Reconstruction of the Wriggler I system for quicker, more compact operations

Summary. Definitions that were stated in the Wriggler I project for operations of force devices, bursting devices and spinal segments are reconstructed in a more advanced system. Pulse burst signals are reduced in size from a maximum of 15 pulses in three ticks to a maximum of 4 pulses in one tick. New "annular movers" control stationary positions of rotating joints of spinal segments, which are reduced from 15 to 7. The reconstructed system aims for production of residential movements with ongoing changes and variations and is simpler, quicker and more efficient than the original designs.

The reader should be familiar with the original construction on pages 18-23 of *Wriggler I, an engineered organism* (2020) ("the wriggler project").

Summaries in this project are based on longer statements in the wriggler project, the "metamorphosis project" (*Metamorphosis of Wriggler I: device development for residential movements*, (2020)) and the "bursters project" (*Elemental Constructions in Virtual Energy Domains* (2015)). Primal forms are set forth in *How to solve 'free will' puzzles and overcome limitations of platonic science* (2016).

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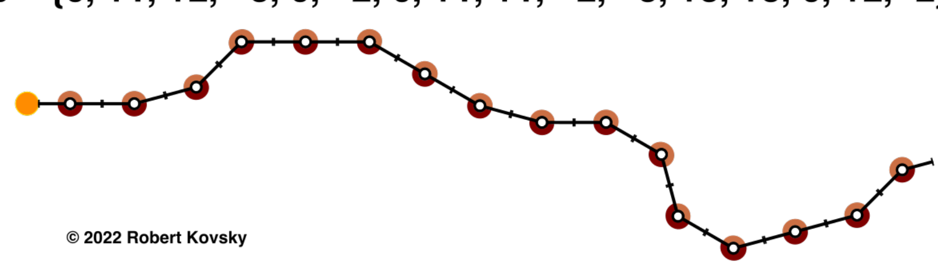
Fig. 9. Linear configuration of reconstructed spinal segments

p = {0, +1, +2, –3, 0, –2, 0, +1, +1, –2, –3, +3, +3, 0, +2, -2}



§ 1 Investigation into errors in prior designs leads to improvements.

Certain errors in the wriggler and metamorphosis projects appear in connection with "low level activations." The errors do not affect principal wriggler constructions that are based on "high level activations."

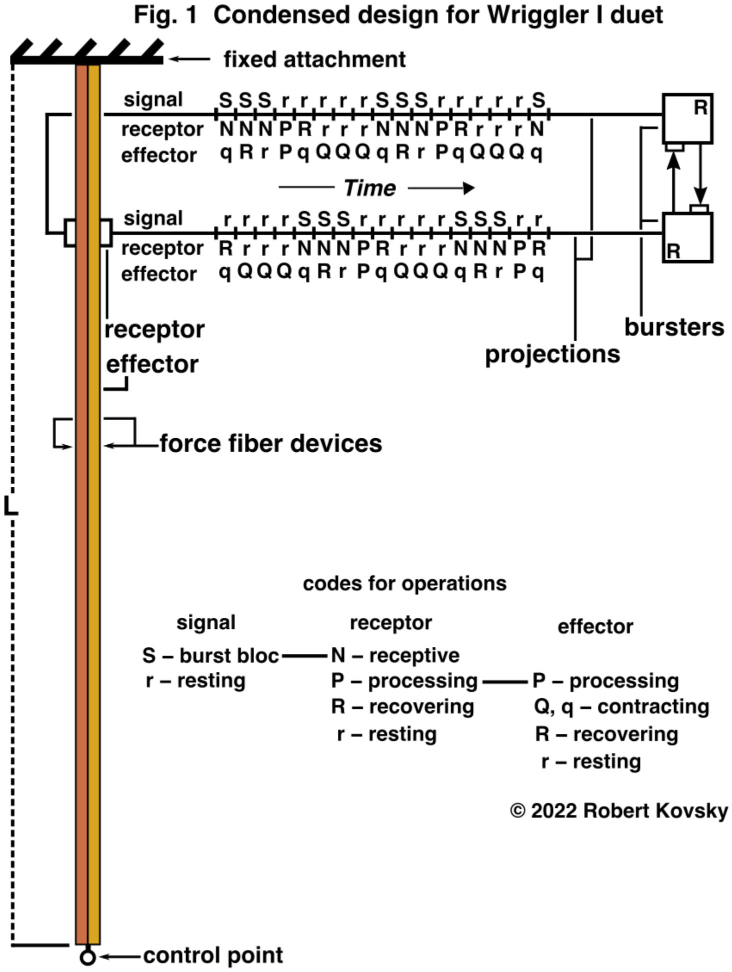
Investigation into the errors uses a condensed design for the original Wriggler I force fiber duet that was set forth in Figs. 5 and 7 of the wriggler project. In this design, long force fibers are emphasized; device definitions, codes and operations are unchanged. In Fig. 1 below, the two force fiber devices in the duet are shown at maximum length "L." They are attached at the top to an unmovable fixture. A ***control point*** is added to ends of fibers; the control point can be mobile in one dimension or fixed to an attachment or guided by a researcher.

As in the original design, a steady stream of ticks provides a temporal structure for device operations, e.g., at the rate of 10 ticks per second. Presumably, a "master clock" entrains synchronized ticking throughout the organism. Ticks are marked on projections in Fig. 1, organizing the coded charts of device operations.

A repeating bursting device **R** ("burster") discharges a pulse burst signal SSS (3 ticks in duration), which travels on a projection to the receptor of a force fiber device. A burst contains n pulses, from 1 to 15. Burster operations are alternating and reciprocating.

The schema NNNPqQQQqR describes operations of a force fiber device. The receptor receives the SSS signal during NNN ticks. Receptor and muscle-like effector process the signal together during the P tick. Then, during a ***work stroke***, the effector produces a twitch for 5 ticks with a force strength set by n. The force ramps up during the initial q tick, is maintained during three Q ticks and ramps down during the final q tick.

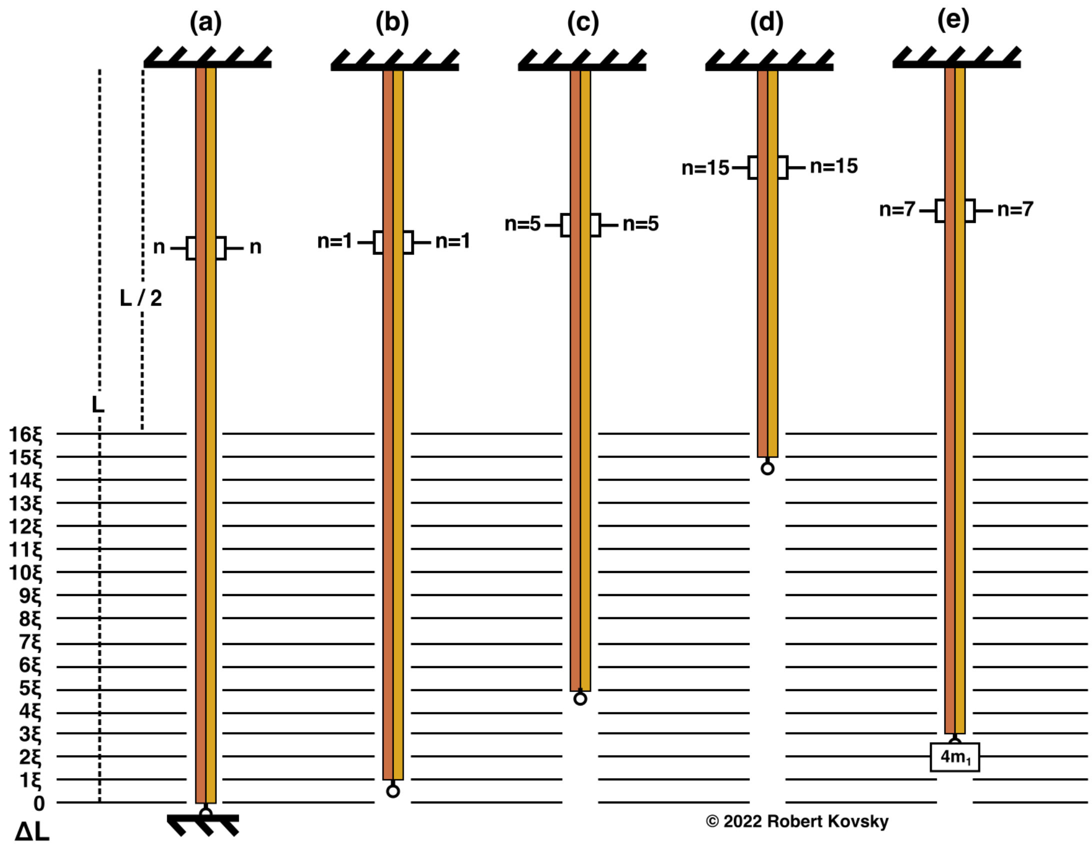
Fig. 1 Condensed design for Wriggler I duet



Bursters repeat a signal until it is changed by the researcher. Driven by repeating signals, alternating twitching and ramping forces overlap and combine to produce a steady force, which can be varied. See the wriggler project, Fig. 7, p.20.

Fig. 2 shows the fundamental repertoire of stationary positions of a Wriggler I force fiber duet.

Fig. 2 Operations and stationary positions of the Wriggler I duet



The first force rule is shown in Fig. 2(a). The control point is fixed and the duet is held at full length L. When steady signals carry bursts with n pulses, the device produces a steady force of $F = nF_1$, where F_1 is the strength of the force produced when n = 1. There is a variable internal tension but no movement. Force devices with different strengths have parallel repertoires.

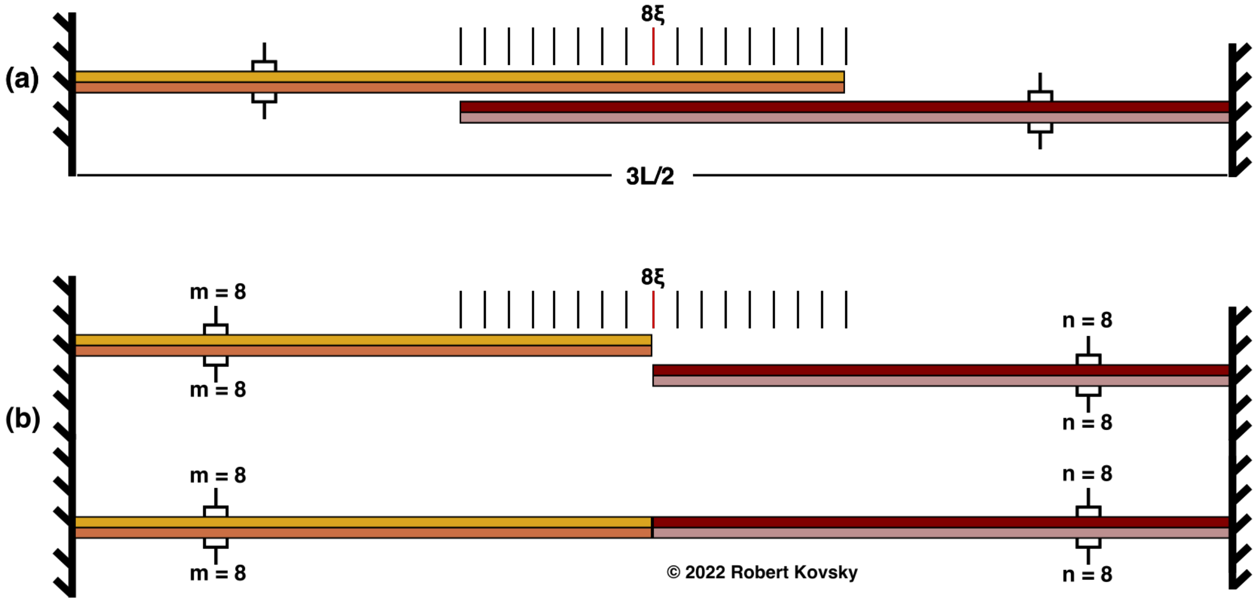
A more general force rule is $F = nF_1 - (j \times \Delta L)$, where ΔL denotes the shortening of the fibers from the full length L. In Fig. 2(b), pulse bursts contain n=1 pulse(s); the control point has been released from the fixture and guided by the researcher. The contractile force has pulled up until the force vanishes at $\Delta L = F_1/j$ — defined as ΔL=1ξ. The stationary position in Fig. 2(b) shows this amount of shortening.

The same "0 force" principle applies to pulse bursts with n=5 and n=15, with stationary positions at ΔL=5ξ and ΔL=15ξ, shown in Figs. 2(c) and 2(d).

In Fig. 2(e), a mass has been attached to the control point. The size of the mass is $4m_1$ where $m_1 = F_1/g$ and g is the well-known gravitational acceleration at the surface of the Earth. The stationary position is at $\Delta L=3\xi$. That is, applying the force rule: $4\times g\times(F_1/g) = 7F_1 - 3\times j\times(F_1/j)$. The mass produces a tension of size $4F_1$ in the whole force fiber device, extending up to the point of attachment.

Next, opposing duets are joined to make up an opposing pair. Fig. 3 shows the simplest example, a position at midline that holds no tension. Fig 3(a) shows the preliminary setup for a series of constructions. Two duets from Fig. 2 are ready to contract in opposite directions. The mobile ends overlap in the center. Stationary positions of duets are referenced to a scale with the ξ measure. The repertoire of each duet has 15 positions arranged in a line; and midline of the range of motion is identified with a measure of 8ξ in both duets.

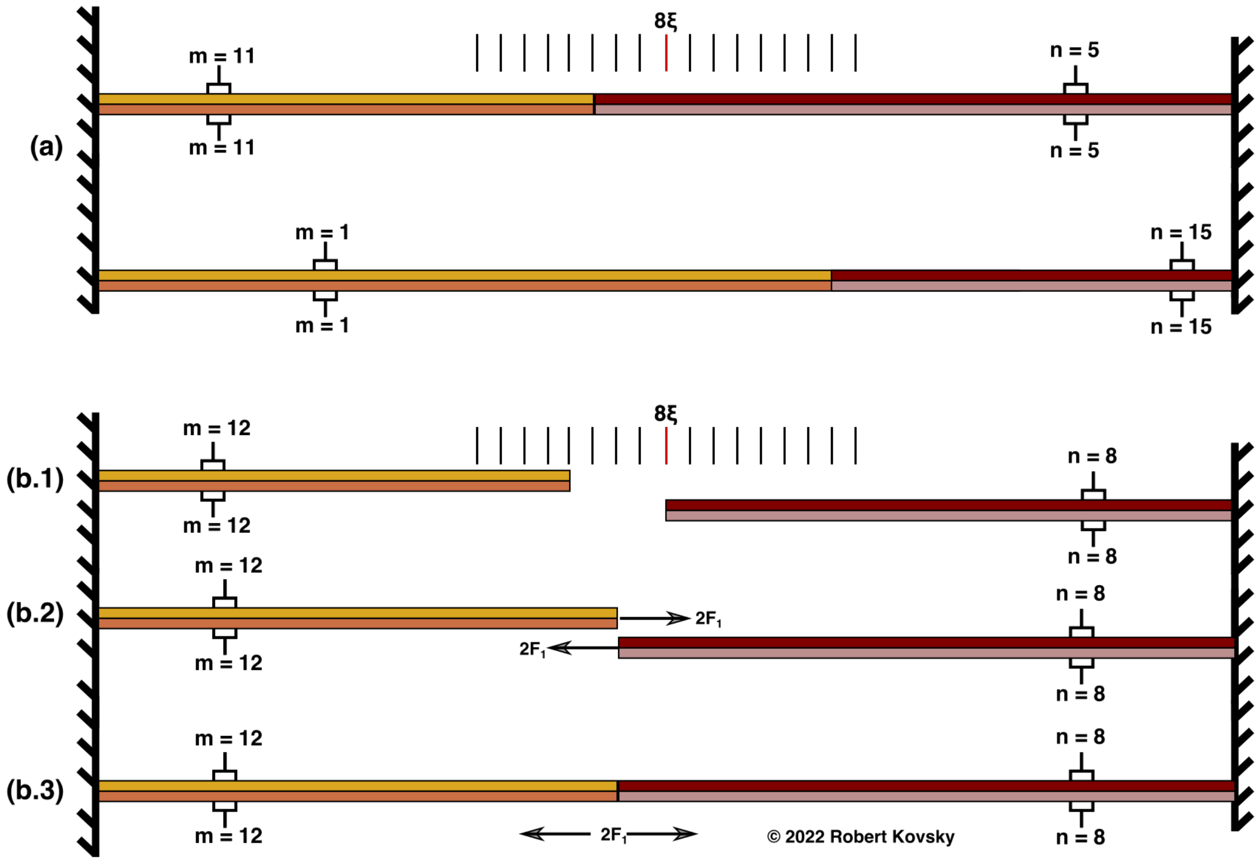
Fig. 3 Opposing duets, initial construction, at midline, without tension



In Fig. 3(b), duets are driven by pulse signals (m,n) = (8,8). The length of each duet contracts until the force is 0, occurring when $\Delta L=8\xi$. The two loose ends of the duets can be "matched" or juxtaposed; and the surfaces can be attached, glued or otherwise joined sufficiently to withstand operating tensions and impulses. This is the initial stationary position in the repertoire of the opposing duet design.

In Fig. 4, the construction of the initial position is developed to make up the full repertoire of stationary positions of the opposing duet design. Fig. 4(a) shows additional examples of stationary positions that hold no tension. Each duet exerts 0 force. A set of 15 tension-free stationary positions is maintained by drive signals (m,n) and a rule that m+n=16.

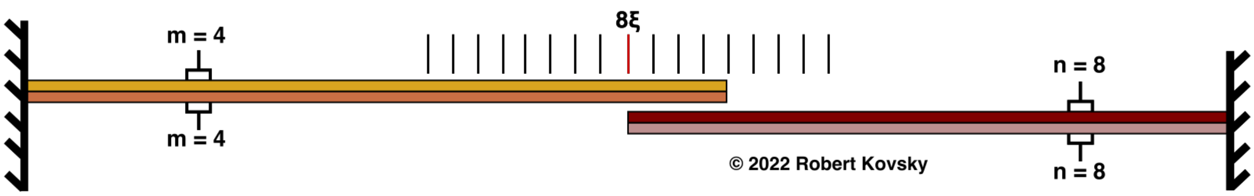
Fig. 4 Opposing duets, general construcions



Positions holding tension are added in Fig. 4(b). In Fig. 4(b.1), drive signals are high enough to produce a gap between ends of duets when F=0. Then, in Fig. 4(b.2), equal tension is applied to the ends. Duets stretch under tension as previously shown in Fig. 2(e). When the tension reaches $2F_1$, the ends can be matched, juxtaposed and attached. Alternatively, and more realistically, ends can be attached before force production. As a result, while drive signals (12,8) are producing steady forces and a stationary position, a tension of $2F_1$ extends through both duets, as shown in Fig. 4(b.3).

Fig. 5 shows an attempt at operations that would fail to actually work. With drive signals (4,8), both duets have contracted to the point where F=0. Forces are not strong enough to bring the ends of the duets into positions where they can be juxtaposed or attached. Operations are defined when a fiber is stretched under tension (Fig. 2(e)) but there is nothing that allows for contraction that is additional to the original contractile force.

Fig. 5: Opposing duets, unworkable construction



The foregoing constructions are summarized by stating rules for stationary positions of the opposing duet design in terms of drive signals (m,n). Operations require that $m+n \geq 16$; lower drive signals are unworkable. If $m+n=16$, no tension is held in the system. Generally, tension $\mathcal{T}$ is maintained at $\mathcal{T} = ½(m+n-16) \times F_1$.

The rules identify errors in prior projects. Many of the activations set forth in §II.B.3 of the Wriggler I project (p. 22) are unworkable. Drive signals do not add up to 16. They would require an additional negative internal tension along with twitching forces. Of the Group 1 activations, only the "most rigid" qualifies as workable (and this activation holds no tension at midline):

(15, 8), (14, 8), (13, 8), (12, 8), (11, 8), (10, 8), (9, 8)
(8, 8) (midline)
(8, 9), (8, 10), (8, 11), (8, 12), (8, 13), (8, 14), (8, 15)

There are 4 workable Group II activations, ranging from

(15, 8), (15, 9), (15, 10), (15, 11), (15, 12), (15, 13), (15, 14)
(15, 15) (midline)
(14, 15), (13, 15), (12, 15), (11, 15), (10, 15), (9, 15), (8, 15)

to

(12, 5), (12, 6), (12, 7), (12, 8), (12, 9), (12, 10), (12, 11)
(12, 12) (midline)
(11, 12), (10, 12), (9, 12), (8, 12), (7, 12), (6, 12), (5, 12).

In an error in the metamorphosis project at 22, an unworkable "most delicate" Group I activation was used in an anticipatory example.

The errors are avoided by restricting available activations. The errors also highlight certain operating features of the designs that suggest improvements.

Minimal underlying "baseline" forces are required for a workable twitch, namely, forces produced by 16 pulses in two bursts carrying drive signals. Suppose that there is a modified device where such baseline forces are produced during each cycle without a pulse input; pulses can independently specify additional forces.

The total number of pulses available in two bursts is 30. More than half of the pulses in drive signals are used to produce baseline forces that must be produced in every cycle. Suppose that each mover produces a baseline force of $8F_1$ in each cycle without any input signal and additional force are specified by the pulse number. Then, the number of pulses in two bursts could be reduced from 30 to 14, with 0-7 pulses in each burst specifying additional force to one side or the other. This is sufficient to produce all 15 stationary positions in the repertoire.

The principles are applied to the "most rigid" Group I activation noted above:

(15, 8), (14, 8), (13, 8), (12, 8), (11, 8), (10, 8), (9, 8)
(8, 8) (midline)
(8, 9), (8, 10), (8, 11), (8, 12), (8, 13), (8, 14), (8, 15).

This becomes the reconstructed activation:

(7, 0), (6, 0), (5, 0), (4, 0), (3, 0), (2, 0), (1, 0)
(0, 0) (midline)
(0,1), (0, 2), (0, 3), (0, 4), (0, 5), (0, 6), (0, 7).

Positions produced according to the reconstructed activation are the same as those in the original activation.

Other changes discussed below include the reduction of positions from 15 to 7. On either side of midline, position ±1 is 15° from midline; position ±2 is 30° from midline; and the extreme position ±3 is 45° from midline. In the wriggler project at 37, the design incorporated a "shortfall (44.8°) from a geometrically ideal maximal joint angle of 45°." In the reconstructed design, there is no shortfall.

§ 2 Reconstruction of spinal segments in anticipated engineered organisms

a. Reconstructed pulse burst signals

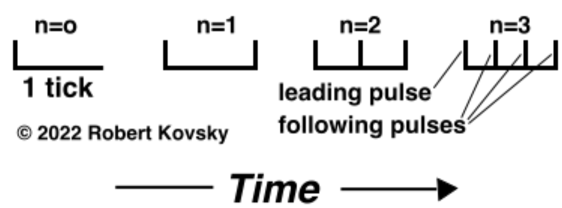
An imaginary Virtual Energy (VE) device domain resembles a domain of electronic circuits and circuit diagrams. Both VE diagrams and electronics diagrams show assemblies of devices that generate and control signals, which are exchanged between devices and which can cause effects, e.g., driving engines and vibrating devices. In each domain, kits of parts are defined that match specifications in diagrams and that presumably work in applications.

Full definitions for pulse burst signals appear in the bursters project at 1 and 4. Pulses travel on projections from one device to another device. Travel is instantaneous, an ideal feature that resembles an electrical signal. It is anticipated that substantial travel times can be accommodated by further developments.

In applications in this project, signals are produced in bursts. One or more pulses occurs in a specific short period of time (a tick) that has silent spacers on each side.

Fig. 6 shows reconstructed burst signals that have a duration of one tick, plus a bit more for completion. The form of the burst is discussed in the metamorphosis project at 24.

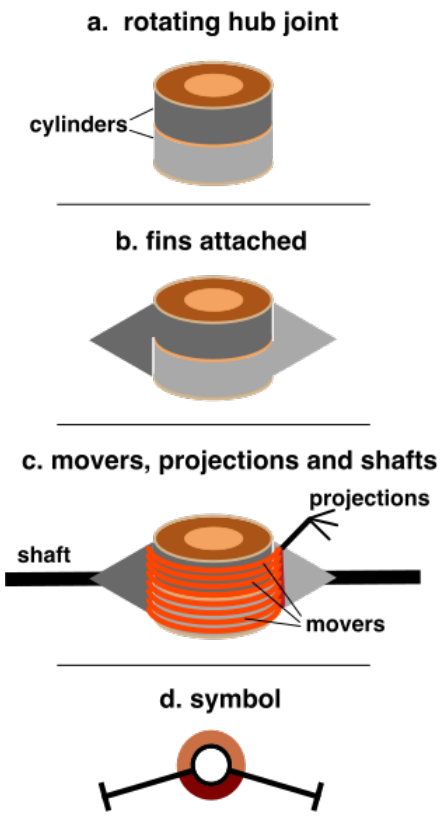
Fig. 6. reconstructed pulse burst signals



The first pulse in the signal, called the ***leading pulse***, starts the device clock but does not modify the strength of the ensuing twitch or pulse burst produced by the receiving device. One to three ***following pulses*** strengthen the ensuing twitch or burst in equal steps. As shown below in Fig. 13, following pulses are timed so that intervals of time between pulses are identical and the final pulse occurs exactly one tick after the leading pulse.

b. Reconstructed hub joint, annular movers and stationary positions

Fig. 7. reconstruction of a hub joint



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The new version of the spinal hub joint, like the original version, resembles the hub of a bicycle wheel. (Fig. 7.a.) In the new version, two identical cylinders rotate smoothly around a common axis. The central hole is reserved for brachial parts. (See the metamorphosis project at 29 and the wriggler project at 36.)

A rigid plastic "fin" is attached to each cylinder, defining and limiting rotations. (Fig. 7.b.) Fins provide anchors for movers on both sides.

In Fig. 7.c., each force fiber runs from fin to fin with its belly lying on a cylinder. A set of fibers produces distributed forces on one side of the fins and an opposing set operates on the other side of the fins. An ***annular mover*** is a set of fin-to-fin fibers that produce a force together. Attached shafts and projections round out the reconstructed spinal segment.

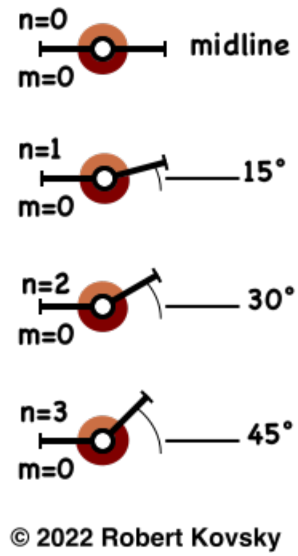
A symbolic form for the spinal segment is introduced. (Fig. 7.d.) The two movers appear as arcs of circles. The length of an arc is the same as the length of a mover in linear opposing duet designs.

Fig. 8 shows stationary positions of a reconstructed spinal segment, resembling original designs in the wriggler project at 37. Operations of a pair of movers in reconstructed spinal segments correspond to those in produced by opposing linear duets, similar to Figs. 3 and 4 above.

Mirror positions result when n is held at 0 and m varies from 0 to 1 to 2 to 3. A set of bends specifies the possible positions: {–3, –2, –1, 0, +1, +2, +3}. Compare to the wriggler project at 37-38.

In successive versions of opposing movers, the number of stationary positions in the repertoire has been reduced from 29 in the first set (wriggler project, 21), to 15 in the restricted set (*Id*., 22), to 7 in the reconstructed version.

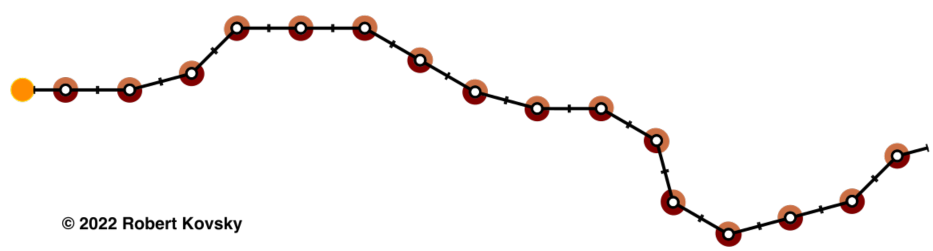
Fig. 8. reconstructed spinal segments



In Fig. 9, reconstructed spinal segments with annular movers are assembled into a linear array. The configuration resembles those in the wriggler project at 40-43.

Fig. 9. Linear configuration of reconstructed spinal segments

p = {0, +1, +2, –3, 0, –2, 0, +1, +1, –2, –3, +3, +3, 0, +2, -2}



c. VES operations of reconstructed force fiber device

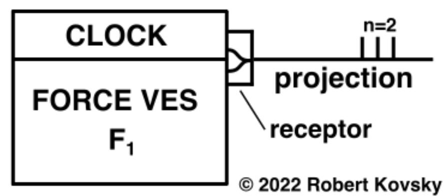
Detailed definitions of force fibers and duets were set forth in the bursters project, 6-11. Underlying principles are based on a class of operating devices called ***engines*** that convert a source of energy into physical forces. Engines include steam engines, internal combustion "gasoline" engines, electrical motors and, I suggest, animal muscles that run on blood sugar. Devices in this project resemble steam engines and gasoline engines that have a cyclical series of distinct processes, e.g., four strokes of a gasoline engine.

The force fiber device is an application of engine-based principles. The fuel for operations is Virtual Energy (VE) which arrives from a source in a flow R, resembling steam flows, gasoline flows, electrical flows and blood sugar flows. In initial device designs, the flow of VE is ready and ample; restrictions are anticipated in larger constructions where VE must be distributed efficiently.

In a device, VE is stored in a Virtual Energy Store (VES). There may be multiple kinds of VES in a device. Device operations are defined in terms of conversions of VE from one form to another. In the force fiber device, source VE flow R is converted into VE stored in the VES and then VE stored in the VES is converted to produce forces.

Fig. 10 shows the schematic structure of the reconstructed force fiber device. A clock controls operations, with ticking set by the master clock. A pulse bundle travels from right to left on the projection. The first pulse in the bundle is the leading pulse and any subsequent pulses (numbering 0, 1, 2 or 3) are following pulses.

Fig. 10. Reconstructed force fiber device



The receptor directs the leading pulse to the clock, starting the clock and the device schema. The clock controls operations N, P, q-Q and R. The receptor directs following pulses to the Force VES, setting the twitch strength. The device has a value for F_1 that resembles the number of ohms of a resistor, e.g., F_1 = 1000 dynes.

VES operations of a reconstructed force fiber are described by the schema NPqQQQqR (compare to NNNPqQQQqR for the original force fiber device in Fig. 1). Two reconstructed force fibers in a duet, operating with alternating beats, produce a steady force together. Adding forces, q+q =Q.

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force device 1: NPqQQQqRNPqQQQqRNPqQQQqRNPqQQQqR…
force device 2: QQqRNPqQQQqRNPqQQQqRNPqQQQqRNPqQ…
sum of forces:  QQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQ…
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Fig. 11 shows operations of the Force VES. Operating controls V(t) and V_b denote energy levels in the VES. During the force-producing process denoted by qQQQq, V(t) is driven down and Virtual Energy in the VES is converted into a twitch that can perform work. Conversion operations resemble those of a steam engine. When hot steam inside a steam engine is cooled, the energy in the steam is converted into a forceful stroke of the engine beam that can, e.g., pump water out of a mine. In the VE domain, VE inside the VES is converted into a forceful twitch of a force fiber device that can, e.g., lift a weight. In models linking input to output via such an operation, details of the conversion can take many forms.

V_b is a variable that is set by the incoming signal and that denotes the VES level at which a co nversion operation is halted. Suppose that, in a steam engine, fresh steam in the chamber has a temperature of 600° F. and that during the work stroke, the temperature of the steam is cooled to a temperature that can be varied. The amount of work produced will increase when the final temperature is lower to 300° F. instead of 400° F.

Every burst has a leading pulse and some bursts have a following pulse or pulses. Each following pulse lowers V_b by one ζ, leading to a force with one more F_1. As a definitional term for the device in Fig. 11, $F = -\{\Delta V(t)/5t.\}$, where ΔV(t) is the change in V(t) during a work stroke, which lasts for 5 ticks or 5t. The measure ζ defines energy levels V(t) and V_b, according to the conversion factor $\zeta = F_1 \times 5t$.

Fig. 11. VES operations of a reconstructed force fiber device

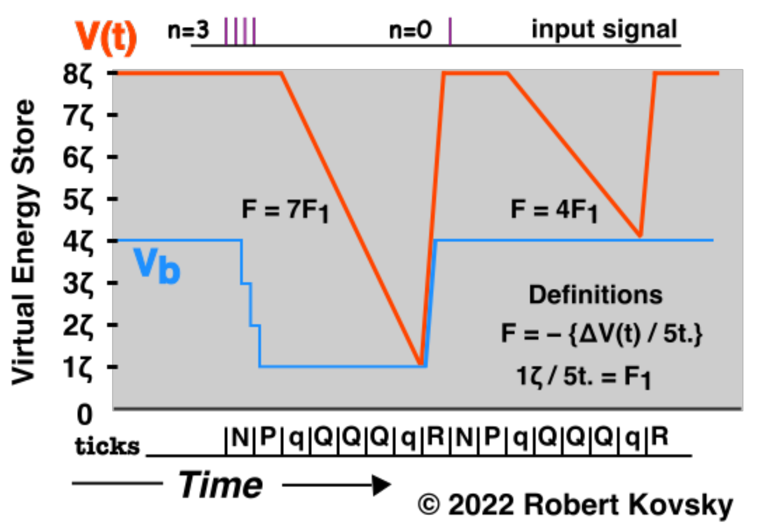


Fig. 11 shows an end-of-range twitch with force $7F_1$ (n=3) and a minimal twitch with force $4F_1$ (n=0). Forces of twitches in the repertoire are $4F_1$, $5F_1$, $6F_1$ and $7F_1$. Arranged as opposing pairs in a duet, two force fiber devices can hold 7 positions.

The reconstructed device accommodates the reduction in the maximum number of pulses in a burst. An incoming pulse burst occurs during a single N tick, with the understanding that a fraction, e.g., .3, of the following P tick is reserved to complete processing of the burst. The remainder of the P tick is used to set the rate of energy conversion and also serves a housekeeping role in separating performance of reception functions from performance of effector functions. The R tick serves a similar housekeeping role.

d. VES operations of reconstructed burster

Fig. 12 shows the schematic structure of a reconstructed bursting device or burster. Details are based on the repeating burster but the schematic structure can be adapted for other bursters, e.g., an inverter burster. A pulse burst travels from right to left to the burster on the input projection. After processing, the device discharges a pulse burst with the same number of pulses that travels from right to left from the burster on the output projection. The receptor channels the leading pulse of the input burst to the clock VES and then channels any subsequent pulses to the burst VES. The port on the other side of the burster channels output pulses to the output projection from both the clock VES and the burst VES.

Fig. 12. Reconstructed bursting device with dual VES

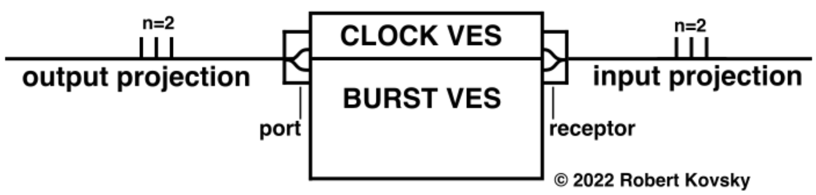
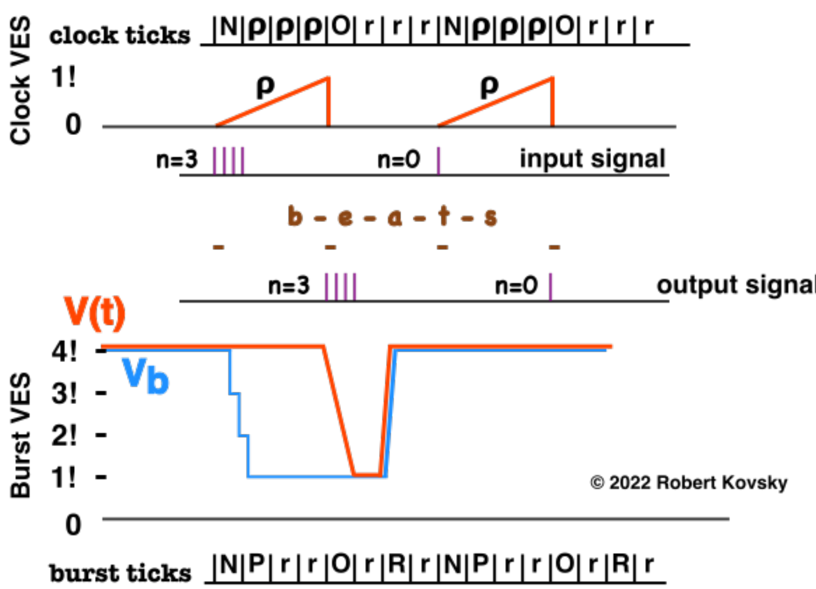


Fig. 13 shows VES operations of a reconstructed repeating burster, with two kinds of VES that operate in a common time. Concurrent schemata share N and O ticks.

In Fig. 13, common aspects of operations are at the center of the figure, namely: the input signal; the output signal; and b-e-a-t-s maintained by the master clock.

The leading pulse arrives on the beat and starts the inflow of VE into the clock VES. After four ticks or one beat, the clock VES discharges the leading pulse of the output burst at the start of the O tick. The rate of VE inflow, ρ, is sufficient for this purpose; discharge is synchronous with the beat. After the O tick, the clock VES rests for three additional ticks (coded by "r").

Fig. 13. VES operations of reconstructed repeating burster device



Following pulses of the input burst are directed to the burst VES, where they lower V_b much the same as in the force fiber VES (Fig. 11).   Preparation operations occur during the P tick.   Any VE conversion and discharge of pulses occurs during the O tick. In Fig. 23, following pulse discharges occur when n=3 but not when n=0, in which case the leading pulse is the only pulse in the burst. In cases where n=1, n=2 or n=3, V(t) is driven downward at a steady rate set to stop a little bit below V_b after 1 tick. As V(t) descends, it will cross one or more VE levels, passing from just above V(t)=n! to just below V(t)=n! — and a pulse is discharged through the port onto the output projection. The final pulse in the burst is discharged at the end of the O tick. If there are 2 or 3 following puls es, equal time periods occur between pulses in the burst. Bursts with equal time periods are congruent with continuing sensory signals discussed in the metamorphosis project.

June 2022