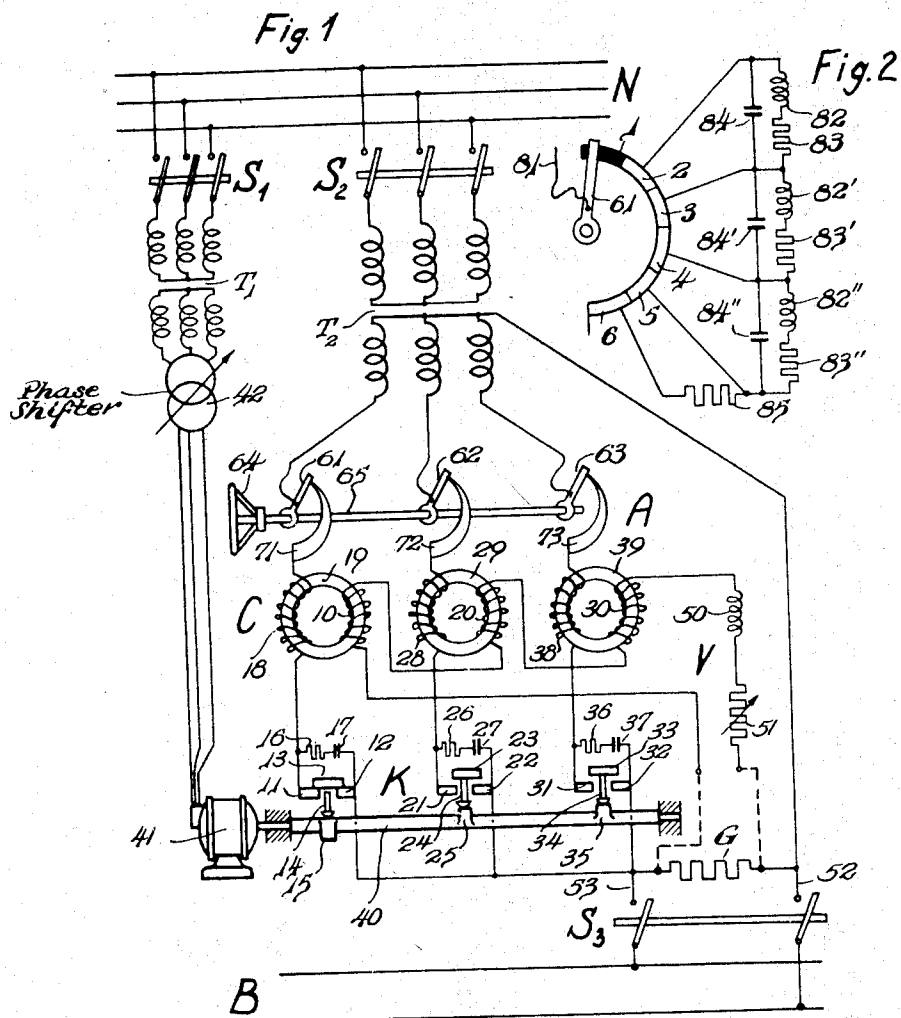


Dec. 24, 1940.

F. KOPPELMANN
METHOD AND APPARATUS FOR PUTTING INTO OPERATION
A MULTIPHASE CONVERTING DEVICE
Filed Aug. 16, 1938

2,225,644



Inventor
F. Koppelman
by Knight Bros. attorneys

UNITED STATES PATENT OFFICE

2,225,644

METHOD AND APPARATUS FOR PUTTING
INTO OPERATION A MULTIPHASE CON-
VERTING DEVICE

Floris Koppelman, Berlin - Siemensstadt, Ger-
many, assignor to Patentverwertungs-Gesell-
schaft mit beschränkter Haftung "Hermes,"
Berlin, Germany, a corporation of Germany

Application August 16, 1938, Serial No. 225,126
In Germany August 16, 1937

3 Claims. (Cl. 175—364)

The present invention relates to a method for putting into operation and under load a multi-
phase converting device having periodically oper-
ated contacts and means for reducing the arcing
at the contacts, and, more in particular, to con-
verters of the type described in my copending ap-
plication, Serial No. 114,965, filed December 9,
1936.

The converting devices according to the co-
pending application are provided with means for
biasing the curves of the operating current and
the operating voltage so as to prevent arcing at
the periodically actuated contacts even in the
case of high intensities or voltages of the current
to be interrupted. These means comprise one or
more saturable reactors ("switching reactors")
which are connected in series with the respective
contacts, and one or more current paths, prefer-
ably capacitive, which are connected in parallel
relation to the respective contact breaks and de-
signed to partially maintain the current when
separating the contacts so that the restraining
voltage across the contact gap increases only
gradually. The switching reactors are provided
with a magnet core consisting of a high-graded
iron whose magnetization curve presents a sharp
saturation bend. The winding and the core
of the reactor are so dimensioned that at very low
current intensities in the neighborhood of the
zero value the iron is unsaturated, but is highly
saturated during the remaining portion of the
transmission period. As a result the resistance
of the reactor is relatively high and the current
curve is flattened in the neighborhood of the zero
passage of the curve so that the current intensi-
ties remain at a low value during an extended
"weak current interval." On the other hand, the
resistance of the reactor is practically nil at
higher current intensities so that the current may
pass without any hindrance. The value at which
the iron is saturated amounts to a fraction of the
effective value of the normal current. The value
of saturation, even in the case of very high ef-
fective current intensities, is preferably of the
order of 1 amp. The above-mentioned means
make it possible to provide the switching device
with lifting contacts which as periodically oper-
ated contacts are particularly advantageous both
from the mechanical and the electrical point of
view as compared with the sliding contacts here-

tofore usual in commutating converters for heavy
currents.

If a multiphase converting device of the
above-mentioned character is put into operation
while under load, it may happen that, owing to a
sudden application of the voltage, irregularities in
the phase sequence occur as a result of transient
effects. Such irregularities tend to disturb the
process of commutation so that the contacts may
be damaged by the formation of arcs.

An object of the present invention is to prevent
disturbances and damage of the nature just men-
tioned.

To this end, according to the invention, the
starting of a converter of the type here referred
to is effected in the following manner. At first
the synchronous drive of the converter is put into
operation, the contacts running idle in electrical
respect. Then the contacts are connected with
the load or supply circuit through a small auxil-
iary load represented by a finely graded starter
rheostat. Thereupon the auxiliary load is gradu-
ally short-circuited. The small auxiliary load is
so chosen as to be sufficient to bring about the
variations of inductance of the switching reac-
tors which are caused by the above-explained de-
saturation phenomenon and which are necessary
for effecting the proper commutation. Finally
the main load is switched in the circuit after the
starter rheostat has been bridged.

The resistors of the rheostat may consist of a
combination of ohmic resistors, inductors or ca-
pacitors. This combination is to be chosen in
such a manner that it affects in each starting po-
sition the phase position of the currents in the
suitable manner as regards the operation of the
mechanical switching contact. The individual
impedance values of each step of the above-men-
tioned rheostat combination may be determined
by tests, care being taken to avoid an arcing in
any starting position during the starting process.

In the accompanying drawing, Fig. 1 exempli-
fies the complete diagram of connections of a
converter arrangement according to the inven-
tion, and Fig. 2 shows details of the starter rheo-
stat employed in the arrangement of Fig. 1.

The arrangement illustrated in Fig. 1 serves to
change three-phase alternating current supplied
from a circuit N into direct current furnished to a
circuit B. The converting apparatus proper con-

sists of a contact device K. This device comprises two stationary contacts 11 and 12, 21 and 22, 31 and 32, respectively, and a movable contact 13, 23 or 33, respectively, in each of the three phases to be interrupted. Reciprocatory tappets 14, 24 and 34, respectively, serve to operate the movable contacts 13, 23 and 33 and are acted upon by cams 15, 25 and 35 mounted on a common cam shaft 40 which is operated by means of a synchronous motor 41. The motor is connected with the A. C. circuit N through a switch S₁, a transformer T₁, and a phase shifter 42 consisting of an adjustable induction voltage regulator. An impedance path, consisting of a resistance 16, 26 or 36 and a capacitance 17, 27 or 37, is connected in parallel to each break of the three interrupters. The stationary contacts 12, 22 and 32 are connected with one another and with one pole 53 of the direct current circuit. Each of the other stationary contacts 11, 21 and 31 is connected with one respective secondary winding of a transformer T₂ through switching reactors E and a rheostat A. The neutral point of the secondary windings is connected with the other pole 52 of the direct current circuit, a switch S₃ being interposed between the D. C. circuit B and the two leads coming from the contact device and the transformer T₂. The primary windings of the transformer T₂ are connected with the A. C. circuit N through a switch S₂. An auxiliary load G bridges the two direct current poles 52 and 53. The useful D. C. loads (not shown) are connected with circuit B.

The reactors C consist of a main winding 18, 28 or 38 series-connected with the respective interrupter, and a magnet core 19, 29 or 39. The cores are further provided with auxiliary windings 10, 20 and 30 which are series-arranged in a biasing circuit V together with a smoothening inductance 50 and a variable resistor 51. The circuit V is fed with direct current from a suitable current source, for instance, from the D. C. load circuit, as indicated by dotted lines. The function of the reactors C is to flatten the current curve in the vicinity of the zero passages, and the biasing circuit V allows adjusting the value of the slight current intensity prevailing during the weak current intervals produced by the reactors.

The starting device A has three contact arms 61, 62 and 63 which may be actuated by means of a hand wheel 64 through a common shaft 65, the contact arms sliding over a semi-circular contact path 71, 72 and 73 respectively. The contact path is subdivided as shown in Fig. 2 into a plurality of segments 2, 3, 4, 5 and 6 between which are arranged impedance steps, some of which consist, for instance, of a series connection of an inductance 82, 82' or 82'' and an ohmic resistance 83, 83' or 83'', a capacitor 84, 84' or 84'' being arranged in parallel relation to the series connection. Another impedance step consists, for instance, of an ohmic resistance 85 only. One of the two outermost contact segments 1 is insulated, whereas the other 6 is connected to the main current circuit. The main current is supplied to the movable contact arm 61 through a flexible conductor 81.

The converter arrangement above-described is put into operation as follows. Fig. 1 shows the arrangement in its condition of rest, all of the switches S₁, S₂ and S₃ being in open position. In order to start the operation, the switch S₁ is closed. The motor 41 now starts running, thus operating the contact interrupters while the device proper is still idle in electrical respect as it is

separated from both the supply circuit N and the load circuit B. Now the switch S₂ is closed and the starting device A is rotated from the position shown to the short circuit position, care being taken to attain the most favorable operating conditions in the different intermediate positions as well as in the end position of the starter, if necessary, by adjusting the phase shifter 42 and/or the resistor 51 by regulating the magnetic bias acting on reactors C. During this procedure, the converter carries only the auxiliary load G. If now the operation is found to be in order, the switch S₃ is closed and thereby the main load in circuit B switched-in. The passage from the auxiliary load to the full load is thus effected without disturbance and without appreciable arcing at the contacts. Accordingly, a readjustment with the aid of the phase regulator 42 or the bias regulator 51, if necessary, is reduced to narrow limits.

What is claimed is:

1. In a multiphase alternating-current converter for connecting a supply circuit with a load circuit, having periodically operated contact interrupters series-connected with saturating reactors for reducing the current intensities in the neighborhood of the zero value of the current to be interrupted, and parallel connected with impedances for biasing the operating voltage of said current, the combination of a starter rheostat having a variable resistance arranged in series connection with each of said contact interrupters and designed to permit a gradual decrease of its resistance value to zero, an auxiliary load connected with the output side of the converter, and means for separating said converter and said auxiliary load from said load circuit during the operation of said rheostat, said rheostat comprising resistances having a reactive component and being dimensioned with relation to said reactors so as to prevent visible arcing at the contacts in intermediate positions of said rheostat.

2. In a converting arrangement for supplying current from a multiphase alternating current circuit to a direct current circuit having a contact interrupter in each phase of said alternating current circuit, phase-adjustable drive means for operating said interrupters in synchronism with the alternating current to be interrupted, saturable and magnetically adjustable reactors series-connected in each of said phases for producing weak current intervals, and impedances connected in parallel relation to said interrupters for biasing the voltage of said current during the opening period of said contacts, the combination of switching means for separating said converter from said direct current circuit, an auxiliary load connected across the converter side of said switch, and a starter rheostat having a graduated impedance combination arranged in series connection with each of said interrupters and designed to gradually decrease its resistance from a maximum value to zero when starting the operation of said converter, said impedance combinations comprising a capacitance and being dimensioned relative to said reactors so as to prevent visible arcing at the contacts during the starting period.

3. The method of starting the operation of a commutating alternating current converter having in each alternating current phase a contact interrupter and a starter rheostat connected in series with a magnetically adjustable saturable reactor for producing weak current intervals, and an impedance connected across the interrupter contacts for reducing the periodical increase of the operating voltage, which comprises the steps

of starting the mechanical operation of the interrupters so as to run idle in synchronism with the alternating current to be interrupted, supplying the interrupters with the alternating current while the rheostats have a high effective resistance and loading the interrupters at first with a small auxiliary load sufficient to effect a proper commutation process, gradually decreasing the

resistance of the rheostats down to the zero value while adjusting the mechanical operation of the interrupters and the reactors relative to each other so as to maintain a proper communication, and finally connecting the converter with the load to be operated.

FLORIS KOPPELMANN.