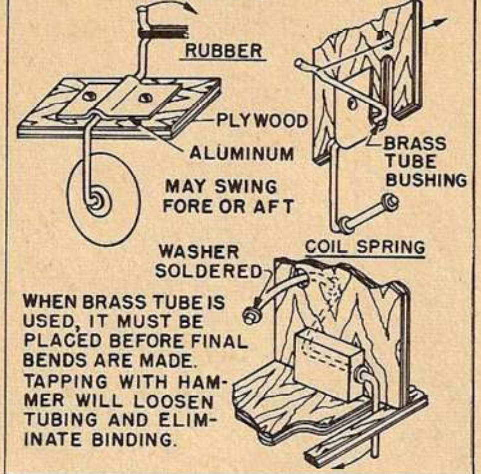
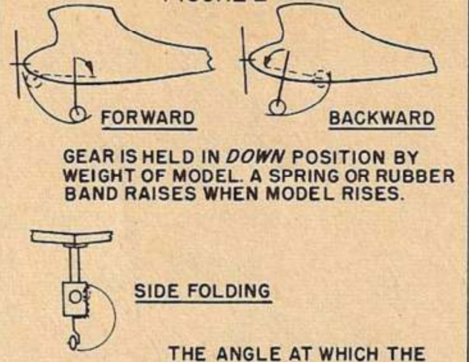
FIGURE 1



WHEN BRASS TUBE IS USED, IT MUST BE PLACED BEFORE FINAL BENDS ARE MADE. TAPPING WITH HAMMER WILL LOOSEN TUBING AND ELIMINATE BINDING.

FIGURE 2



GEAR IS HELD IN *DOWN* POSITION BY WEIGHT OF MODEL. A SPRING OR RUBBER BAND RAISES WHEN MODEL RISES.

THE ANGLE AT WHICH THE GEAR IS SET MUST BE SUCH THAT TAKE-OFF SHOCK IS TAKEN BY THE MOUNTING AND DOES NOT KNOCK THE GEAR UP PREMATURELY

FIGURE 3

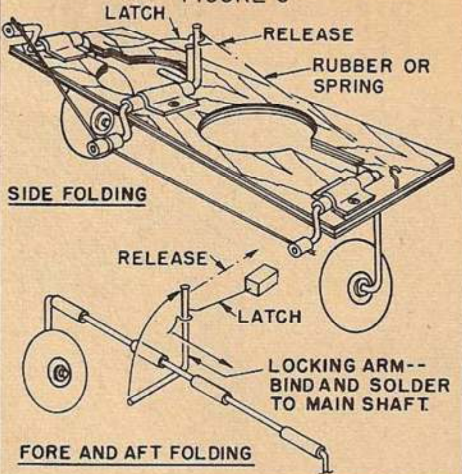
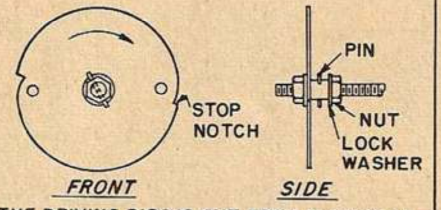


FIGURE 4



THE DRIVING DISC IS CUT FROM ALUMINUM AND SECURELY MOUNTED ON TAKE-OFF SHAFT EXTENDING FROM GEAR BOX. THE SIZE OF THE DISC MUST BE SUFFICIENT TO PROVIDE A STROKE EQUAL TO THAT OF THE OPERATING ARM OF THE GEAR. TWO HOLES IN THE DISC ACCOMODATE THE TWO LINKS USED WITH A REVERSING ELECTRIC MOTOR. WITH A ONE-DIRECTIONAL POWER SOURCE, ONLY ONE LINK IS MADE DIRECTLY TO THE DISC.

FIGURE 5

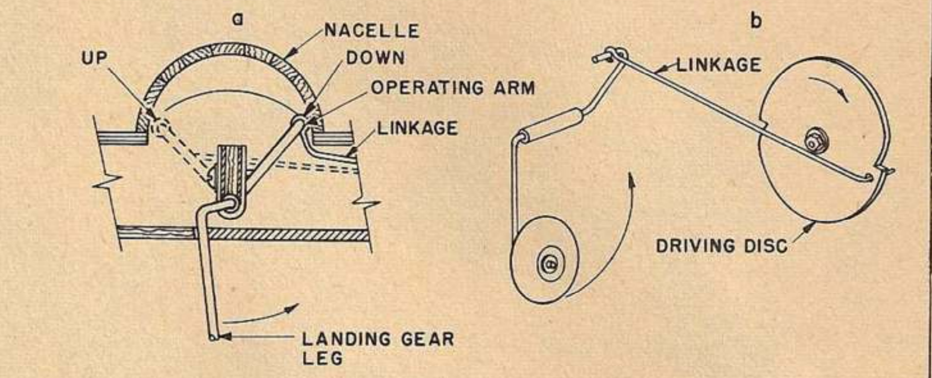
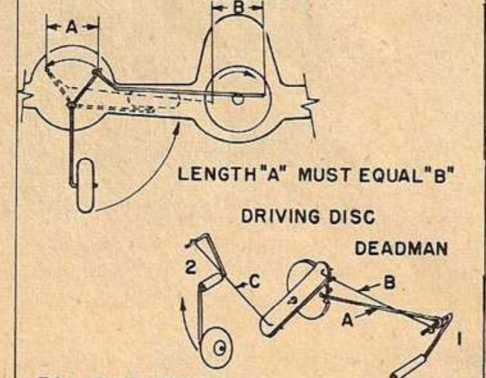


FIGURE 6



LEG I IS DRIVEN BY DISC THROUGH LINK A. LINK B DRIVES DEADMAN, WHICH DRIVES LEG 2 THROUGH LINK C.

FIGURE 7

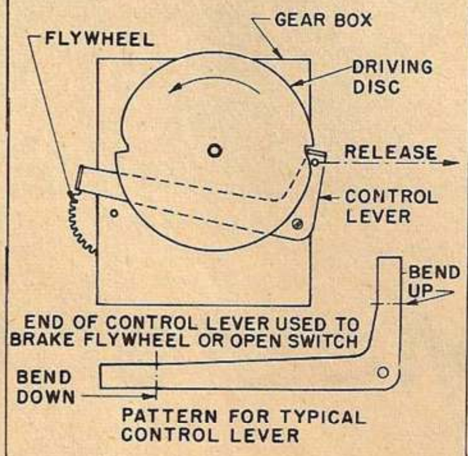


FIGURE 8

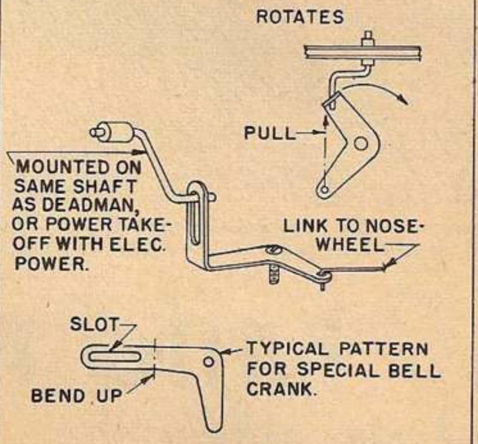


FIGURE 9

TYPICAL GEAR BOX FOR USE WITH ELECTRIC MOTOR. SPEED IS REDUCED AND TORQUE IS INCREASED BY APPROXIMATELY 500:1.

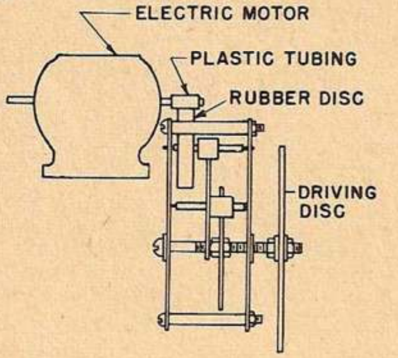
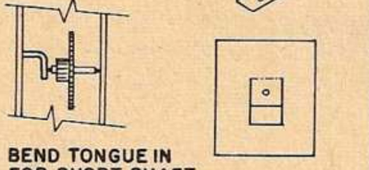


FIGURE 10

IN ORDER TO ADAPT GEARS WITH SHAFTS OF DIFFERENT LENGTHS TO USE IN A GEAR BOX, A TONGUE MAY BE CUT AND BENT AS INDICATED, TO ACCOMODATE EITHER A LONGER OR SHORTER SHAFT. THE HOLE SHOULD BE DRILLED AFTER BENDS ARE MADE.



BEND TONGUE IN FOR SHORT SHAFT, IN FOR LONG ONE

FIGURE 11

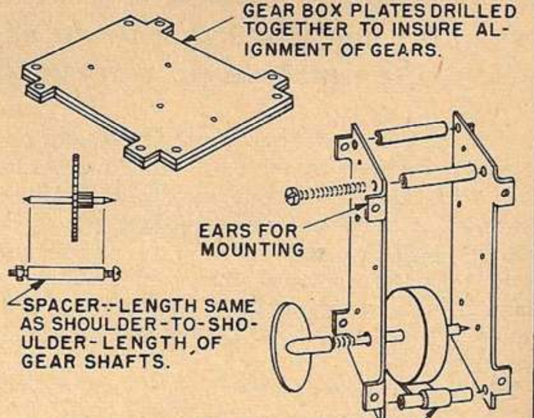


FIGURE 12

'A' AND 'B' STEP-DOWN GEARS; 1, 2, & 3 IDLER TRAIN

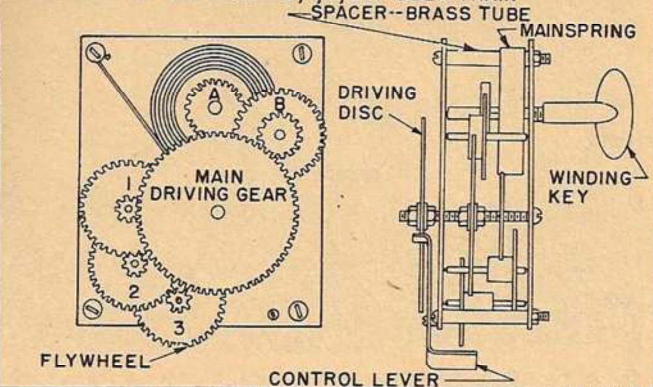


FIGURE 13

FRONT-FOLDING GEAR AS USED ON B-17 AUTOMATICALLY LOCKS BOTH UP AND DOWN.

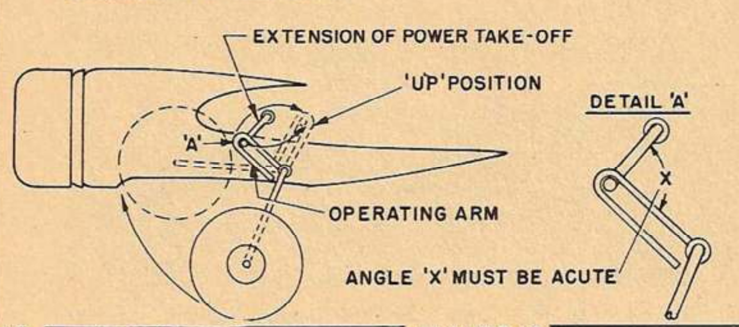


FIGURE 14

NOSE WHEEL RISES NEARLY VERTICALLY FOR SCALE EFFECT.

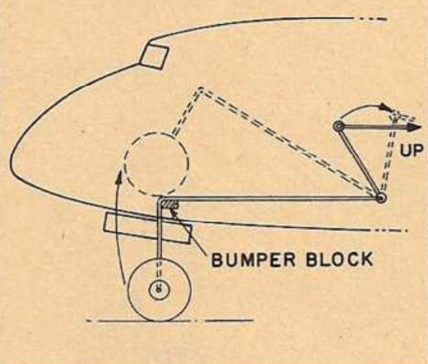


FIGURE 15

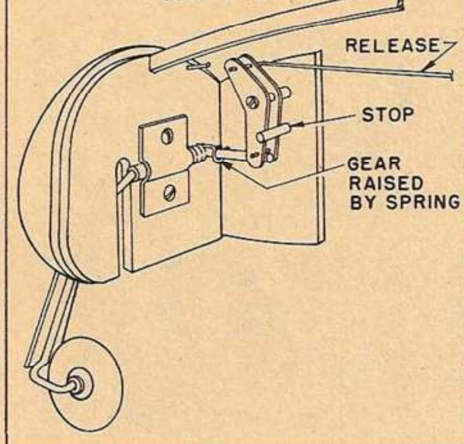


FIGURE 16

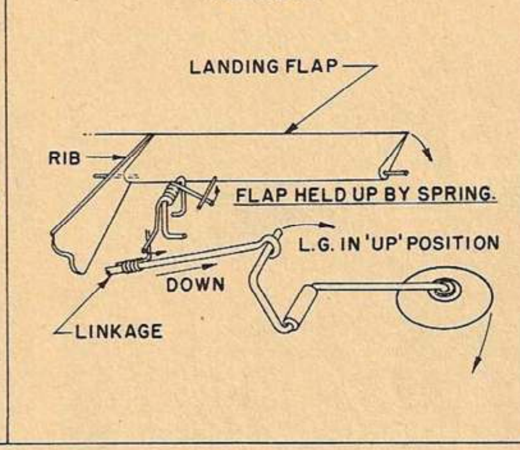


FIGURE 18

LIGHTS WIRED IN PARALLEL

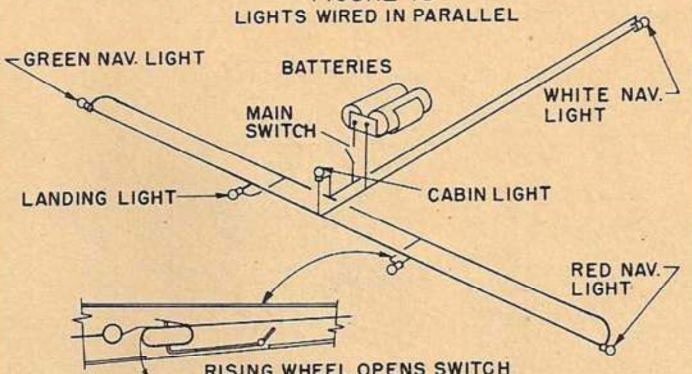
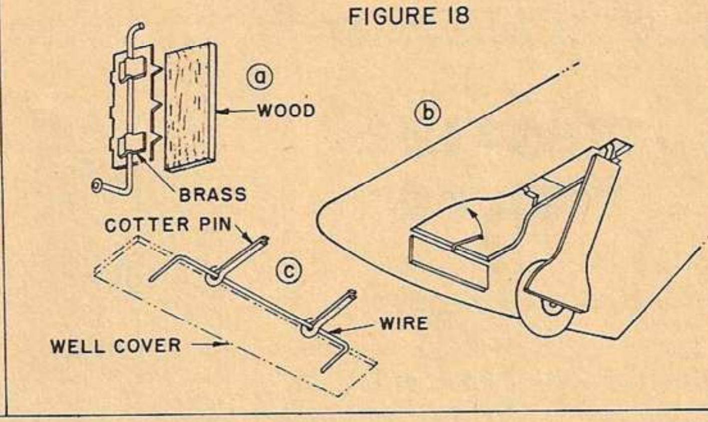


FIGURE 18



retract that gear

Nothing more exciting than a plane in its flared approach with gear and flaps fully extended.

by KEITH LAUMER

Simple-how-to-do-it instructions that take all the mystery out of gear and flap actuation while in flight. Try it on your next model.

► A practical retracting landing gear must meet a few basic requirements. It must be rugged enough to withstand the shock of repeated landings and take-offs—some of them rough. A system depending on precise adjustment and requiring delicate handling is useless in a model intended for regular flying.

The system must also be light enough that its weight does not offset its advantages. A model which can barely struggle into the air under its load of equipment makes a dull project, and is difficult to handle.

In addition, the installation must be capable of being built by the average modeller from common materials, using ordinary hand tools.

Retracting gears range in complexity from simple one-wheelers which are held in the down position by the weight of the model and retract on take-off, to scale tricycle systems capable of multiple up and down operation during a flight, often tying in with operable landing flaps and lights. While these types differ greatly in detail, there are a number of factors common to all, and frequently a modeller who has never experimented with such mechanisms can learn a great deal by constructing some of the simpler gears before attempting the more complex.

Single leg gear: The simplest retracting gear, usually used on contest-type free-flight models, consists of a single leg with one wheel, used to permit take-off. The wheel retracts by a spring or rubber band (*Continued on page* 34)

Retract That Gear

(Continued from page 17)

as the ship leaves the ground, and remains up, reducing air resistance (drag) and raising the centers of gravity and frontal area. The retracted wheel may remain partly exposed to aid in landing. The basic requirement here is a smooth-working hinge, and an easily adjustable spring tension. Too much tension will cause the gear to snap up prematurely, dropping the model on the ground, while too little will leave the gear hanging like a broken leg. Several simple hinging arrangements are shown in Fig. 1.

This type gear may be arranged to retract forward, backward or sideways (Fig. 2.) The size of the piano wire used for the gear should be great enough to give adequate stiffness without undue weight. One-sixteenth inch wire is sufficient for short-leg gears (under 3 inches) on light half-A models; 3/32 wire will do for longer gears, up to five inches, on models spanning up to about 48 inches. Beyond that, ⅛ inch wire is necessary, and on very heavy jobs the wire should be doubled.

One shot gear: The next type to be considered is the "one shot" gear, capable of being both raised and lowered. for a one-cycle operation only. Such gears are also spring or rubber operated, and require only a "trip" action for each step of function. It is essential that this action have a positive lock feature, in both raised and extended positions, and a "fail-safe" arrangement in case of failure to lock up. This gear is ideal for light-weight scale or semi-scale control line ships, and is very practical for any control line type.

The gear can be installed so as to be actuated by the full up position of the up line, or, in the case of stunt models where extreme range of control is needed, by a third line. Number 30 linen thread is heavy enough for a third line for this and most other model applications.

The gear is raised after take-off by a quick plucking motion of the line, which releases the lock, and permits the spring or rubber to snap the gear up. The momentum of the rising gear drives it against pressure into the up-and-locked position, and the actuating rubber or spring disengages. The next flick of the line opens the lock, permitting the gear to drop of its own weight to the down-and-locked position. If the lock fails to engage on the up motion, the gear merely drops back to the down-and-locked position, and the actuating rubber or spring disengages. The next flick of the line opens the lock, permitting the gear to drop of its own weight to the down-and-locked position. If the lock fails to engage on the up motion, the gear merely drops back to the down-and-locked position. The gear must then be "cocked" or loaded for the next flight.

Fig. 3 shows a number of alternative arrangements possible, for front, rear, and side-folding systems. Sturdy hinges are a must for this or any other gear which must take landing shock, while of course smooth operation is essential. While any of the hinges shown in Fig. 1 are also suitable for this gear, the brass tube is preferable for heavier models. Correct adjustment of the locking latch is a must, and fortunately this is easily done by bending the wire slightly until proper action is obtained. By simply adjusting dimensions to

(Continued on page 36)

Retract That Gear

(*Continued from page 34*)

requirements, this system can be adapted to many scale models.

Multiple cycle: Full-operating, multiple-cycle gears are a step beyond the one-shot gear, requiring a power source, and a power-driven action for both up and down. Again the positive lock for both up and down is a basic requirement of a practical system; without it, vibration will tend to cause the gear to crank down in flight, and landing shock will drive the extended gear up, damaging the model. Such systems can be built for a simple snap-up, snap-down action, powered directly from a source such as multi-strand rubber, or a helical spring. If an electric motor is used, a gear box is necessary to convert high rpm to high torque needed to handle the load. A gear box is also used with the rubber or spring power if realistic slow cycling is wanted.

First, let's consider the linkage and hinging problems of this type gear. Since almost all power sources produce a rotary action, it is necessary to convert this action into a thrust, either fore-and-aft or in-and-out as required. This is most easily done by using a driving disk, firmly mounted on the take-off shaft of the power source. Mere soldering of this disk is inadequate, since the forces acting in shear tending to cause the disk to slip on the shaft are extremely great. A tight press fit, onto a shaft having a key or flat, fitting exactly the hole in the disk is a good start. There should also be locking nuts tightened down hard against both sides of the disk, and if possible a pin inserted through a sleeve which is an integral part of the disk, and the shaft. This is not so formidable as it sounds, since such a disc can easily be turned from brass or steel on a small lathe, or a large clock gear with the edge smoothed can be used (Fig. 4.)

Assuming a two wheel gear, folding sideways into the wing, the driving disk should be mounted in the fuselage on the centerline of the wing, and in the same plane as the middle of the hinge of the landing gear legs. The legs, passing through the hinge, extend upward, then forward, forming the arm which must be linked to the disk. Figure 5a shows the angle used to give the arm room for action. In order to use the portion of the arc having the greatest lateral extension, for maximum effectiveness, the arm should be so adjusted that its up and down positions are symmetrical with relation to the vertical, as seen from the front.

With a reversible electric motor, both legs of the gear can be linked directly to the disk; turning one way raises the gear, the other lowers it. With a one-directional power source, however, only one leg can be driven directly by the disk, since two linkages will, of course, cross each other after one revolution, preventing further action. In this case, the second leg must be linked through a "dead man" to the first leg which is driven by the disk. If the two legs with their operating arms are carefully bent to identical dimensions, and the dead man employs equal arms, the two legs will automatically be perfectly synchronized.

If an accidental discrepancy in the length of the operating arms is created, this can be compensated for by using slightly different lengths of arm on the dead man, or distances from center of linkage holes in the disc in the case of the electric motor driven system. (Fig. 6.)

The lock arrangement is simply made by filing notches in the edge of the disk into which a lightly spring loaded lever drops when the disk reaches the full up and down positions, the other end of the lever dropping against a high-speed gear as a brake, so that the braking load is not on the driving shaft. With a one-directional power source, the system is activated by pulling the line attached to this lever, which lifts it from the notch and permits the disk to rotate one half revolution to the opposite setting, the lever riding the edge of the disk, to drop in again when it reaches the other notch. This cycle can be repeated to the extent of the stored power of the spring.

The same method can be adapted to an electric system, the lever being the switch which is closed by pulling the third line and automatically opens when it drops into the notch. (Fig. 7.)

The shaft on which the dead man is mounted can also be used to operate other mechanisms, such as a nose wheel in a tricycle ship, or landing flaps, in perfect coordination with the main gear. There are a number of ways of translating this alternating rotary action to a fore-and-aft movement for nose wheel operation. Simplest perhaps, is the use of a pin engaged in a bellcrank with an extended arm. The pin, riding in a vertical slot in the upturned portion of the arm, causes the bellcrank to rotate in the horizontal plane, applying the push-pull action to the shaft linked to the nose wheel, the operation of which is covered below. (Fig. 8.)

Power source: Given the operating gear, driven by a disk, the question of power source can be next discussed. In actual practice, the power supply is usually decided on first, some considerations being availability of apparatus, weight-carrying ability of the model, configuration of the airplane, etc. A model carrying batteries for lights might be overloaded by an electric system, unless insulated lines and an outside power source are used. Electric motors are available from hobby shops, while it is usually necessary to operate on an old alarm clock to procure a suitable spring motor. The clock is also an excellent source of gears for the gear box.

Gear boxes: Whether an electric motor is used, or a spring motor which you wish to slow down for smooth realistic action, a gear box is a necessity. In the first instance, the purpose of the gear train is to slow the action from perhaps 5000 rpm to about 10 rpm with a resultant increase in torque from one butterfly-power at the motor to a force at the take-off of the gear box which is capable of shearing a heavy solder joint. To construct this gear box, it is necessary to use about four gears, each having about a five to one ratio, to achieve an overall 500:1 ratio. The motor shaft, with a piece of plastic tubing slipped over it, drives a rubber-tired wheel or hard rubber disk, having a small gear on the same shaft. (Fig. 9.) This small gear engages a larger gear having about five times as many teeth as the small one, the teeth, of course, being of the same pitch or spacing. Gears removed from a clock come in matched sets, so no difficulty should be encountered in selecting suitable gears. This gear again carries a small gear on the same shaft, driving the next large gear. By counting the teeth on each member of each pair of gears, and dividing the smaller into the larger, you learn the ratio of the individual gear. Multiplying these ratios together gives the overall figure.

After determining the number of gears you need to obtain about 10 rpm, (from 5 to 15 will do), determine the optimum layout of the gears to give you the clearances you need inside the fuselage for elevator pushrod, structural members, etc. Then, using dividers, measure the center to middle-of-tooth distance of each gear, and lay out the gear train on 1/32 to 1/16 inch aluminum. Arrange the train so that the motor will have room for mounting, and so that the take-off shaft will be on the centerline of the wing. Also keep the switch lever in mind, and place the components so that nothing interferes with the actuating arrangement. (Fig. 9.)

Don't forget to include "ears" on the plate for rigid mounting of the box.

The blanks for both plates of the gear box should be cut out, and the two drilled while clamped rigidly together, to insure correct alignment of gears. Drill the smallest holes possible to accommodate the needle bearings which most gear shafts have. If you have no "pin" drills, a piece of piano wire sharpened to a chisel shape will cut aluminum nicely.

All of your gears, coming from a single clock, should have equal-length shafts. If they do not, it will be necessary either to remount the gear on a new shaft cut from steel wire and ground to a needle tip at each end, or to cut and bend down a tongue to reduce the span for the shorter shaft. (Fig. 10.) Four holes should be drilled near the corners of the plates, again being careful not to interfere with other components, and long bolts selected to hold the box together. Sections of brass tubing cut to exact length to permit the gears to turn freely while not slipping out of place, serve as spacers over the bolts. (Fig. 11.)

It is usually necessary to replace the shaft on at least the final drive gear, since it must project from the box and receive the disk. A steel bolt, about ½ inch longer than the depth of the box, and about ⅛ inch in diameter is ideal. The gear must be very firmly attached to the shaft, as the disk is. Nuts tightened down against it help, but a pin through the gear and the shaft is very desirable. Too large a hole for the pin weakens the shaft, and it may be necessary to enlarge the shaft to about 3/16" if you cannot drill a hole small enough. The pin must be of piano wire to prevent shear. Test this assembly rigorously before you install it, by trying to force the gear to turn on the shaft, holding it with pliers, and turning the gear by hand. If you can move it at all, it's not good enough; try again.

For one-directional drives, such as springs or rubber, the purpose of the gear train also is to slow down the rotation of the driving disk, as a result cutting down the number of revolutions of the disk on one winding of the motor. This is accomplished by stepping down the speed of the spring driven shaft about 25:1 with two gears to the take-off shaft, then adding another three gears INCREASING the speed to a very high speed fly-wheel gear at the end of the line. Since there is a physical limit to the speed at which this gear can rotate, the entire system runs at a leisurely pace. It is this last gear which is braked by the actuating lever, and the train must be so laid out as to make it accessible at the edge of the box, on the side toward the outer edge of the circle. (Fig. 12.)

With this type gear box, the spring motor is usually mounted in the box as it is in a clock. A clock spring, about ¼ inch wide and eight inches long, complete with ratchet and winding key can be transferred in to your new box, as well as, quite probably, the step-up gear train.

Keep accessibility of the winding key in mind when selecting the location of the mainspring. If it is not possible to place it so that it is directly accessible from outside the finished fuselage, a flexible cable or a rigid extension shaft can be fitted easily. A length of ¼ inch brass tubing with a slotted end can be used as an extension key to reach the box from the rear of the fuselage through a small hole.

If rubber power is used, as long a loop as is practical should be used, made up of about 10 strands of ¼ flat rubber, or equivalent. This can be wound easily from the rear, just as is an escapement motor or rubber model.

For fore-and-aft folding gears, a simpler arrangement can be used. The takeoff shaft of the power source or gear box, placed at right angles to the span of the wing, can simply be extended out through the wing and bent down to form the legs of the gear. If the gear folds down to the rear, a block can be so placed as to serve as a bumper against which the legs seat to absorb landing shock. If the gear folds up to the rear, the shock is transmitted through the gear to the locking lever, which must accordingly be ruggedly built. It is also possible to adapt the locking principle explained below in connection with nose wheel design, to this type gear. (Fig. 13.)

Nosewheels: Nosewheels are usually driven by a take-off arrangement from the main gear system, both because this insures coordinated action, and because it is usually simpler. Several methods of obtaining a fore-and-aft thrust for this actuation are shown at Fig. 8. Almost invariably, nosewheels fold to the rear. In some cases, however, they rise almost vertically, and this effect can be most easily approximated

(*Continued on page 42*)

by using a fairly long rearward extension of the landing gear leg to the pivot point. (Fig. 14.) The actuating motion in either case is a simple push to front or rear respectively. The problem here is locking the gear down in such a way that the hard landing shock is resisted directly before it can be transmitted back through the linkage into the rest of the system. Rough landings are frequently taken mainly by the nosewheel, and, to be practical, it must be able to take this kind of treatment without damage.

Fig. 15 shows a very effective lock which can be built to be as rugged as any fixed gear. It will be noted that in the down position, the bellcrank has moved to such a position that it is past dead center, and a thrust against it from the operating arm of the nose gear tends not to fold the gear, but merely presses the heavy bellcrank against a solid hard rubber stop. The slightest pull from the linkage arm, however, unlocks the arrangement, and permits the spring loaded gear to fold slowly, along with the main gear. While this type of individual lock is not needed with side-folding gears or with rear-lowering gears, it can be used to good advantage with front-lowering systems, as had been noted. It is necessary, of course, to adapt it accordingly for this use. The rear-pull unlocking action can be supplied by a short downturned arm at the end of the extended take-off shaft, as shown in Fig. 13. Thus the motor serves actually only to operate the lock, while the gear itself is spring loaded for up, and is pushed down by the locking arm, against the raising spring.

Landing flaps: Flaps can be added to any operating gear without much trouble. The flaps must be well mounted for smooth action, and should be linked together so that both can be actuated by a single mechanism. Fig. 16 shows a basic approach which can be adapted to almost any ship. The light spring holds the flap up as long as the gear is not fully extended. It is a good idea usually to so adjust the travel of the operating arm that the flaps pull in at once when the gear starts up, and stay seated until the gear is almost fully extended. This makes the transition easier for the pilot to handle. The flaps should not be allowed to come down more than about 15-20°, to avoid an excessive ballooning tendency and poor control.

Lights: Landing light systems can be installed after the gear has been laid out. Regular two-pen-cell type bulbs are excellent for this purpose, as they have built-in focusing lenses which produce a spotlight effect. Lightweight wiring such as telephone switchboard wire should be used, and simple cut-off switches can be snipped from shim brass and adjusted to open and close at any point in the cycle desired. Fig. 17 shows a typical layout.

Well covers: For a truly smooth-looking job, and for the maximum in aerodynamic efficiency, it is a good idea to install well covers. Generally, the main portion of the cover is attached directly to the landing gear leg. It is important to install the landing gear so that it folds completely inside the wing or fuselage, to a position at least 1/16 inch below the surface. A fitting, or fittings, can then be cut from shim brass or tin can stock and be soldered to the leg, with points spaced along the edge ready to receive the cover. Covers are best cut from balsa or plywood and attached to the fittings, pressing the points into the wood (Fig. 18a). The cover outlines should be cut to a good fit so as to clear freely, and glued in place before shaping the surface to a perfect flush fit. Metal covers can be used, but these are much more difficult to work, and do not match the surrounding finish very well.

The portion of the well accommodating the lower half of the wheel is thus left open, requiring a separate cover. This should be hinged solidly, to open away from the other half. A piece of wire bent at a right angle and glued to the inner side of the cover is all that is required to close it. As the wheel enters the well, it contacts the operating arm and pushes it ahead, thus closing the cover. When the wheel emerges, a spring opens the cover and holds it. (Fig. 18b.)

Hinges for well covers can be made very neatly and strongly by using very small cotter pins, engaged on a wire frame set into the cover. (Fig. 18c.)

Assembly: It is usually an excellent idea to install the gear in the model as soon as there is sufficient structure in place to receive it. An open fuselage frame, with wing spars set in place, and a few ribs, including the ones on which the gear will be hinged, is the best set-up for ease in working with the gear. The main gear leg assemblies should be built and placed first, followed by the gear box and power source. The linkages can then be added with ease. Note that it is necessary to establish the length of the operating arm extensions of the gear legs so that they have clearance to operate inside the wing thickness or nacelle, as the case may be, and also so that the length of the arc they swing is equal to the travel of the point on the driving disk to which they are linked. Linkage arms must be carefully bent to the correct lengths to give proper up and down positions. The nose wheel, if any, should next be installed and the lock adjusted to work smoothly before being linked to the power source. Flaps and lights are added last, the structure of the airframe being added as necessary as you go along. Bottom wing skins should be added before making well covers, and before completing flap shaping, to insure flush fits. The entire structure should be thoroughly doped inside before sealing off, to avoid oil soaking from the lubricated system.

The systems and principles described above which are as easily applicable to R/C as to C/L are only a general outline of the possibilities, and the individual builder will be able to develop many variations, adaptations, and extensions thereto, as he discovers the fascination of tinkering with these mechanisms, which can add a large measure of fun, authenticity, and performance to his models.

Mac-Fan-Tum

(*Continued from page 27*)

Start by cutting A, B and C from 1 in. x 1 in. soft balsa. Don't round off the outer edges at this stage but cut a 1/8 in. rebate in A and B as shown. Pin and cement these parts together over the plan view. Now cut D and E from hard 1/4 in. sheet, being careful to angle the half-depth slot in the centre of these parts so that they intersect at the correct angle. D and E should now be cemented in place and the centre reinforced with triangular blocks to form a good solid engine mounting. Cement ply parts F and G in position (photo 1) and carefully bevel the edges of fairing pieces H and J until they seat snugly into place. Mark the anti-torque vane angles clearly on these parts.

The topside sheet covering can now be fitted. The grain should run parallel with the outer edges of the model and the panels are joined over parts D and E; leave the centre area open (photo 2). Mark the exact centre of piece G and with a pair of compasses set to radius A-A, carefully mark a circle on the sheeting; then cut away the unwanted balsa. (photo 3)

The engine should now be temporarily fixed in place over the *exact* centre of piece G. Use long bolts and pass these through to the underside of panel F. Trim the bolt ends flush with their retaining nuts. Cut an accurate cardboard disc to radius B-B