July 29, 1958 E. J. DIEBOLD 2,845,592

CONTACT TIME ADJUSTMENT FOR MECHANICAL RECTIFIERS

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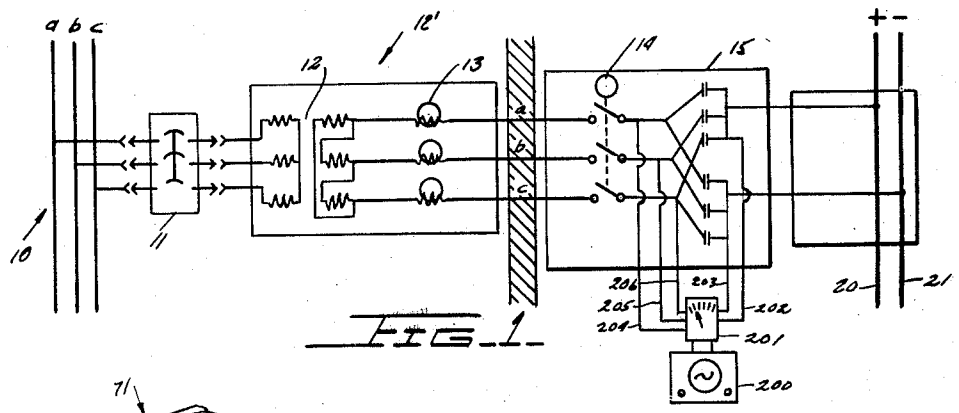


FIG. 1

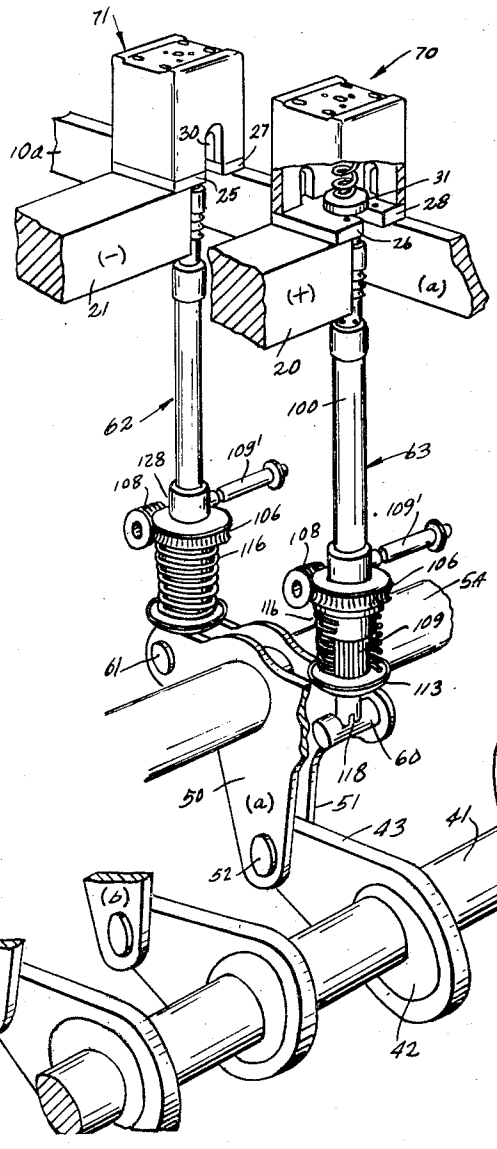


FIG. 2

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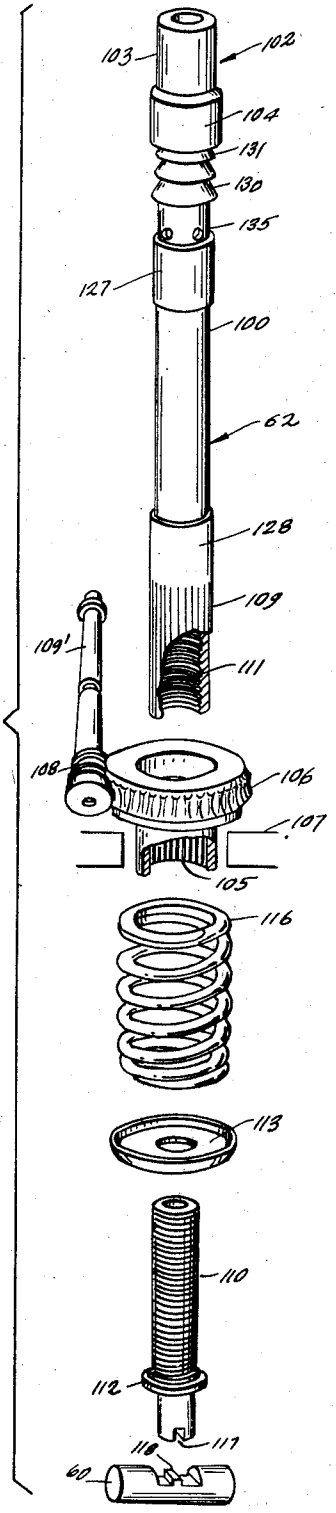
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CONTACT TIME ADJUSTMENT FOR MECHANICAL RECTIFIERS

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Fig. 3.



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FIG. 4

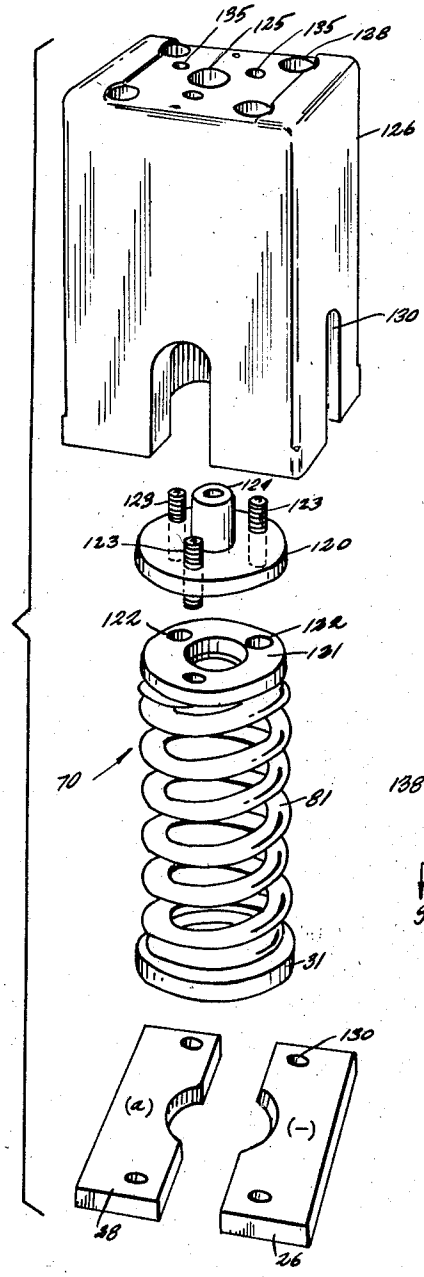
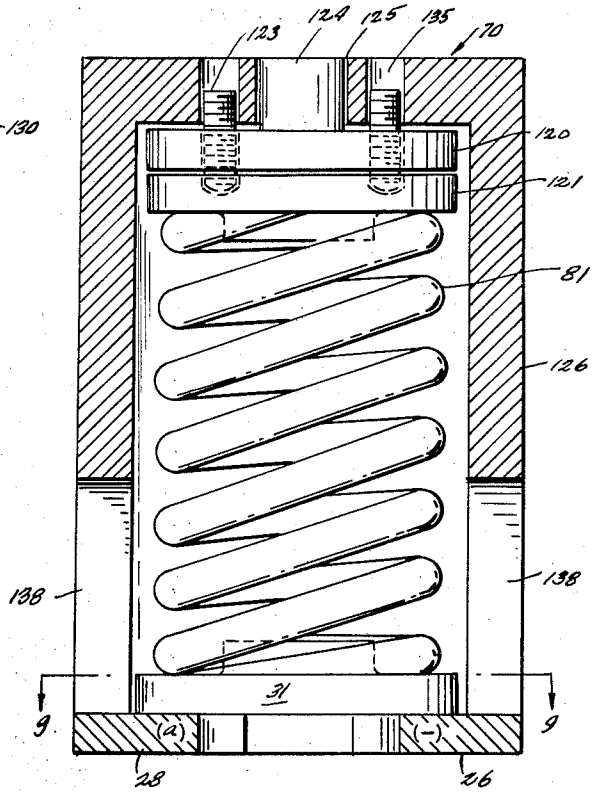


FIG. 5



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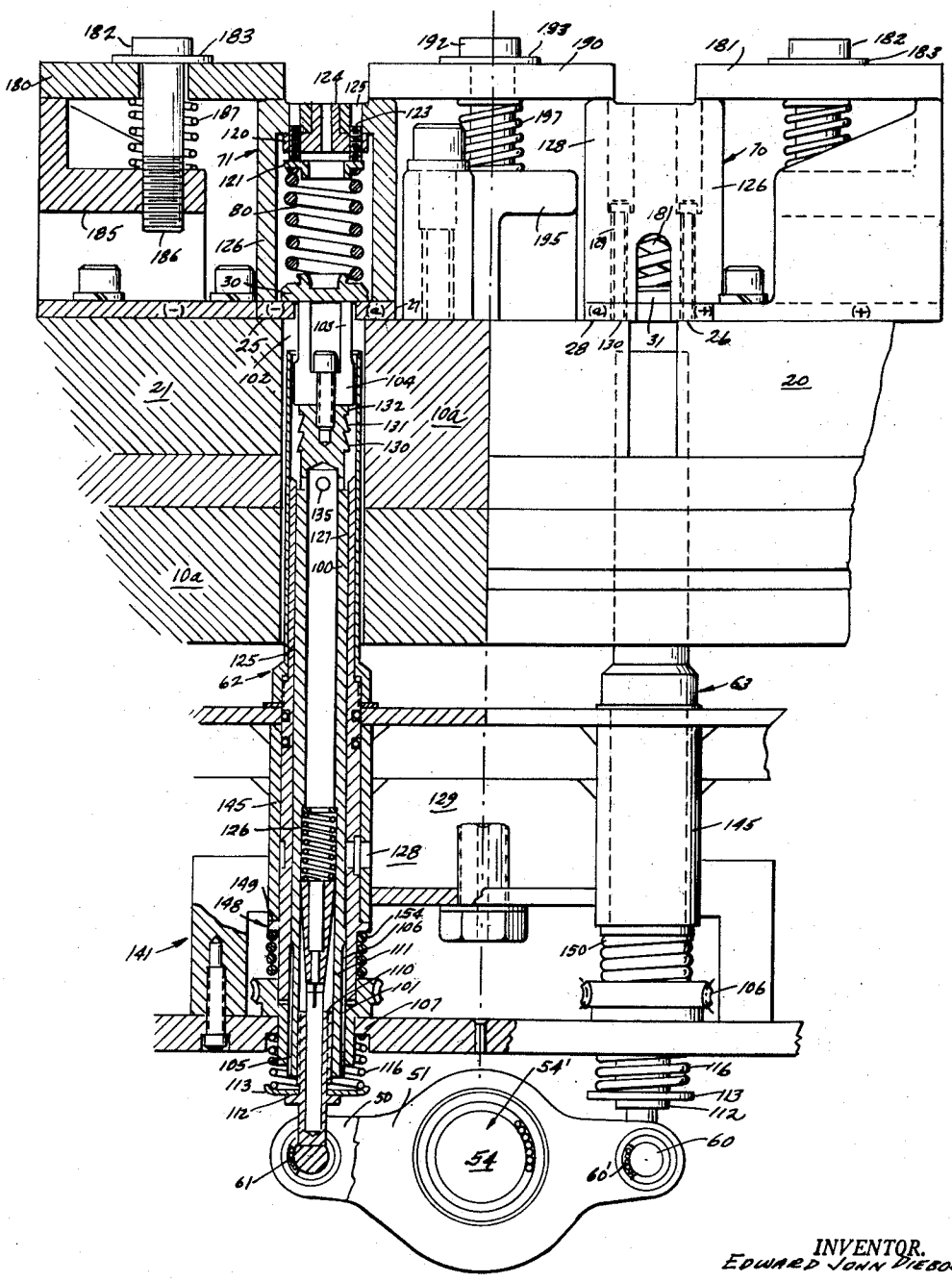
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FIG. 6.



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FIG. 7

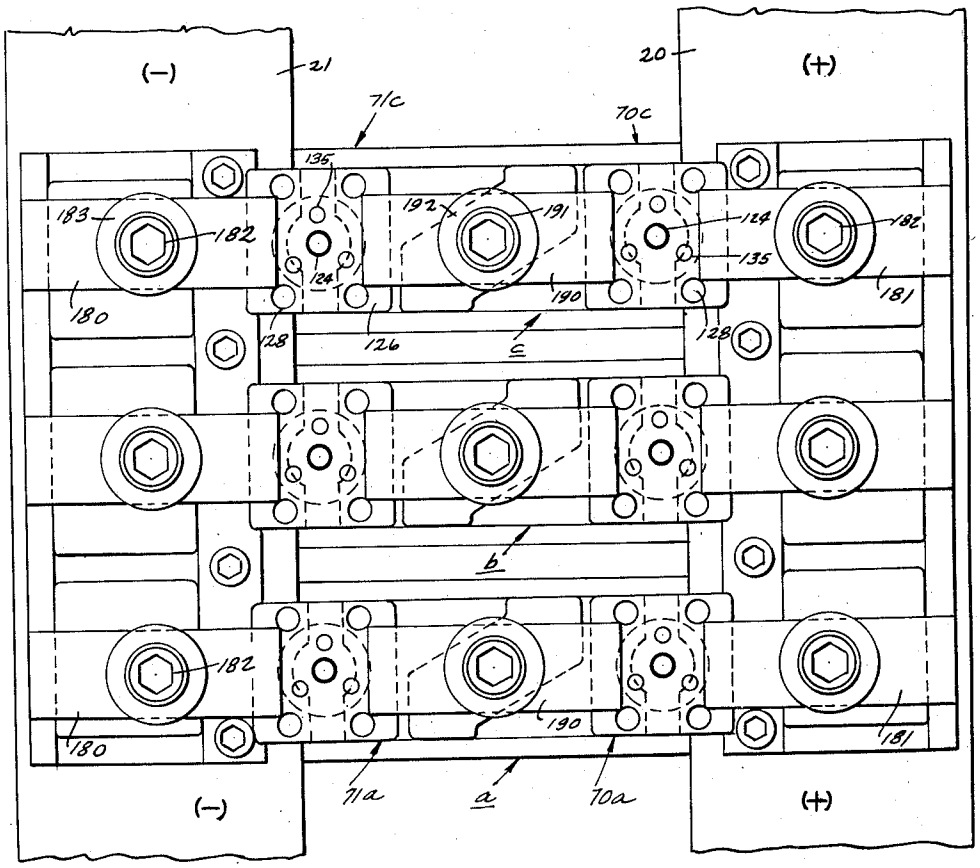
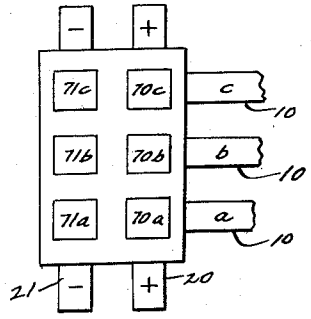


FIG. 8



MAKE SEQUENCE 71a - 70c - 71b - 70a - 71c - 70b - 71a - ETC.

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FIG. 9

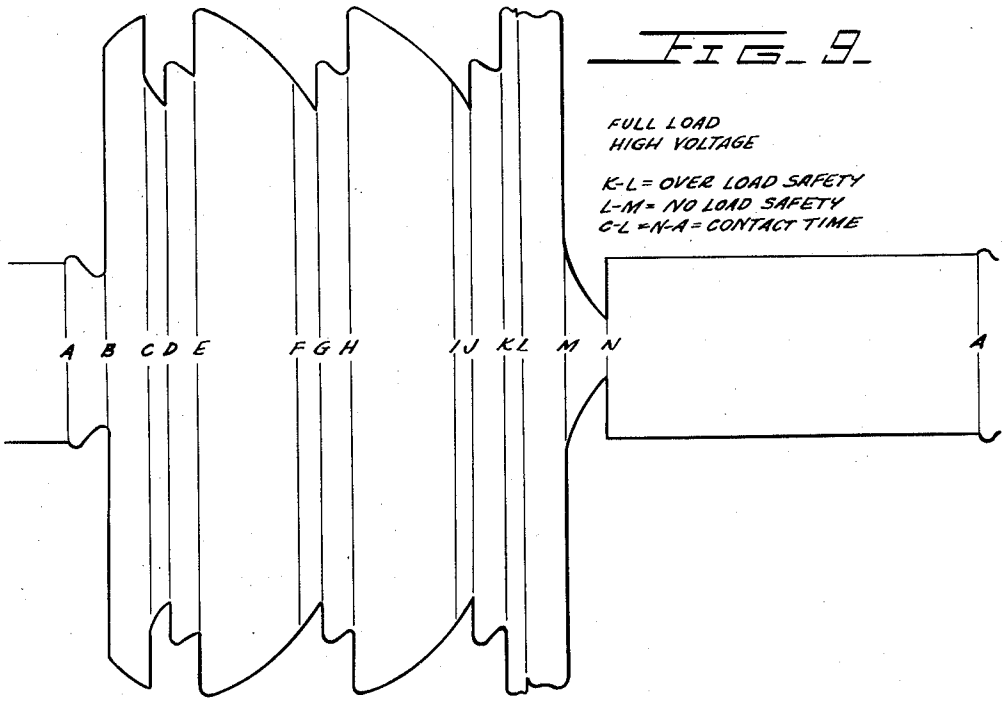


FIG. 10

		POSITION OF THE SELECTOR SWITCH 201						
	NUMBER OF THE CONTACT IN QUESTION →	71a	70a	71b	70b	71c	70c	
A	OPENING OF CONTACT (BREAK)	71a	70a	71b	70b	71c	70c	A
B	END OF BREAK STEP	71a	70a	71b	70b	71c	70c	B
C	CLOSING (MAKE), BEGIN OF MAKE STEP	70a	71a	70b	71b	70c	71c	C
D	END MAKE STEP, BEGIN COMMUTATION	70a	71a	70b	71b	70c	71c	D
E	END OF COMMUTATION	70c-70a	71c-71a	70a-70b	71a-71b	70b-70c	71b-71c	E
F	CLOSING (MAKE), BEGIN OF MAKE STEP	71c	70c	71a	70a	71b	70b	F
G	END MAKE STEP, BEGIN COMMUTATION	71c	70c	71a	70a	71b	70b	G
H	END COMMUTATION	71b-71c	71a-70c	71c-71a	70c-70a	71a-71b	70a-70b	H
I	MAKE, BEGIN MAKE STEP	70b	71b	70c	71c	70a	71a	I
J	END MAKE STEP, BEGIN COMMUTATION	70b	71b	70c	71c	70a	71a	J
K	END COMMUTATION, BEGIN BREAK STEP	70a-71b 70a	71a-71b 71a	70b-70a 70b	71b-71c 71b	70c-70a 70c	71c-70a 71c	K
L	MECHANICAL BREAK	70a	71a	70b	71b	70c	71c	L
M	END OF BREAK STEP	70a	71a	70b	71b	70c	71c	M
N	MAKE (CLOSING OF CONTACT)	71a	70a	71b	70b	71c	70c	N

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United States Patent Office 2,845,592 Patented July 29, 1958

2,845,592

CONTACT TIME ADJUSTMENT FOR MECHANICAL RECTIFIERS

Edward John Diebold, Ardmore, Pa., assignor to I-T-E Circuit Breaker Company, Philadelphia, Pa., a corporation of Pennsylvania

Application August 29, 1952, Serial No. 307,024

7 Claims. (Cl. 321—43)

My invention relates to mechanical converter or rectifiers of the type set forth in copending application Serial No. 212,017, filed February 21, 1951, now Patent No. 2,693,569, and is more particularly directed to a structural arrangement whereby contact time adjustment can be made by means of a stationary adjustment means while the converter or rectifier is running and under load.

A mechanical converter produces direct voltage by making metallic contact between a proper phase of an A. C. system and the associated D. C. system during the time interval the particular phase of the A. C. system is capable of delivering energy in the desired direction and breaking the metallic contact when the A. C. phase reverses its voltage in relationship to the D. C. voltage. This operation is performed sequentially and repeatedly in synchronism with the A. C. frequency.

With the structure of my invention contact time adjustment is provided to compensate for accumulated inaccuracies in manufacturing and for wear and to obtain exact time required for operation. This adjustment is made by modifying the length of individual push-rods and is accomplished with precision while the machine is running and under load.

The structure of my invention for adjusting the contact timing comprises a push rod with internal threading at its lower end to receive an adjusting screw which is externally threaded. The push rod has an external spline which meshes with an internal spline on a worm gear. The worm gear is positioned to have no longitudinal movement, with its motion restricted to rotational movement. The worm gear is controlled by a worm which terminates outside the mechanism housing. The adjusting screw is constructed at its lower end in a manner so that it is limited to vertical movement. Hence, manual rotation of the worm gear, through the cooperating splines, will rotate the push rod. Since the adjusting screw cannot rotate, the rotation of the push rod will move it toward or away from the adjusting screw due to the threaded engagement therebetween. Hence, the effective length of the push rod is rapidly and easily adjusted by means of a worm which remains stationary with respect to the vertical oscillation of the push rod.

An oscilloscope is placed across the contact converter and an oscillogram of the voltage conditions thereacross are obtained. By means of a comparison with a diagram of the desired voltage configuration, the operator can rapidly determine whether or not the mechanical converter is operating with proper overload safety, no load safety and sufficient contact time of engagement and disengagement.

A tabulation chart is used by the operator in coordination with the oscillogram and diagram of desired voltage configuration to permit the operator to determine which contact connect push rod assembly must be adjusted to make the oscillogram conform to the diagram of the desired voltage configuration. Hence, by this means a simple, rapid and effective procedure is utilized to enable

the operator to make the proper adjustment of the length of the push rod assemblies.

A primary object of my invention is the provision of stationary means for contact time adjustment while the rectifier is running.

Another object of my invention is to provide means contact time adjustment for a mechanical rectifier to compensate for accumulated inaccuracies in manufacture and for wear.

Still another object of my invention is to provide adjustment means for a mechanical rectifier whereby the effective length of the contact push-rod can be adjusted from stationary means while it has vertical oscillatory motion.

A further object of my invention is a mechanical rectifier with adjustment means to obtain the exact time required for operation, with the adjustment means being operative while the rectifier is running and under load.

Another object of my invention is a mechanical rectifier contact time adjustment means whereby each bridging contact comprising the contact between each phase bus of the source and the positive and negative bus of the load can be repeatedly and independently adjusted and altered.

A further object of my invention is to provide individual contact time adjustment for each of the bridging contacts of a mechanical rectifier while the unit is operating under load conditions.

Another object of my invention is to provide adjustment means to modify the length of individual push rods with precision while the machine is running and under load.

Another object of my invention is to provide a visual indicator to the operator to enable him to rapidly and effectively make the proper adjustment of the push rod assembly.

A further object of my invention is to provide an oscilloscope arrangement by which the operator has a guide to indicate which contact assembly should be adjusted.

A still further object of my invention is to provide a novel push rod assembly adjustment means which can be properly adjusted in accordance with a comparison of an oscillogram of the voltage across the contact converter and a diagram of the desired voltage configuration.

These and other objects of my invention will be apparent from the appending description taken in connection with the drawings in which:

Figure 1 is a schematic electrical connection diagram of a single mechanical rectifier unit in which my invention is used showing the attachment of the oscilloscope to the contact converter.

Figure 2 is a perspective view of the control of the push rod and its effect on the contact engagement and disengagement.

Figure 3 is an exploded perspective view showing the novel contact time adjustment means of my invention.

Figure 4 is an exploded perspective view of the replaceable contact assembly used with my invention.

Figure 5 is a cross-section view of the assembled replaceable contact assembly of Figure 4.

Figure 6 is a side detailed view of the push rod and associated removable and replaceable contact assembly.

Figure 7 is a top view of Figure 6 illustrating the arrangement and assembly of the removable and replaceable contact assemblies.

Figure 8 is a schematic diagram of Figure 7 showing the position of the contact converters with respect to the supply alternating current and load direct current bus bars.

Figure 9 is an oscillogram of the voltage across any one of the contact converters.

Figure 10 is a tabulation to co-ordinate the oscillogram

of Figure 9 with the contact structure effecting the various positions thereof.

In Figure 1, the source of alternating current is taken from the alternating current lines **10** through the circuit breaker **11** to step down transformer **12**. The source current is then passed through the commutating reactors **13** to "step" the current for switching purposes as set forth in application Serial No. 212,017, filed February 21, 1951. The enclosure means **12** and construction of the commutating reactor **13** are more fully described in copending application Ser. No. 301,880, filed July 31, 1952, now Patent No. 2,759,128.

The current then passes through disconnect switches **14** to the contact converter **15** which forms the subject of the instant application. The contact converter **15** sequentially and repeatedly in synchronism with the A. C. frequency connects the alternating current source buses **10***a, b, c* to the D. C. load buses **20—21**.

The contact converter **15** is bridge connected to permit better use of the power transformer **12** by doubling the phase operation of the connector and thereby result in smoother D. C. current and less interference with commutation facilities as best seen in Figures 2, 6 and 7.

The bridge connected contact converter **15** has two sets of contacts, a negative set **25—30—27** (*a*—) in contact block **71** and a positive set **26—31—28** (*a*+) in contact block **70**. The two sets of contacts are off set 180° electrical degrees from each other and the contacts in either positive or negative set for all the phases *a, b* and *c* are set 120° apart. The circuit may be supplied with three phase voltage *a, b* and *c* and at one period of time the load current will flow from phase *a* through contact *a*+ through the load and back over a contact *c*— to phase *c*. During positive commutation between phases *a* and *b*, the load current divides between these two phases by closed contacts *a*+ and *b*+.

For the purpose of simplification, I have shown in Figure 2 the switching structure which is used at phase *a*, it being understood that the switch apparatus for phases *b* and *c* are identical in construction, as seen in Figure 7.

An excited type synchronous motor **40** is energized from the three phase source voltage *a, b, c* and drives shaft **41**. A cam **42** is integrally attached to the shaft **41** and therefore driven by the motor **40**. The cam **42** drives an eccentric **43**. The eccentric member **43** is pinned to bell cranks **50—51** by means of pin **52**. Since the bell cranks **50—51** are rotatably mounted by bearing **54'** on a fixed overlap control shaft **54**, the movement imparted to eccentric **43** by cam **42** is a reciprocating motion which in turn is imparted to the bell cranks **50—51**.

The cross extension arms of the bell cranks **50—51** are connected by rocker arm pins **60—61** which serve as the driving means for push rods **62** and **63**. The rocker arm pins **60—61** are connected to extending arms **50—51** by means of bearing **60—61** so that these pins **60—61** have a rotational movement to enable them to maintain constant engagement with the push rods **62—63** as will hereinafter be more fully described.

Push rods **62** and **63** are identical in construction and are shown in the exploded detailed view of Figure 3 and in the detailed side view of Figure 6. Upward movement of push rod **62**, imparted thereto by the rocker arm pin **60** will urge the movable disc shaped bridging contact **31** against the bias of contact spring **81** and thereby disengage it from engagement with stationary A. C. contact **28** and stationary D. C.+ contact **26**.

The construction and operation of the replacable contact structure **70—71** is illustrated in Figures 4, 5 and 7 and explained in detail in copending application Ser. No. 307,067, filed August 29, 1952, now Patent No. 2,798,909.

The structure and operation of the adjustable push rod **62** will best be understood from the following description taken in connection with the exploded detailed view of Figure 3 and the detailed side view of Figure 6. The push rod **100** is provided with external splines **101** at its lower portion and an insulated heat **102** at its upper portion. The reduced cross-sectional head **103** and the enlarged cross-sectional portion **104** of insulating head **102** are sufficiently small to move through the opening provided by the space between stationary contacts **26—28** to thereby enable the head **103** to engage the bridging contact ring **31**. Hence, when the contact rod **100** is moved upward by the rocker arm pin **60** or **61** the reduced cross-sectional portion **103** of the insulating head **102** will be driven through the inside diameter of the stationary contacts **25—27** or **26—28** and portions **103** will engage the lower surface of the ring contact **30** or **31** and urge it upward against the bias of contact spring **80** or **81** to contact disengaged position.

The insulating material **102** is designed to prevent the movable contact **30** or **31** from moving away from the stationary contacts with an oscillatory motion to thereby prevent delayed contact separation which would decrease the safety portion of the step.

External splines **101** located at the lower edge of the contact rod **100** mesh with the internal splines **105** of the worm gear **106**. Hence, the push rod **100** has vertical movement with respect to the worm gear **106** but is restricted from having rotational movement with respect thereto due to the mesh of splines **101** and **105**. The worm gear **106** as will hereinafter be more fully explained has no vertical movement and is restricted to rotational movement. The worm gear **106** is in mesh with the worm **108** which is controlled by the shaft **109** as seen in Figures 2 and 3. Hence, manual rotation of shaft **109** will rotate worm **108**. The mesh engagement between worm **108** and worm gear **106** will cause worm **109** to rotate the worm gear **106**. The mesh engagement of the internal splines **105** of worm gear **106** with the external splines **101** of push rod **100** will cause rotational movement of the push rod **100** due to the rotational movement of worm gear **106**. As will hereinafter be more fully explained, rotational movement of push rod **100** will cause the adjusting screw **110** to thread toward or away from the push rod **100**. Thus, rotation of the worm **108** will cause a change in the over-all length of the push rod **62**.

The lower portion of push rod **100** is hollow and has a threaded internal portion **111**. The internal threads **111** mesh with the external threads of the adjusting screw **110**. Near the lower portion of the adjusting screw **110** is a flange **112** which acts as a stop or rest for the return spring cap **113**. The return spring **116** is concentric with the adjusting screw **110** and is seated at its lower end against the return spring cap **113** and at its upper end against the stationary ledge **107**. The lower end of the adjusting screw **110** is provided with a slot **117** that registers with the key or projection **118** on rocker arm pin **60**.

The engagement of projection **118** with slot **117** prevents rotational movement of the adjusting screw **110** so that its motion is limited to vertical movement. Thus, during operation of the rectifier the synchronous motor **40** oscillates the pin **60** through eccentric **43** and bell cranks **50—51** and causes the push rod **100** and attached adjusting screw **110** to move as a single unit.

As heretofore noted the rocker pins **60** and **61** are mounted in bearing **60'** and **61'** of extension arms **50** and **51**. The projection slot engagement **117—118** between the push rod **62** and rocker pin arm **61** are always in engagement due to the force of return spring **116** and the rotational movement of the pins **61** permitted by the bearing **61'** as seen in Figure 6.

A detailed view of the support mounting and construction of the push rod of Figure 3 is shown in Figure 6.

A housing **125** serves as a guide and vertical support for the push rod **100**. Anti-friction bearing **126—127** on the push rod **100** serve as the physical support and guide

for the vertical movement of the push rod means **62**. The push rod **62** is force fed lubricated by means of oil which is fed into the area between the rod **100** and the housing **125** through port **128** from oil chamber **129**. A plurality of oil drip shields **130, 131, 132** are attached to the upper portion of the push rod **100**. The oil drip shield **130, 131, 132** function in a well known manner to prevent excess oil from reaching the insulating head **103** and thereby prevent any oil from reaching the bridging electrical contact **30**. Return holes **135** are provided to return the excess oil through the hollow interior of the push rod **100**.

The entire push rod assembly **62** of removable contact assembly **71** and housing means **125** are supported by stationary structures **141** and **142**. The lower stationary structure **141** has an extension member **107** which serves as a bearing support for the worm gear **106** and also as the upper seat for the return spring **116**. The extension **145** of stationary support structure **141** serves as the support for the housing member **125**. The flange **148** on the housing **125** abuts the stop bushing **149** of support **145**. The flange **148** also serves as the upper abutment for the worm gear spring **150**, the lower end of this spring resting on the worm gear **106** to continuously urge the gear **106** into engagement with the bushing **107**.

Thus, the operation of push rod assembly **62** and **63** is as follows: rotation of the synchronous motor **40** oscillates the bell crank member **50—51** about the fixed axis **54**. The sliding engagement between slot and pin **117—118** of the push rod and rocker arm pin **60** or **61** plus the guide of housing **125** imparts only vertical movement to the push rod **100**. Since the push rod assemblies **62** and **63** are mounted on opposite ends of the bell crank **50—51**, they will be 180° out of phase with each other. At a predetermined position of the upstroke the insulating head **103** will engage the bridging contact **30** and move it upward against the downward bias of the 150 pound contact spring **80** and thereby interrupt the circuit between phase bus **10***a* at stationary contact **27** and the D. C. negative bus **20** at contact **25**. The bridging contact **30** will remain disengaged from these stationary contacts **25—27** during the remaining portion of the upstroke and for a predetermined time or distance of the down stroke travel of the push rod assembly **62**.

It will therefore be apparent that for a given R. P. M. of the synchronous motor **40** the time of contact engagement and disengagement and length of time that the contacts remain engaged and disengaged will be a function of the effective length of the push rod assembly **62—63**.

As heretofore noted adjustment to modify the length of the individual push rod assemblies **62** and **63** for phases *a, b* and *c* is accomplished by means of worm **108** and worm gear **106**. The worm gear **106** is continuously urged against the bushing **107** by means of hold-down spring **150** and hence has no vertical motion either independently or with the push rod **100**.

Thus, when the rectifier is operating, the spline mesh **105—111** between the worm gear **106** and push rod **100** permits the rocker arm pin **61** to oscillate the push rod assembly **62** in a vertical path while the worm gear **106** remains stationary. Hence, while the machine is running and under load, the worm gear **106** and worm **108** will remain stationary and thereby be available for adjustment to modify the effective length of the push rod **62**. Rotation of the worm gear **106** by the operators rotation of worm **108—109** will cause the push rod **100** to rotate due to mesh therebetween at splines **105—109**. However, since the adjustment screw **110** is keyed to the rocker arm **60** or **61** and held in right engagement therewith by means of return spring **116**, the adjustment screw **110** will not be rotated by the rotation of worm gear **106**. Hence, the push rod **100** will be threaded toward or away from the adjustment screw **110**, depending on the direction of rotation of the worm **108**, to thereby alter the effective length of push rod assembly **62**.

As best seen in Figures 7 and 8, six bridging contact structures may be used in a unit to rectify 5,000 amperes. That is, a pair of contact assemblies and push rod assemblies are provided for each phase *a, b, c* of the source to alternately connect it to the positive and negative buses **20—21** of the load. Thus, each unit switching each phase either to positive or negative can be independently and individually adjusted to modify the length of the push rod and achieve proper contact time adjustment.

As fully set forth in copending application Serial No. 212,017, filed February 21, 1951, the mechanical converter will operate at its greatest efficiency when the contact converter **15** causes contact engagement and disengagement at the proper time during the current stepping operation caused by the commutating reactor **13**. Hence, with the apparatus of my invention the push rod assembly **62** can be modified in length to adjust for contact time engagement and disengagement and length of time of contact engagement and disengagement to insure maximum efficiency of operation and proper overload and no load safety.

As best seen in Figures 1 and 8, the contact converter **15** is an assembly which contains the plurality of contact blocks for each phase. For example in phase A, contact blocks **70***a* and **71***a* are provided for contact conversion to the negative D. C. bus **21** and the positive D. C. bus **20**, respectively.

As seen in Figure 1, an oscilloscope **200** is connected to the selector switch **201**. Leads **202, 203, 204, 205** and **206** connect the selector switch **201** to the stationary A. C. and D. C. contacts of the contact assemblies **70** and **70***a*. Hence, by means of the selector switch **201**, the oscilloscope **200** can be selectively connected across the stationary contacts of contact assemblies **71***a*, **71***b*, **70***a*, **70***b* etc.

It will be noted that when the proper adjustments of the pre-excitation winding of the commutating reactor **13** and the connecting rod of the push rod assemblies **62, 63** have been made, the voltage configuration seen on the oscillogram of oscilloscope **200** will be identical for all of the contact assemblies. The desired configuration of the voltage across the stationary contacts is best seen in Figure 9.

When the selector switch **201** is positioned to connect the oscilloscope **200** across stationary contacts **25—27** of contact block **71***a*, the voltage will be flat when contact **71***a* is closed, as seen to the left of the oscillogram of Figure 9.

The tabulation chart, as seen in Figure 10, is used in co-ordination with the configuration on the oscillogram to indicate to the operator the particular components which cause various configurations at the various times indicated.

For example, with the selector switch **201** positioned to connect the oscilloscope **200** across the stationary contacts of contact assembly **71***a*, the left vertical column, under "position of selector switch **201**," of the tabulation chart of Figure 10 is used.

Thus, for example, as seen in either extreme and or left hand end columns of the chart, time A represents the opening or break of the movable contact **30** with the pair of stationary contacts **25—27** of contact block **71***a*.

The voltage configuration between times A and B is caused by the break coil of the commutating reactor **13** and is fully described in my copending application Serial No. 212,017, filed February 21, 1951. Thus, time B represents the end of the break step for contact block **71***a*. At time C, as can readily be determined from the tabulation chart of Figure 10, the step length for the contact block **70***a* begins.

For the purposes of adjusting the magnitude of pre-excitation of the commutating reactor **13**, the operator investigates the configuration of the voltage between times K and M. As clearly set forth in the above mentioned application, the magnitude of the relatively horizontal

portion between times K and M will enable the operator to determine whether the pre-excitation should be increased or decreased.

For the purposes of this invention, namely contact time adjustment, the operator is primarily concerned with the configuration of the voltage between times K and M and is particularly interested in the configuration at time contact.

As may be observed from the chart **10**, the pip that occurs at time contact is indicative of the mechanical break or opening of the contacts at **70***a*.

As best seen in the ideal curve of Figure 9, it is desirable to have the pip (the disengagement of the contacts at **70***a*) between times K and M occur after ⅓ of the time between K annd M. That is, it is desirable to have ⅓ of the step length created by the commutating reactor **13***a* elapse before the movable contact is disengaged from the stationary contacts at **70***a*, assuring proper overload safety. Hence, the ⅓ distance between times K and L represent overload safety.

On the other hand the overload safety period should not be greater than one third of the step length of the time between K and M.

The reason for this is that the time elapse between L and M represents the time that the contacts of **70***a* must disengage and deionize so that the arc will not strike at time M.

Thus, the time period between L and M must be sufficiently long to permit de-ionization of the atmosphere between the movable and stationary contacts of contact block **70***a*. Hence, this region between times L and M is the no load safety period. Thus, when the oscilloscope **200** is connected across stationary contacts of block **71***a*, the operator can readily determine whether the associated contact block **70***a* is being disengaged at the proper time within its step length period K and M.

In the event that the overload safety period K and L and the no load safety period L through M did not favorably compare with the desired voltage configuration curve of Figure 9, the effective length of the push rod assembly **63** can be modified by the adjustment means, **109' 108**, in the manner heretofore described.

It will be noted that the time elapse between C and L will represent the length of contact time engagement of the contacts at **70***a* and the time elapse between N and A will represent the length of time of contact engagement of the contacts **71***a*.

Thus, it will be apparent as above described that the oscilloscope **200** connected across the stationary contacts of contact block **71***a* will enable the operator to determine the time when the contacts **70***a* will open (pip at time L). Hence, the period of contact **70***a* engagement and time of contact **70***a* disengagement can be readily and easily modified and adjusted by the operator.

Thus, in similar manner, with the oscilloscope **200** connected across the contacts **70***a* by means of the selective switch **201**, the period of contact engagement (N–A) and disengagement of contacts **71***a* can be modified by adjustment means **109'**, **108** of push rod assembly **62** in a manner heretofore described.

In summary, I have provided a novel contact push rod assembly with adjustment means which remain stationary during the vertical oscillatory movement of the assembly.

By providing an oscilloscope which can be selectively connected across any one of the six sets of contact converters, the operator can rapidly and easily determine whether or not the time or period of time of contact engagement and disengagement is desirable and can rapidly and easily move this time and period of time by my novel adjustment means.

In the foregoing I have described my invention only in connection with preferred specific embodiments thereof. Many variations and modifications of the principles of my invention within the scope of the description herein are obvious. Accordingly, I prefer to be bound not by the specific disclosure herein but only by the appending claims.

I claim:

1. In a mechanical converter providing a unidirectional current, a push rod assembly comprising a push rod and an adjusting screw; adjustment means connected to cause relative movement between said push rod and said adjustment screw to modify the effective length thereof, said adjustment means remaining stationary during the running of said mechanical converter and means to impart vertical motion to said push rod assembly and prevent rotation of said adjusting screw.

2. In a mechanical converter providing a unidirectional current, a push rod assembly comprising a push rod and an adjusting screw; adjustment means comprising a worm and a worm gear, said worm gear having splines on the internal surface thereof, said push rod having splines on the external surface thereof, said worm gear splines and said push rod splines being in mesh engagement, said adjustment screw being threaded externally, said push rod being threaded internally, said external threads of said adjustment screw being in mesh engagement with said internal threads of said push rod, means to impart vertical motion to said push rod assembly and prevent rotation of said adjusting screw.

3. In a converter having cooperating contacts comprising stationary contacts and a movable contact, means to bias said movable contact into engagement with said stationary contact, a rotatable shaft and eccentric thereon connected to control the movement of a push rod assembly in a first direction, said push rod engaging and disengaging said movable contact during running operation of said converter, said push rod effective to move said movable contact against the force of said means to effect contact disengagement, said push rod assembly comprising a push rod and adjusting screw, time of contact engagement and disengagement determined by the effective total length of said push rod and adjusting screw, adjustment means to modify the effective length of said push rod assembly, said adjustment means comprising a worm and worm gear, said worm and worm gear having no motion in said first direction said eccentric being operatively connected to said adjusting screw to impart vertical motion to said push rod assembly and prevent rotation of said adjusting screw.

4. In a converter having cooperating contacts comprising stationary contacts and a movable contact, means to bias said movable contact into engagement with said stationary contact, a rotatable shaft and eccentric thereon connected to control the movement of a push rod assembly in a first direction, said push rod engaging and disengaging said movable contact during running operation of said converter, said push rod effective to move said movable contact against the force of said means to effect contact disengagement, said push rod assembly comprising a push rod and adjusting screw, time of contact engagement and disengagement determined by the effective total length of said push rod and adjusting screw, adjustment means to modify the effective length of said push rod assembly during operation of said push rod assembly, said adjustment means being independent of the movement of said rotatable shaft and eccentric thereon, said eccentric being operatively connected to said adjusting screw to impart vertical motion to said push rod assembly and prevent rotation of said adjusting screw.

5. In a mechanical converter for energizing a D.-C. load from a multiphase A.-C. source comprising commutating reactors, contact converters, an oscilloscope, and a plurality of push rod assemblies, each of said converters comprising a pair of stationary and a bridging moveable contact therefor, each of said push rod assemblies connected to cause engagement and disengagement

of said movable contact with said stationary contact of its respective contact converter, each phase of said A.-C. source being connected in series with one of said commutating reactors, the stationary contacts of one of said contact converters and said D.-C. load, said oscilloscope connected across at least one of said pair of stationary contacts, adjustment means to alter the effective length of said push rod assembly, alteration of the effective length of said push rod being effective to alter the oscillogram of said oscilloscope.

6. In a mechanical converter providing a unidirectional current by synchronously engaging and disengaging a pair of contacts connected in series with said A.-C. load, a push rod assembly comprising a push rod and an adjusting screw; said push rod being operable to engage and disengage said pair of contacts adjustment means connected to cause relative movement between said push rod and said adjustment screw to modify the effective length thereof, said adjustment means remaining stationary during the running of said mechanical converter, an oscilloscope across said contacts of said mechanical converter, the oscillogram of said oscilloscope being a measure of the point of disengagement of said contacts.

7. The method of altering the effective length of a mechanical converter push rod assembly comprising the steps of selectively connecting an oscilloscope across the stationary contacts of a mechanical converter and varying the effective length of the push rod assembly until the oscillogram of said oscilloscope achieves a predetermined configuration.

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