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E. T. HOCH

SYSTEM OF GROUPING UNITS

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Fig. 1.

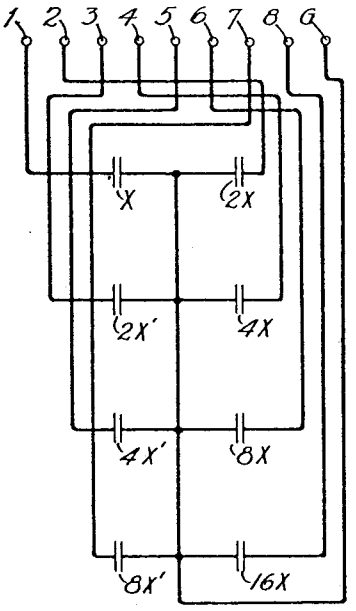
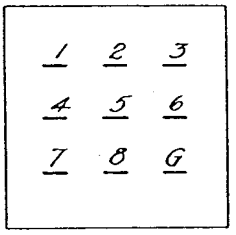


Fig. 2.



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UNITED STATES PATENT OFFICE.

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SYSTEM OF GROUPING UNITS.

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This invention relates to a system of connecting units such for example as condenser units to cover a given range of values.

The object of this invention is to provide a system of grouping or connecting units, having wide manufacturing limits, which will cover a given range of values with small intervals between successive steps.

There are, at present, two main systems of grouping units, one of which, known as the decade system, has units of 1X, 2X, 3X, 4X, 10X, 20X, etc. while the other system follows a geometric progression having units whose values are 1X, 2X, 4X, 8X, 16X, etc. The latter system has the advantage of covering a greater range with the same number of units; the decade system covering a range of 10X with four units or 110X with eight units, while the geometric progression system covers a range of 15X with four units and 255X with eight units.

In either of these systems, however, the units must be accurate to within plus or minus 5% of their nominal value to avoid large intervals between steps, in case the value of one unit is low and the value of the next succeeding unit is high. With the necessity of such close limits these systems are not desirable where quantity production of the units is required.

While the above systems use but one unit in each step, this invention contemplates the use of two or more units in a group corresponding to a step of the above system, and while maintaining small intervals between successive steps comparable with the intervals of the above system, permits the use of units varying as much as plus or minus 33⅓% of the nominal value. Therefore quantity production of these units is possible, since such wide limits do not require great manufacturing accuracy. With a permissible variation of 33⅓%, the upper limit of each group will be twice its lower limit; that is, if the nominal value of a group is 1½X, the lower or minimum limit of the group will be X and the upper or maximum limit will be 2X. In the next succeeding group, the minimum limit will be the maximum limit of the preceding group or 2X and its maximum limit will be 4X for a nominal value of 3X. In other words, in a group having a nominal value of 1½X, each unit in the group may have any value between X and 2X, and for a nominal value of 3X, the units may have any value between 2X and 4X. With such a grouping the greatest interval between progressive steps will be 2X or the maximum of the smallest group, and this will hold true regardless of the variations of the individual units as long as they remain within the limits specified. That this condition is met may be seen from the following concrete examples in which values have been chosen covering the extremes of the system. These examples are made up of groups having but two units in each group. By using more than two units in a group the interval between steps may be decreased, but the additional cost may be so great as to more than offset the advantage.

First, let us assume that the ideal condition is attained; i. e. that each unit in a group has the nominal value of the group, such a system would be

First group	1½X	1½X
Second group	3 X	3 X
Third group	6 X	6 X
Fourth group	12 X	12 X

It will readily be seen that values may be obtained from 1½X to the greatest value of the system in intervals of 1½X. As stated above, the greatest intervals between succeeding steps should not exceed the upper limit of the smallest value group. The upper limit in any group is 33⅓% higher than its nominal value, so that for the smallest group in the above case the upper limit is 2X. Therefore, systems in which both units of each group have the nominal value will satisfy the condition.

In a second example let it be assumed that one unit of each group has the minimum value and the other has the maximum value. The following represents such a system:

First group	X	2X
Second group	2X	4X
Third group	4X	8X
Fourth group	8X	16X

In such a system values from X to the maximum of the system may be obtained in intervals of X. As the allowed intervals is the upper limit of the smallest group, or 2X, this system also satisfies the condition.

The worst condition which may be met

is a system in which both units of one group have the minimum allowed value, while the units of the next succeeding group have the maximum allowed value. Such a system is represented as follows:

First group	X	X—(both minimum value)
Second group	4X	4X—(both maximum value)
Third group	6X	6X—(both nominal value)
Fourth group	16X	16X—(both maximum value)

The values obtainable in such a system are X, 2X, 4X, 5X, 6X, 7X, 8X, 10X, etc. It will be seen that the largest interval in this system is 2X, which is the maximum permissible. A system such as this last example, will probably be rare in practice so that the system will be such that the intervals of succeeding steps will be less than the maximum limit permissible.

The particular application of this system is in connection with condenser units, although it is not limited to such, but may apply to resistance units, inductance units, etc. in the electrical art, and may find numerous applications in other arts.

Condensers grouped in accordance with this invention are particularly adapted to carrier telephone systems where it is desired to have a plurality of capacity units, which may be combined to give any desired value within a certain range, while maintaining the necessary accuracy.

The manner of connecting the units will be better understood by referring to the attached drawing, in which, Fig. 1 represents schematically condenser units arranged in accordance with this invention and Fig. 2 represents schematically the top of a condenser group which has been potted showing the location of the terminals.

Each unit has one of its terminals brought out for external connection. Condenser unit X has one side connected to terminal 1, unit 2X to terminal 2, unit 2X′ to terminal 3X, etc. The other side of each unit is connected to a common terminal marked G. Fig. 2 shows the terminals arranged in a commercial unit. After it has been decided what the capacity is to be, the terminals of the units which will give this capacity are strapped. For instance, if the capacity desired is 9X, terminals 1 and 6 are strapped; for 10X either terminals 2 and 6, or 3 and 6 are strapped. From this, it is readily seen how any value within the range of the group may be obtained by strapping the proper terminals.

What is claimed is:

1. Electrical apparatus comprising groups of a plurality of electrical units, each, the maximum permissible value of the individual units of each group being twice the minimum permissible value, the minimum permissible value of the units of each succeeding group being the maximum permissible value of the preceding group.

2. Electrical apparatus comprising groups of two units each, the maximum permissible value of the individual electrical units of each group being twice the minimum permissible value, the minimum permissible value of the units of each succeeding group being the maximum permissible value of the preceding group.

3. Electrical apparatus comprising groups of two units each, the maximum limit of the individual electrical units of each group being twice the minimum limit, the minimum limit of the individual units of each succeeding group being the maximum limit of the units of the preceding group, the maximum interval between any one step and the next succeeding step not exceeding the maximum limit of the values of the units of the group having the smallest value.

4. Electrical apparatus comprising groups of two electrical units each, each unit having a nominal value from which it may vary an amount not to exceed plus or minus 33⅓%, the minimum limit of the value of the units of any group being the maximum limit of the value of the units of the preceding group, said groups giving progressive steps, the maximum interval between successive steps not exceeding the maximum limit of the values of the units of the smallest valued group.

5. Electrical apparatus comprising groups of two electrical units each, each unit having a nominal value from which it may vary an amount not to exceed plus or minus 33⅓%, the nominal value of each successive group, being twice the nominal value of the preceding group, said groups giving progressive steps, the maximum interval between successive steps not exceeding the maximum limit of the values of the units of the smallest valued group.

In witness whereof, I hereunto subscribe my name this 10th day of March A. D., 1926.

ELLERY T. HOCH.