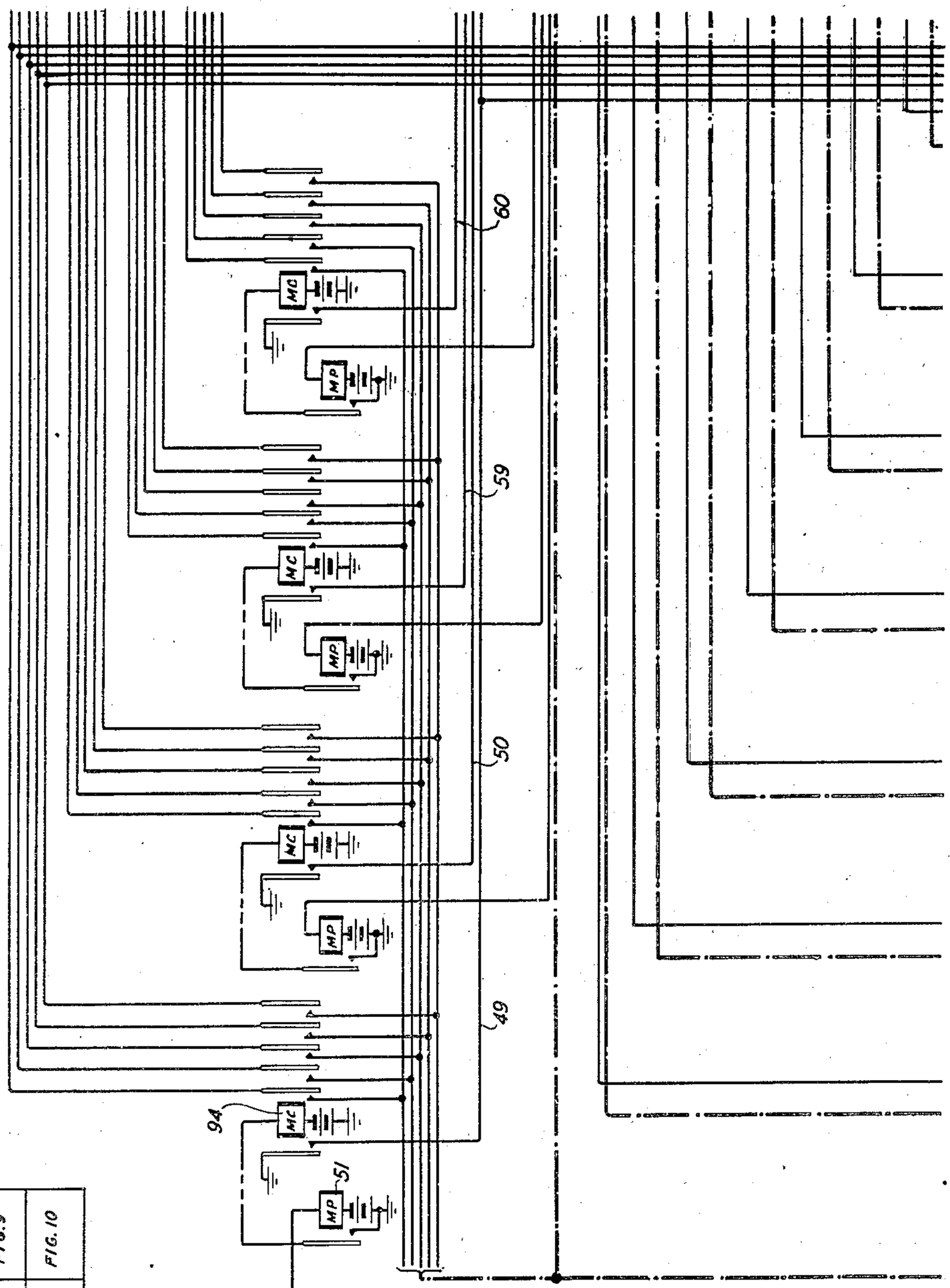

FIG. 3

OFFICE FRAME CONNECTOR 1

FIG. 11

FIG. 3	FIG. 4	FIG. 5	FIG. 6	FIG. 7	FIG. 8	FIG. 9	FIG. 10

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MARKER CIRCUIT FOR CROSS BAR TELEPHONE SYSTEMS

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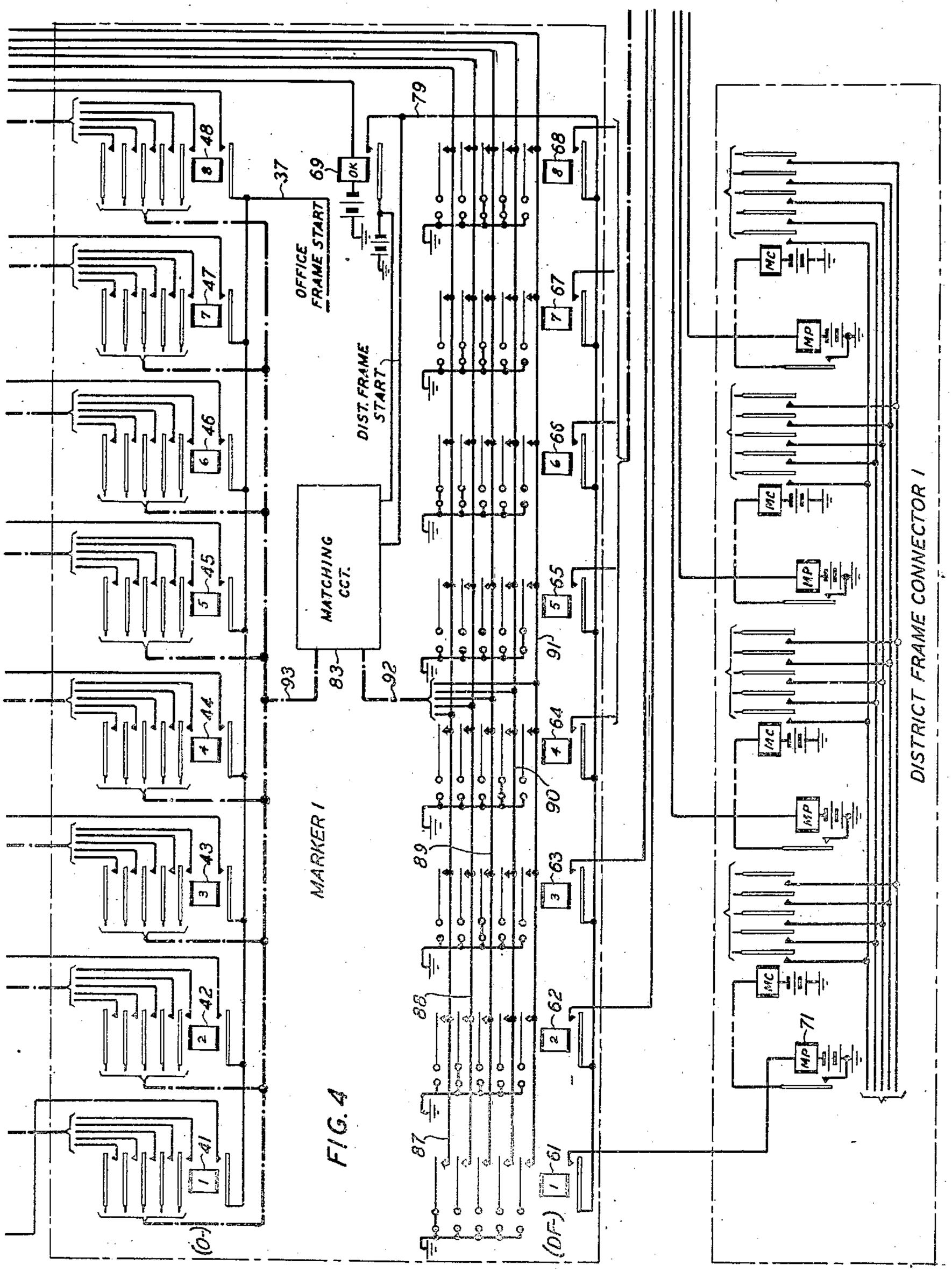

FIG. 4

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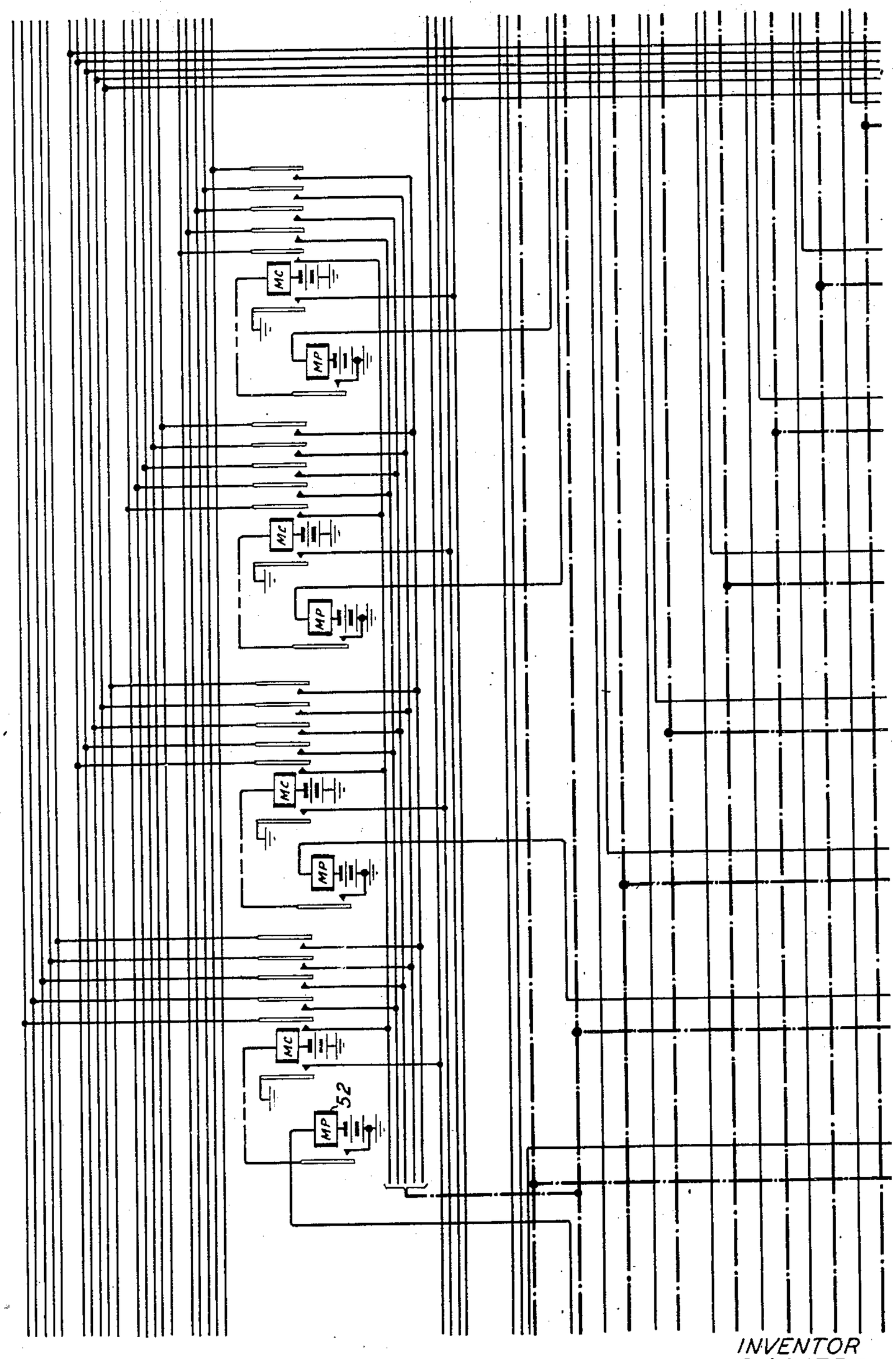

FIG. 5

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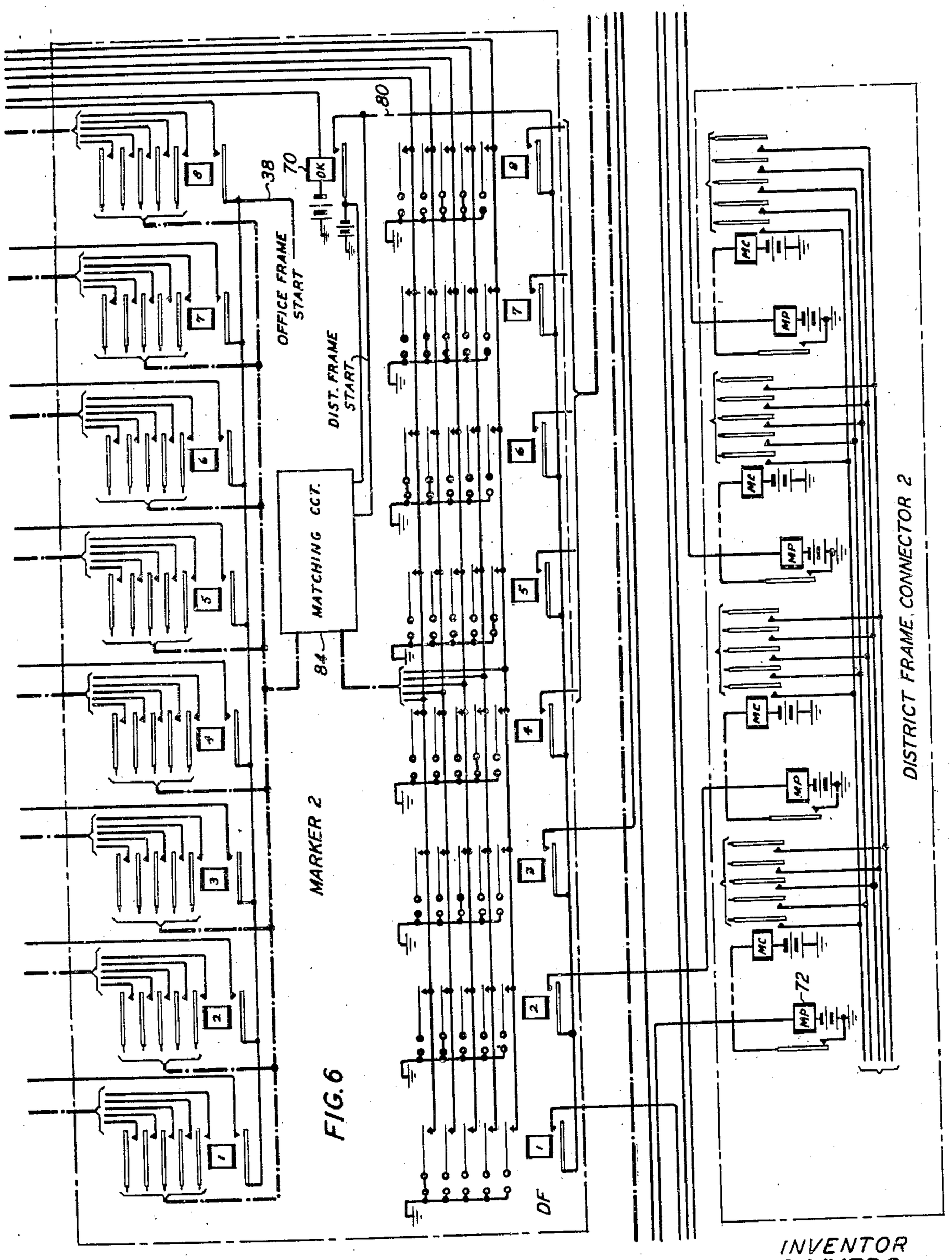

FIG. 6

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Filed Dec. 28, 1943 10 Sheets-Sheet 7

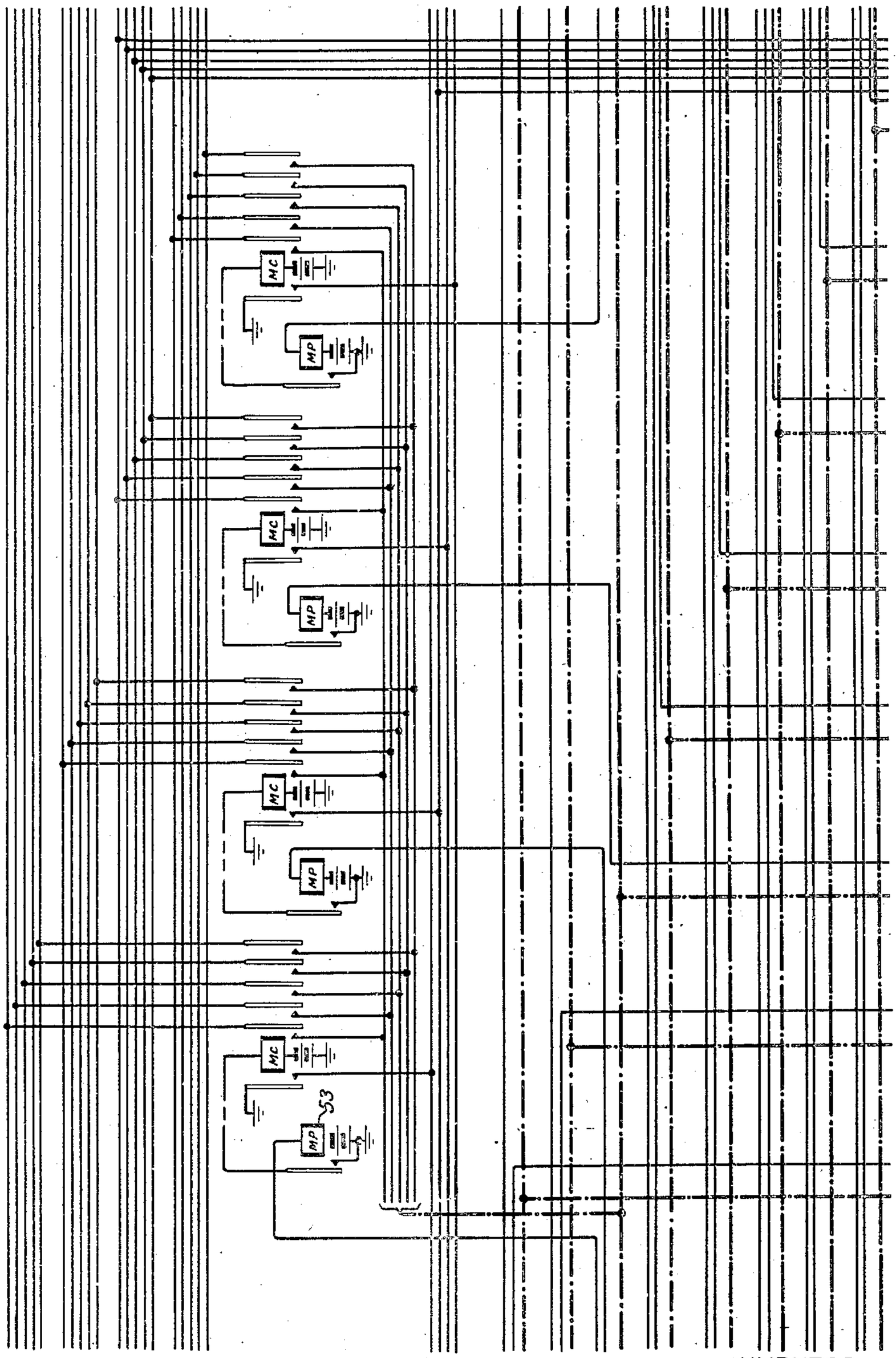

FIG. 7

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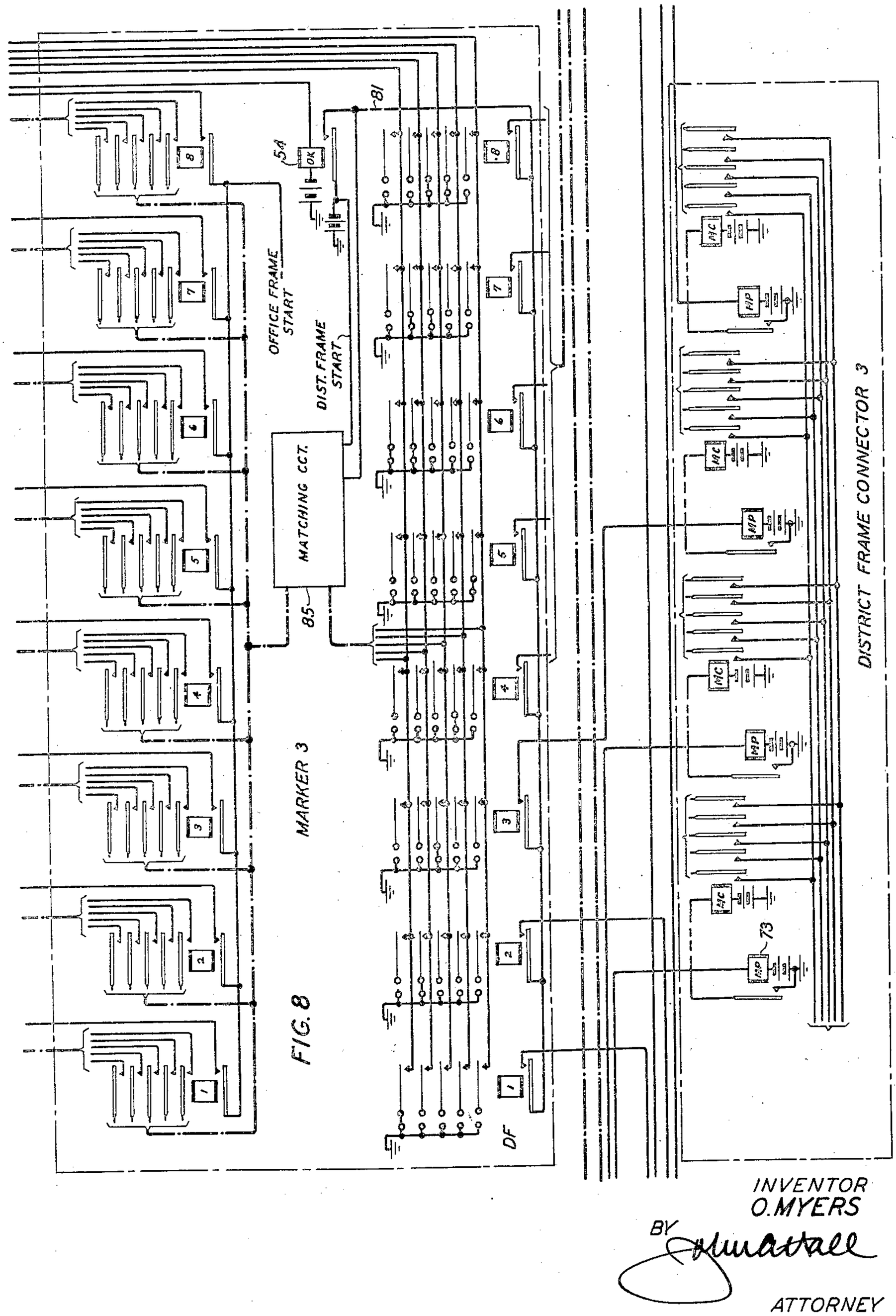

FIG. 8

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Filed Dec. 28, 1943 10 Sheets-Sheet 9

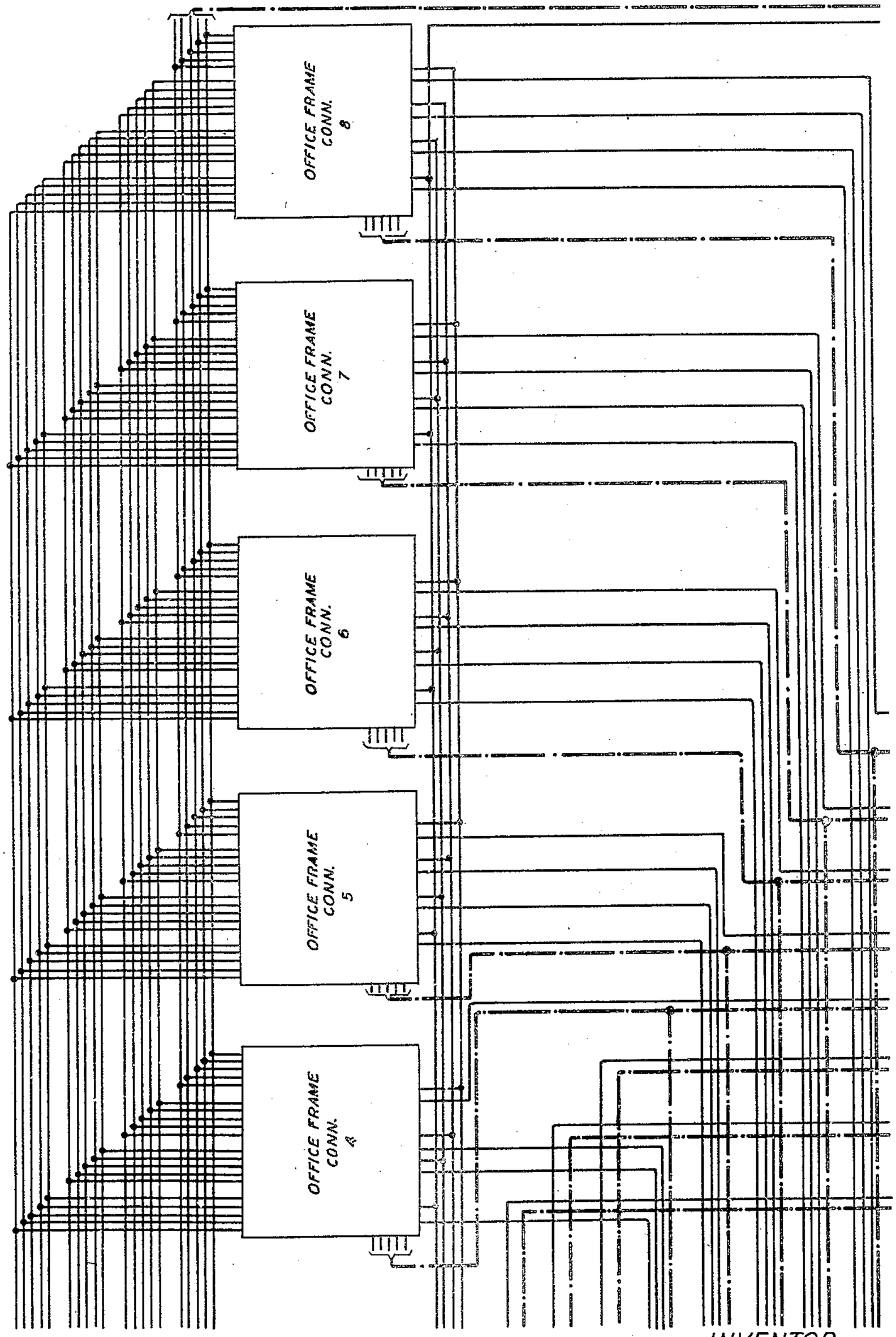

FIG. 9

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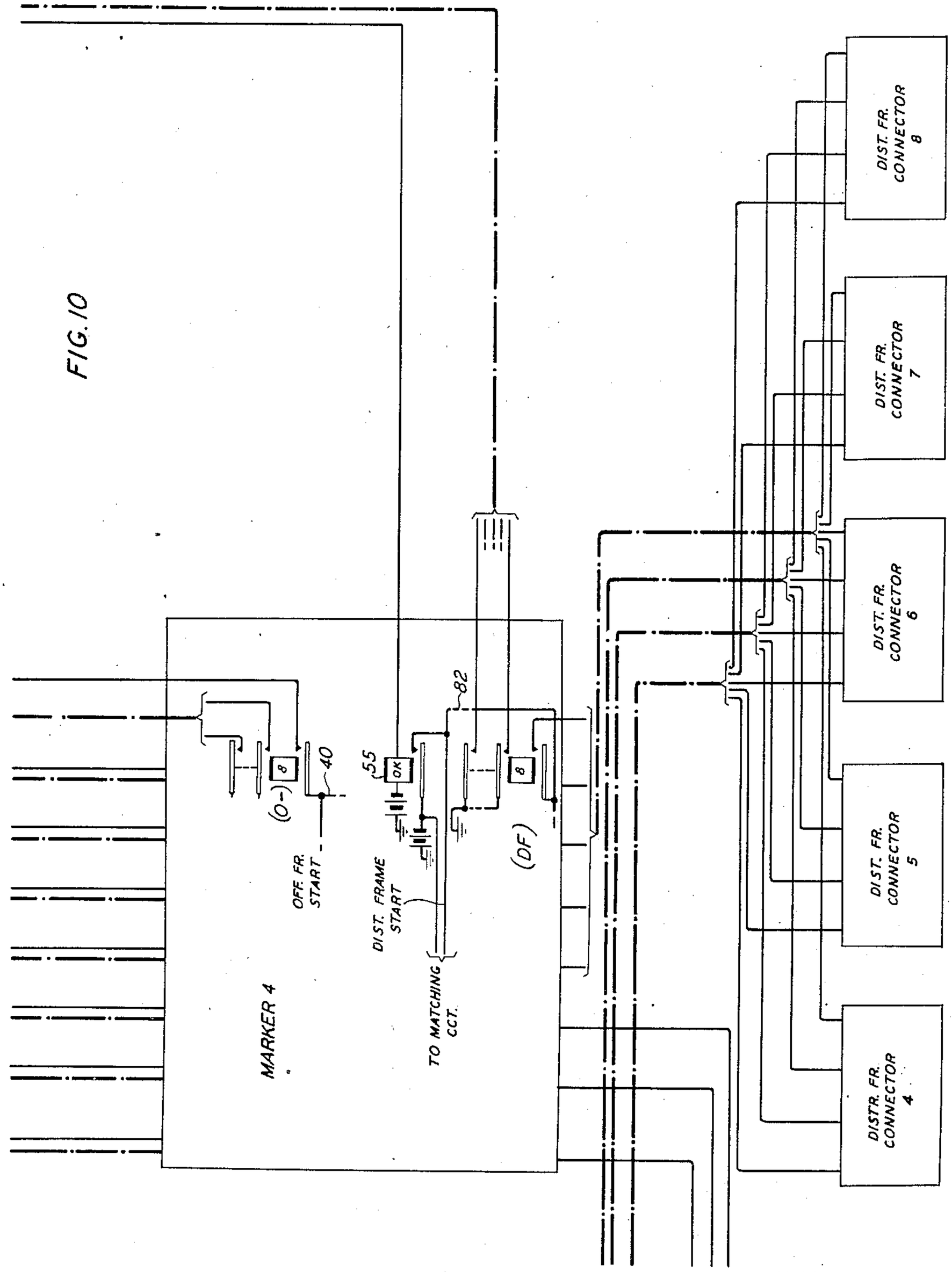
FIG. 10



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Patented Mar. 4, 1947 2,416,710

UNITED STATES PATENT OFFICE

2,416,710

MARKER CIRCUIT FOR CROSSBAR TELEPHONE SYSTEMS

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Application December 28, 1943, Serial No. 515,917

11 Claims. (Cl. 179—22)

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This invention relates to telephone systems and particularly to cross bar dial telephone systems.

The object of the invention is to render more efficient the use of certain common apparatus particularly in the time factors involved. Where a very small number of apparatus units are used in common by a very large number of subscribers, the period or the holding time during which such an apparatus unit is appropriated for the performance of its specified function on any one mission is of the greatest importance and every effort must be made to make such period short.

In a preferred embodiment of the invention the marker holding time in a cross bar dial telephone system is of prime importance. Since, by way of example, five markers may be employed to care for peak load traffic conditions in a busy office for ten thousand lines, and each such marker comprises an expensive apparatus unit it will be understood that considerable economy could be effected if the marker holding time could be reduced to the point that only four markers need be employed.

Since the marker holding time is in the order of less than a second, a saving of time measured in milliseconds is a consideration of value.

One of the false operations to be guarded against is the phenomenon known as mutual lockout. Where two markers simultaneously attempt to connect to the same office and district frames, if one gains priority over the office frame and the other gains priority over the district frame each will be locked out, the one waiting for the release of the adversely held district frame and the other waiting for the release of the adversely held office frame. This trouble has been cured by arranging the circuits so that the marker connects to the office and district frames in a definite order. The office frame is always seized first and not until the success of this operation is assured is an attempt made to seize the district frame. Thus if the seizure of the office frame is held up due to such office frame being adversely held, the attempt at seizing the district frame is delayed even though a district frame is in condition for immediate seizure. Or if an office frame has been seized the whole operation may be delayed due to an adversely held district frame. As a measure against mutual lockout this arrangement is highly satisfactory but it means that all operations of the marker are penalized by the additional holding time required for this step-by-step operation. It is, therefore, desirable to provide for simultaneous seizure of both the office and district frames by the marker.

In accordance with the present invention, a set of district frame matching relays is provided as a means for controlling the start lead to the district frame connector which matching relays

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provide for immediate starting of the operation of seizing a district frame simultaneously with the starting of the operation of seizing an office frame, while still providing a means for preventing mutual lockouts in case two or more markers attempt to simultaneously set up connections through the same office and the same district frames.

The district frame matching relays consist of a set of local code relays responsive to the designation of the wanted district frame stored in the marker and a set of companion code relays responsive to the code stored in a competing marker which has succeeded in appropriating and is adversely holding a wanted office frame connector. In their normal unoperated condition, these relays hold the start lead to the district connector preference relay open. The operation of any one of these relays will connect battery to such start lead, but the operation of one relay of the local set and the corresponding relay of the companion set will maintain the opened condition. Thus when the local set is operated in code and none of the companion set is operated, the start lead will be closed to battery. If, thereafter, the companion set is operated in code, then the start lead is maintained closed to battery if the codes are different so that there is a mismatch or the start lead is opened and returned to its normal condition if the codes are the same so that those of the local code relays operated are matched by those of the companion code relays operated.

There is provided in addition an office frame check relay known herein as the OK relay which is responsive to the proper seizure of the office frame connector, which relay will connect battery to the district frame connector start lead. This relay is provided to work in conjunction with the district frame matching relays so that under a certain normal condition where no interference is encountered and the district frame matching relays indicate a perfect match a false retirement of the marker will be avoided. This may better be understood through the following description of the three conditions which will be encountered in service.

In case there is no interference—as where the operation is straightforward—the start lead for the district frame connector is closed by the operation of the district frame relay in the marker since one or more of the local code matching relays will connect battery to such start lead. While the companion code relays operated through the office frame connector multicontact relay will thereafter open this circuit by presenting a perfect match, this start lead will be closed at another point by the operation of the OK relay when and if the multicontact relay in the office frame connector operates—for this

relay while it closes the circuit to the companion code relays also causes the operation of the OK relay. Thus the time element heretofore introduced by the necessary wait for a relay similar in function to the OK relay to operate is hereby eliminated.

Under a second condition—as where the wanted office frame connector is in use—the start lead to the district frame connector is closed as before but since the particular office frame connector multicontact relay cannot now be operated the OK relay cannot be operated. However, some other multicontact relay in the wanted office frame connector will be operated at this time and therefore the companion code relays will be operated.

If under this condition there is a mismatch—indicating that the marker which is now holding such office frame connector is building up a connection through a district frame different from that wanted by the marker now making this test—then battery will be maintained on the district frame connector start lead so that this marker can seize and hold its district frame regardless of the fact that it cannot yet seize a wanted office frame. Thus the start lead for the district frame connector is closed by the matching relays and the OK relay plays no part in this operation until the wanted office frame is actually seized—at which time a match will be provided through a reoperation of the companion code relays so that like the first case described the matching relays will open the battery connection to the start lead but the OK relay will at the same time close an alternative path.

If under the second condition noted there is a match indicating that the marker which is now holding the wanted office frame connector is building up a connection through the same district frame as that wanted by the marker now making this test—then battery will be taken off of the district frame connector start lead. Thus the marker making the test retires to allow the other marker which is in possession of the office frame connector to also seize its wanted district frame connector and complete its function.

A feature of the invention is a code matching circuit in the marker which will indicate to the marker the identity of the district frame held by another marker which is adversely holding a wanted office frame.

It should be noted that the invention has for the sake of simplicity been described in connection with the originating marker in a local cross bar system. It applies as well to similar operations in other situations as, for instance, in the terminating markers in local cross bar systems and to the markers used in toll cross bar systems where a much larger number of simultaneous seizures must be made. In accordance with the complexity of the system the invention becomes more useful so that while it may readily be understood from the following description of its application in its simplest form, it will find its most useful application in more complex systems.

Another feature of the invention is the use of a permutation code for identifying the different district frames wanted. Thus a set of five conductors electrically effected in different code combinations will identify two to the fifth power or thirty-two different district frames. The invention herein described shows the use of

five such conductors and five relays in each of the local code relay set and the companion code relay set. Other numbers of such conductors and relays may be used in accordance with the number of district frame or similar apparatus units to be identified.

For the purpose of disclosing details of the cross bar telephone system to which the present invention may be applied, reference is made herein to Patent 2,235,803 issued to W. W. Carpenter, March 18, 1941, and to an article entitled Cross-bar dial telephone and switching system by F. J. Scudder and J. N. Reynolds, published in the Bell system technical journal, volume 18, January 1939, pages 76 et seq.

The drawings consist of ten sheets having eleven figures, as follows:

Fig. 1 is a block diagram showing the general layout of a cross bar dial telephone system and locating one place where the present invention may be employed;

Fig. 2 is a schematic circuit diagram through which the principle of operation of the present invention may be explained;

Figs. 3 to 10, inclusive, are circuit diagrams showing sufficient circuit details of the various units used in a cross bar dial telephone system to illustrate the invention, and

Fig. 11 is a block diagram showing how Figs. 3 to 10, inclusive, are joined to form a complete circuit diagram.

In a system such as that shown in Fig. 1 a subscriber at station 1 in making a call automatically establishes a connection through the line link frame 2, under control of the control circuit 3, thence through a district junctor circuit 4, thence through a sender link frame 5, under control of a control circuit 6, to an idle subscriber sender 7. The calling subscriber then dials the number of the called party—which number comprises generally a three-digit office code and then a four-digit station code. As soon as the office code has been recorded in the sender 7, a marker connector 8 is operated and an idle originating marker 9 is seized and the office code registration is transferred thereto. The marker then operates a district frame connector 10 and an office frame connector 11 and proceeds to select and establish an available path through the district link frame 12 and the office link frame 13 to an outgoing trunk 14. This system is well known and is disclosed in great detail in the publication above mentioned but is described here shortly in order to give a clear picture of where the devices known as markers, district and office link frames and district and office frame connectors are used and to give a general idea of their functions.

The marker is a complicated and expensive apparatus unit and it is therefore desirable to use as few as possible in an office. Therefore anything which will contribute to a saving of time in its use is worth while. As set forth hereinbefore a certain small time element is added to the normal operation of the marker to guard against a certain interference difficulty known as mutual lockout which sometimes occurs when two markers simultaneously attempt to operate the same district frame connector and the same office frame connector. In accordance with the present invention this normal time element is subtracted so that the average holding time of the marker is lessened. This is done by means of a matching circuit whereby when two markers simultaneously try to operate the same office frame

connector the one which is locked out looks into the marker which has succeeded in operating this connector to determine if both markers are also trying to operate the same district frame connector. If this proves to be the case then the marker which makes this comparison test releases the district frame connector to give the other marker which has seized the office frame connector right of way. In this manner a mutual lockout will be avoided and the marker which has given way to the other will only have to wait for approximately the normal lockout time encountered where ordinary lockout occurs.

The fundamental circuit for this operation is shown in Fig. 2. This diagram is divided by three vertical broken lines. The circuits at the right and the left represent the circuits of interest in a marker and as shown may be the circuits of one marker or they may be parts of the circuits of two different markers. The circuits between the first and second (from the left) broken lines represent the circuits in an office frame connector and the remaining circuits between the second and third vertical broken lines are those leads which are common to all markers.

In each marker there is one DF relay such as 15 for each district frame connector which in addition to other functions will act as shown in Fig. 2 to place ground in a code combination on a set of five leads. By way of example the relay 15 is shown as wired to place a ground on conductor 16. These five leads (more may be used if the five place code is insufficient to characterize the number of district frame used—or less if the number of district frame is smaller) are multipled upwardly through the leads 17 to the other DF relays in this same marker. The leads are also multipled downwardly in the bundle 18 to the circuit at the right where each connects to a local code relay such as 19, 20, 21, 22 and 23. Thus when a DF relay is operated in the marker it will place a particular code combination on its own set of local code relays (19 to 23) and on the five conductors which will be extended possibly through an office frame connector relay to another marker to operate therein the companion code relays 24 to 28. Each marker also has one O relay such as 29 for each office frame connector which in addition to other functions will act as shown in Fig. 2 to connect the companion code relays 24 to 28 to the common code conductors. Thus when the subscriber sender has recorded the office code and has transferred this information to the marker in the manner well known the marker will operate one DF relay and one O relay in accordance with this transferred information. When this marker has succeeded through its office frame start lead 30 in operating its (MP) marker preference relay 31 in the wanted office frame connector and this relay in turn has succeeded in operating its (MC) marker multicontact relay 32 the code conductors marked by its DF relay 15 will be extended to the common conductors 33 which may be extended from its relay 29 to its companion code relays 24 to 28. Thus in the case where a marker succeeds in seizing its wanted office frame connector it will operate its local code relays 19 to 23 as well as its companion code relays 24 to 28 with the result that corresponding relays in the local code group and the companion code group will be operated. An inspection of the circuit controlled by this relay will show that when corresponding relays of these two groups are in the same conditions that the battery connected to the armatures of the local

code relays will not reach conductor 34 connected to the armatures of the companion code relays. However, since the marker has succeeded in seizing its wanted office frame connector relay 32 will be operated and this will ground conductor 35 which leads to the OK relay 36, and this relay will place battery on the district frame connector preference relay start lead 34. In this case the time element sought by the present invention to be eliminated comprises the time taken to close the start lead 34 through the sequential operation of relays 31, 32 and 36. However, it will be noted that immediately the DF relay in the marker has been operated some one of the local code relays, say 19, operates and thus extends battery to the start lead 34. Now in time the relay 32 will become operated and shortly thereafter relay 24 in the companion code group will operate and remove battery from conductor 34. But in the meantime the OK relay 36 will have substituted a battery connection to start lead 34 to maintain this lead closed. Thus the time element taken for the sequential operation of relays 31, 32 and 36 is saved.

Let us assume that the marker represented by the part of the circuit to the left has succeeded in operating its office frame connector relays 31 and 32 but is otherwise blocked because some other marker (represented by the part of the marker circuit to the right) is in possession of the wanted district frame connector. This other marker will have operated its local code relay 19, will have thereby closed through its start lead 34 and thus have seized its wanted district frame connector. But this other marker may be assumed to want the same office frame connector and will thus have operated its relay 29. Since the first marker wants the district frame now occupied by the second marker it will have grounded conductor 16 so that a connection will be extended through the corresponding contacts of relays 32 and 29 to operate the companion code relay 24. This relay will open the connection which had been closed by relay 19 and thus will remove the battery connection to lead 34. In this case, since the second marker (to the right) has not been able to operate its wanted office frame connector seized through the operation of relay 19 will be released. Thereupon the first marker will seize such released district frame connector and will complete its function and the second marker will wait its turn. As soon as the first marker releases its office frame connector the second marker will proceed in the usual manner.

The third kind of operation is where the first marker has succeeded in seizing its wanted office frame connector and has operated the relays 31 and 32 and where the second marker wants this same office frame connector and has therefore operated its relay 29. In this case the two markers while both wanting the same office frame connector want different district frame connectors. The second marker may therefore have operated its local code relays 19, 21, and 23, by way of example, and have seized its wanted district frame connector. Since it is blocked from getting its wanted office frame connector it in effect looks into the rival (first) marker to see if that marker is trying to seize the district frame connector that this second marker has. Therefore a connection is established through the operation of relays 15, 32 and 29 and results in the operation of companion relay 24. While this relay will open the battery connection to the start wire 34 established by relay 19, there

will be no way to open the similar connections established by relays 21 and 23 and hence the second marker will not release the district frame connector which it has seized but will wait in the normal manner for its wanted office frame connector to become idle. The first marker will seize its wanted district frame connector in the normal manner.

Thus a match in the operation of the local code relays and the companion code relays will show that the the marker is operating without interference in which case the OK relay operates and substitutes a battery connection to the start wire 34, or it will show that interference which would otherwise cause a mutual lockout has been encountered in which case the OK relay will fail to operate and the seized district frame connector is released in favor of the interfering or rival marker. A mismatch in the operation of the local code relays and the companion code relays will show that only normal interference—not leading to a mutual lockout has been encountered and hence normal delays will take place but no district frame connector will be released.

The above description will give a clear picture of the manner in which the circuits operate. The following description, while necessarily somewhat of a duplication will show the proper relationship between the various units. In Figs. 3 to 10, inclusive, the circuits for four markers and eight each of office frame connectors and district frame connectors are shown.

Fig. 4, for instance, shows in the upper broken line rectangle certain essential elements of one marker and in the lower broken line rectangle certain essential elements of the first of eight district frame connectors. The first of eight office frame connectors is shown in Fig. 3 and the remaining like units are shown in the other figures.

Thus an office frame connector start lead is shown as 37 in the first marker, 38 in the second marker, 39 in the third marker and 40 in the fourth marker. When the first marker, by way of example, operates any one of the office relays such as 41 to 48 this start lead will be extended to the corresponding marker preference relays 51 to 58 respectively (relays 54 to 58 being not shown). Thus the first marker will operate the first marker preference relay in each office frame connector. In like manner the second marker will operate the second marker preference relay in each office frame connector and so on. In each office frame connector there is shown an MC (multicontact) relay eventually responding to each MP relay. Each such MC relay has a left-hand armature which will ground one of the four leads 49, 50, 59 and 60 to operate the corresponding OK relays 69, 70, 79 and 80. The OK relay in each marker will control the district frame connector start leads 79, 80, 81 and 82. In the first marker the lead 79 will be extended by the DF relay (61 to 68) operated to operate the corresponding marker preference (MP) relay (71 to 78) in the district frame connector. In each marker there is shown a matching circuit (83 to 86) which also controls the corresponding district frame connector start lead.

It should be noted that each DF relay (61 to 68) grounds the code wires 87 to 91 in a different combination and that the same different combinations appear in the other markers. These five code wires also are multipled to the armatures of the first multicontact relays (51 to 53) in each office frame connector. The front contacts of all the MC relays in one office frame connector are multipled together so that the five code wires may then be extended in multiple to the first office relay such as 41 in each marker. The code wires are then extended over the path 93 to the matching circuit 83. Thus it is clear that regardless of which MC relay is operated in the first office frame connector, some indication will come in to the companion code relays in the matching circuit 83 if the first marker has operated its O relay 41. If the first marker has operated relay 51 and this relay has succeeded in operating its corresponding MC relay 94, then the matching circuit 83 will indicate a match and OK relay 69 will become operated at about the time that the match is established in the matching circuit 83, in the manner hereinbefore described.

It is believed that the other operations heretofore described will be clear.

What is claimed is:

1. In an electrical control system, a master control circuit, a plurality of connectors through which said master control circuit may exercise control over other circuits, means in said master control circuit for simultaneously starting the seizure of a plurality of idle ones of said connectors, and means operating through a busy one of said connectors for identifying in said master control circuit another of said connectors.

2. In an electrical control system, a master control circuit, a plurality of groups of connectors through which said master control circuit may exercise control over other circuits, means in said master control circuit for simultaneously starting the seizure of an idle connector in each of said groups, and means in a busy connector in a given group for identifying in said master control circuit a connector in another of said groups sought by the means adversely holding said connector in said given group.

3. In an electrical control system, a master control circuit, a plurality of groups of connectors through which said master control circuit may exercise control over other circuits, means in said master control circuit for simultaneously starting the seizure of an idle connector in each of said groups, and means in a seized connector in a given one of said groups for identifying in said master control circuit a connector in another of said groups sought by the means which has seized said connector in said given group.

4. In an electrical control system, a plurality of master control circuits, a plurality of groups of connectors through which said master control circuits may exercise control over other circuits, means in each said master control circuit for simultaneously starting the seizure of a connector in each of said groups, and means in a previously seized connector in a given one of said groups for identifying in a first of said master control circuits seeking to seize said previously seized connector, a connector in another of said groups sought by a second of said master control circuits which has previously seized said connector in said given group.

5. In an electrical control system, a master control circuit, a plurality of groups of connectors through which said master control circuit may exercise control over other circuits, means in said master control circuit for identifying a connector in a first of said groups sought to be appropriated by said master control circuit, means in said master control circuit for identifying a connector in a first of said groups sought to be appropriated by other means, and means for matching the re-

sponse of said first means to the response of said second means.

6. In an electrical control system, a plurality of master control circuits, a plurality of groups of connectors through which said master control circuits may exercise control over other circuits, means in each of said master control circuits for identifying a connector in a first of said groups sought to be appropriated by said master control circuit, means in each of said master control circuits for appropriating a connector in a second of said groups, means in each of said master control circuits for identifying a connector in said first of said groups sought to be appropriated by that one of said master control circuits which has appropriated said connector in said second of said groups, means for matching the response of said first identifying means to the response of said second identifying means, and means for appropriating a connector in said first of said groups controlled by said matching means.

7. In an electrical control system, a master control circuit, a plurality of groups of connector circuits for extending said master control circuit, means in said master control circuit for designating a connector circuit in each of said groups for seizure, means including a seized connector in a first of said groups for identifying a connector designated for seizure in another of said groups, means responsive to the correspondence of the connector identified in said other group to the connector designated in said other group for controlling the seizure of said connector designated for seizure in said other group.

8. In an electrical control system, a plurality of master control circuits, a plurality of groups of connector circuits for extending said master control circuits, a start circuit in each said master control circuit for controlling a connector in a first of said groups, a matching circuit in each of said master control circuits partly responsive to a designation established therein of a connector in said first group and partly responsive to a designation of a connector in said first group transmitted thereto through a connector in a second of said groups, a check relay in each of said master control circuits responsive to the appropriation thereby of a connector in said second of said groups, said start circuit being under control of said matching circuit and said check relay.

9. In an electrical control system, a plurality of master control circuits, a plurality of groups of connector circuits for extending said master control circuits, a start circuit in each said master control circuit for controlling a connector in a first of said groups, a matching circuit in each of said master control circuits partly responsive to a designation established therein of a connector in said first group and partly responsive to a desig-

nation of a connector in said first group transmitted thereto through a connector in a second of said groups, a check relay in each of said master control circuits responsive to the appropriation thereby of a connector in said second of said groups, means responsive to a partial operation of said matching circuit and also responsive to a mismatched operation of said matching circuit for closing said start circuit, and means responsive to an operation of said check relay for closing said start circuit, whereby a partial operation of said matching circuit will close said start circuit and a following operation of said check relay will hold said start circuit closed in substitution of the first said closure thereof when a matched complete operation of said matching circuit opens said first closure of said start circuit, whereby a mismatched operation of said matching circuit will maintain said start circuit closed in the absence of an operation of said check relay and whereby a matched operation of said matching circuit in the absence of an operation of said check relay will open said previously closed start circuit.

10. In an electrical control system, a plurality of master control circuits, a plurality of connector circuits for extending said control circuits, means in each of said control circuits for recording information therein, and means in each said control circuit for matching the information recorded in a master control circuit which has seized one of said connectors with the information recorded in a master control circuit seeking to seize the same said connector circuit.

11. In an electrical control system, a plurality of master control circuits, a plurality of connector circuits for extending said control circuits, means in each said control circuit for recording information therein, means for seizing said connectors in accordance with said recorded information, lockout means for barring the seizure of a said connector when appropriated by one of said control circuits, and a matching circuit in each of said control circuits effective in a barred control circuit for comparing the information stored therein to the information stored in that control circuit which has successfully seized the said connector.

OSCAR MYERS.

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2,348,628	Holden	May 9, 1944
2,346,915	Frederick	Apr. 18, 1944
2,332,878	Vroom	Oct. 26, 1943
2,399,203	Beaumont	Oct. 20, 1942
1,991,193	Carpenter	Feb. 12, 1935