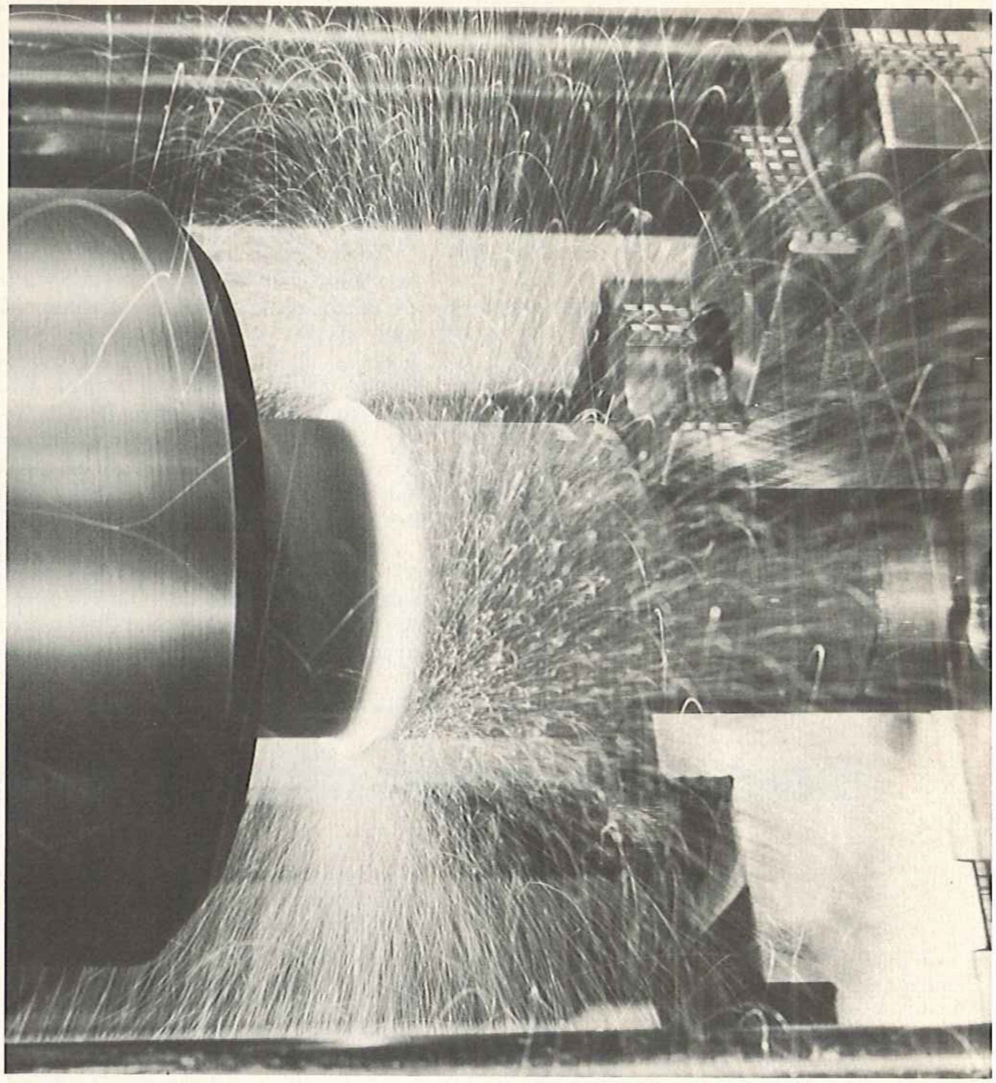
10 jobs for friction welding

A shop that friction-welds bimetal assemblies on a commercial basis finds it a better, cheaper method of assembling some parts



Friction welding is able to join two different materials to provide different properties or to use different stock on opposite ends of the weld line. Variables in the process include rotational speed, pressure between the parts, and time

Friction welding can save material costs by allowing the use of less costly materials or the elimination of some material entirely. Or it can cut costs by reducing machining time. At Graham Engineering, we have found that friction welding can be a better and cheaper method of part assembly.

To friction-weld two parts, we hold one part steady and rotate the other at about 2000 rpm in a machine much like a lathe. The two parts are brought together under axial pressure of about 20,000 psi. When friction brings the parts to red heat at their interface, rotation is stopped, and axial force is increased to 40,000-60,000 psi, which forges the two pieces together.

Here are some examples of parts and the ways in which we assembled them:

A drawn can requires a threaded flange on one end, but brazing a threaded flange to the can was costly and unreliable. Instead, we friction-welded a machined flange to it and then threaded the flange. There is no brazing ring; no cleanup is required; and the joint is as strong as the parent material. Thousands of these assemblies are made at our plant daily.

Drive pinions must be made of 8620 material although the shaft can be 1020 steel. Since the shaft portion weighs 11 lb and there is a difference of $0.06 per lb between the two materials, there is a potential saving of $0.66 per piece when the part is friction-welded instead of machined from one piece.

A pump shaft that works in corrosive fluid must have the corrosion resistance of stainless steel, but that portion of the shaft within the drive motor should be nonstainless for its magnetic properties. The solution—making the shaft bimetal by friction-welding C1025 steel to 316 stainless—not only reduces the cost but improves the shaft's properties as well.

An engine exhaust valve needs to be heat resistant (and, therefore, brittle) on one end and tough on the other end to take the constant impact from the valve lifter. We weld 2112 stainless, which can accept the higher heat, on the flanged end to 1051 steel, which has very high impact strength, on the stem.

A newsprint-machine roller does not have to be made from solid material. It can be a tube with the end rollers friction-welded to it.

A control rod, which is several feet in length, need not be made of solid bar stock but can be a forging at one end and a threaded section at the other. Tubing replaces the solid bar stock, and the threaded section and the forging are friction-welded to either end.

Sections of a part can be efficiently premachined and then friction-welded into the final component. This method of manufacturing parts is rapidly becoming the most advantageous use of friction welding. Because it is a close-tolerance process, concentricity between parts can be kept within 0.010 in. tir—close enough to require only a single finish-grinding operation after welding, for most parts.

A 6-ft hex bar has half of its length rolled with an Acme thread. In order for the thread to be rolled, the hex bar must be machined before threading. This is a costly method of threading because the part must be fed into and pulled out of the thread roller.

With friction welding, round stock is brought to size and then merely fed through the thread roller. The threaded part is then friction-welded to the hex

By John Eden, executive vice president
Graham Engineering Corp., York, Pa.

with a steeper cup angle (approximately 40 deg included angle) for heavier-thrust usage. There would be 21 sizes in each of these lines, ranging from a bore of 25 mm to a bore of 120 mm, for a total of 63.

- A combination general-purpose and pinion line, designated N, with a cup angle approximating 32.5 deg. There would be 35 sizes from 25 mm to 320 mm.
- A high-thrust, steep-angle line (W) with included cone angles of 67.5 deg in the smallest ID (25 mm) decreasing to 60 deg in the largest (150 mm). There would be a total of 24 sizes in this line.
- And two lines (P and R) for machine tool spindle and other high-speed applications. With a 35-deg included angle, these lines are distinguished by their shorter rollers. The lighter-duty line (P) would include 37 IDs from 20 mm to 320 mm, while the heavier R line would number 18 sizes from 100 mm to 320 mm.

One area neglected by existing ISO standards is double-row tapered roller bearings. These are included in the U.S. proposal in the form of double-row boundary dimensions for the general-purpose and combined general-purpose and pinion lines (C, D, E, F, G, and N).

Includes ISO tolerancing

Since present ISO tolerance values are considered tighter than necessary for many applications, the addition of new classes will be proposed. The proposal accepts the use of ISO tolerancing technique, however, which differs from that used conventionally in the U.S. U.S. tolerances for inch-size tapered roller bearings are on the plus side with minus zero, while ISO tolerances are just the opposite.

Especially for this reason, the proposal calls for an identification system starting off with the prefix "J" to identify the metric bearings and their tolerance direction. Individual line designation and bore size in millimeters are also included in the identification code, as is a system of part numbering for individual components of any bearing.

Timken spokesmen point out that international acceptance of the proposed standard, which would take several years, would not immediately result in the manufacture of all sizes and styles. Some might never be made. But whenever a requirement arose for a specific tapered roller bearing application, the standard would exist to provide reasonable design reflecting the best of today's technology and resulting in bearings that could be manufactured easily and economically.

Timken is confident that European users will accept bearings meeting the proposed standard. Those who have seen the designs like them, Timken states. And if Timken has to tool up for new bearings at some $50,000 for each one, the company wants those bearings to reflect the best that can be made. ■

Machinery orders start to recover

Manufacturers of nonelectrical machinery expect a healthy gain in incoming orders during the second half of 1971, according to the latest quarterly forecast conducted by McGraw-Hill Publications' Department of Economics, and these orders will hold at relatively high levels in the first half of 1972. [This survey was completed just prior to the President's announcement of his new economic program.]

Strong recovery anticipated

New orders are expected to make a strong recovery in the second half of this year, with quarterly increases of 9% and 11%, say the machinery producers surveyed between mid-July and mid-August. And orders for the first half of 1972 are expected to be slightly higher.

For the 12-month period ending next June, orders are expected to average 7% higher than in the comparable 1970-71 period. When this is adjusted for expected price increases of 4-5%, there is a slight real gain in orders. Of course, the price freeze and the possibility of a tax credit make this comparison difficult.

If the improvement forecast for second-half 1971 materializes, it should offset the disappointing level of first-half orders. The New Orders Index would then average 304 (1957-59 orders = 100) for the year, down less than 1% from 1970's average of 306.

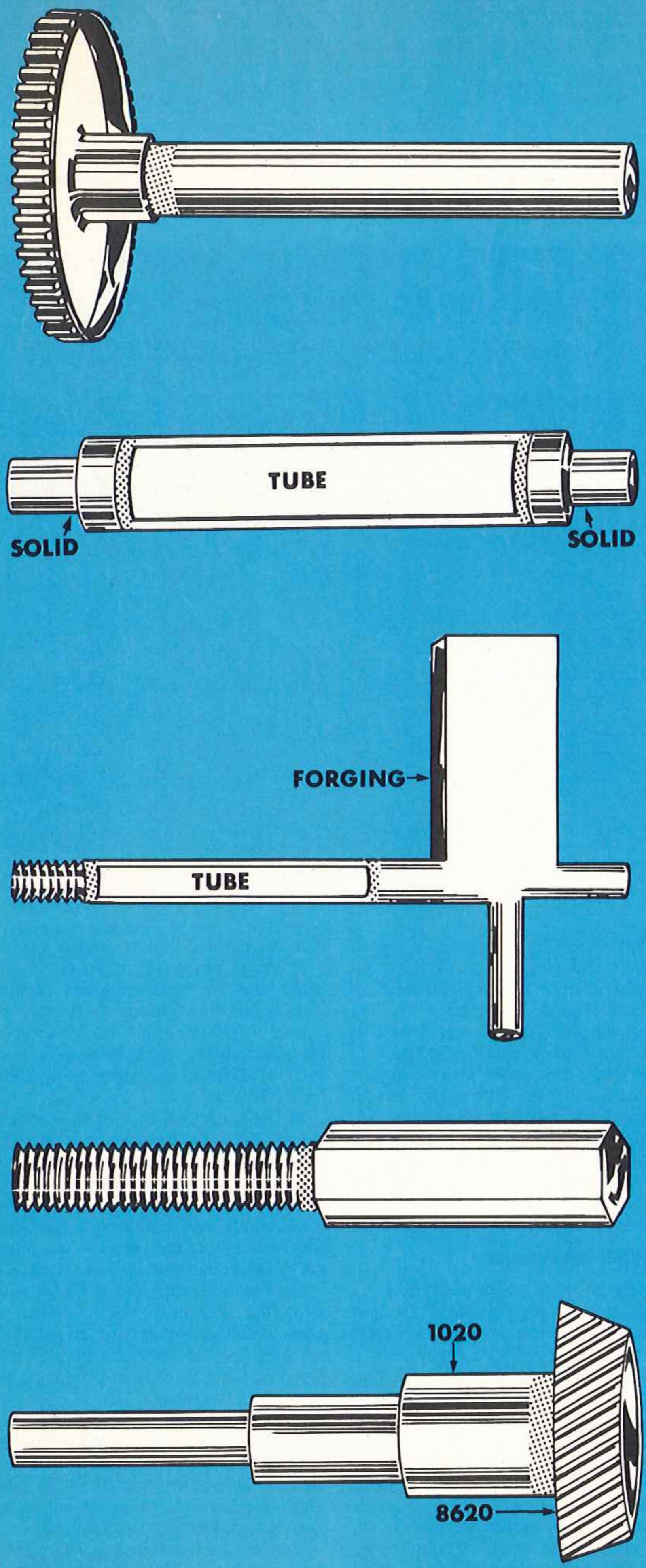
Expect orders to be higher

When surveyed, manufacturers in all but one of the machinery groups covered in the survey expected orders to be higher in the 12 months ending next June than in the comparable 1970-71 period. The largest gains were expected by producers of engines and turbines (+41%) and pumps and compressors (+33%).

Manufacturers of textile machinery expect a 24% rise in orders, while producers of chemical-process equipment expect gains of 18%. (These two groups are part of the "other industrial machinery" category in the table below). Manufacturers of metalworking machinery also anticipate a rise of 18%. More modest increases are expected by manufacturers of construction, mining, and material-handling equipment (+10%) and office machinery (+4%). Manufacturers classified in the "other industrial machinery" group, except for textile-machinery and chemical-process-equipment manufacturers, expect an average decline of 1% in new orders. ■

	TOTAL MACHINERY Seasonally adj	TOTAL MACHINERY Unadjusted	Pumps & compressors	Engines & turbines	Construction & mining mach'y	Metalworking machinery	Office machinery	Other Ind'l machinery
1st Qtr '70	305	315	136	247	190	174	495	369
2nd	295	311	137	200	199	147	482	381
3rd	306	298	130	178	178	159	573	321
4th	318	300	147	220	173	127	517	345
1st Qtr '71	299	309	193	257	194	119	534	337
2nd	278	292	205	295	190	135	487	299
3rd*	303	295	213	339	192	142	472	296
4th*	337	318	217	366	202	152	529	314
1st Qtr '72*	324	335	230	329	212	167	566	342
2nd*	325	342	235	313	204	177	628	339

* Forecast made in mid-August 1971. (1957-59 orders = 100)



Possible combinations in a friction-welded assembly include highly machined gear and a plain shaft, tubing between two machined end caps, a forging at one end, machined and unmachined stock, and different steel alloys, both machined

bar, and the part is finished. This method provided the customer with a 12% saving on part cost.

A flanged shaft made from a forging has to be rough-machined, centered, and finish-machined, all before grinding—and all relatively slow operations.

The flange, on the other hand, can be blanked to tolerance and the shaft produced on a screw machine. The two are friction-welded together, and the part is ready for finish grinding. The cost saving on this part is 14%.

A piston with a forged eye on one end and a threaded section on the other requires grinding over its length. Grinding is slow, and difficult to perform because of the forged eye on the end.

The manufacturer can buy ground stock in long lengths, cut it to length, and friction-weld it to the forging at a 22% saving in cost.

Heavy forgings with wide flanges and bores larger than 1½ times the main diameter are expensive to manufacture. In addition, setup for each run is costly, and schedule commitments often necessitate long delivery times.

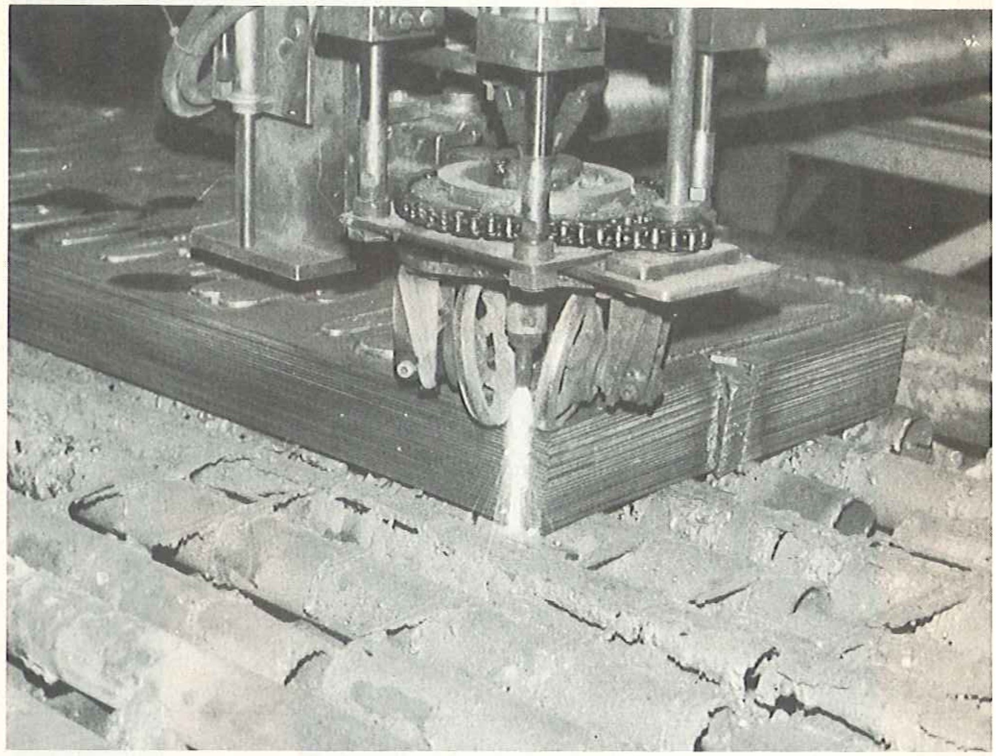
A simple and fast answer to parts of this type is to friction-weld two pieces of bar stock together. Simply buy stock of the required diameter, cut to length, and friction-weld together. The weldment is a duplicate of the forging but is made at a lower cost.

The trick to manufacturing savings with friction welding is to recognize a possible application, especially where this process might never have been considered before. These are some of the potential advantages:

- Use of lower-cost materials.
- Elimination of materials.
- Premachining of a portion of a part.
- Elimination of forgings.

The rule in friction welding is to remember that a part shown on an engineering drawing may not have to be a single piece of stock. If there are good reasons for making two pieces, there may also be savings. ■

Does your flame-cutting stack up?



Angled pressure wheels hold down stock on both sides of the cut, reducing distortion and insuring compression. Note also surplus-pipe table

Flame-cutting stacked sheets can speed production of simple or complex parts, but it takes some skill and knowledge of the pitfalls

Any time you can cut more than one part in a single pass, you stand to boost your production or cut your costs—sometimes you can do both. Flame-cutting of stacked metal sheets or plates offers just such opportunities.

The basic idea behind stack-cutting is to pile the sheets together so they can be cut like a solid block. But because a stack of relatively thin sheets doesn't behave exactly like a solid block, it takes both good tooling and technique to get the most from your flame-cutting machine.

The main problems encountered are that contact between sheets is imperfect and that the sheets tend to move in respect to each other. If there are air gaps because the sheets are not perfectly flat or because rust or dirt gets between them, the cutting-gas stream can divert into the stack. This will disturb the smoothness of the cut, possibly ruining some of the sheets.

To solve the problem of stack compression, the edges of the sheets can be tack-welded; this prevents sheet motion but does not solve gap problems. Pressure can be applied to hold the sheets together, but C-clamps are impractical because they have to be loosened and shifted as the torch moves. Also, this might require a second operator and result in lower production.

Entire stacks have been submerged in water, so that interior gaps would be filled with water rather than air. But heated water quickly becomes a gas and causes more gaps. And water is too messy and troublesome—even if the technique did work.

The best solution to the pressure problem seems to be a system of traveling compression that rides along with the torch. One way to do it is with a set of pivot wheels that ride on each side of the torch and exert a force of 500 lb on the stack. On a machine installed at Specialty Mfg. Co., Allentown, Pa., the area of wheel contact is less than 1 sq in., so pressure is more than 500 psi.

To solve the problem of support without having the cutting-gas stream blow back into the sheets, Specialty uses a table laid with surplus pipe, spaced one pipe diameter apart. When the gas stream impinges on the pipe, it rapidly burns through, but enough of the pipe remains to support the stack of sheets.

Economic advantages

When cutting a single piece from ¼-in. plate, a cutting speed of 20 ipm might be reasonable for good accuracy. To insure equivalent accuracy through a 4-in. stack, 10 ipm might be reasonable. However, a 4-in. stack would include 16 pieces of stock, so the effective cutting speed would be 160 ipm.

This would assure a tolerance of 0.030 in. on the edges of the bottom sheets in the stack, which is quite good, considering that a tolerance of 1/16 in. is normal in ¼-in. stock. With more relaxed tolerances, the cutting machine can be operated at even higher speeds.

In stack-cutting, the edges of the top piece may be melted by the preheat flame, and the bottom sheet may be wasted by adhering slag. But if there are 80 pieces in the stack (such as a 5-in. stack of 1/16-in. material), the waste is only 2.5%.

Material up to ⅜ in. can be stack-cut readily. The limiting factor is not the thickness of the steel but the height of the stack. Thus, stack-cutting shows advantages over both templet-controlled single-torch and multiple-torch cutting—not only to the extent of the number of layers, but also in faster setup.

Stack cutting can also compete with short-run stamping. For example, a piece with 22 in. of contour length, 1/16 in. thick, can be stacked 4 in. high (64 parts) and cut at 10 ipm, producing 64 parts in 2.2 minutes. This is equal to about 1700 parts per hour, if you ignore setup time. Even if stamping can be done faster, stack-cutting involves no die cost. And if the run should be only 10,000 pieces or so, it is likely that stack-cutting would be less costly, overall.

Further, stack-cutting can be applied to a multiple-torch setup, at least in

By Edward S. Young, vice president
Harris Calorific Co., Cleveland